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VOL. LVIII.

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ISSUED FOR 1904.

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VOLUME LVIII.

CONTAINING

ISSUED FOR 1904.

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DECEMBER, 1904.

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.*

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

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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 Carboniferous Lamellibranchiata, by Dr. Wheelton Hind.
- The Inferior Oolite Ammonites, by Mr. S. S. Buckman.
- The Sirenoid 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 following Monographs are in course of preparation:

- The Carboniferous Lepidodendra, by Dr. D. H. Scott.
- The Fossil Cycadeæ, by Mr. A. C. Seward.
- The Reptilia of the Oxford Clay, by Dr. C. W. Andrews.
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ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1904,

WITH

LIST

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY PUBLISHED.

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ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR ENDING 31ST MARCH, 1904.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE, 17TH JUNE, 1904.

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

IN THE CHAIR.

THE COUNCIL, in presenting their Fifty-seventh Annual Report, have much pleasure in referring to the activity which at present prevails in the study of British fossils. The monographs offered to them during the year were considerably more numerous and extensive than they were able to accept for immediate publication. They decided, however, to follow the precedent of 1902 in expending some of the balance which still remained to the Society's credit after their recent investment. They were thus enabled to issue another large volume illustrated by no less than forty-eight plates. This publication for the year 1903 included the completion of Dr. Foord's "Carboniferous Cephalopoda of Ireland," and of the first volume of Mr. Woods' "Cretaceous Lamellibranchia." It also comprised instalments of the monographs of English Chalk Fishes, Carboniferous Lamellibranchiata, and British Graptolites, besides the first part of a monograph of the Lower Palæozoic Trilobites of Girvan.

While, however, the scientific work of the Society affords reason for gratification, the Council regret to have to record a continued decrease in the annual income. The total receipts during the financial year were only £485 9s. 6d., or

£44 5s. 0d. less than last year. The total expenditure during the year was £726 5s. 10d., thus exceeding the income by £240 16s. 4d. The sum of £663 6s. 5d. was expended solely on printing, illustrating, binding, and distribution. Now that the Society's balance has been reduced, it is obviously necessary for the immediate future to revert to the publication of volumes containing only the normal number of plates.

During the past year the Society has again sustained serious losses, and the Council have to deplore the death of their Treasurer, Mr. Robert Etheridge, which occurred in December. Mr. Etheridge had filled the office of Treasurer since 1885, and the loss of his genial presence is a cause of much sadness to his colleagues. Among other deaths may be specially mentioned those of Dr. Gatty, who served for many years on the Council, and of Mr. William Vicary, who was one of the oldest members of the Society. The Council have had the pleasure of enrolling a few new active members; but the Society still lacks the support of several of the younger students of fossils, on whose adherence the future prosperity of its work depends.

Thanks are 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.

The lamented death of Mr. Etheridge in December necessitated the appointment of a new Treasurer, and the Council were glad to be able to secure the *ad interim* assistance of Dr. George J. Hinde, F.R.S., who undertook the duties of the vacant office, and is now recommended to the Society for election to it. There being already two vacancies in the list of the Council according to its original constitution, it is only necessary for three members to retire. It is proposed that these be Professor Boyd Dawkins, Dr. Wheelton Hind, and Dr. D. H. Scott; and that the new members be Bishop Mitchinson, Rev. G. F. Whidborne, and Messrs. W. H. Hudleston, T. Leighton, and A. Strahan; that the President be Dr. Henry Woodward; the new Vice-President, Mr. Hudleston; the Treasurer, Dr. 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.

Cr. *Year ending March 31st, 1904.* *Dr.*

Cr.	£	s.	d.
Balance from last Account—			
On Deposit	300	0	0
Current Account	182	4	4
Subscriptions—1 for 1900	1	1	0
" 1 " 1901	1	1	0
" 12 " 1902	12	12	0
" 153 " 1903	160	13	0
" 173 " 1904	181	13	0
" 1 " 1905	1	1	0
341			
Carriage paid by Foreign Members	0	19	11
Sales by Messrs. Dulau & Co.	99	2	3
Interest on Deposit	5	19	4
Dividends (1903 and 1904), less tax	21	7	0
	£967	13	10

Dr.	£	s.	d.
Letterpress printing, paper, binding, and distribution	325	19	7
Lithographic printing	167	2	9
Drawing and preparing illustrations	170	4	1
Secretary's honorarium	52	10	0
Postage and stationery	6	4	8
Audit of stock	2	2	0
Fire Insurance	0	15	0
Bank charges, stamps, discounts, and gratuity	1	7	9
Subscriptions paid in error returned	3	3	0
Cash in hand	1	1	0
Balance at Bank—			
On Deposit	100	0	0
Current Account	137	4	0
	£967	13	10

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.

Walter Derham,
John Hopkinson,
Thos. Leighton.

May 6th, 1904.

LIST OF MEMBERS.*

CORRECTED TO 1st NOVEMBER, 1904.

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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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[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.

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,, LVIII	,, 1904	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. lxv—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).

[1] These Volumes are issued in two forms of binding: first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope.

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

Volume	I	for	1847	was	issued	to the	Members,	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.
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,,	XXXIV	,,	1880	,,	,,	,,		May, 1880.
,,	XXXV	,,	1881	,,	,,	,,		May, 1881.
,,	XXXVI	,,	1882	,,	,,	,,		June, 1882.
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,,	XXXIX	,,	1885	,,	,,	,,		January, 1886.
,,	XL	,,	1886	,,	,,	,,		March, 1887.
,,	XLI	,,	1887	,,	,,	,,		January, 1888.
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,,	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.
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THE

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A MONOGRAPH

OF

THE FISHES

OF THE

OLD RED SANDSTONE OF BRITAIN.

BY

RAMSAY H. TRAQUAIR, M.D., LL.D., F.R.S.,

KEEPER OF THE NATURAL HISTORY COLLECTIONS IN THE ROYAL SCOTTISH MUSEUM,
EDINBURGH.

PART II, No. 2.—THE ASTEROLEPIDÆ.

PAGES 91—118; PLATES XIX—XXVI.

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part of the posterior ventro-lateral is in like manner considered to be a separate plate, and designated "posterior ventral."

As already mentioned, *Pterichthys* was considered by Pander to be synonymous with *Asterolepis*, and it, consequently, does not come in for special treatment in the "Placodermen." Nevertheless some very instructive figures of Scottish specimens of this genus are given in pl. v of that work, and it is interesting to note that he represents the posterior ventro-lateral plate as undivided, and explains the apparent separation of a "thoracic" plate from the anterior ventro-lateral as being due to fracture.

I have already mentioned (p. 74) that the existence of the supposed "thoracic" plate to which the pectoral limb in *Pterichthys* was articulated was looked upon by Beyrich, Lahusen, and Zittel as constituting a character separating this genus from *Asterolepis*. Pander was, however, right—there is no such separate plate for bearing the pectoral limbs in *Pterichthys*, or in any other Asterolepid genus. But a valid ground of distinction may be found in the mode of articulation of the anterior median dorsal plate, which in *Pterichthys* is overlapped behind by the posterior dorso-lateral, instead of overlapping it, as in *Asterolepis*, and I for my part consider this character to be quite sufficient to warrant the separation of the two genera. It is, however, not so with my friend Professor Jaekel of Berlin, who in a recent paper[1] pronounces himself unwilling "auf Grund so unwesentlicher Differenzen, wie der rändlichen Verbindungsart zweier Rumpfplatten, Gattungen auseinander zu halten." But there is still another difference between the two genera of which I only became aware recently, on examining the text-figure on p. 53 of Jaekel's paper quoted above. There we have a representation of the plates of the ventral surface of "*Asterolepis Milleri*," the elements of the right arm being shown.

Now in Figs. 34 and 35, p. 65 of the present work, I have drawn the plates of the pectoral limb of *Pterichthys* as they undoubtedly are in *Asterolepis*, the forearm consisting of two centrals, dorsal and ventral, two pairs of marginals and a terminal, the latter forming the pointed extremity of the limb. But in Jaekel's figure, just quoted, the "terminal" is dismembered so as to produce not only an additional ventral (presumably also an additional dorsal) central, but likewise two additional marginals, the *inner* of which forms the point. That Jaekel is right here I have convinced myself by a careful re-examination of specimens in the British as well as in the Edinburgh Museum, so that we have again a difference between the two genera which cannot be overlooked, and which I have embodied in the present amended restoration of *Pterichthys*, Figs. 51 and 52.

In these amended figures of mine another change must be noted. In my

[1] "Ueber die Organization und systematische Stellung der Asterolepiden," 'Mai-Protokoll der Zeitschr. der deutschen Geol. Gesellsch.,' Bd. lv, 1903, pp. 41—60.

previous restorations of *Pterichthys* as well as of *Asterolepis*, I gave the outline of the external margin of the ventral aspect of the posterior ventro-lateral plate as becoming slightly excavated or concave posteriorly. This was due to those outlines having been taken from natural internal casts of the plates in question, the fact being thereby overlooked that, the bone being considerably thicker at that place,

Fig. 51.

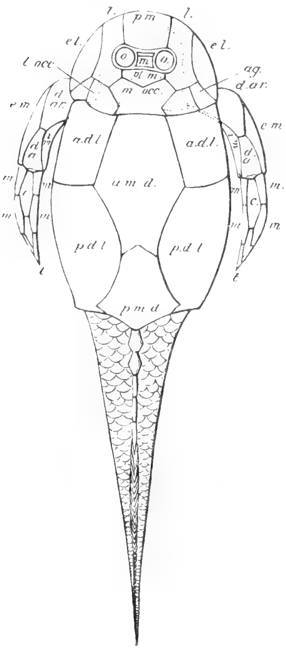


Fig. 52.

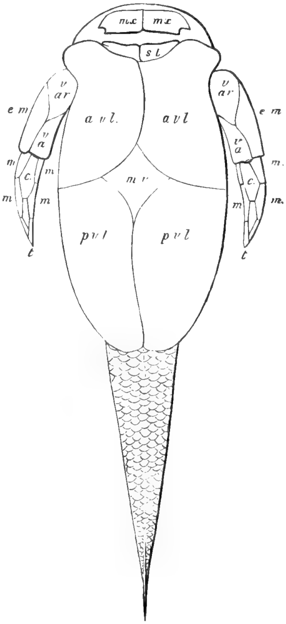


Fig. 51.—Restored figure of *Pterichthys Milleri* from the dorsal aspect altered from that on p. 65, Fig. 34, by the addition of the small narrow plate in front of the median of the head and the rectification of the elements of the forearm. Lettering as before.

Fig. 52.—The same from the ventral aspect, amended from Fig. 35, by the rectification of the elements of the forearm and of the outline of the posterior ventro-lateral plates. Lettering as before.

the exterior configuration does not exactly correspond. So that when the bone is completely preserved, the margin in question is seen to sweep round in an unbroken curve as now represented

Reverting now to Jaekel's recent paper, there is a point in his account of the exoskeleton of *Pterichthys* concerning which I must emphatically record my dissent from his conclusions. According to my description of the body-carapace of *Pterichthys* and other Asterolepidæ, the upper part of the side (Fig. 36, p. 65) consists of an anterior and posterior *dorso-lateral* plate, the "anterior" and "posterior lateral" of Hugh Miller and Sir P. Egerton, with whose previous observation I am here in accordance. Now, these two plates are traversed in antero-posterior succession by a continuous longitudinal groove, cut obliquely into the bone from below upwards, so that the upper margin overhangs as it were, and this groove is also continuous in front with the lateral line groove on the head, and is consequently to be considered as part of the same system.

By Professor Jaekel, on the other hand, this groove is looked upon as the remains of a suture separating each bone into two elements, upper and lower, those in the case of the anterior plate being interpreted as "*operculum*" and "*suboperculum*," while the posterior one is in like manner dismembered into "*supracleithrum*" and "*cleithrum*." The question as to the possibility of homologising the dermal plates of Asterolepidæ or any other Ostracoderms with skeletal elements in Teleostomi must be reserved for another chapter of this work; at present it is sufficient to say that, being unable to accept Prof. Jaekel's homologies for these bones, I see no reason to depart from the system of names, based on that of Pander, which I have up to this time used in this monograph. At present the question is as regards a matter of fact, and here it must also be noted that the grooves in question were looked upon as obsolete sutures by Pander as far back as 1857, and that he was also inclined to consider the set of similar grooves on the cranial bones as belonging to the same category.[1]

Jaekel, however, does not seem to deny that these head grooves belong to the sensory canal system, and if that be the case, the same interpretation must be given to the groove along the side plates, for in perfect specimens of *Bothriolepis Canadensis* the groove on the lateral occipital of the head can be directly traced into that on the anterior dorso-lateral of the carapace.

Nor does he deny that on the internal or visceral aspect of these side-plates no line of division is observable in the normal condition, though *in compressed specimens* there is a tendency for the plate to divide and gape along the line of the groove in question. This is, however, merely the result of pressure along the obvious line of least resistance, and this artificial division never extends to the thickened part of the plate concerned, anterior in the case of the anterior dorso-lateral, posterior in the case of the plate behind.

Again, Professor Jaekel makes a point out of the occasional occurrence of granulation on what I consider to be the oblique walls of the sensory groove, but which, according to him, are the imbricating surfaces (*Ueberschiebungsflächen*) of distinct plates. That this proves anything at all, beyond the fact that we have here before us an open groove, I cannot see. Lastly, he points to a slightly prominent line above, and parallel with the groove in question, and coinciding with the

[1] 'Placodermen,' p. 50.

longitudinal angle along which the lateral plates are bent, as indicating the remains of an obsolete lateral canal. Here I must frankly confess that I see nothing at all suggestive that this line, a mere "Kante" with some longitudinal arrangement of the tubercles, has anything whatever to do with the lateral line system. But to my mind the similarity in character between the cephalic lateral line grooves and that in the lateral body-plates of each side and their demonstrable continuity in the lateral occipital region quite settles the question.

In a paper on *Pterichthys*, published in 1891 by Dr. J. V. Rohon,[1] a peculiar structure is mentioned in connection with a specimen of *Pt. Rhenanus* (Beyr.) from the Middle Devonian of the Eifel. This appears in the form of a horizontal osseous septum placed below the hollow of the posterior median dorsal plate, and thus, as it were, dividing off an upper chamber from the rest of the cavity of the body-carapace. I have not seen the specimen myself, though Dr. Smith Woodward, who has, assures me that Dr. Rohon's figures of the appearance in question are quite correct. I must therefore content myself with stating that such a structure has not yet been detected in any British specimen of the genus.

I must now add a few words as to the validity of the generic name *Pterichthys* for the fishes now under consideration. This name, given by Agassiz to specimens collected by Hugh Miller at Cromarty, was, as already mentioned, first published by Murchison in 1840, and has been in general use among geologists and palæontologists for this genus up to the present time. It is therefore a matter of considerable regret that it was not noticed from the beginning, that Swainson[2] had already given the same generic name to a fish of the family Scorpænidæ, namely, the *Apistus alatus* of Cuvier. For, according to the strict rules of biological nomenclature, a generic name once applied to a particular type cannot be passed on to any other; and so, in 1859, Bleeker[3] proposed to cancel *Pterichthys* of Agassiz, and to substitute for it the modified term *Pterichthyodes*.

Apparently unaware of Bleeker's action, Mr. S. A. Miller, of Cincinnati, proposed in 1893 the name *Millerichthys*, "in honour of Hugh Miller, who was really the first to fully characterise and illustrate the genus in his Old Red Sandstone."[4] However, Dr. O. P. Hay of New York decides that "*Millerichthys*" is

[1] Ueber *Pterichthys*. 'Verhandl. russ-kaiserl. mineralog. Gesellschaft. St. Petersb.' (2), vol. xxviii, pp. 292—316. As pointed out by Jaekel, *op. cit.*, p. 46, Dr. Rohon has confused the anterior with the posterior aspect of his fossil.

[2] 'Natural History of Fishes, Amphibia, and Reptiles, or Monocardian Animals,' London, 1839, vol. ii, p. 65.

[3] 'Enumeratio specierum Piscium hujusque in Archipelago Indico observatarum,' prefaced by a general classification of fishes, entitled 'Systematis piscium naturalis Tentamen.' 'Verhandelingen der Naturkundige Vereeniging in Nederlandsch Indie,' Daal vi, 1859. *Pterichthyodes* is proposed for *Pterichthys*, Agassiz, at p. xxi of the 'Tentamen.'

[4] 'North American Geology and Palæontology,' First Appendix, Cincinnati, 1892, p. 716.

"superfluous as well as devoid of euphony," and therefore adopts the name of *Pterichthyodes*, as proposed by Bleeker.[1]

Now, so far as my knowledge goes, it does not seem that the name *Pterichthys*, as proposed by Swainson for the Scorpænoid fish in question, has ever gained currency among ichthyologists. Bleeker himself, though in the 'Tentamen' he proposed to cancel the name in the Agassizian sense on account of its previous application by Swainson to Cuvier's *Apistus alatus*, nevertheless in his "Enumeratio" uses the Cuvierian name for that species, and gives *Pterichthys alatus* (Swainson) as a synonym.

Therefore, though *law* would seem to demand that a new name should be given to the Old Red Sandstone Wingfish of Agassiz and Hugh Miller, *common-sense* seems to me to point to the retention of the time-honoured and familiar one of *Pterichthys*. Accordingly I content myself with giving the facts. Others may alter the name; I shall not.

Distribution of Pterichthys.—Though doubtful fragments from the Devonian and Silurian of Russia were in bygone times referred by Agassiz and Pander to *Pterichthys*,[2] the species definitely referable to this genus have as yet only been found in the Middle Old Red of Scotland (Orcadian Series) and in the Middle Devonian of Germany (*Pt. Rhenanus*). The large plates from the Upper Old Red Sandstone of Scotland, formerly familiarly slumped together by collectors as "*Pterichthys major*," belong to species of *Bothriolepis*, *Asterolepis* and *Psammosteus*.

British Species of Pterichthys.—In the 'Poissons Fossiles du vieux grès rouge,' Agassiz described eight species from Scotland, namely *Pt. latus*, *testudinarius*, *Milleri*, *productus*, *cornutus*, *cancriformis*, *oblongus*, and *major*, and to those Sir P. Egerton afterwards added *Pt. quadratus* from the Scottish Beds, and *macrocephalus* from the Upper Old Red of Farlow in Shropshire. In 1888[3] I showed that *major* of Agassiz and *macrocephalus* of Egerton were both referable to *Bothriolepis*, and that the Orcadian species of *Pterichthys* had, as in the case of those of other genera from the same beds, been needlessly multiplied by Agassiz. Accordingly I then cancelled the species *latus*, *testudinarius*, and *cancriformis*, to which Smith Woodward presently added *quadratus* of Egerton, besides pointing out that Agassiz' *testudinarius* had the priority over his *cornutus*.[4] But I had already come to the conclusion that neither of these two last-mentioned names

[1] "On some Changes in the Names, Generic and Specific, of certain Fossil Fishes," 'American Naturalist,' vol xxiii, 1899, p. 791.

[2] *Pterichthys arenatus* (Agassiz), "Poiss. Foss. v. grès rouge,' 1845, p. 133, pl. xxx *a*, fig. 3, Devonian, St. Petersburg; *Pt. cellulosus* (Pander) in A. von Keyserling, 'Reise in das Petschoraland,' 1846, p. 292 *a*, Devonian, Petschora Land; *Pt. elegans* (*Harderi*) and *striatus* (Pander), 'Monogr. foss. Fische Sil. Syst.,' 1856, p. 63, pl. v, figs. 9, 10, 11.

[3] 'Geol. Mag.' (3), vol. v, p. 509.

[4] 'Cat. Foss. Fishes Brit. Museum,' pt. ii, 1891, pp. 212 and 216.

could stand, so in 1892[1] I reduced the number of British species of *Pterichthys* to three as follows:

1. *Pterichthys Milleri* (Ag.) with the carapace ovate inferiorly and the terminal division of the arm slender and tapering. Including also *Pt. latus* (Ag.), *cornutus* (Ag.), *quadratus* (Egert.), and *cancriformis* (Ag.), *pars*.

2. *Pt. productus* (Ag.), carapace ovate inferiorly, terminal division of arm expanded externally. Including also *Pt. cancriformis* (Ag.), *pars*.

3. *Pt. oblongus* (Ag.), carapace long and narrow inferiorly, terminal division of arm expanded externally.

In this paper I also expressed myself as "strongly suspecting that there is but one species in the Lower[2] Old Red Sandstone of Scotland and that the distinction of the arms is a sexual one." Now after a period of twelve years has passed I still hold that opinion, and for the following reasons:

1. In all the forms the external sculpture of the plates is the same, and the contour of the ventral aspect of the body-carapace is liable to such an amount of variation as to render it insufficient to serve as a specific character.

2. The shape of the distal segment is, therefore, the only tangible mark of distinction left, and yields us among the *Pterichthys* of the Scottish Orcadian beds only two forms—the one *Pt. Milleri* with tapering distal arm-segment, and the other *Pt. productus*, with that part peculiarly expanded.

3. Taking into account that the taper-armed form is usually broader in its contour than the broad-armed one, it seems not at all unlikely that the difference is a sexual one, and that *Milleri* is the female and *productus* the male of one common species. As that, however, is a position which cannot be proved, I shall here describe the two forms as distinct species.

PTERICHTHYS MILLERI, *Agassiz*. Plates XIX, XX, Plate XXII, figs. 1 and 2.

1841. PTERICHTHYS MILLERI, *H. Miller* (ex *Agassiz*). Old Red Sandstone, pp. 49—53, pls. i and ii.
1844. — — and PT. LATUS, *Agassiz*, Poiss. Foss., vol. ii, pt. i, p. 302 (names only).
1844. — LATUS, *Agassiz*. Poiss. Foss. v. Grès rouge, p. 12, pl. iii, figs. 3, 4.
1844. — TESTUDINARIUS, *Agassiz*. Ibid., p. 14, pl. iv, figs. 1—3.
1844. — MILLERI, *Agassiz*. Ibid.
1844. — CORNUTUS, *Agassiz*. Ibid., p. 17, pl. ii, figs. 1—4.
1844. — CANCRIFORMIS, *Agassiz*. *Pars.*, ibid., p. 17, pl. i, fig. 5, *non* fig. 4.

[1] 'Proc. Roy. Phys. Soc., Edinb.,' vol. xi, 1892, pp. 283—285.
[2] For "Lower" substitute now "Middle" or "Orcadian."

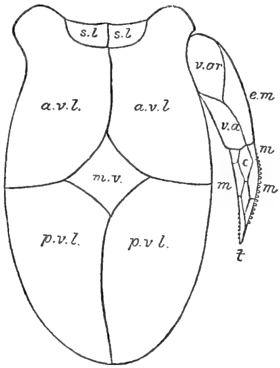
1848.	PTERICHTHYS QUADRATUS, *Sir P. Egerton.*	Quart. Journ. Geol. Soc., p. 313, pl. x, figs. 1 and 2.
1848.	— TESTUDINARIUS, *Sir P. Egerton.*	Ibid., p. 312.
1849.	— CORNUTUS, *Sir P. Egerton.*	Ibid., p. 313.
1855.	— LATUS, *M'Coy.*	Brit. Palæoz. Foss., p. 600.
1855.	— TESTUDINARIUS, *M'Coy.*	Ibid., p. 600.
1855.	— CORNUTUS, *M'Coy.*	Ibid., p. 600.
1888.	— MILLERI, *Traquair.*	Geol. Mag. (3), vol. v, p. 509.
1888.	— CORNUTUS, *Traquair.*	Ibid., p. 509, and Ann. Mag. Nat. Hist. (6), vol. ii, pl. xvii, figs. 1—3.
1891.	— MILLERI, *A. S. Woodward.*	Cat. Foss. Fishes Brit. Mus., pt. ii, p. 212, pl. v, figs. 1—7.
1891.	— TESTUDINARIUS, *A. S. Woodward.*	Ibid., p. 216, pl. v, fig. 8; pl. vi, fig. 1.
1894.	— MILLERI, *Traquair.*	Asterolepidæ Pal. Soc., p. 65, figs. 34—36.
1903.	ASTEROLEPIS MILLERI, *Jaekel.*	Zeitschr. deutsch. geol. Gesellsch., vol. lv, Protokolle, pp. 41—60.

Specific Characters.—Distal segment of pectoral appendage narrow and tapering; adult form having the flat ventral surface of the carapace rather broad, the anterior ventro-lateral plate being equal in length to the anterior or only slightly longer, and the distance between the posterior margin of the ventral carapace and the centre of the median ventral plate being approximately equal to the breadth of this part of the carapace at the point indicated. Narrower forms (*Pt. cornutus*), however, occur, in which the shape of the ventral surface of the body-carapace shows some approximation to that in the next species (*Pt. productus*), the posterior ventro-lateral plates being proportionately longer and the breadth at the median ventral plate somewhat smaller. The restored figures given in the text at pp. 65 and 92 were taken from specimens of so-called "*cornutus.*"

Description.—Pl. XIX, fig. 1, represents one of the best specimens in the British Museum, which has already been figured by Dr. Smith Woodward in his 'Catalogue.' It is of the type of *Pt. latus* (Ag.), which is evidently the adult form of the small specimens figured by Agassiz as *Pterichthys Milleri.* Like the great majority of specimens of this genus, it is compressed vertically, but, unlike most, it shows the greater part of the dorsal surface of the body-carapace, that aspect of the fish being ordinarily the one adherent to the matrix. The head shows very little, with the exception of the pair of maxillary plates (*mx.*), which are well seen *in situ*, the front portion of the cranial shield having become shoved a little backwards. We note here the rounded notch situated at the posterior external angle, instead of simply on the outer side as in *Bothriolepis* (see text-figure, p. 112). The pectoral limbs are crushed, the left one in such a manner as to obscure the slender and tapering form of the distal segment. The median dorsal plate (*a. m. d.*) is pretty well shown as regards its external outline, but the posterior part of the upper aspect of the carapace has splintered off, uncovering the upper surfaces of the posterior ventro-lateral plates (*p. v. l.*) below.

On the same plate, Figs. 2 and 3, we have the dorsal and ventral surfaces of the unique specimen in the Hugh Miller Collection in the Royal Scottish Museum,[1] Edinburgh, already described and figured by Agassiz as the type of his *Pt. testudinarius*, and referred to at page 90 of this work as showing both surfaces. The dorsal surface erroneously interpreted by Agassiz as the ventral is seen in Fig. 2, and shows well the general form of the head, the position of the orbit, and the form and relations of the *median occipital* (*m. occ.*) and *post-median* (*pt. m.*)

FIG. 53.



Diagrammatic outline of the contour of the ventral surface of the body-carapace and left pectoral appendage in the ordinary form of *Pterichthys Milleri.*

plates. On the body-carapace the bone is nearly altogether lost, but a pretty good impression of the under surfaces of the plates is retained, in which all their outlines may be discerned, the *posterior median dorsal* (*p. m. d.*) being, however, somewhat deficient behind. On the under surface of the specimen (Fig. 3) the bone, though mostly preserved, is divided by such a number of reticulating cracks as to assume also a tessellated appearance. Yet the outlines of all the elements of this surface, except the maxillary, are distinctly traceable, though the right *posterior ventro-lateral* (*p. v. l.*) is injured at its hinder extremity. But the *semi-lunars* (*s. l.*) behind the mouth are well defined, as well as the *median ventral* (*m. v.*), which appears small because its margins are largely overlapped by the lateral plates and only the sculptured area is exposed.

In Pl. XX, fig. 1, the configuration of the ventral aspect is well shown, though the body-plates are seen from their smooth internal or upper surfaces.

[1] Formerly the "Museum of Science and Art."

Quite in front the cranial buckler is seen, with some remains of the ocular plates in the large orbit, while at the left side the much displaced *extra-lateral* (*e. l.*) is seen in impression. A very good view is here obtained of the form of the pectoral limbs, the tapering contour of the distal segment characteristic of the present species being well shown, while we may also note the fine denticulation of the free edges of the two proximal external marginal elements. The somewhat broadly ovate outline of the ventral surface characteristic of the "*latus*" type is also very apparent, the anterior and posterior ventro-lateral plates being nearly of the same length, and the distance from the posterior margin of the carapace to the middle of the median ventral plate being equal to the breadth of the whole ventral surface at the middle point. The *median ventral* (*m.v.*) looks large in comparison with the same plate in the previously described specimen (Pl. XIX, Fig. 3), but is due to its entire internal surface, unoverlapped by any other element, being visible.

Fig. 2 of the same plate represents a specimen in the Williamson collection in the Manchester Museum, for the privilege of figuring which I am indebted to Dr. W. E. Hoyle. It has been already alluded to at p. 69 of this work as having furnished evidence for the form of the caudal fin in my restored figure on p. 65, Fig. 36. Here we have a dorsal view of the body-carapace, which is, however, obliquely cut off by the stone in front and on the right side, a portion of the left pectoral appendage being, however, seen below and in front. The great interest of this specimen centres, of course, in the heterocercal caudal extremity. At this part the prolongation of the body axis turns slightly upwards, the dorsal margin being set with narrow oblique fulcral scales which are distinctly seen to be distichous, or in two rows, while the fin-membrane on the ventral aspect has a low triangular contour, getting gradually narrower posteriorly, and, like that of *Cephalaspis*, devoid of any division into upper and lower lobes.

Fig. 1, Pl. XXII, represents a specimen from Achanarras, Caithness, lying right on its side—a somewhat unusual position in which to find specimens of *Pterichthys*. The tapering form of the pectoral appendage characteristic of *Pt. Milleri* comes out very clearly, and the proportions of body to tail are well exhibited. We note here the arrangement of the scales on the side in longitudinal rows, the dorsal fin with its enlarged scales on the anterior margin, and the narrow oblique fulcra on the upper border of the caudal body prolongation; unfortunately, however, as is usually the case, the delicate caudal fin-membrane has almost entirely disappeared, so that its contour is lost.

Fig. 2 is the distal portion of the arm in a specimen from Tynet Burn, in which the tapering contour is seen in a very typical manner.

The head-shield of *Pterichthys Milleri* seen from the internal surface, and *minus* the loosely articulated extra-lateral plates, is given in Pl. XX, Fig. 3, and displays, in the middle of the orbit, the *median* or pineal plate and also some remains of the *oculars*. Fig. 4 on the same plate is an *anterior median dorsal* plate from Cromarty; the angles are lost, but the external sculpture of closely set tubercles is clearly given. Fig. 5 is, in like manner, a specimen of the right posterior ventro-lateral plate, also from Cromarty, and nearly entire. Part of the osseous matter is gone, but part also remains, and this shows the same tubercular ornament as in Fig. 4. Lastly, in Pl. XIX, Fig. 4, we have a detached right *posterior dorso-lateral* plate from Achanarras, seen from the internal aspect. Here it may be noted that, as the plate has been crushed quite flat, a longitudinal fracture has taken place for three fourths of its extent along the course of the lateral line groove (see p. 93).

Remarks.—As already indicated, all the reputed species of *Pterichthys* described by Agassiz and Sir P. Egerton from the Scottish Orcadian rocks, with the exception of *Pt. productus* (and that may possibly be only a sexual form of the same creature), must find their place under *Pt. Milleri*, which, although not occurring first in Agassiz' great work on the fishes of the Old Red Sandstone, has priority secured to it by the description and figures previously published by Hugh Miller in his 'Old Red Sandstone.'

The synonymy may be dealt with as follows:

Pt. latus (Agassiz).—This is evidently the adult form of the comparatively small specimens figured as *Milleri* in the 'Poiss Foss. v. grès rouge,' Pl. I, Figs. 1, 2, and 3. Types of *latus* in British Museum and in the Gordon Cumming Collection at Forres.

Pt. testudinarius (Agassiz).—Founded on the apparently small size of the median ventral plate, of which in the unique type specimen from Cromarty (Agassiz, *op. cit.*, Pl. IV, Figs. 1, 2, and 3, and present work, Pl. XIX, Figs. 2 and 3) only the sculptured surface is exhibited. The proportions of the ventro-lateral plates agree with those in the majority of specimens of *Pt. Milleri.*

Pt. cancriformis (Agassiz).—Agassiz states that the form of the body and head recalls *Pt. productus*, but that the only difference consists "dans la structure des nageoires pectorales, qui au lieu d'être coupées obliquement se termine en une pointe longue fine et très-acerée." An examination of the type specimens, from Orkney, in the British Museum shows clearly enough that the original of Fig. 5, Pl. I (Agassiz, *op. cit.*) belongs to *Pt. Milleri*, while that of fig. 4 is just as clearly referable to *Pt. productus.*

Pt. cornutus (Agassiz).—Supposed to be distinguished by the presence of a prominent spine on each of the caudal scales, but this is not verifiable on the type specimens, which are all in the British Museum. These type specimens, three in number, are represented on Pl. II of Agassiz' work on the fishes of the "Old Red." The specimen represented with its counterpart in Fig. 1 of that plate wants the pectoral appendages, and shows otherwise nothing to distinguish it from ordinary specimens of *Pt. Milleri*. The original of Fig. 5 shows the unmistakable pectoral limb of *Pt. Milleri*, though the ventral aspect of the body-carapace is of a slightly narrower contour than that in the ordinary form of that species. But the specimen from which Fig. 4 was taken shows at the first glance the shape of carapace characteristic of the *oblongus* form of *Pt. productus*, and, the previously hidden terminal portion of the pectoral limb having been, with Dr. Smith Woodward's authority, uncovered, the identification with "*productus*" was proved by the expanded form of the part in question. The specimens figured by Dr. Smith Woodward in his 'Catalogue' (Pt. ii, Pl. V, Fig. 8, and Pl. VI, Fig. 1) as *Pt. testudinarius* come, however, by the tapering pectoral limb, and the comparative narrowness of the ventral surface of the carapace, under the type of "*cornutus*" as exemplified in Agassiz' Pl. II, Fig. 5.

Pt. quadratus (Egerton).—Like Dr. Smith Woodward, I fail to see any tangible distinction between this supposed species and the broader form of *Pt. Milleri*.[1]

Geological Position and Localities.—In the Middle Old Red or Orcadian Series of Orkney, Caithness, and the Moray Firth area:

Orkney: In the Stromness Beds, but not common. *Caithness:* Common in the beds worked at Achanarras Quarry, near Spital and about ten miles south of Thurso. But it seems to be absent from the Thurso Beds, as well as from those at John o'Groats, which latter yields the small Asterolepid named by me *Microbrachius Dicki*. *Moray Firth:* In limestone nodules at nearly all the fish-bearing localities of the Orcadian Old Red in this region, but especially at Cromarty, Lethen Bar, and Gamrie. Edderton and Tynet Burn may also be mentioned, though it occurs less frequently in these localities than in the others previously named.

PTERICHTHYS PRODUCTUS, *Agassiz*. Plates XXI and XXII, figs. 3 and 4.

1844.	PTERICHTHYS PRODUCTUS, CANCRIFORMIS (*pars.*) and OBLONGUS, *Agassiz*.	Poiss. Foss., vol. ii, pt. i, p. 302 (names only).
1844.	— — *Agassiz*.	Poiss. Foss. v. grès rouge, p. 16, pl. v, figs. 1—4.
1844.	— CANCRIFORMIS, *Agassiz*.	Ibid., pl. i, fig. 4, *non* fig. 5.
1844.	— OBLONGUS, *Agassiz*.	Ibid., pl. iii, figs. 1 and 2.
1844.	— CORNUTUS, *Agassiz*.	Ibid., pl. ii, fig. 4, *non* figs. 1, 2, and 5.
1848.	— PRODUCTUS, *Sir P. Egerton*.	Quart. Journ. Geol. Soc., vol. iv, p. 312.
1848.	— OBLONGUS, *Sir P. Egerton*.	Ibid., p. 313.

[1] Dr. Smith Woodward in his "Catalogue," pt. ii, p. 212, gives the "Geological Society of London" as the location of the type of Egerton's "*quadratus*." I could not find the figured specimen in that collection, but there is one there, labelled in Sir Philip's handwriting "*Pterichthys quadratus*," which is certainly referable to "*Milleri*."

1855. Pterichthys ? cancriformis, *M'Coy.* Brit. Palæoz. Foss., p. 599.
1855. — productus, *M'Coy.* Ibid., p. 600.
1855. — oblongus, *M'Coy.* Ibid., p. 600.
1880. — *Lahusen.* Verh. russ.-kais. mineral. Gesellsch. [2] vol. xv, pl. ii, fig. A.
1888. — productus, *Traquair.* Geol. Mag. [3], vol. v, p. 509.
1888. — oblongus, *Traquair.* Ibid., p. 509.
1891. — productus, *A. S. Woodward.* Cat. Foss. Fishes Brit. Mus., pt. ii, p. 217.
1891. — oblongus, *A. S. Woodward.* Ibid., p. 219.

Specific Characters.—Distal segment of pectoral limb expanded on the inner

Fig. 54.

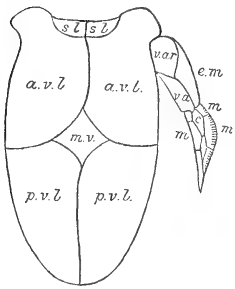


Fig. 55.

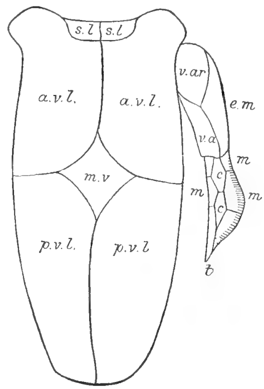


Fig. 54.—Diagram of the proportions of the under surface of the body-carapace and left pectoral appendage in a broad variety of *Pterichthys productus.*

Fig. 55.—Diagram of the proportions of the under surface of the body-carapace and left pectoral appendage in the narrow or "*oblongus*" form of *Pterichthys productus.*

aspect. Contour of ventral aspect of carapace variable, sometimes comparatively broad, more usually tending to assume a long and narrow appearance by a greater lengthening of the posterior ventro-lateral plates in proportion to the anterior. Carapace tending to be proportionately high as well as narrow. Surface ornament as in *Pt. Milleri.*

Description.—The peculiarity of the distal segment of the arm is seen in the specimens figured in Pl. XXI, Figs. 1, 2, and 4, and in Pl. XXII, Figs. 3 and 4. The last mentioned figure is rendered specially instructive by being placed immediately under a drawing of the corresponding part in a typical specimen of *Pt. Milleri,* whereby it is seen that though all the elements are in the present species proportionately broader, this condition is most marked in the case of the outer marginals.

The proportions of the ventral surface of the carapace are variable. In the specimen represented in Pl. XXII, Fig. 3, which, according to the contour of the pectoral limb, seems to belong to this species, the shape is like that of the "*latus*" form of *Pt. Milleri*, the length of the anterior and posterior ventro-lateral plates being equal, and the breadth at the median ventral plate being even greater than the distance between the centre of that element and the posterior margin of the carapace. But in the four type specimens figured by Agassiz in Pl. V of his 'Fishes of the Old Red Sandstone,' we see a tendency for the carapace to become proportionally longer and narrower, and, in fact, it is not possible to differentiate the original of Fig. 2 from the "*oblongus*" form as represented in his figs. 1 and 2 on Pl. III of the same monograph.[1]

Pl. XXI, Fig. 1, of the present work represents a very pretty specimen of this "*oblongus*" form, though the sides appear perhaps a little more curved than is usual. Here the posterior ventro-lateral plates are longer by nearly one sixth than the anterior ones, and the breadth of the ventral surface of the carapace at the median ventral plate is equal to the distance between the *posterior margin of that element* and the hinder extremities of the posterior ventro-lateral plates.

Another specimen of this form is seen in Fig. 2 of the same plate, and shows the ventral plates from their internal surfaces, except the left anterior ventro-lateral, which is wanting, as is also the greater part of the median ventral, though the lozenge-shaped space which it occupied is very apparent. This specimen is a typical example of the so-called "*oblongus*," as is seen by the narrow shape of the ventral surface of the carapace, the proportional length of the posterior ventro-laterals, and the expanded contour of the distal segment of the pectoral limb. The tail, *minus* the caudal fin, is well preserved, the scales being arranged in longitudinal rows, as in *Pt. Milleri*, and showing also the same form. An unusually good view of the dorsal fin (*d.*) is also here afforded, whence it is evident that not only are certain elongated scales placed along its anterior margin, but also that a few of a rounded form clothe the lower part of its sides; the minute scales covering the rest of the expanse of the fin exhibit, to a certain extent, a linear arrangement.

The elevated form of the carapace is seen nowhere better than in the specimen from Cromarty represented in Fig. 3 of Pl. XXI. It is an example of the "*oblongus*" form, showing a natural cast of the interior of the lateral plates in an absolutely uncompressed condition, and illustrating well the statement of Sir P. Egerton that the "contour of *Pterichthys* must have considerable resemblance to a high-backed tortoise." It would have looked still more like a high-backed tortoise had the median dorsal plates been present. The space occupied by the *posterior dorso-lateral* plate (*p. d. l.*) is worthy of notice on account of the imprints of three

[1] Of the specimens figured on the above quoted plate, the original of Fig. 1 and the counterpart of Fig. 2 are in the British Museum; the others are in the Gordon Cumming Collection at Forres.

internal rounded ridges which it bears. One of these, nearly vertical in direction and gently concave behind, is coincident with the free posterior margin of the plate; the second, nearly straight, arises from near the middle of the first and passes obliquely upwards and forwards to the centre of the antero-superior margin; while the third, starting from the same point behind, runs longitudinally backwards with a slight upward concavity to a point somewhat below the middle of the posterior margin of the anterior dorso-lateral plate. A casual inspection of the figure might suggest that this line indicates the supposed suture between two original divisions of the posterior ventro-lateral plate, as maintained by Jaekel (see p. 93). It is, however, the impression of an internal longitudinal elevation, which happens to lie directly under the course of the lateral line groove on the outer surface.[1]

Fig. 4 shows a smaller specimen from the same locality, also lying on its side, but crushed quite flat. In addition to the lateral plates, it shows the anterior and posterior median dorsals, and the pectoral limb with its expanded termination.

Remarks.—As already indicated, it seems to me that *Pterichthys productus* and *oblongus* pass into each other, so the latter must be absorbed in the former, and the name *productus* must accordingly stand for the species. Again, between *Pterichthys productus*, as now defined, and *Pt. Milleri* there is also no thoroughgoing distinction except in the form of the termination of the pectoral appendage, for the differences in the proportions of the carapace are only relative. This, together with the fact that the two forms always occur together in the same beds and in the same localities, seems also to indicate, though it cannot be proved, that we have only one species of *Pterichthys* in the British Orcadian rocks, and that the differences between *Pt. Milleri* and *Pt. productus* are of a sexual character.

Geological Position and Localities.—The same as in the case of *Pt. Milleri.*

MICROBRACHIUS, *Traquair*, 1888.

1867. PTERICHTHYS, *C. W. Peach (pars.).*
1888. MICROBRACHIUS, *Traquair.*
1891. MICROBRACHIUM, *A. S. Woodward.*

Generic Characters.—Pectoral appendage short. Carapace broad dorsally and narrow on the ventral surface. On the dorsal or upper surface the anterior margin of the carapace forms a deep re-entering angle or emargination in which the head is received. Antero-lateral margin of anterior dorsal plate first overlapping and then overlapped by the anterior dorso-lateral; its postero-lateral margin overlapped by the posterior dorso-lateral, as in *Pterichthys* and *Bothriolepis.*

[1] The same internal elevations are, of course, also present in *Pt. Milleri.* Impressions of similar ridges have also given rise in former times to the erroneous dismemberment from the anterior ventro-lateral plate of a supposed "thoracic" one for bearing the arms, and of a "posterior ventral" from the posterior ventro-lateral. See Sir P. Egerton on *Pterichthys,* 'Quart. Journ. Geol. Soc.,' vol. iv, 1848, Fig. 2, p. 305, and also my remarks on p. 74, *ante.*

History.—The first mention of the little Asterolepid which forms the type of this genus is in a paper by the late Mr. C. W. Peach, "On Fossil Fishes of the Old Red Sandstone of Caithness and Sutherland," in the 'Proceedings' of the meeting of the British Association held at Dundee in 1867. After remarking that up to 1863 not a vestige of *Pterichthys* had been found in Caithness or Sutherland, he stated that he found this exceedingly small species at John O'Groats in the former county. He gave, however, no description of it beyond saying that it had small spined arms, but remarks that "if a new species, the author intends to call it after his late valued friend, Robert Dick."

Peach's specimens having come into the possession of the Edinburgh Museum, I gave in 1888 a brief description of the species which was unquestionably new to science. And on account of the want of a tail capable of preservation, coupled with the peculiar articulation of the anterior median dorsal plate, I proposed to make it the type of a new genus—namely *Microbrachius*.

MICROBRACHIUS DICKI, *Traquair*. Plate XXII, figs. 5—8.

1867. PTERICHTHYS DICKI, *C. W. Peach*. Rep. Brit. Assoc. for 1867 (1868); Trans. Sect., p. 72 (name only).
1888. MICROBRACHIUS DICKI, *Traquair*. Geol. Mag. [3], vol. v, p. 510, and Ann. Mag. Nat. Hist. [6], vol. ii, p. 502, pl. xviii, figs. 7 and 8.
1891. MICROBRACHIUM DICKI, *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, p. 223.

Description.—As there is only one species of the genus known, no specific diagnosis is necessary.

It is quite a small creature, varying in length from $\frac{3}{4}$ to $1\frac{1}{4}$ inch. The shape of the carapace recalls that of *Bothriolepis* in being evidently depressed—broad dorsally, but narrow on the flat ventral aspect. Figs. 5 and 6 on Pl. XXII represent two specimens in which the dorsal plates are seen from the internal aspect, and, though crushed quite flat, give a good idea of the general form of the back of the creature, the arrangement of the plates of which as visible from within is also seen in the appended text-figure 56.

The head is large, being almost as long as the dorsal portion of the carapace; its posterior contour is angulated so as to fit into the corresponding wide angular excavation of the anterior margin of the last named part. None of the specimens show any cranial osteological details, save some faint indications of the position of the orbit, and of the outline of the premedian plate.

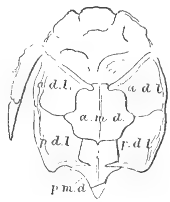
As already mentioned, the dorsal aspect of the carapace is broad like that of

Bothriolepis, from which it is, however, distinguished in shape by the wide re-entering angle in front for the reception of the back part of the head.

The *anterior median dorsal plate* (*a. m. d.*) is peculiarly short and broad, and on the external aspect (Fig. 7, Pl. XXII) shows a blunt longitudinal elevation in the anterior half of its length. As usual, it is overlapped behind by the posterior median dorsal; laterally it first overlaps and is then overlapped by the anterior dorso-lateral, behind which it is overlapped by the posterior dorso-lateral as in *Pterichthys* and *Bothriolepis*. These relationships of the anterior median dorsal to the surrounding plates may be easily understood by comparing Fig. 7 on Pl. XXII with the outline of the dorsal plates seen from within given in the appended text-figure.

The *anterior dorso-laterals* (*a. d. l.*) are remarkable for the length of their outer margins and the oblique direction of their anterior borders, whereby the angularly excavated contour of the front of the carapace is brought about. The *posterior*

Fig. 56.



Dorsal plates of the carapace of *Microbrachius Dicki*, seen from the internal aspect; the outlines of the head and of one of the arms are likewise shown.

dorso-laterals are broad and, as already mentioned, overlap the posterior part of the outer margin of the anterior median dorsal. The *posterior median dorsal* (*p. m. d.*) largely overlaps the hinder margin of the plate in front, and as shown in Fig. 56 projects backwards in a prominent sharply pointed process.

The ventral surface of the carapace (Pl. XXII, Fig. 8, magnified) is peculiarly narrow in proportion to the breadth of the dorsal aspect, and the free extremities of the posterior ventro-laterals (*p. v. l.*) are almost always seen projecting behind the posterior median dorsal in specimens viewed from the back. The median ventral plate (*m. v.*), or at least its exposed area, is very small.

The exposed surfaces of the body plates are ornamented by a very fine granulated or tuberculated sculpture, which in the anterior median dorsal tends to coalesce in concentric lines (Fig. 7).

The pectoral limb is short as in *Pterichthys*. The form and number of its individual elements cannot be made out, but a prominent serration of its outer margin is distinctly enough seen in most of the specimens.

No tail has ever been observed in any of the very numerous specimens which have occurred, so that this part, as in *Bothriolepis*, could not have possessed any elements capable, or at least easily capable, of preservation. We shall presently see that evidence, not only of the existence of a tail in *Bothriolepis*, but of its actual configuration, has at last been obtained.

Remarks.—In the form of the carapace, and in the *apparent* absence of a tail, this little creature reminds us of *Bothriolepis*, though the contour of the anterior margin of the dorsal part of the carapace is somewhat different, not only from that in that genus, but in any other Asterolepid form known to me. The articulation of the anterior median dorsal plate is also quite peculiar, so that, in spite of Jaekel's strictures on the use of such a character as generic, I must still maintain that the genus is entitled to stand.

Geological Position and Localities.—Peach's specimens were derived from certain flaggy beds belonging to the uppermost division of the Orcadian series at John O'Groat's, Caithness, where he found them in 1863 along with two other fishes, then also new to science, namely, *Tristichopterus alatus* (Egerton) and *Dipterus macropterus* (Traquair). Since that time up to the present none of these fishes have been obtained from John O'Groats, but eight years ago[1] Dr. J. S. Flett came upon all three in the grey flags of Deerness, in Orkney, in which they are common, and in fact constitute the only identifiable fossils. The Deerness specimens are not so nicely preserved as those from the original locality, but the identification of the John O'Groats horizon in Orkney by means of those fishes is a matter of great geological interest.

BOTHRIOLEPIS, *Eichwald*, 1840.

GLYPTOSTEUS, *Agassiz*.	BOTHRIOLEPIS, *Agassiz* (pars).
PAMPHRACTUS, *Agassiz*.	PTERICHTHYS, *Agassiz, et cet. auct.* (pars).
PLACOTHORAX, *Agassiz*.	ASTEROLEPIS, *Pander* (pars).
HOMOTHORAX, *Agassiz*.	STENACANTHUS, *Leidy*.
ODONTACANTHUS, *Agassiz*.	HOLONEMA, *Cope* (pars).

Generic Characters.—Premedian plate of head not notched in front; post-median small, not excluding the median occipital from the posterior boundary of the orbit; extra-lateral, if present, small and narrow. Posterior commissure of the lateral line system on the head, formed by a V-shaped groove, the apex of which is

[1] Flett, J. S., "On the Discovery in Orkney of the John O'Groats Horizon of the Old Red Sandstone," 'Proc. Roy. Phys. Soc. Edinb.,' vol. xiii, 1896, p. 255. See also the same author's paper on "The Old Red Sandstone of the Orkneys" in 'Trans. Roy. Soc. Edinb.,' vol. xxxix, pt. 2, pp. 383—424.

situated on the median occipital, while each lateral limb runs obliquely forwards and outwards close to the main groove on the lateral plates. Anterior median dorsal plate overlapping the anterior dorso-lateral, but overlapped by the posterior dorso-lateral plate. Pectoral appendages at least as long as the carapace; in the proximal segment on the outer aspect the articular plates are in contact for some distance above the external marginal, while on the dorsal aspect the anconeal is reduced to a very small rounded plate, thereby permitting the external and internal marginals to come into contact with each other between it and the articular; distal portion of the appendage narrow and tapering. Tail not usually preserved; apparently not provided with ossified scales.

History.—This genus was founded by Eichwald, in 1840,[1] upon certain plates or fragments of plates occurring in the Upper Devonian of Russia, which differed from those of *Asterolepis* in having the surface pitted instead of tuberculated. From his very brief original description it is evident that he had before him fragments of a creature allied to *Pterichthys;* but unfortunately he ascribed teeth to it, and imagined that its scutes were arranged in longitudinal rows like those of the sturgeons.

In the "Tableau Générale" prefixed to the first volume of the 'Poissons Fossiles' Agassiz applied the name *Glyptosteus reticulatus*, but without description, to similar plates both from Russia and from Scotland. But in the 'Poissons Fossiles du vieux grès rouge' he adopted Eichwald's name *Bothriolepis*, though giving the genus a place in his family of "Célacanthes," and including in it an undoubted Rhizodont, with fluted laniary teeth, which he described and figured as *B. favosus.*[2] It is also to be noted that in the same work he described as *Pterichthys major*, *Pamphractus hydrophilus* and *Andersoni*, *Homothorax Flemingii*, *Placothorax paradoxus*, *Odontacanthus crenatus* and *heterodon*, remains which have all turned out to be referable to *Bothriolepis* of Eichwald. By Pander, indeed, not only these genera, but also *Bothriolepis* itself, were considered to be simply synonymous with *Asterolepis.*[3]

The near affinity, at all events, of *Bothriolepis* to *Asterolepis* was acknowledged in 1860 by Eichwald,[4] who, though still keeping the two genera separate, placed them close together in the family of "Placodermes." His statement is very clear that "Le corps du *Bothriolepis* est composé de plaques, et peut-être aussi d'organes à ramer semblables a ceux de l'*Asterolepis*," and the figure given represents an

[1] "Die Thier- und Pflanzen-reste des alten rothen Sandsteins und Bergkalks im Novgorodschen Gouvernement," 'Bull. Sci. St.-Pétersbourg,' April, 1840.

[2] Referred by Smith Woodward to Hall's genus *Sauripterus*, 'Cat. Foss. Fishes Brit. Mus.,' pt. ii, 1891, p. 365.

[3] 'Placodermen,' p. 44.

[4] 'Lethæa Rossica,' vol. i, p. 1513, pl. lvi, fig. 3.

anterior median dorsal plate of undoubted Asterolepid type. That he was right in keeping *Bothriolepis* as a distinct genus was clearly shown by Lahusen in 1879. Describing a head with a portion of the body attached, as well as some other parts of the body and arms of a species to which he gave the name of *B. Panderi*, Lahusen[1] pointed out that the course of the cephalic furrows (lateral line system) was not the same as in *Asterolepis*; second, that the post-median plate was different in shape; third, that there was no "os terminale"; fourth, that the articular plates were longer. But when he speaks of the arms being simpler in structure, and we compare his figures, it is quite clear that he had before him only the proximal segment of the limb; and it must also be noted that in some cases he regarded the grooves of the cephalic lateral line system as sutures, or at least as former sutures, and so very considerably increased the number of bones which he allotted to the cranial shield.

A contribution to the structure of *Bothriolepis*, published shortly afterwards by Trautschold,[2] consists largely of corrections of Lahusen's paper in matters of detail. He also formulates the differences between the heads of *Bothriolepis* and *Asterolepis*, laying stress on much the same points as Lahusen, but adding that the angular and opercular elements (Pander) are wanting in the former genus, though, strangely enough, the angular is represented in the diagram which he gives of the head of *Bothriolepis*. Noteworthy it is that he mentions having found in one specimen a lid or cover to the "orbit" and accurately fitting it. As regards the arms, of which he had no complete specimens, he pointed out certain differences in the arrangement of their constituent plates, and considered it doubtful whether the limb was divided into proximal and distal portions as in *Asterolepis*.

G. Gürich,[3] in 1891, gave a few notes on specimens of *Bothriolepis* plates in the Mineralogical Museum at Breslau, in which he noted that Lahusen had, in his above-quoted paper, put the hinder aspect of the posterior median dorsal plate forwards, and also that Trautschold, in a paper on *Coccosteus*, had attributed the same plate to a species of the last mentioned genus.

The discovery by the officers of the Canadian Geological Survey of numerous well-preserved entire specimens of *Bothriolepis* in the Upper Devonian rocks of Scaumenac Bay, enabled Mr. Whiteaves to give a description,[4] accompanied by excellent figures, of a new species of the genus, to which he gave the name of *Pterichthys* (*Bothriolepis*) *Canadensis*. These Canadian specimens are certainly the

[1] "Zur Kenntniss der Gattung *Bothriolepis*," 'Verh. russ.-kais. mineral. Gesell.' (2), vol. xv, 1880, p. 136, pls. i and ii.

[2] "Ueber *Bothriolepis Panderi*, Lahusen," 'Bull. Soc. Imp. Nat. Mosc.,' vol. lv, pt. 2, 1880, p. 169, pl. ii.

[3] "Ueber Placodermen und andere devonische Fischreste im Breslauer mineralogischen Museum," 'Zeitschr. deutsch. geol. Gesellsch.,' vol. xliii, 1891, pp. 902—913.

[4] 'Trans. Roy. Soc. Canada,' vol. iv, sect. iv, 1887.

finest examples of Asterolepid remains yet discovered, and clearly show all the salient features of *Bothriolepis* in a manner never before exhibited. Unfortunately, Mr. Whiteaves does not seem to have then had complete access to the literature of the subject; for, apparently unaware of what Lahusen and Trautschold had written, he said: "It is still open to question, however, whether the genus *Bothriolepis* is or is not a valid one and sufficiently distinct from *Pterichthys*."

In my essay on the structure and classification of the Asterolepidæ published in 1888, I considered that I had brought together the main facts regarding this genus, which facts conclusively showed that although *Bothriolepis* was indeed a veritable Asterolepid, nothing could be more salient than the *generic* distinctions which separate it from both *Pterichthys* and *Asterolepis*; and I also showed that, besides the "*Pterichthys*" *major* of Agassiz, two other reputed species of *Pterichthys*, namely, *hydrophilus*, Ag., and *macrocephalus*, Egerton, must also be transferred to *Bothriolepis*. On the appearance, a year later, of the late Professor Newberry's 'Palæozoic Fishes of North America,' I was, therefore, rather surprised to find that in treating of *Bothriolepis* he seemed to consider its relations to *Pterichthys* as still a matter of uncertainty! His remarks certainly do not indicate that he had given much study to the subject.

On the other hand, we find that the treatment accorded to *Bothriolepis* in the second part of Dr. Smith Woodward's 'Catalogue' published in 1891 is wholly accurate and up to date. In the following year the same author published a noteworthy contribution to our knowledge of the genus by accurately figuring the "maxillary" plates, the form of which had been somewhat imperfectly given by Whiteaves.

As Agassiz had, years previously, failed to diagnose fragments of the arm of *Bothriolepis*, and had attributed them to a new genus, namely, "*Placothorax*," so in 1856 we find Leidy figuring the distal part of a *Bothriolepis* limb as a spine, to which he gave the name of *Stenacanthus nitidus*.[1] And thirty-five years later a similar mistake was made by Cope,[2] who interpreted a corresponding fragment of *Bothriolepis* as a spine of *Holonema*. This has been already noted by Dr. Smith Woodward.[3]

Restoration of Bothriolepis.—British specimens of the genus are mostly fragmentary; if entire, as in the case of *B. hydrophilus* of Dura Den, then they are not well preserved. To gain a proper insight into our native species it will, therefore, be as well in the first place to illustrate, by a couple of restored figures, the structure and configuration of a non-British species, *B. Canadensis*, of which the

[1] J. Leidy, "Description of some Remains of Fishes from the Carboniferous Formations of the United States," 'Journ. Acad. Nat. Sc. Philadelphia,' vol. iii, second series, pt. iii, 1856, p. 164, pl. xvi, figs. 7 and 8.

[2] "On the Characters of some Palæozoic Fishes," 'Proc. Nat. Mus.,' vol. xiv, 1891, p. 456.

[3] 'Geol. Mag.,' vol. ix, 1892, p. 234.

numerous entire specimens in our great museums have furnished us pretty well with the means of becoming acquainted with its details. Its first describer, Whiteaves, has already given us a restoration[1] which affords an excellent general idea of its shape and of the arrangement of its osseous plates, though faulty as to a few details of the head, to which allusion has already been made.

The head occupies nearly one third of the entire length and shows, on the upper surface, an orbit which is smaller and further back than in *Asterolepis*. The *median occipital* plate (*m. occ.*) has its lateral margin more perpendicular to the posterior one than in the last named genus; its anterior aspect shows, not merely a shallow re-entering angle for the post-median plate, but a deep semi-elliptical notch or excavation, on each side of which it takes part in the formation of the posterior boundary of the orbit. Consequently the *post-median* (*p.m.*) is small, entirely received in the aforesaid notch of the median occipital, and thus excluded from joining the laterals as in *Pterichthys* and *Asterolepis*. The *lateral occipitals* (*l. occ.*) and the *angular* (*ag.*) do not call for any special comment, but the *laterals* (*l.*) are much broader than in *Asterolepis*, while the *extra-laterals* (*e. l.*) are very small, narrow, and pointed in front.

The orbit is, as already mentioned, small compared with that of *Asterolepis*, and, moreover, its anterior margin shows scarcely any re-entering flexure. Its right and left portions are filled up by the ocular plates (*o.*), between which are other two, namely the *median* or pineal (*m.*), and a very narrow plate *x* close in front of it. From the centre of this narrow plate, as shown by Whiteaves, a small linear process with expanded lower extremity passes down perpendicularly into the interior of the head, though what its function can be is difficult to imagine.

On the under surface of the head (Fig. 58) and close to the anterior margin are the two small maxillary plates (*mx.*), which differ in form from those of *Pterichthys* (see p. 65), firstly in having the external notch very shallow, and situated on the anterior, instead of the posterior external angle of the plate, and secondly, in having the posterior internal angle so rounded off that at the symphysis the two plates touch each other only quite in front. These plates, as in *Pterichthys*, are when visible almost always displaced.

The pattern of the cephalic lateral line grooves is considerably different from that in *Asterolepis* and *Pterichthys*. No transverse commissure unites the lateral groove of each side across the occipital plates; but in front, just at its incurved flexure on the lateral plate, a conspicuous branch is given off, which runs forwards and outwards to the margin of the shield, while immediately behind the origin of this branch and on the inner side of the main groove a small ear-shaped mark is often, though not always, seen. On the median occipital two slighter grooves are observable, forming an angle with each other behind, whence diverging obliquely

[1] 'Trans. Roy. Soc. Canada,' vol. iv, sect. iv, pls. vi and vii.

forwards and outwards, they pass over the lateral plates and terminate near the flexure of the great groove close behind the origin of its small outer branch. It may be noted that, as pointed out by Smith Woodward, a small sensory groove is also seen on each maxillary plate.

The articulations of the body-plates are as in *Pterichthys*, the *anterior median dorsal* (*a. m. d.*) overlapping the *anterior dorso-lateral* (*a. d. l.*) of each side, but being itself overlapped by the *posterior dorso-laterals* (*p. d. l.*). On the other surface (Fig. 58) the place of the two *semilunars* of *Pterichthys* and *Asterolepis* is apparently taken by a single plate (*s. l.*). The course of the lateral line groove

Fig. 57.

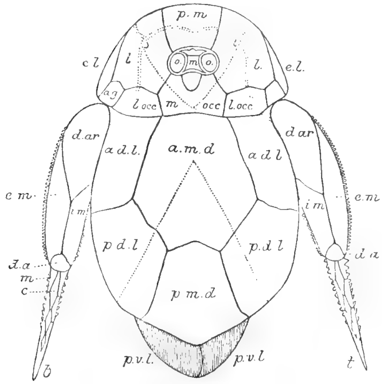


Fig. 58.

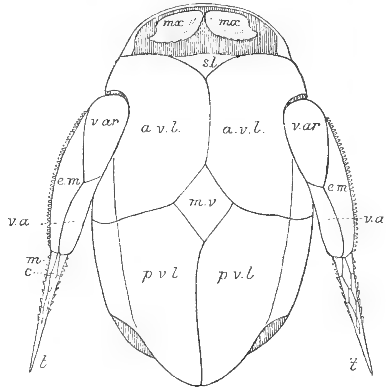


Fig. 57.—Restored figure of *Bothriolepis Canadensis;* dorsal surface. *m. occ.*, median occipital; *l. occ.*, lateral occipital; *ag.*, angular; *pt. m.*, post-median; *p. m.*, pre-median; *l.*, lateral; *e.l.*, extra-lateral; *m.*, median; *o.*, ocular; *a. d. l.*, anterior dorso-lateral; *a. m. d.*, anterior median dorsal; *p. d. l.*, posterior dorso-lateral; *p. m. d.*, posterior median dorsal; *d. a.*, dorsal anconeal; *d. ar.*, dorsal articular; *c. m.*, external marginal; *i. m.*, internal marginal; *c.*, centrals of lower arm; *m.*, marginals of lower arm; *t.*, terminal.

Fig. 58.—Restored figure of *Bothriolepis Canadensis;* ventral surface. *mx.*, maxillary plate; *s. l.*, semilunar; *a. v. l.*, anterior ventro-lateral; *p. v. l.*, posterior ventro-lateral; *m. v.*, median ventral; *v. ar.*, ventral articular; *v. a.*, ventral anconeal; *c.*, centrals; *m.*, marginals of lower arm; *t.*, terminal.

is exactly as in *Pterichthys*, and, as already mentioned, its passage from the external occipital of the head on to the anterior dorso-lateral of the body is in many specimens distinctly verifiable.

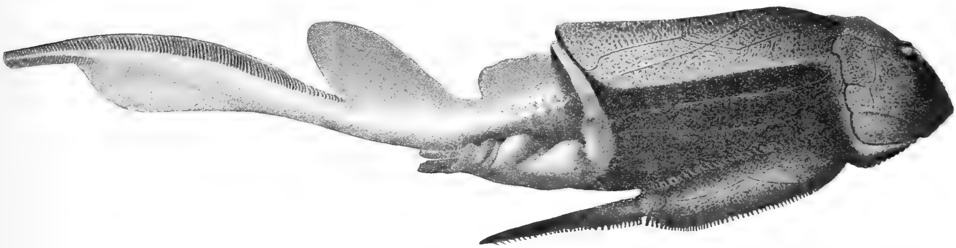
The pectoral appendages are longer than the dorsal aspect of the carapace, and even pass beyond the termination of the ventral surface. The proximal portion is also longer than the distal, though the proportion seems to vary; roughly speaking, however, the difference between the two portions is less than one third of the longer. The proximal portion is, like that of *Asterolepis*, trigonal in transverse section; and the plates of which it is composed are also similar in number and arrangement save that the *dorsal anconeal* (*d. a.*) is a small rounded element placed just at the "elbow" joint, whereby the external and internal marginals are allowed to come together for a considerable distance between it and the distal extremity of the *dorsal articular* (*d. ar.*). The two articulars, as noted in the generic diagnosis, meet together on the outer aspect over the external marginal; this relation is, however, not seen in the Canadian specimens, though demonstrable in many fragments from Scotland and Russia.

The lower or "fore" arm is slender and pointed, and is constructed on the same plan as in *Asterolepis*, only there are above and below two central pieces (besides the terminal) and consequently there are three marginal elements (*m.*) on each side.

Postscript to Restoration of Bothriolepis.—Regarding the apparent absence of a tail in otherwise complete examples of this genus I wrote in 1888:

"It is remarkable that no tail is seen in *Bothriolepis*, though numerous

Fig. 59.



Professor Patten's reconstruction of *Bothriolepis* seen from the side. From his paper quoted below.

specimens both of *B. Canadensis* and *B. hydrophilus* seem perfect in every other respect. It is therefore plain that caudal scales were absent, though it does not seem to me quite so safe to assume that no caudal appendage was ever present, for the posterior aspect of the carapace shows a large opening, just as in *Pterichthys*, out of which it is difficult to conceive that absolutely no body prolongation ever proceeded, and it does seem quite possible that a tail might have existed, though unprovided with hard parts capable of preservation. Moreover, in a specimen of *B. Canadensis* in the Edinburgh Museum there is to be seen, just at the place where the tail occurs in *Pterichthys*, a peculiar dark organic-looking film, which is strikingly suggestive of the remains of such an appendage."

Since the preceding general account of *Bothriolepis* was in type I have received a paper from Professor Patten, of Dartford College, New Hampshire ("New Facts concerning *Bothriolepis*," 'Biol. Bulletin,' vol. vii, No. 2, July, 1904, pp. 113–124), in which such a tail is in fact described and figured in *B. Canadensis*. It was clearly composed of soft tissues, with the exception of a row of short slender rod-like bodies extending along the dorsal margin of the heterocercal caudal fin, and another row, much less extensive, placed just below the tip of that fin. To afford a clearer idea of the contour of the parts concerned I reproduce one of Professor Patten's figures, which shows not merely one, but two dorsal fins. The second of these, very prominent, is obviously the equivalent of the one present in *Pterichthys*, while the other, in front, is more undefined.

Professor Patten's paper contains also some interesting details concerning the mouth- and eye-plates, the consideration of which must be deferred.

Geological Distribution.—*Bothriolepis* is the characteristic Asterolepid genus of the estuarine aspect of the Upper Devonian formation, and is represented by various species in strata of that age in Britain, Russia, Canada, and the United States.

Bothriolepis major, *Agassiz*, sp. Plates XXIII—XXVI.

1844. Glyptosteus reticulatus, *Agassiz.* Poiss. Foss., vol. i, p. xxxiv (name only).
— Pterichthys major, *Agassiz.* Poiss. Foss. v. Grès. rouge, pp. 5, 19, 133, pl. xxxi, figs. 1—3.
1845. Bothriolepis ornatus, *Agassiz* (*errore*). Ibid., pl. xxix, figs. 3—5.
— Placothorax paradoxus, *Agassiz.* Ibid., p. 134, pl. xxx *a*, figs. 20—23.
1860. Asterolepis major, *Eichwald.* Leth. Rossica, vol. i, p. 1511.
1880. Bothriolepis major, *Lahusen.* Verh. russ.-kais. miner. Gesellsch. [2], vol. xv, p. 136.
1888. — — *R. H. Traquair.* Geol. Mag. (3), vol. v. p. 510, and Ann. Mag. Nat. Hist. (6), vol. ii, p. 501.
— — giganteus, *R. H. Traquair.* Geol. Mag. (3), vol. v, p. 510, and Ann. Mag. Nat. Hist. (6), vol. ii, p. 504, pl. xviii, fig. 3.
1891. — major, *A. S. Woodward.* Cat. Foss. Fishes Brit. Mus., pt. ii, p. 226, pl. vi, figs. 5—8.
1896. — — *R. H. Traquair.* In Harvie-Brown and Buckley's Vert. Fauna Moray Basin, p. 265, pl. viii.

Specific Characters.—Median dorsal plates not carinated mesially; sensory groove crossing pre-median plate tolerably close to the anterior margin; sculpture consisting of tubercles more or less confluent into reticulating ridges; tubercles showing stellation of bases in unworn specimens; no prominent denticulation observed on margins of pectoral appendages.

Description.—The photographic figures given in Pl. XXIII—XXVI will give the reader a better idea of the form and sculpture of the bony elements forming the exoskeleton of this species than pages of words; the following description resolves itself therefore more or less into an explanation of the plates. Most of these figures represent plaster casts taken from sharp impressions occurring in a hard, siliceous, vitreous-looking, coarse, sometimes even pebbly, sandstone at Carden Hill, Sweet Hillock, and Rocky Park, near Alves, and in this way the details of the external form and sculpture are brought out in a manner which could not be attained by figuring the fossils themselves.

Head.—Pl. XXIII, Fig. 1, shows a head, natural size, and perfect except as regards the extra-lateral and angular plates, which are wanting. To be noted is the course of the sensory groove, and its comparative nearness to the margin of the head in front; also the **V**-shaped commissure on the median occipital and lateral plates, the orbit being set between the limbs of the **V**. Another head is shown in Fig. 5, with parts of the anterior median dorsal and anterior dorso-lateral plates in apposition behind, and in this specimen the sculpture is finer and the tubercles in many places run together into tolerably straight lines, while in other places an irregularly reticulated pattern is formed.

In Fig. 2 of the same plate we have the *median occipital* plate of a large individual, natural size, showing the deep indentation in front for the post-median element, behind which is the posterior commissure of the sensory groove. The *pre-median* element is shown, natural size, in Fig. 3, crossed in front by the sensory groove which in the middle is flexed into a sharp angle with backwardly directed apex. A portion of the right *lateral* plate is also represented of the natural size in Fig. 4, showing the sensory groove with its antero-lateral branch. This must have belonged to a large specimen, and it may be noted that the sculpture is proportionately large and coarse.

Body.—In Fig. 1 of Pl. XXIV is shown, one half natural size, a plaster cast of an *anterior median dorsal* plate. Its form is broad, depressed, gently convex, but *not keeled;* hexagonal, but the anterior margin has nearly twice the extent of the posterior. At the posterior margin is seen the transversely elongated triangular area overlapped by the posterior median dorsal, but the lateral areas overlapped by the posterior dorso-lateral plates are not visible. The nature of the external sculpture needs no description. Another anterior median dorsal plate (cast) is shown, natural size, in Pl. XXIII, Fig. 6, the coarse external sculpture of which is to be noted. Although the plate is exactly one half the linear size of the one last described, the tubercles, ridges, and intervening hollows are just as large, and in like manner very considerably larger than those on the corresponding element in Fig. 5, which when complete must have had about the same dimensions.

In Pl. XXIV, Fig. 2, we have a photograph one half natural size, of the internal surface of a similar plate taken from an actual specimen from Newton Quarry, Alves. Here is distinctly shown the median ridge extending from nearly the posterior margin right on to the front, while about one third from its anterior termination it gives off on each side, at an acute angle, a forwardly directed branch, which is, however, rather faintly exhibited in the photograph. These ridges are not seen either in *Pterichthys* or *Asterolepis*. We observe in this figure on the left side (right hand side of the reader) the extensive antero-lateral area for overlapping the anterior dorso-lateral plate, while on the other side a portion of the bone is broken away at the corner, showing the impression of the external sculpture below.

The outer surface of the *posterior median dorsal* plate (cast) is shown in Pl. XXV, Fig. 1, where, like the anterior median dorsal, it is seen to be entirely destitute of a keel along the middle line. The internal surface is represented by another specimen, Fig. 2, which is perfect except as regards a small piece broken away from the hinder part of the right margin. In the middle line and nearer the back than the front, is a rough, longitudinal crest, no doubt for muscular attachments; quite in front is a transversely elongated triangular area for overlapping the posterior margin of the anterior median dorsal, while on each side is an extensive surface for overlapping the posterior dorso-lateral element. Both of these plates are represented one half the natural size.

The outer aspect of the *anterior dorso-lateral* plate (cast) is shown in Pl. XXIV, Fig. 3, and is complete anteriorly and posteriorly, but not quite so at the sides. The exposed surface of the *dorsal* portion is two and a half times as long as broad; part, but only part, of the area overlapped by the anterior median dorsal is seen along its inner border. The *lateral* aspect of the plate is imperfect, yet shows very distinctly the longitudinal lateral sensory groove running along from front to back. The internal aspect of the plate, cast from the counterpart of the same specimen is shown in Fig. 4, the broad area for overlapping the posterior dorso-lateral being conspicuous at the posterior end. The lines distinctly radiating from a point near the front show perfectly plainly that the plate was ossified from one centre, and does not represent two fixed elements, as supposed by Jaekel to be the case, at least in *Pterichthys*.

Of the *posterior dorso-lateral* element, no perfect specimen has turned up, the most perfect I have seen being represented in Pl. XXV, Fig. 3 (cast); it is, unfortunately, deficient along the inner margin of its dorsal portion. The lateral portion is, however, pretty well intact, and shows a large surface or area, deep and broad behind, which is overlapped by the corresponding posterior ventro-lateral, and over which the backward continuation of the lateral line groove is observable. In front of both the dorsal and lateral portions of the plate is seen the area overlapped by the anterior dorso-lateral, while behind we see part of the surface overlapped by the posterior median dorsal.

The right *anterior ventro-lateral* (cast) is shown in Pl. XXV, Fig. 4, the specimen being nearly complete except that the brachial process is broken. The plate of the left side, not so complete, is seen in Fig. 5 (also from a cast), but here we have the greater portion of the upper arm attached, while in Pl. XXIII, Fig. 7, we have a natural size representation of the same element broken, it is true, along its inner and posterior margins, but showing the brachial process (*b. p.*) in its entirety. This last figure, which is taken from an actual specimen from Whitemire, near Forres, shows also in an unmistakable way the stellation of the bases of the confluent tubercles.

Pl. XXV, Fig. 6, represents the left *posterior ventro-lateral* plate, one half natural size, from a cast. It is nearly complete, and shows both the horizontal or ventral and the ascending or lateral portions, the considerable height of the latter being interesting in connection with the large size of the area on the posterior dorso-lateral, which it overlaps.

The lozenge-shaped *median ventral* is shown in Pl. XXIV, Fig. 5, which is also taken from a cast, one half natural size. In general configuration it presents no features specially distinguishing it in form from the corresponding plate in *Pterichthys* or in *Asterolepis*.

Pectoral Appendages.—In no case has an entire "arm" of *Bothriolepis major* been found, though in Pl. XXV, Fig. 5, we have a view of the greater part of the ventral aspect of the proximal segment, the elements here seen being the ventral articular, part of the ventral anconeal and part of the external marginal. The two articular pieces, dorsal and ventral, seem to have much the same general shape, so that I feel unable to say to which category the detached specimens represented in Pl. XXVI, Figs. 2 and 3, respectively belong. Of these Fig. 2 shows the outer sculptured surface, Fig. 3 the internal smooth aspect of a similar plate. The appended text figures show the internal and external aspects of the upper extremity of an arm from Scat Craig. On the outer aspect, Fig. 60, the articular dorsal (*d. ar.*) and ventral (*v. ar.*) plates are seen to be in contact for a considerable distance above the space occupied by the external marginal, while on the inner, Fig. 61, the internal articular (*i. ar.*) is displayed with its narrow upper margin taking part in bounding the opening by which these plates clasp the base of the brachial porcess (*b. p.*).

Of the "forearm," with the exception of the one figured by Agassiz as *Placothorax paradoxus*, 'Poiss. Foss. v. grès rouge,' Pl. XXX *a*, Figs. 22, 23, I have only seen the impression of a portion deficient at both ends, of which a plaster cast of one half the natural size is represented in Pl. XXVI, Fig. 4.

Entire Specimens.—It is only in the uppermost or "Rosebrae" beds of the Upper Old Red Sandstone of the Elgin district that one or two specimens with body plates in apposition have been found—*impressions* I should say, for in the Rosebrae rock not a vestige of the osseous substance remains in any of its contained fish-bones, plates, or scales. The best of these which I have seen is from Rosebrae

Quarry, and belongs to the collection of the Geological Survey of Scotland. It is represented in Pl. XXVI, Fig. 1, of the natural size, and shows the form of the dorsal aspect of the body and the greater part of the head. Unfortunately, the head is imperfect in front; but, allowing for that deficiency, its length would be contained a little more than three times in the total of about seven inches. The posterior part of the carapace appears just a little too narrow in the figure owing to the fact that the absolute flatness of the photograph gives no idea that the cavity of the impression expands a little laterally below the level of the surface of the stone in that region. The ornament of the plates is fine, but scarcely finer than in the specimen from Alves figured in Pl. XXIII, Fig. 5.

Another is from Laverockloch Quarry on the same horizon, and is in the

Fig. 60.

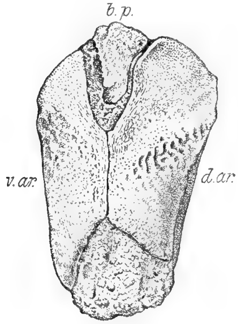


Fig. 61.

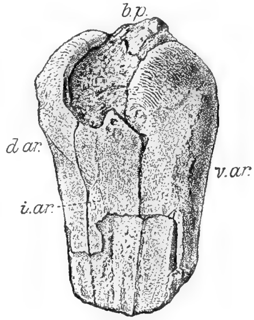


Fig. 60.—Upper extremity of the pectoral limb of *Bothriolepis major*, from Scat Craig, magnified by one half.

Fig. 61.—Ventral aspect of the same specimen, also magnified one half. *b. p.*, brachial process; *d. ar.*, dorsal articular; *i. ar.*, internal articular; *v. ar.*, ventral articular.

collection of the Royal Scottish Museum, Edinburgh. Here also the head is imperfect in front, but its estimated entire length would be contained less than three times in a total of four and a quarter inches. Now, as the greatest breadth of the carapace is two and three quarter inches, this specimen is proportionately shorter and broader than that from Rosebrae last described; and, moreover, the posterior median dorsal shows just a trace of carination. Nevertheless, until further information comes to hand, I hardly consider those differences sufficient to warrant the erection of a new species.

Remarks.—This is the *Pterichthys major* of Agassiz, a name which, as already remarked (p. 76), has in bygone years been too often "taken in vain" by Scottish collectors, every big fish-plate from the Upper Old Red Sandstone being freely referred to it without further examination. The name was originally given to the proximal plates of a pectoral appendage from the Findhorn, and figured by Agassiz in

PLATE XIX.

Fig

1. *Pterichthys Milleri*, seen from the dorsal surface; natural size. From a specimen from Lethen Bar in the British Museum (50109).

2. Dorsal aspect of head and carapace, without pectoral appendages or tail, of a specimen from Cromarty, in the Hugh Miller Collection, Royal Scottish Museum. This is the type of *Pterichthys testudinarius* of Agassiz. Natural size. *o. o.*, orbit.

3. Ventral view of the same specimen.

4. Detached right ventro-lateral plate, seen from the internal aspect; natural size. From Achanarras, Caithness, in the Royal Scottish Museum, Edinburgh.

PLATE XIX.

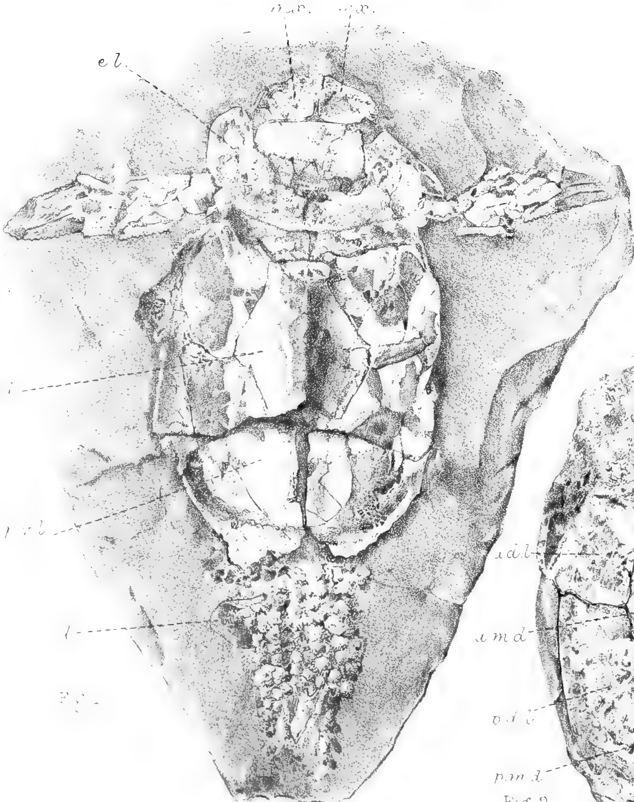


Fig. 4.

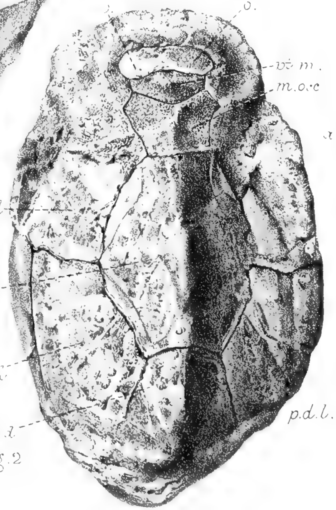


Fig. 2

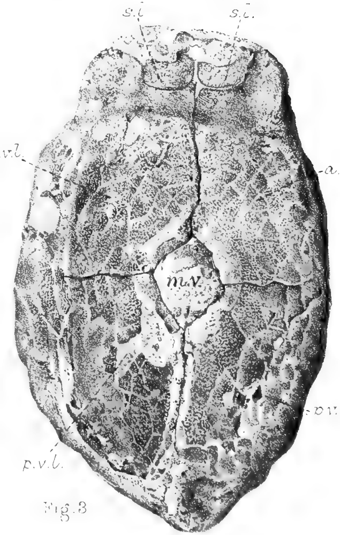


Fig. 3

J Green del et lith

Mintern Bros. imp.

PLATE XX.

Fig.

1. *Pterichthys Milleri*, from a specimen from Lethen Bar in the British Museum (49191). Here the plates of the ventral surface of the carapace are seen from their inner surfaces.

2. A specimen from the same locality, showing the greater part of the body-carapace from the dorsal aspect, part of the left pectoral appendage, the dorsal fin, and the heterocercal caudal with indication of the fin-membrane; natural size. From a specimen in the Williamson Collection, Manchester Museum.

3. Central part of the head of a specimen from the same locality, in the British Museum (49187), showing the orbit, with remains of the median and ocular plates. Natural size.

4. Anterior median dorsal plate, with deficient margins, but showing the external sculpture. From Cromarty, in the Hugh Miller Collection, Royal Scottish Museum. Natural size.

5. Posterior ventro-lateral plate, with part of the bony matter preserved and showing the external sculpture. Also from Cromarty, in the Hugh Miller Collection, Royal Scottish Museum. Natural size.

PLATE XX.

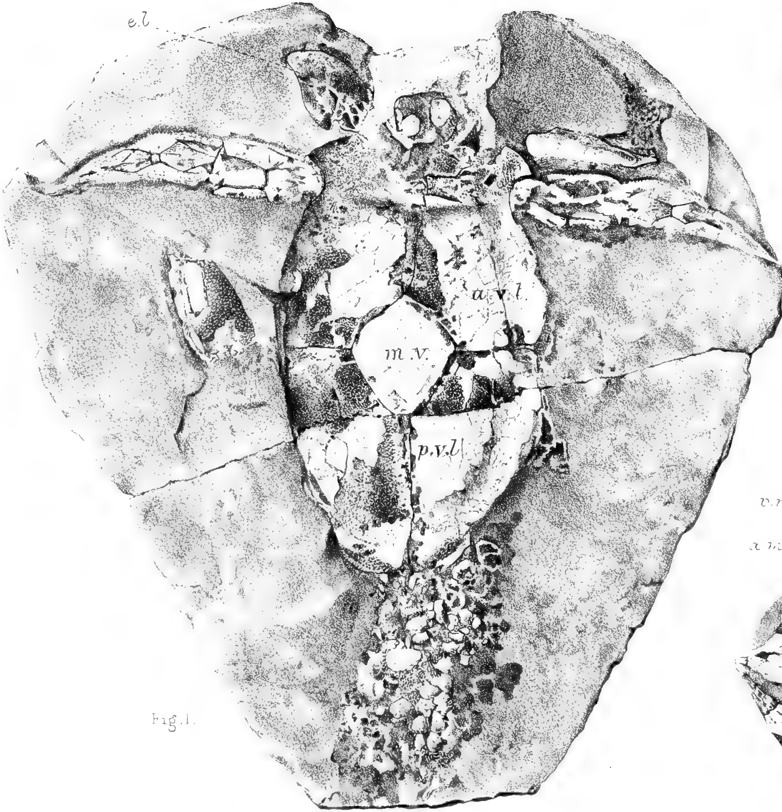


Fig.1.

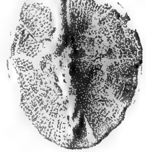


Fig.4

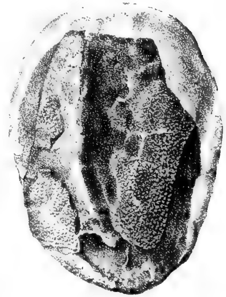


Fig.5.

Fig.3

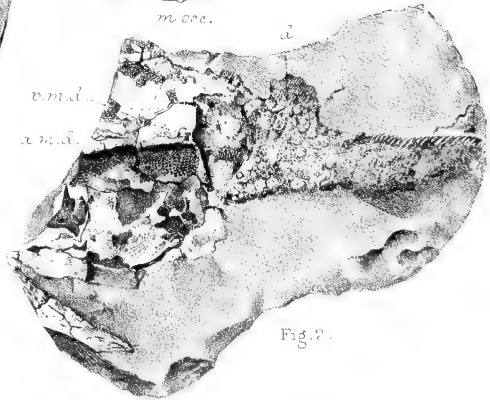


Fig.2.

Mintern Bros. imp.

PLATE XXI.

Fig.

1. Specimen of *Pterichthys productus*, seen from the ventral surface; natural size. From Lethen, in the British Museum Collection (49189).

2. Another specimen, natural size, showing three of the ventral plates of the carapace from the internal surface, the right pectoral appendage, the dorsal fin, and the tail pedicle. From Lethen, in the British Museum (50112).

3. Natural internal cast, uncompressed, of the lateral plates of the left side of *Pterichthys productus*; natural size. From a specimen from Cromarty, in the Hugh Miller Collection, Royal Scottish Museum, Edinburgh.

4. Body carapace with right pectoral appendage of a small specimen of *Pterichthys productus*, laterally compressed; head and tail wanting; natural size. From Cromarty, in the Hugh Miller Collection, Royal Scottish Museum, Edinburgh.

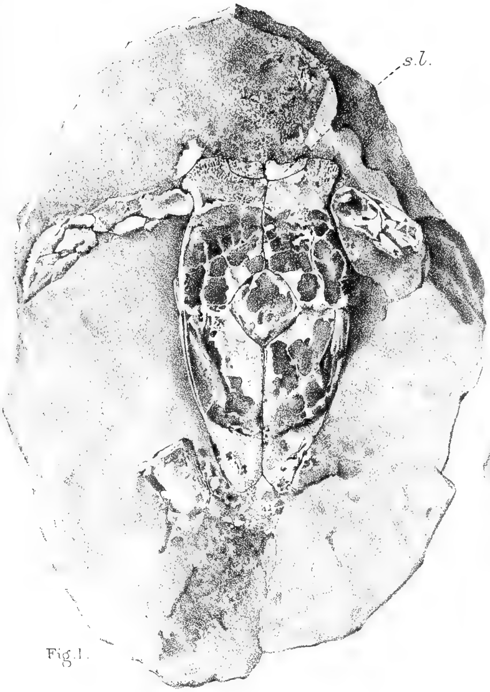


Fig.1.

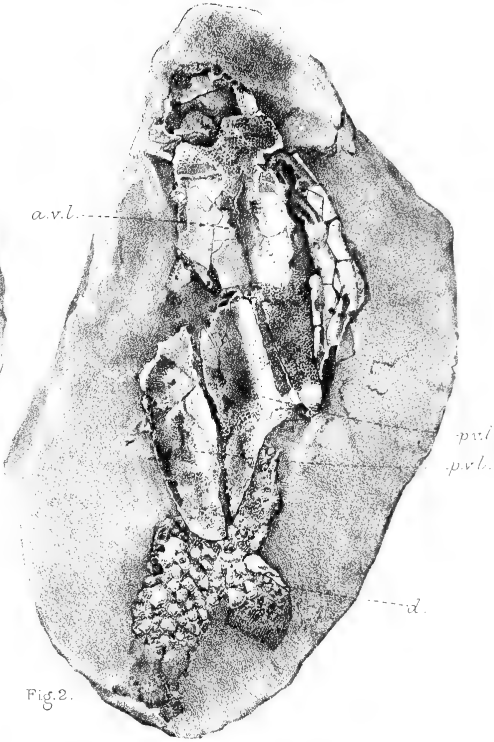


Fig.2.

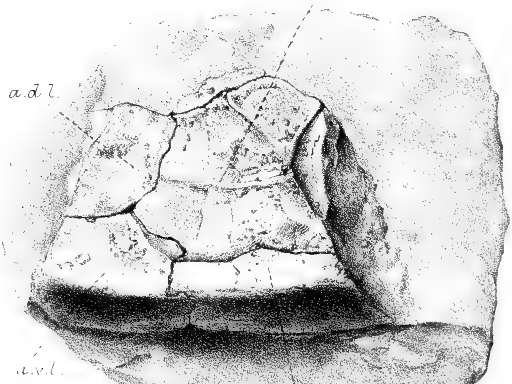


Fig 3.

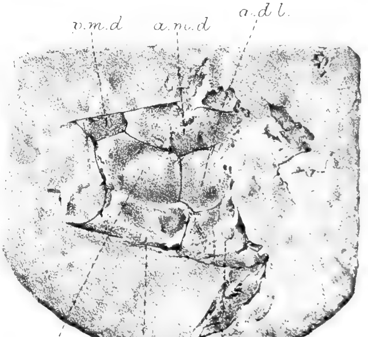


Fig 4.

J Green del et lith.

Mintern Bros. imp

PLATE XXII.

FIG.

1. *Pterichthys Milleri,* crushed laterally; natural size. From Achanarras, Caithness, in the Collection of the Author.

2. Distal portion or segment of the pectoral appendage in a specimen of *Pterichthys Milleri* from Tynet Burn, in the British Museum (35981). Natural size.

3. *Pterichthys productus*, showing the ventral plates of carapace seen from the internal surface ; natural size. From Lethen, in the British Museum Collection (50111).

4. Distal portion of the pectoral appendage in a specimen of *Pterichthys productus* from Lethen, in the British Museum (39174). Natural size.

5. *Microbrachius Dicki,* dorsal surface, seen from the internal aspect; natural size. From Deerness, Orkney, in the Collection of the Author.

6. Another specimen from the same locality; natural size; in the Collection of the Author.

7. *Microbrachius Dicki*; anterior median dorsal plate, showing its articulation with the anterior dorso-laterals; one third larger than natural size. From John O'Groats, Caithness, in the Royal Scottish Museum, Edinburgh.

8. Ventral aspect of the carapace of the same species from the same locality, magnified by one half. In the Royal Scottish Museum, Edinburgh.

PLATE XXII.

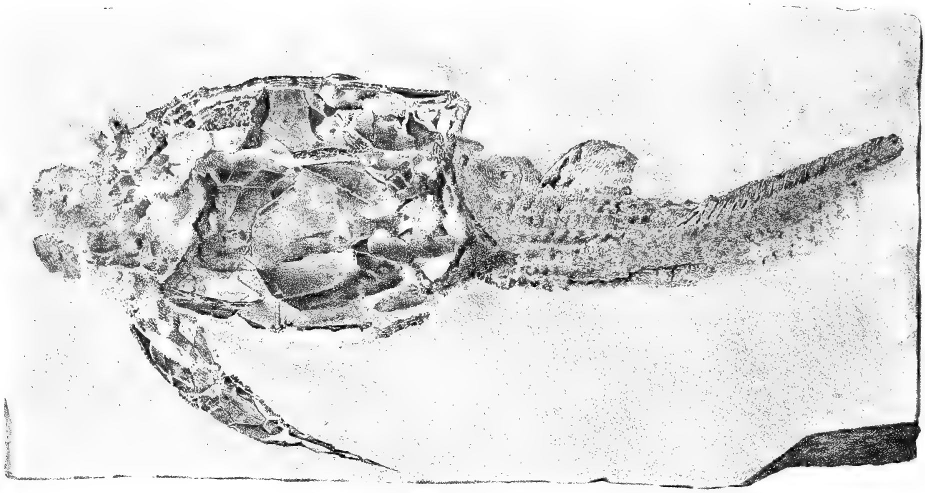


Fig. 1.

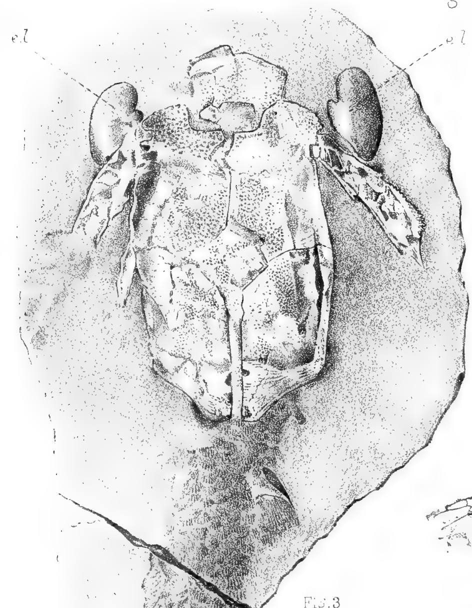


Fig. 3

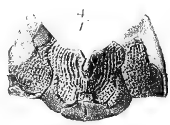


Fig. 7.

Fig. 5

Fig. 8

Fig. 2

Fig. 4

Fig. 6

J. Green del et lith.

Mintern Bros imp.

PLATE XXIII.

Fig.

1. Head of *Bothriolepis major*: natural size; bony substance preserved; from Newton Quarry, near Elgin. The extra-lateral and angular plates are wanting, as are also the pieces which should occupy the orbital space.

2. Median occipital plate; natural size; bony substance preserved. From the same locality.

3. Pre-median plate; natural size; bony substance preserved. From the same locality.

4. A large portion of the right lateral plate of the head; natural size; bony substance preserved, and showing well the sensory groove with its antero-lateral branch. From Whitemire, near Forres.

5. Natural size representation of a plaster mould of a sharp impression of a head with the anterior parts of the dorsal plates. On the right side the continuity of the lateral sensory groove of the head with that on the anterior dorso-lateral plate is distinctly seen. The original from Alves, near Elgin, was presented to the Royal Scottish Museum by the Rev. Mr. McKemmie.

6. Anterior median dorsal plate; natural size; from a plaster mould of an impression from Alves; slightly deficient on the left side. Original in the Elgin Museum.

7. Greater part of the right ventro-lateral plate, showing the entire brachial process (*b.p.*), and the external sculpture in which the stellate character of the tubercles happens to be well seen. Natural size. From Whitemire, near Forres.

The originals of all the above figures, except fig. 6, are in the Royal Scottish Museum, Edinburgh.

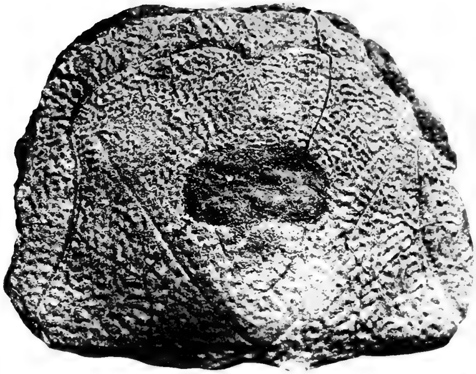


Fig 1

Fig 2

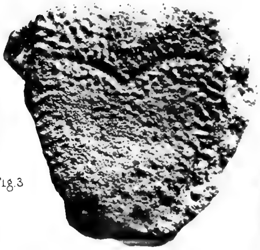
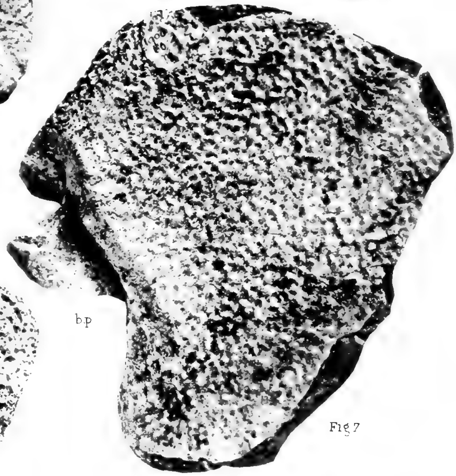


Fig 3

Fig 4



b.p

Fig 7

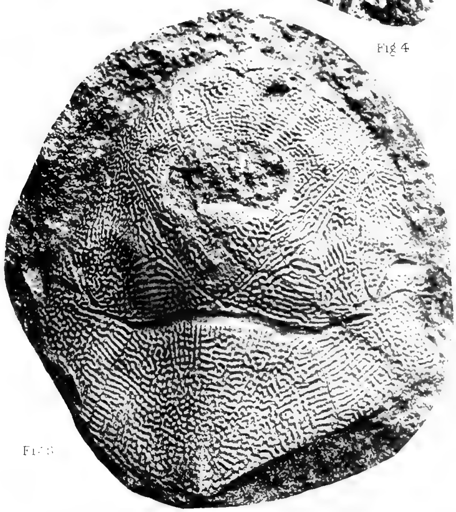


Fig [illegible]

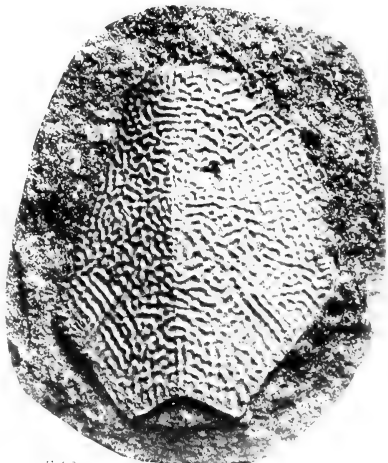


Fig [illegible]

London Stereoscopic Co imp.

PLATE XXIV.

FIG.

1. Plaster mould from an impression of the outer surface of an anterior median dorsal plate of *Bothriolepis major* from Alves, in the Elgin Museum. One half natural size.

2. Internal surface of a similar but slightly larger plate, with the bony substance preserved, belonging to the Royal Scottish Museum. One half natural size.

3. Plaster mould from an impression of the outer surface of a left dorso-lateral plate from Rocky Park, Alves, belonging to the Royal Scottish Museum. Lateral line groove well shown. One half natural size.

4. Plaster mould from the counterpart of the same specimen, also in the Royal Scottish Museum. Here the internal surface of the plate is represented, and shows conspicuously the extensive surface behind for overlapping the posterior dorso-lateral plate.

5. Plaster mould from an impression of a median ventral plate, from Alves, near Elgin. One half natural size.

Fig.4

½

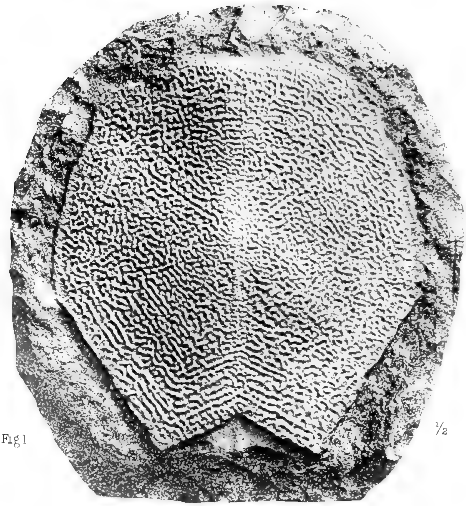


Fig 1

½

½

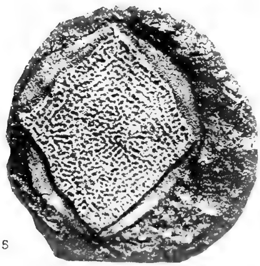


Fig.5

½

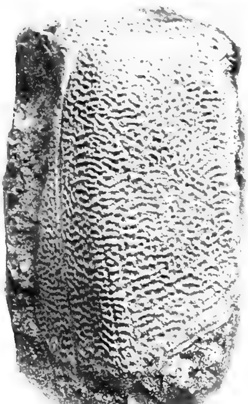
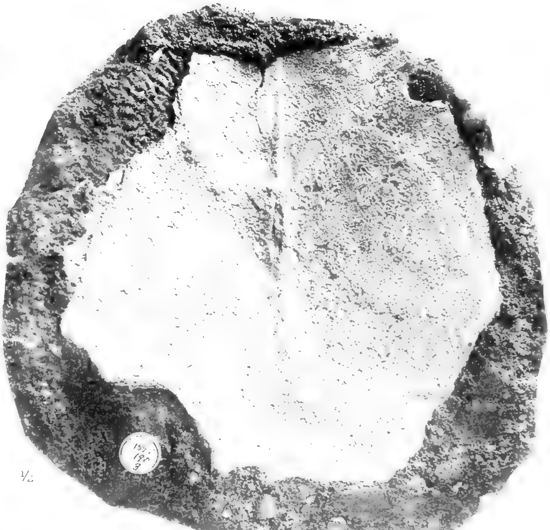


Fig.3



½

Fig 2

London Stereoscopic C° imp

PLATE XXV.

FIG.

1. Plaster cast from an impression of the outer surface of a posterior median dorsal plate of *Bothriolepis major*, from Alves, in the Elgin Museum. Slightly deficient in the middle of the posterior margin, otherwise complete. One half natural size.

2. Plaster cast taken from an impression of the internal surface of a similar plate from the same locality in the Elgin Museum, showing well the areæ for overlapping the anterior median dorsal, and the posterior dorso-laterals. One half natural size.

3. Plaster cast from an impression of a somewhat imperfect left posterior dorso-lateral plate from the same locality, in the Elgin Museum. One half natural size.

4. Plaster cast from an impression of a tolerably perfect right anterior ventro-lateral plate from Newton Quarry, near Elgin, in the Royal Scottish Museum. One half natural size.

5. Plaster cast from an impression of a not quite perfect left anterior ventro-lateral from Alves, in the Elgin Museum. Attached is seen the greater part of the proximal segment of the pectoral appendage, the elements seen being the ventral articular, the external marginal, and the ventral anconeal. One half natural size.

6. Plaster cast from an impression of a left posterior ventro-lateral plate, from Alves. One half natural size. Original in the Royal Scottish Museum.

½

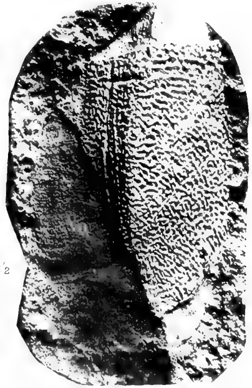
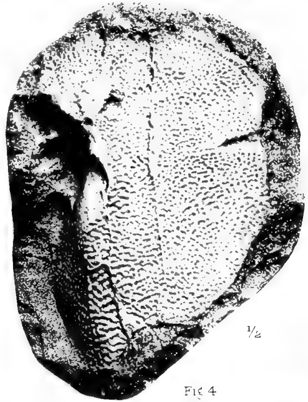


Fig 3



½

Fig 4

Fig 5

½

Fig 1

½

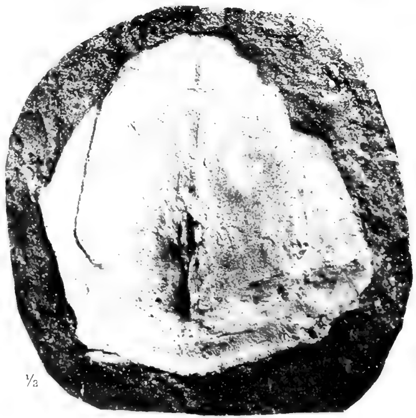


Fig 2

Fig 6

Stereoscopic Co.

PLATE XXVI.

Fig.

1. Impression of the dorsal surface of a nearly entire specimen of *Bothriolepis major*, from Rosebrae Quarry, near Elgin. Natural size. The pectoral appendages are wanting, the right side of the front of the head is wanting, and a long narrow piece has been broken out of the right side of the body. Natural size. Geological Survey of Scotland.

2. Plaster cast of an impression of the outer surface of one of the articular plates of the pectoral appendage. One half natural size. Original, from Alves, in the Royal Scottish Museum.

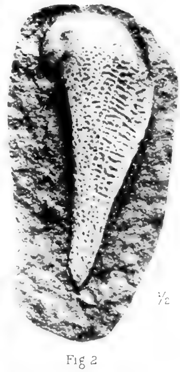
3. Plaster cast of an impression of the internal surface of a similar plate, also from Alves, and contained in the Royal Scottish Museum. One half natural size.

4. Plaster cast of an impression of part of the distal segment of the pectoral appendage. One half natural size. Original, from Alves, in the Elgin Museum.

Fig 1

½

Fig 3



½

Fig 2

Fig 4

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1904.

LONDON:

MDCCCCIV.

A MONOGRAPH

OF THE

CRETACEOUS LAMELLIBRANCHIA

OF

ENGLAND.

BY

HENRY WOODS, M.A.

UNIVERSITY LECTURER IN PALÆOZOOLOGY, CAMBRIDGE.

VOL. II. PART I.

LIMIDÆ.

PAGES 1—56; PLATES I—VII.

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PRINTED BY ADLARD AND SON, LONDON AND DORKING.

DESCRIPTION OF SPECIES.

Family—LIMIDÆ, *d'Orbigny.*

Genus—LIMA, *J. G. Bruguière*, 1797.

('Encyc. méthod.,' Tabl. Vers., pl. ccvi.)

LIMA CANALIFERA, *Goldfuss*, 1836. Plate I.

1836. LIMA CANALIFERA, *A. Goldfuss.* Petref. Germ., vol. ii, p. 89, pl. civ, fig. 1.
1839. — — *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. i, p. 24.
— — MULTICOSTATA, *Geinitz.* Ibid., p. 24, pl. viii, fig. 3.
1841. — CANALIFERA, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 56.
— — LATICOSTA, *Römer.* Ibid., p. 57, pl. viii, fig. 9.
1843. — MULTICOSTATA, *H. B. Geinitz.* Die Verstein. von Kieslingswalda, p. 23, pl. vi, fig. 10.
1846. — LATICOSTA, *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 34.
— — MULTICOSTATA, *Reuss.* Ibid., p. 34, pl. xxxviii, figs. 7, 8, 18.
— — — *H. B. Geinitz.* Grundr. d. Verstein., p. 472.
1850. — CANALIFERA, *Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 190.
— — MULTICOSTATA, *Geinitz.* Ibid., p. 192.
— — CANALIFERA, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 167.
? — — MULTICOSTATA, *d'Orbigny.* Ibid., p. 248.
— — LATICOSTA, *d'Orbigny.* Ibid., p. 249.
1863. — CANALIFERA, *A. Kunth.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 726.
— — — *R. Drescher.* Ibid., vol. xv, p. 356.
? 1868. — MULTICOSTATA, *E. Eichwald.* Lethæa Rossica, vol. ii, p. 459.
1870. — MULTICOSTA, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 174.
— — CANALIFERA, *Pictet and Campiche.* Ibid., p. 175.
1872. — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 38, pl. ix, figs. 6—8.

1876.	LIMA CANALIFERA,	*D. Brauns.*	Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 386.
1877.	— —	*A. Fritsch.*	Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 132, fig. 117.
1893.	— cf. CANALIFERA,	*R. Michael.*	Zeitschr. der deutsch. geol. Gesellsch., vol. xlv, p. 242.
1898.	— CANALIFERA,	*G. Müller.*	Mollusk. Untersenon. v. Braunschweig u. Ilsede (Abhandl. d. k. preussisch. geol. Landesanst. N.F., Heft 25), p. 28.
1901.	— —	*H. Imkeller.*	Kreidebild. am Stallauer Eck (Palæontographica, vol. xlviii), p. 32, pl. iii, fig. 10.
—	— —	*F. Sturm.*	Jahrb. d. k. preussisch. geol. Landesanst. für 1900, vol. xxi, p. 90.

Description.—Shell moderately convex, oval or subtriangular; height a little greater than length; outline rounded, except the antero-dorsal margin, which is nearly straight and rather long. Apical angle from 105° to 110°. Umbones rather small, close together. Anterior area slightly depressed, with small radial ribs. Anterior ears small; posterior larger, with growth-lines and faint radial ribs.

Ornamentation consists usually of 18, but sometimes of as few as 14 or as many as 21 very strong, rounded, straight ribs, which are separated by broader furrows. In well-preserved specimens numerous concentric linear ridges occur on both ribs and furrows, and projecting growth-ridges are seen at regular intervals on the ribs.

Measurements :

	(1)	(2)	(3)	(4)	(5)
Length	70	56	52	43	32 mm.
Height[1]	76	58	54	44	35 ,,

(1—5) Upper Greensand, Ventnor.

Affinities.—An exact comparison of the English specimens with the foreign examples of *Lima canalifera* is rendered difficult owing to the fact that the former have the shell well preserved whilst the latter occur chiefly as casts. In both cases the number and breadth of the ribs show considerable variation. The fine concentric ornamentation is the same in both, as is shown by Goldfuss' figure, but in some of the best preserved English specimens there occur also transverse ridges on the ribs at regular intervals. Somewhat similar ridges are shown in Goldfuss' figure, but they seem to be present chiefly on the sides of the ribs and

[1] In all species of *Lima* (unless otherwise stated) this is measured obliquely to the hinge-line so as to give the greatest height.

in the neighbourhood of the umbo only. With the exception of this character the English specimens agree closely with the foreign examples, and this difference may very well be due to the latter being much less perfectly preserved than the former. Moreover, in some English specimens the ridges mentioned are partly or entirely wanting.

The English examples occur at a lower horizon than those found abroad, namely, in the zone of *Pecten asper.* The foreign specimens are found in the Turonian and Senonian, and possibly also in the Cenomanian, and, like the English examples, they occur chiefly in beds of a sandy nature. This last fact may account for the absence of the species in the English Chalk, during the deposition of which the sea-floor was formed of ooze and was at a greater depth.

Lima Etalloni, Pictet and Campiche,[1] from the Valanginian, presents some resemblance to *L. canalifera*, but has a smaller apical angle; the character of its fine ornamentation is unknown.

Type.—Goldfuss' specimens came from the Senonian of Quedlinburg, Haltern and Regensburg.

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

Lima Galliennei, *d'Orbigny*, 1847. Plate II, figs. 1*a*—*c*.

1847. Lima Gallienniana, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 548, pl. cccexx, figs. 1—3 (*Galliennei* on plate).
1850. — — — Prodr. de Pal., vol. ii, p. 166.
1854. — Galliennei, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 171.
1867. — — *E. Guéranger.* Album Paléont. de la Sarthe, p. 18, pl. xxiii, figs. 23, 24.
1869. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.
1871. Radula Galliennei, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.

Description.—Shell compressed, more or less oblong with rounded margin; height greater than length. Antero-dorsal margin straight or slightly concave. Apical angle large. Umbones close together. Anterior area only slightly depressed, with sharp borders.

Ornamentation consists of 12 to 15 strong, much elevated ribs with rounded

[1] 'Terr. Crét. Ste. Croix' (1869), p. 141, pl. clxiv, fig. 3.

summits, separated by broader rounded furrows. Both ridges and furrows bear numerous flattened radial ridges separated by linear grooves; the ridges, in well-preserved specimens, are serrate or granular. At distant intervals a few well-marked growth-ridges occur.

Measurements:

	(1)	(2)
Length .	49 .	70 mm.
Height .	54 .	78 ,,

(1, 2) Upper Greensand, Devizes.

Affinities.—This species is distinguished from *L. canalifera* (p. 1) by the valves being more compressed, the ribs fewer in number, the grooves relatively broader, and by the presence of fine radial ornamentation on the ribs and grooves.

Remarks.—This appears to be a rare species in England. The specimens from Devizes are in the Museum of Practical Geology. The specimen from Humble Rocks was collected by Mr. Jukes-Browne, and is now in the Sedgwick Museum.

Type.—From the Cenomanian of Coudrecieux, Sarthe.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Devizes. Base of Chalk Marl (Bed 10) of Humble Rocks, West of Lyme Regis.

LIMA VECTENSIS, sp. nov. Plate II, figs. 2, *a*—*c*.

Description.—Shell large, rather compressed, ovate, height greater than length; antero-dorsal margin straight, the remainder forming a regular curve. Anterior area deeply depressed. Apical angle apparently about 100°. Anterior ear small; posterior ear larger, with a few ribs.

Ornamentation consists of about 40 rather strong, narrow ribs, with rounded summits which, in places, are slightly tubercular. The ribs are closer together on the anterior part of the valves than elsewhere. The interspaces are much broader than the ribs, and are flat or slightly concave; they are marked by numerous fine, concentric ridges.

Affinities.—This species resembles *Lima Dujardini*, Deshayes,[1] from the Senonian, but the interspaces are flat or nearly flat instead of concave, and the well-marked scale-like projections which, in *L. Dujardini*, are placed at intervals on the ribs, but without a concentric arrangement, are not seen.

[1] Dujardin, 'Mém. Soc. géol. de France,' vol. ii (1837), p. 227, pl. xvi, fig. 3. D'Orbigny, 'Terr. Crét.,' vol. iii (1847), p. 569, pl. ccccxxvii, figs. 1—4.

Remarks.—I have seen one example only; it consists of both valves, but with the posterior margin imperfect.

Type.—In the Museum of the Ventnor Institute.

Distribution.—Upper Greensand, chert beds (zone of *Pecten asper*) of the Isle of Wight.

LIMA SUBOVALIS, *Sowerby*, 1836. Plate II, figs. 3, 4 *a*, *b*, 5 *a*, *b*, 6 *a*, *b*, 7 *a*, *b*.

1836. LIMA ? SUBOVALIS, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 359, 342, pl. xvii, fig. 21.
1839. — ASPERA, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 23 (*partim*).
? 1847. — SUBOVALIS, *A. d'Archiac.* Mém. Soc. géol. de France, ser. 2, vol. ii, p. 309.
— — ORNATA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 551, pl. ccccxxi, figs. 6—10.
1850. — — — Prodr. de Pal., vol. ii, p. 167.
— — — *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 192.
1867. — — *E. Guéranger.* Album Paléont. de la Sarthe, p. 19, pl. xxiv, figs. 7, 12.
1869. — SUBOVALIS, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.
1870. — ORNATA, *Pictet and Campiche.* Ibid., pp. 169, 173.
1871. RADULA (ACESTA) ORNATA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.
1872. LIMA ORNATA, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 205, pl. xlii, figs. 16, 17.
? 1877. — — *A. Peron.* Bull. Soc. géol. de France, ser. 3, vol. v, p. 502.
1877. — RAULINIANA, *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxiii, p. 502, pl. xxi, fig. 2.
1893. — ORNATA, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 234.

Non 1852. — — *A. Buvignier.* Statist. géol., etc., de la Meuse, Atlas, p. 23, pl. xviii, figs. 17—19.

Description.—Shell compressed, ovate or subtrigonal, oblique, considerably higher than long, with the ventral and posterior margins rounded. Apical angle about 74°. Umbones small, close together. Anterior area rather small, depressed, limited by a ridge, ornamented with ribs separated by broader grooves.

Ornamentation consists of numerous (65 to 70) fairly strong, rounded ribs of summits, separated by broader rounded furrows. Both ridges and furrows bear numerous flattened radial ridges separated by linear grooves; the ridges, in well-preserved specimens, are serrate or granular. At distant intervals a few well-marked growth-ridges occur.

Measurements:

	(1)	(2)
Length .	49 .	70 mm.
Height .	54 .	78 ,,

(1, 2) Upper Greensand, Devizes.

Affinities.—This species is distinguished from *L. canalifera* (p. 1) by the valves being more compressed, the ribs fewer in number, the grooves relatively broader, and by the presence of fine radial ornamentation on the ribs and grooves.

Remarks.—This appears to be a rare species in England. The specimens from Devizes are in the Museum of Practical Geology. The specimen from Humble Rocks was collected by Mr. Jukes-Browne, and is now in the Sedgwick Museum.

Type.—From the Cenomanian of Coudrecieux, Sarthe.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Devizes. Base of Chalk Marl (Bed 10) of Humble Rocks, West of Lyme Regis.

Lima vectensis, sp. nov. Plate II, figs. 2, *a*—*c*.

Description.—Shell large, rather compressed, ovate, height greater than length; antero-dorsal margin straight, the remainder forming a regular curve. Anterior area deeply depressed. Apical angle apparently about 100°. Anterior ear small; posterior ear larger, with a few ribs.

Ornamentation consists of about 40 rather strong, narrow ribs, with rounded summits which, in places, are slightly tubercular. The ribs are closer together on the anterior part of the valves than elsewhere. The interspaces are much broader than the ribs, and are flat or slightly concave; they are marked by numerous fine, concentric ridges.

Affinities.—This species resembles *Lima Dujardini*, Deshayes,[1] from the Senonian, but the interspaces are flat or nearly flat instead of concave, and the well-marked scale-like projections which, in *L. Dujardini*, are placed at intervals on the ribs, but without a concentric arrangement, are not seen.

[1] Dujardin, 'Mém. Soc. géol. de France,' vol. ii (1837), p. 227, pl. xvi, fig. 3. D'Orbigny, 'Terr. Crét.,' vol. iii (1847), p. 569, pl. cccexxvii, figs. 1—4.

Remarks.—I have seen one example only; it consists of both valves, but with the posterior margin imperfect.

Type.—In the Museum of the Ventnor Institute.

Distribution.—Upper Greensand, chert beds (zone of *Pecten asper*) of the Isle of Wight.

Lima subovalis, *Sowerby*, 1836. Plate II, figs. 3, 4 *a*, *b*, 5 *a*, *b*, 6 *a*, *b*, 7 *a*, *b*.

1836. Lima ? subovalis, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 359, 342, pl. xvii, fig. 21.
1839. — aspera, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 23 (*partim*).
? 1847. — subovalis, *A. d'Archiac.* Mém. Soc. géol. de France, ser. 2, vol. ii, p. 309.
— — ornata, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 551, pl. ccccxxi, figs. 6—10.
1850. — — — Prodr. de Pal., vol. ii, p. 167.
— — — *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 192.
1867. — — *E. Guéranger.* Album Paléont. de la Sarthe, p. 19, pl. xxiv, figs. 7, 12.
1869. — subovalis, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.
1870. — ornata, *Pictet and Campiche.* Ibid., pp. 169, 173.
1871. Radula (Acesta) ornata, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.
1872. Lima ornata, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 205, pl. xlii, figs. 16, 17.
? 1877. — — *A. Peron.* Bull. Soc. géol. de France, ser. 3, vol. v, p. 502.
1877. — Rauliniana, *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxiii, p. 502, pl. xxi, fig. 2.
1893. — ornata, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 234.

Non 1852. — — *A. Buvignier.* Statist. géol., etc., de la Meuse, Atlas, p. 23, pl. xviii, figs. 17—19.

Description.—Shell compressed, ovate or subtrigonal, oblique, considerably higher than long, with the ventral and posterior margins rounded. Apical angle about 74°. Umbones small, close together. Anterior area rather small, depressed, limited by a ridge, ornamented with ribs separated by broader grooves.

Ornamentation consists of numerous (65 to 70) fairly strong, rounded ribs of nearly equal size, but sometimes (chiefly near the posterior border) with smaller intercalated ribs. The ribs diverge slightly from a nearly median line, and bear short spiny or scaly projections at regular intervals but not usually with a concentric arrangement. The spines are rather nearer the inner than the outer side of each rib. The grooves are narrow near the umbo but become broader in passing ventrally, and at the ventral margin may exceed the ribs in breadth. The grooves are rounded and (in some specimens) show transverse ridges. More or less distinct growth-lines occur at intervals.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)
Length	25	21	20	17	16	14 mm.
Height	34	28	29	23	23	20 ,,

(1, 3) Cambridge Greensand.
(2) Base of Chalk Marl, Folkestone.
(4, 5) Upper Greensand, Warminster.
(6) ,, ,, Haldon.

Affinities.—This species belongs to the same group as the Senonian forms *L. Dunkeri*, Hagenow,[1] and *L. muricata*, Goldfuss.[2] It is distinguished from the former by its smaller apical angle and by the spines on the ribs being placed more closely together. *L. muricata* differs from *L. subovalis* in having fewer ribs with their ornamentation developed into long scale-like projections, and in having oblique grooves in the interspaces.

Remarks.—A comparison of the type of *Lima subovalis* with examples of *L. ornata* leaves no doubt as to their identity. The type-specimen of the former is somewhat worn, but sufficiently well-preserved for identification, and another specimen on the same tablet shows the ornamentation quite clearly; the shell is not silicified, so that it was evidently not obtained from Blackdown—the locality given by Fitton—but it has all the appearance of specimens found at Warminster.

The examples from the Cambridge Greensand were referred to *L. Rauliniana*, d'Orbigny,[3] by Mr. Jukes-Browne. The interior of these is filled with phosphate, and the shell, although in some respects well-preserved, is rather abraded, so that the remains of the spines usually appear as notches on the inner side (that facing the median line) of each rib. The transverse ornamentation in the grooves is often very distinct. Mr. Jukes-Browne has recently re-examined these specimens and agrees with me in thinking that they cannot be separated from *L. subovalis*. I

[1] 'Neues Jahrb. für Min., etc.' (1842), p. 556; Vogel, 'Holländ. Kreide' (1895), p. 17, pl. i, fig. 9; Ravn, 'Mollusk. Danmarks Kridtaflej.' (1902), p. 100, pl. ii, fig. 14.

[2] 'Petref. Germ.,' vol. ii (1836), p. 89, pl. ciii, fig. 4; Vogel, *op. cit.*, p. 17, pl. i, figs. 10, 11.

[3] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 542, pl. cccexvii, figs. 5—8; 'Prodr. de Pal.' (1850), vol. ii, p. 138; Pictet and Campiche, "Foss. Terr. Crét. Ste. Croix" ('Matér. Pal. Suisse,' ser. 5, 1869), p. 154, pl. clxvi, fig. 2.

have not been able to obtain specimens of *L. Rauliniana*, but it seems to differ from *L. subovalis* in having a larger posterior ear and in other characters.

Types.—In the Bristol Museum (No. 1778), from the Upper Greensand, probably of Warminster. The type of *L. ornata* is from the Cenomanian of Le Mans. The specimen from the Cambridge Greensand figured by Jukes-Browne is in the Sedgwick Museum, Cambridge.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Haldon. Upper Greensand (zone of *Pecten asper*) of North Dorset, and Warminster. Cambridge Greensand (derived). Rye Hill Sand of Maiden Bradley. Chloritic Marl of Rocken End (Isle of Wight). Base of Chalk Marl (Greensand bed) of Folkestone. Also recorded by the Geological Survey from the Cenomanian of Devon and Chard.

LIMA SCABRISSIMA, sp. nov. Plate II, figs. 8*a*, *b*, 9*a*, *b*.

Description.—Shell compressed, ovate, height greater than length; antero-dorsal margin rather short, straight or slightly concave, ventral and posterior margins forming a regular curve. Anterior area much depressed, sharply limited, nearly smooth or with faint ribs. Apical angle about 92°. Posterior ear of moderate size, with distinct growth-lines; anterior ear small.

Ornamentation consists of a large number of narrow, rounded, more or less undulating ribs separated by broader grooves. The ribs are generally of nearly equal size, but smaller ones may be intercalated in the grooves. At regular intervals the ribs bear scales or lappet-like projections which are arranged concentrically and may become vertical at their ends; these scales are continued across the grooves as laminar projections. On the anterior and posterior ribs the "scales" become more pointed.

Measurements :

	(1)	(2)	(3)
Length .	54 .	52 .	38 mm.
Height .	62 .	58 .	42 ,,

(1—3) Upper Greensand, Warminster.

Affinities.—This species is near to *Lima rhotomagensis*, d'Orbigny,[1] from the Cenomanian of Rouen, but is distinguished from it by being much less convex, by having a smaller anterior area and a smaller apical angle, and by the ribs being relatively narrower and the grooves broader.

Types.—In the Museum of Practical Geology.

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

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 557, pl. ccccxxii, figs. 8—11.

Lima aspera (*Mantell*) 1822. Plate II, figs. 10, 11; Plate III, figs. 1 *a*, *b*, 2–4.

1822. Plagiostoma ? aspera, *G. Mantell.* Foss. S. Downs, p. 129, pl. xxvi, fig. 18.
1854. Lima aspera, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 170.
1870. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 169.
1871. Radula (? Acesta) aspera, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 415.
1903. Lima aspera, *A. J. Jukes-Browne.* Cret. Rocks of Britain (Mem. Geol. Survey), vol. iii, p. 450.

Non 1836. — — *A. Goldfuss.* Petref. Germ., vol. ii, p. 90, pl. civ, fig. 4.
— 1839. — — *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 23, pl. xxi, fig. 10.
— 1841. — — *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 56.
— 1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 34, pl. xxxviii, fig. 17.
— 1847. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 566, pl. ccccxxv, figs. 3–6.
— 1850. — — — Prod. der Pal., vol. ii, p. 248.
— — — — *A. Alth.* Beschreib. d. Umgebung von Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 243.
— 1863. — — *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 150.
— 1869. — — *E. Favre.* Moll. Foss. de la Craie de Lemberg, p. 135.
— 1870. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), pp. 171, 173.
— 1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Die Weissenberg. u. Malnitz. Schicht., p. 132, fig. 118.
— 1883. — — — Ibid., III, Die Iserschicht., p. 114.
— 1887. — — *A. Peron.* L'Hist. Terr. de Craie (Bull. Soc. Sci. hist. et nat. de l'Yonne, ser. 3, vol. xii), p. 150.
— 1889. — (Plagiostoma) aspera, *O. Griepenkerl.* Senon. von Königslutter (Palæont. Abhandl., vol. iv), p. 40.
— 1898. — aspera, *G. Müller.* Mollusk. Untersch. v. Braunschweig u. Ilsede (Abhandl. d. k. preussisch. geol. Landesanst., N.F., Heft 25), p. 26, pl. iv, fig. 5.
— 1900. — — *C. Gagel and F. Kaunhowen.* Jahrb. d. k. preussisch. geol. Landesanst. für 1899, p. 232.

Description.—Shell ovate, higher than long, outline rounded, with the antero-dorsal and postero-dorsal margins straightened; convexity small. Umbones small, pointed, close together, apical angle 80° to 90°. Anterior area deep, narrow.

Anterior ears triangular, rather small; posterior ears obtusely triangular, elongate, with radial ribs.

Valves ornamented with numerous flattened ribs arranged on either side of a line passing from the umbo to the ventral margin, from which they diverge slightly. The ribs are nearly straight or slightly undulating, but are often bent abruptly where they cross growth-lines. Surface of ribs nearly smooth, but sometimes showing very fine concentric ridges or (when worn) oblique striæ. On the inner edge of each rib—that facing the middle line—there are short, slit-like indentations, above each of which a short spiny projection is seen in perfectly preserved specimens. These slits and spines do not, as a rule, show a concentric arrangement. The grooves separating the ribs are very narrow and are marked with pits near the umbo and with transverse grooves ventrally. Sometimes near the margins of the valves new ribs are intercalated or old ones bifurcate.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Length	31	30	28	26	24	19	16 mm.
Height	36	33	33	35	26	23	21 ,,
Number of ribs	66	41	60	46	42	41	52

(1, 2, 3, 7) Totternhoe Stone, Burwell.
(4) ,, ,, Cherry Hinton.
(5, 6) Chalk Marl, Folkestone.

Affinities.—The Senonian form figured as *Lima aspera* by Goldfuss, Reuss, and Fritsch is clearly distinguished from this species by the chevron-like ornamentation on the ribs. Pictet and Campiche suggest that Goldfuss' species may be identical with *Lima Dunkeri*, Hagenow,[1] from Rügen, but this view is not supported by the figures given by Vogel and Ravn. The form figured by d'Orbigny has a larger apical angle than *L. aspera*, Mantell, and does not show the spiny projections on one side of the ribs.

The example figured by Reuss[2] as *Lima plana* is similar in form to *L. aspera*, Mantell, but does not appear to possess the spiny projections on the ribs.

Types.—I have not been able to find the types.[3] They came from the Chalk Marl of Hamsey and Stoneham.

Distribution.—Chloritic Marl of Eastbourne. Chalk Marl of Folkestone, and Blue Bell Hill (Burham). Totternhoe Stone of Arlesey, Burwell, Cherry Hinton, and Stoke Ferry.

[1] 'Neues Jahrb. für Min.,' etc. (1842), p. 556.

[2] 'Verstein. böhmisch. Kreideformat.' (1846), p. 35, pl. xxxviii, fig. 20.

[3] The name *aspera* was used by Chemnitz (1784) for a recent species of *Lima*, but since that has been shown to be a synonym of *Lima scabra* (Born, 1780) there does not appear to be sufficient reason for giving a new name to the Chalk species which, for over eighty years, has been known as *Lima aspera*, Mantell.

Sub-genus—PLAGIOSTOMA, *J. Sowerby*, 1814.

('Min. Conch.,' vol. i, p. 175.)

LIMA (PLAGIOSTOMA) SUBRIGIDA, *Römer*, 1836. Plate III, figs. 5*a*, *b*, 6—9. Text-figs. 1, 2, 3.

1836. LIMA SUBRIGIDA, *F. A. Römer*. Verstein. nord-deutsch. Oolithen-geb., p. 79, pl. xiii, fig. 16.
— — PLANA, *Römer*. Ibid., p. 80, pl. xiii, fig. 18.
1841. — SUBRIGIDA, *Römer*. Die Verstein. d. nord-deutsch. Kreidegeb., p. 57.
— — PLANA, *Römer*. Ibid., p. 57.
1877. — SUBRIGIDA, *G. Böhm*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xxix, p. 235.
1896. — — *A. Wollemann*. Ibid., vol. xlviii, p. 836.
1900. — — *Wollemann*. Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussich. geol. Land., N.F., pt. 31), p. 30.

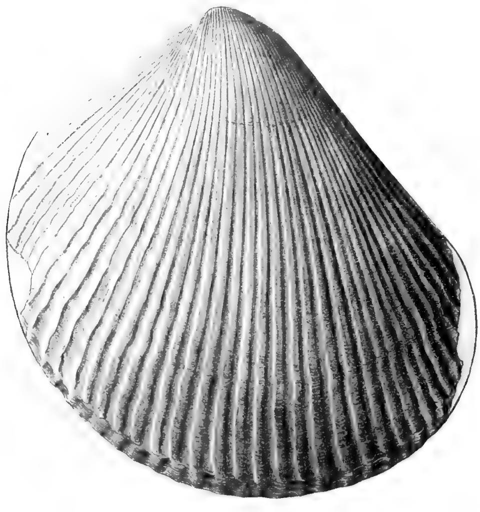

FIG. 1.—*Lima (Plagiostoma) subrigida*, Römer. Claxby Ironstone, Lincolnshire. Right valve. Natural size. Sedgwick Museum, Cambridge.

Description.—Shell convex, oval, height slightly greater than length; antero-dorsal margin nearly straight, postero-dorsal much shorter and nearly straight, the remainder rounded and forming a regular curve. Apical angle rather more than a right angle. Umbones of moderate size. Area large, with a large triangular ligament pit near the middle but bending posteriorly. Anterior area large, deeply depressed, especially near the ears. Ears rather large, the anterior triangular, the posterior rather larger, more elongate; surface with growth-lamellæ only.

Surface ornamented with numerous (43 to 52) radial ribs, which are straight or slightly undulating. The ribs are flattened; near the umbo they are separated by narrow grooves, but in passing ventrally the grooves increase in width and become as wide as or wider than the ribs. The grooves are rather shallow and rounded. The anterior and posterior ribs are narrower than the others. Near the umbo the grooves are punctate, but in passing ventrally the pits soon become replaced by

Fig. 2.—*Lima* (*Plagiostoma*) *subrigida*, Römer. Claxby Ironstone, Benniworth Haven. Right valve. Natural size. Sedgwick Museum.

transverse furrows separated by ridges, and the latter may pass on to the ribs. On the anterior area ribs are small or absent, but growth-lines are usually distinct.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Length . .	109	100	80	73	72	64	63	38	31	mm.
Height . .	114	108	85	79	76	65	65	36	40	,,
Thickness . .	—	63	—	—	—	—	36	—	—	,,
Number of ribs .	48	49	48	51	46	43	52	52	44	

(1—9) Claxby Ironstone, Benniworth Haven.

Affinities.—*L. vigneulensis*, Pictet and Campiche,[1] is distinguished from *L. subrigida* by its more quadrilateral outline, more numerous ribs and finer

[1] 'Terr. Crét. Ste. Croix' (1869), p. 138, pl. clxii, figs. 5—8.

grooves, and also by the earlier part of the shell being nearly smooth. *L. aubersonensis*, Pictet and Campiche,[1] is relatively longer and has narrower grooves.

Remarks.—On account of the imperfect figures of *L. subrigida* given by Römer, the English specimens have not hitherto been referred to that species; they agree perfectly with the descriptions except in the number of ribs, but Dr. Wollemann informs me that that character is variable. I have sent a specimen from the Claxby Ironstone to Dr. Wollemann, and he is able to confirm my identification of the species. Specimens from the Speeton Clay differ from those found in Lincolnshire in having fewer ribs with relatively fewer grooves, but since this is a very variable character it cannot be regarded as indicative of more than a local variety.

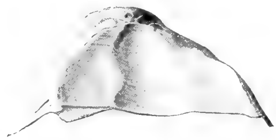

FIG. 3.—*Lima (Plagiostoma) subrigida*, Römer. Claxby Ironstone, Benniworth Haven. Area of right valve. × $\frac{2}{3}$. Sedgwick Museum.

Types.—From the Hilsthon of Brunswick.

Distribution.—Claxby Ironstone (zone of *Belemnites lateralis*) of Benniworth Haven. Upper part of the Speeton Clay of Speeton.

LIMA (PLAGIOSTOMA), sp. cf. ORBIGNYANA, *Matheron*, 1842. Plate III, figs. 10, *a*—*c*.

1842. LIMA ORBIGNYANA, *P. Matheron.* Cat. Foss. des Bouches-du-Rhone, p. 182, pl. xxix, figs. 3, 4.
1846. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 530, pl. cccexv, figs. 1—4.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 107.
1855. — — *G. Cotteau.* Moll. Foss. de l'Yonne, p. 100.
1865. — — *H. Coquand.* Mon. Aptien de l'Espagne, p. 149.
1866. — — *P. de Loriol.* Foss. Oolith. Corall. Valang. et Urgon. Mt. Salève, p. 82, pl. D, fig. 13.
1867. — — *de Loriol*, in *Favre.* Rech. géol. Sans Savoie, vol. i, p. 387, pl. C, fig. 24.
1869. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 126, pl. clxi, fig. 4.
1871. RADULA (ACESTA) ORBIGNYANA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.

[1] Loc. cit., p. 140, pl. clxiv, figs. 1, 2.

Description.—Shell moderately convex, oval, higher than long, ventral and posterior margin rounded. Umbones sharp. Apical angle about 83°. Anterior area depressed, limited by a rounded edge, ornamented with ribs. Ears with distinct growth-ridges. Posterior ear higher than long, and larger than the anterior ear.

Ornamentation consists of about 52 flattened ribs, slightly undulating, separated by very narrow grooves with pits. Near the ventral margin the ribs become divided by a median groove. Near the anterior and posterior margins the ribs are rather narrower than elsewhere. A few moderately distinct growth-lines occur.

Measurements :

Length	20 mm.
Height	25·5 ,,

Affinities.—This is distinguished from *L. villersensis* (see below) by its more numerous and narrower ribs.

Remark.—I have seen one specimen only, which is preserved in the British Museum, No. L 15754.

Distribution.—Lower Greensand (Ferruginous Sands) of Shanklin.

LIMA (PLAGIOSTOMA) VILLERSENSIS? *Pictet and Campiche*, 1869. Plate III, figs. 11*a*, 11*b*, 12*a*, *b*, 13.

? 1869. LIMA VILLERSENSIS, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), pp. 127, 162, pl. clxi, fig. 5.

Description.—Shell moderately convex, oval, higher than long, ventral and posterior margins rounded. Umbones sharp. Apical angle about 85°. Anterior area depressed, bounded by a sharp edge. Posterior ear larger than the anterior, higher than long, with the outer angle obtuse, and with a few radial ribs.

Ornamentation consists of from 32 to 36 broad, flattened, nearly straight ribs, separated by linear grooves with distinct pits. Near the anterior, and sometimes near the posterior border, the ribs become narrower. A few well-marked growth-ridges may occur at distant intervals. Near the ventral margin of the valves (ventral to a growth-ridge) the position of the ribs is sometimes slightly shifted, and the number of ribs may increase owing to the fission of some.

Measurements :

	(1)	(2)	(3)	(4)
Length .	20 .	19 .	18 .	14 mm.
Height .	26·5 .	25 .	22 .	17 ,,

(1—4) Lower Greensand, Faringdon.

Affinities.—I have seen only a few examples of this form. They agree with *L. villersensis* except in having a rather smaller apical angle. In this respect they resemble *L. Orbignyana*, Matheron (see above), but they differ from that species in possessing fewer and straighter ribs. I have not seen any undoubted example of *L. villersensis* and am unable to state whether the apical angle is constantly larger than in the English specimens. Pictet and Campiche say that it is about 95°, but the specimen they figure possesses an apical angle of 90° only. In the English specimens it is about 85°.

This is the form which was referred by Sharpe[1] to *L. consobrina*, d'Orbigny, but it possesses considerably fewer ribs than that species.

Type.—*L. villersensis* is found in the Valanginian of Ste. Croix.

Distribution.—Lower Greensand of Faringdon.

LIMA (PLAGIOSTOMA) SEMIORNATA, *d'Orbigny*, 1847. Plate III, figs. 14, 15, 16*a*, *b*. Plate IV, fig. 1.

1847. LIMA SEMIORNATA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 555, pl. ccccxxii, figs. 1—3.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 167.
1867. — — *E. Guéranger*. Album Paléont. de la Sarthe, p. 19, pl. xxiv, fig. 13.
1870. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 169.
1871. RADULA (PLAGIOSTOMA) SEMIORNATA, *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.
? 1885. — — — *F. Nötling*. Die Fauna d. baltisch. Cenoman. (Palæont. Abhandl., vol. ii), p. 15, pl. ii, fig. 4.

Description.—Shell compressed, rounded, height and length nearly equal. Antero-dorsal border straight or slightly concave. Umbones close together. Anterior area depressed, with a sharp edge. Apical angle 120°.

Surface nearly smooth, shiny, with numerous, very fine, regular, concentric linear ridges, and with radial punctate grooves near the umbo and near the anterior and posterior margins. The grooves near the anterior margin are fewer and more widely separated than those near the posterior margin.

[1] 'Quart. Journ. Geol. Soc.,' vol. x (1853), p. 193 (*sub-consobrina*, d'Orbigny, 'Prodr. de Paléont.,' (1850), p. 167).

Measurements :

	(1)		(2)		(3)		(4)		(5)
Length .	32	.	31	.	29	.	29	.	23 mm.
Height .	33	.	32	.	29	.	26	.	23 ,,

(1, 2) Upper Greensand, Potterne.
(3, 5) ,, ,, Ventnor.
(4) ,, ,, Blackdown.

Affinities.—This species is distinguished by its compressed valves and rounded outline.

Type.—From the Cenomanian of Le Mans.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Potterne (Devizes) and Blackdown. Upper Greensand (zone of *Pecten asper*) of Ventnor. Chalk Marl of Folkestone.

Lima (Plagiostoma) Meyeri, sp. nov. Plate IV, figs. 2,3. Text-fig. 4.

1896. Lima simplex, *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. lii, p. 152.

Description.—Shell ovate or subtrigonal, much compressed, a little higher than long, oblique, considerably inequilateral; antero-dorsal margin long and

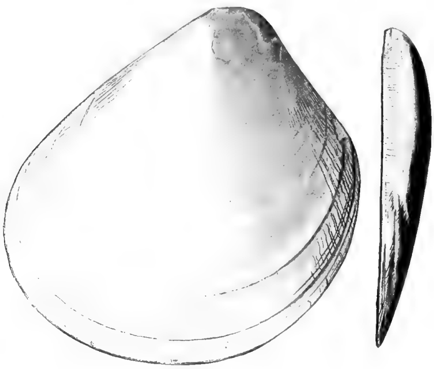

Fig. 4.—*Lima (Plagiostoma) Meyeri*, sp. nov. Upper Greensand, Warminster. Museum of Practical Geology, No. 8838. Left valve and antero-dorsal view. Natural size.

straightened, ventral and postero-ventral margins rounded. Umbones small, close together. Apical angle from 90° to 100°. Anterior area depressed, long and narrow, with a few radial ribs and vertical grooves. Posterior ear small; anterior ear not seen.

Ornamentation consists of narrow, linear, shallow, pitted grooves which may be confined to the anterior and posterior parts of the valves or may extend over the whole surface. The grooves are somewhat irregular and the interspaces are broad and flattened. At distant intervals a few well-marked growth-rings occur, beyond which, in some cases, the ribs cease.

Measurements :

	(1)	(2)	(3)	(4)	(5)	
Length .	69 .	53 .	48 .	42 .	34	mm.
Height .	71 .	56 .	52 .	47 .	37	,,

(1—5) Upper Greensand, Warminster.

Affinities.—This species differs from *Lima semiornata* (p. 14) in being larger, relatively higher, more trigonal in outline, and in having the radial grooves more extensively developed. It is distinguished from *Lima simplex*, d'Orbigny,[1] in being much less convex, in the height being relatively less, the antero-dorsal margin shorter, the anterior area smaller, and the anterior grooves less prominent.

The shell is relatively longer and the apical angle larger than in *L. sub-consobrina*, d'Orbigny.[2] It is also relatively longer, with a longer antero-dorsal margin and the radial grooves less well developed, than in *L. cretacea* (p. 22).

Types.—From Warminster. In the Museum of Practical Geology.

Distribution.—Upper Greensand (zone of *Pecten asper*) of Warminster. Rye Hill Sands and Chloritic Marl of Maiden Bradley. Cenomanian (Meÿer's Beds 10 and 11) of Hooken and Dunscombe (Devon coast).

LIMA (PLAGIOSTOMA) GLOBOSA (*Sowerby*), 1836. Plate IV, figs. 4 *a*—*c*, 5 *a*, *b*, 6 *a*—*c*.

1836. LUCINA? GLOBOSA, *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol. iv, p. 335, pl. xi, fig. 2 (non *Lucina globosa*, Römer, 1839).
1854. LIMA GLOBOSA. *J. Morris*. Cat. Brit. Foss., ed. 2, p. 171.
1895. — — *E. Tiessen*. Zeitschr. der deutsch. geol. Gesellsch., vol. xlvii, p. 473.

Description.—Shell very convex, of moderate size, oval, length considerably greater than height, outline rounded with the antero-dorsal margin long and straightened. Umbones incurved, blunt. Apical angle about 118°. Anterior area large, very deep, limited by a sharp edge, with radial ribs. Ears small.

Surface of valves polished, with faintly-marked growth-lines at intervals;

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 545, pl. cccexviii, figs. 5—7.

[2] Ibid., p. 556, pl. cccexxii, figs. 4—7; *L. sub-consobrina*, d'Orbigny, 'Prodr. de Paléont.,' vol. ii (1850), p. 167.

ornamented with numerous pits having a regular radial and concentric arrangement and giving rise (in some cases) to the appearance of slightly-raised radial and concentric ribs. Near the ventral margin the pits become more elongated (parallel with the margin) and their concentric arrangement may become wavy or irregular. At the anterior and posterior margins the radial arrangement is often more distinct than elsewhere. Sometimes on the median part of the valve the concentric arrangement alone can be recognised.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Length	31	27	25	24	22	20	18	12 mm.
Height	25	23	21	21	19	17	16	10 ,,

(1—3, 5, 7, 8) Totternhoe Stone, Burwell.
(4) Chalk Marl, Ventnor.
(6) ,, ,, Clevancy.

Affinities.—This species closely resembles *Lima albensis*, d'Orbigny,[1] from the Gault of Ervy (Aube), Machéroménil (Ardennes), the Perte-du-Rhône, etc. I have not seen any specimens of *L. albensis*, but it appears to differ from *L. globosa* in the absence of the punctate ornamentation and in having a smaller apical angle.

L. globosa is distinguished from *L. Hoperi* (see below) by its smaller size, more inflated valves, and by the close-set rows of radial and concentric pits.

Type.—In the Museum of the Geological Society, No. 1538, from the Chloritic Marl of the Isle of Wight.

Distribution.—Gault of Folkestone. Red Limestone of Hunstanton. Upper Greensand of Warminster. Cambridge Greensand (base of Chalk Marl). Chalk Marl of Ventnor, Clevancy, Chilcomb well (Winchester), Burham, Folkestone and Cherry Hinton. Cenomanian of Wilmington. Totternhoe Stone of Burwell. Zone of *H. subglobosus* of Chilcomb and Fulbourn.

LIMA (PLAGIOSTOMA) HOPERI, *Mantell*, 1822. Plate IV, figs. 7, 8*a*, *b*, 9*a*, *b*, 10, 11*a*, *b*, 12*a*, *b*.

1822. PLAGIOSTOMA HOPERI, *G. Mantell.* Foss. S. Downs, p. 204, pl. xxvi, figs. 2, 3, 15.
— — — *J. de C. Sowerby.* Min. Conch., vol. iv, p. 111, pl. ccclxxx.

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 541, pl. ccccxvi, figs. 15, 16; 'Prodr. de Paléont.,' vol. ii (1850), p. 138; Pictet and Roux, 'Moll. Foss. Grès verts de Genève' (1852), p. 488, pl. xl, fig. 9; Pictet and Campiche, "Foss. Terr. Crét. Ste. Croix" ('Matér. Pal. Suisse,' ser. 5, 1869), p. 160.

1822. Plagiostoma Mantelli, *A. Brongniart.* Descript. géol. envir. de Paris. In *Cuvier's* Ossem. Foss., vol. ii, pt. 2, p. 600, pl. iv, fig. 3.
1825. Pachytos Hoperi, *M. J. L. Defrance.* Dict. Sci. nat., vol. xxxvii, p. 207.
1827. Plagiostoma punctatum, *S. Nilsson.* Petrif. Suecana, p. 24, pl. ix, fig. 1.
1832. Lima Hoperi, *G. P. Deshayes.* In *J. G. Bruguière,* Hist. nat. des Vers et des Moll. (Encyc. méthod.), vol. ii, p. 349.
1836. — Mantellii, *A. Goldfuss.* Petref. Germ., vol. ii, p. 92, pl. civ, fig. 9.
— — Hoperi, *Goldfuss.* Ibid., p. 91, pl. civ, fig. 8.
— — — *Lamarck.* Anim. sans Vert. (ed. 2 by Deshayes and Milne-Edwards), vol. vii, p. 120.
1837. Plagiostoma punctatum, *W. Hisinger.* Lethæa Suecica, p. 54 (*not* pl. xv, fig. 3).
1838. Lima Hoperi, *H. G. Bronn.* Lethæa Geognost., vol. ii, p. 682, pl. xxxii, fig. 8.
1839. — — *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 24 (? *partim*).
1841. — Mantellii, *F. A. Römer.* Die Versteín. d. nord-deutsch. Kreidegeb., p. 58.
— — Hoperi, *Römer.* Ibid., p. 58.
— — Nilssoni, *Römer.* Ibid., p. 57.
1842. — Goldfussi, *F. v. Hagenow.* Neues Jahrb. für Min., etc., p. 555.
? 1846. — Mantelli, *H. B. Geinitz.* Grundr. d. Versteín., p. 472, pl. xx, fig. 13.
— — Hoperi, *Geinitz.* Ibid., p. 473, pl. xx, fig. 14.
— — — *A. E. Reuss.* Die Versteín. der böhm. Kreideformat., pt. 2, p. 34, pl. xxxviii, figs. 11, 12.
1847. — Sowerbyi, *J. Müller.* Petref. der Aachen. Kreidef., pt. 2, p. 67.
1850. — Hoperi, *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 192.
— — Sowerbyi, *Geinitz.* Ibid., p. 192.
— — Hoperi, *A. Alth.* Geogn.-palæont. Beschreib. von Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 240.
? — — Mantelli, *R. Kner.* Versteín. v. Lemberg (Haidinger's Naturwissensch. Abhandl., vol. iii, pt. 2), p. 29.
— Plagiostoma Hoperi, var., *J. de C. Sowerby,* in *F. Dixon.* Geol. Sussex, pp. 348, 356 (p. 383, ed. 2), pl. xxviii, fig. 21.
1851–2. Lima Sowerbyi, *H. G. Bronn.* Lethæa Geogn., ed. 3, vol. ii, pt. 5, p. 278, pl. xxxii, fig. 8.
? 1852. — Hoperi, *R. Kner.* Denkschr. d. k. Akad. d. Wissensch. Wien, Math.-nat. Cl., vol. iii, p. 318.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 171 (*partim*).
1863. — — *S. Placketko.* Das Becken von Lemberg (Jahresber. d. k. k. zweit. Ober-gymnas. in Lemberg, 1863), p. 19.
— — *A. von Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 148.
— — — *R. Drescher.* Ibid., p. 355.
1869. — — *E. Favre.* Moll. Foss. de la Craie de Lemberg, p. 137, pl. xii, fig. 19.

1870. LIMA HOPERI, *F. Römer.* Geol. von Oberschles., p. 315, pl. xxxiv, fig. 10.
— — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér Pal. Suisse, ser. 5), pp. 171, 173.
— — SOWERBYI, *Pictet and Campiche.* Ibid., p. 173.
1872. — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 41, pl. ix, figs. 13, 14.
1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 133, fig. 120.
1882. — HOPERI, *H. Schröder.* Zeitschr. der deutsch. geol. Gesellsch., vol. xxxiv, p. 263.
1883. — SOWERBYI, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: III, Iserschicht., p. 115, fig. 87.
1888. — HOPERI, *A. Peron.* L'Hist. Terr. de Craie, p. 149.
1889. — (PLAGIOSTOMA) HOPERI. *O. Griepenkerl.* Senon. v. Königslutter (Palæont. Abhandl., vol. iv), p. 40.
— — HOPERI, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: IV, Teplitz. Schicht., p. 84, fig. 78.
— — — *E. Holzapfel.* Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 240, pl. xxvii, fig. 5.
1892. — (PLAGIOSTOMA) HOPERI, *E. Stolley.* Die Kreide Schleswig-Holsteins (Mittheil. a. d. Mineralog. Instit. Univ. Kiel, vol. i), p. 237.
1893. — HOPERI, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: V, Priesener Schicht., p. 100.
1894. — — *B. Lundgren.* Mollusk. i *Mammillatus-* och *Mucronata*-zonerna (K. Svenska Vet. Akad. Handl. N. F., vol. xxvi, No. 6), p. 42.
1897. — — *R. Leonhard.* Kreideformat. in Oberschles. (Palæontographica, vol. xliv), p. 46.
— — — *A. Hennig.* Revis. Lamellibr. i Nilsson's 'Petrific. Suecana,' (K. Fysiogr. Sällsk. i Lund. Handl., N. F., vol. viii), p. 30, pl. ii, fig. 13.
— — (PLAGIOSTOMA) HOPERI, *H. Woods.* Quart. Journ. Geol. Soc., vol. liii, p. 383.
1898. — HOPERI, *G. Müller.* Mollusk. Untersen. v. Braunschweig u. Ilsede, p. 24, pl. iv, fig. 12.
1901. — — *A. Wollemann.* Jahrb. d. k. preussisch. geol. Landesanst. für 1900, vol. xxi, p. 15.
1902. — — *A. Wollemann.* Lüneburg. Kreide (Abhandl. d. k. preussisch. geol. Landesanst., N. F., Heft 37), p. 58.
— — — *J. P. J. Ravn.* Mollusk. Danmarks Kridtaflej.: I, Lamellibr. (K. Danske Vid. Selsk. Skrift. 6 Række, nat. og math. Afd., vol. xi), p. 99, pl. ii fig. 18.

Non 1847. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 564, pl. ccccxxiv, figs. 10—13.
— 1847. — MANTELLI, *d'Orbigny.* Ibid., p. 568, pl. ccccxxvi, figs. 3—5.
— 1850. — HOPERI, *d'Orbigny.* Prodr. de Pal., vol. ii, p. 248.
— — — MANTELLI, *d'Orbigny.* Ibid., p. 248.
— 1877. — HOPERI, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 134, fig. 121.
— — — MANTELLI, *Fritsch.* Ibid., p. 134, fig. 122.
— 1872. — HOPERI, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 40, pl. ix, figs. 11, 12.
— 1881. — — *J. Kiesow.* Cenomanverstein. a. d. Diluvium d. Umgeg. Danzig's (Schrift d. naturf. Gesellsch. in Danzig, N. F., vol. v), p. 414, figs. 9, 10.
? — 1893. — sp., cf. HOPERI, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 234.

Description.—Shell convex, oval, rounded, considerably inequilateral, longer than high. Antero-dorsal margin rather long, slightly convex or nearly straight; postero-dorsal margin rather short; the remainder forming a regular curve. Umbones close together. Apical angle 115° to 117°. Ears rather small, with growth-lines; the posterior longer than high and larger than the anterior ear. Anterior area large, deep, with a more or less sharp border, often with radial grooves which vary in number and are more distinct near the umbo than anteriorly.

Surface of shell nearly smooth. In the region of the umbo numerous linear grooves with pits occur; these may also extend on to the anterior and posterior parts of the shell, and in some cases they are present on the middle of shell, reaching a part of the way or even quite to the ventral margin. The grooves are slightly wavy, sometimes discontinuous, and are deeper near the anterior and posterior margins, and often more widely separated near the former. New grooves are introduced at various distances from the umbo.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Length	57	57	56	52	51	51	47	41	37	34	31	31	mm.
Height	52	50	52	50	47	46	42	39	32	32	28	26	,,

(1) *M. cor-anguinum* zone, Gravesend.
(2) *Uintacrinus* band, Devizes Road, Salisbury.
(3, 6, 12) *A. quadratus* zone, East Harnham.
(4, 7) *M. cor-anguinum* zone, Gravesend.
(5, 10) *M. cor-anguinum* zone, Northfleet.
(8) Chalk Rock, Underwood Hall, Dullingham.
(9, 11) *B. mucronata* zone, Norwich.

Affinities.—This species was described by Brongniart under the name *Plagiostoma Mantelli* from specimens which were sent to him by Mantell from near

Brighton—probably from Lewes. Mantell[1] regarded *Plagiostoma Mantelli* as a synonym of his *Plagiostoma Hoperi*, and I think there can be no doubt as to the correctness of that view.

Geinitz (1872) considered *Lima Hoperi* of Sowerby to be distinct from *L. Hoperi* of Mantell, thinking that the former (which he named *L. Sowerbyi*) was distinguished by being almost smooth, whereas the latter is covered with radial grooves. The smooth and the grooved forms agree exactly in shape, and between these extremes in ornamentation every gradation may be seen. Moreover, although one of the specimens figured by Mantell (fig. 3) is ornamented all over, the others (figs. 2, 15) possess grooves on the sides only. I think, therefore, that there can be no doubt as to the identity of *L. Hoperi* of Sowerby and *L. Hoperi* of Mantell. Further, it should be noted that Sowerby's specimens were sent to him by Mantell as examples of his *L. Hoperi*.

The specimens figured by Geinitz (1872) as *L. Hoperi* (from the Pläner-kalk of Strehlen) are relatively higher (especially fig. 11) than Mantell's species, and are probably examples of *L. cretacea* (see below).

L. Hoperi of d'Orbigny[2] differs in having a smaller apical angle, in being relatively higher, much compressed, and with the grooves more widely separated. It may, however, be only a variety of *L. Hoperi*, Mantell. I have seen undoubted examples of *L. Hoperi*, Mantell, from the Senonian of Marromme (near Rouen), Lillebonne (Seine-Inférieure), and from other French localities. The form described and figured by d'Orbigny as *L. Mantelli* is referred to below (p. 23).

L. Lamberti of Peron,[3] from the zone of *Micraster breviporus* of Joigny, may be only a variety of *L. Hoperi*. It is stated to differ chiefly in its greater length, but in this respect it can, I think, be matched by some undoubted varieties of *L. Hoperi*.

For the relation of *L. Hoperi* to *L. globosa* see page 17, and to *L. cretacea* see page 23.

Remarks.—This species varies considerably in the extent of the ornamentation. Some examples are smooth, save for the pitted grooves near the umbo; in many cases the grooves are continued on to the sides of the shell; less frequently they extend to the middle of the valve, and may even reach the ventral margin. I have not seen sufficient examples, of which the exact horizons are known, to enable me to determine whether any of the varieties are characteristic of certain zones.

Types.—I have not seen the types. The specimens figured by Sowerby are in the British Museum. The types, and also Sowerby's specimens, came from the Upper Chalk (probably from the zone of *Micraster cor-testudinarium* or the zone of

[1] 'Trans. Geol. Soc.,' ser. 2, vol. iii (1835), p. 206.

[2] See Jukes-Browne, 'Quart. Journ. Geol. Soc.,' vol. lii (1896), p. 152.

[3] 'Hist. Terr. de Craie' (1888), p. 151, pl. ii, fig. 1.

M. cor-anguinum) near Lewes. An example from Cambrai is in the d'Orbigny Collection at Paris, but it is probably not the specimen figured in the 'Paléontologie Française.'

Distribution.—(i) Zone of *Terebratulina* of Bevendean, near Brighton.[1]

(ii) Zone of *Holaster planus* of Winchester, Lewes, Dover, Kenley, Cuxton. Chalk Rock of Boxmoor, Luton, Underwood Hall (Dullingham), Westley Waterless.

(iii) Zone of *Micraster cor-testudinarium* of Lewes, Dover, Purley, Strood, Chatham, Swaffham[2] (Norfolk).

(iv) Zone of *Micraster cor-anguinum* of Winchester, Porton, Witherington, Quidhampton, Lewes, the Sussex coast, St. Margaret's, Gravesend, Northfleet, Halling Pit (South Croydon).

(v) Zone of *Marsupites testudinarius* of the coasts of Sussex, Thanet, and Yorkshire. *Uintacrinus* band of Devizes Road, Salisbury.

(vi) Zone of *Actinocamax quadratus* of East Harnham, Hursley (Winchester), the coasts of Sussex and Yorkshire.

(vii) Zone of *Belemnitella mucronata* of the Dorset coast and Norwich.

(viii) Chalk of Trimingham.

LIMA (PLAGIOSTOMA) CRETACEA, nom. nov. Plate IV, figs. 13, 14 *a*—*c*, 15. Plate V, figs. 1*a*, *b*, 2, 3, 4*a*, *b*.

? 1847. LIMA MANTELLII, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 568, pl. cccccxxvi, figs. 3—5 (non *L. Mantelli*, Brongniart).

? 1850. — — — Prodr. de Pal., vol. ii, p. 248.

— — LÆVIUSCULA, *J. de C. Sowerby*, in *F. Dixon.* Geol. Sussex, p. 347 (p. 382, ed. 2), pl. xxviii, fig. 14, (non *L. læviuscula*, Sowerby, 1822).

? 1872. — HOPERI, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 40, pl. ix, figs. 11, 12.

? 1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 134, fig. 121.

? — — MANTELLI, *Fritsch.* Ibid., p. 134, fig. 122.

? 1888. — — *A. Peron.* L'Hist. du Terr. de Craie, p. 151.

Description.—Shell of small convexity, oval, very inequilateral, higher than long. Antero- and postero-dorsal margins nearly straight, the remainder forming a

[1] Also recorded from the *Terebratulina* zone of South Dorset by Dr. Barrois.

[2] This may be from the *M. cor-anguinum* zone.

regular curve. Umbones small, close together. Apical angle usually about 100°, but sometimes only 90°. Ears small, the posterior larger than the anterior. Anterior area of moderate size, very deep, with a sharp edge and numerous radial ribs.

Ornamentation consists of numerous, well-defined, radial grooves with distinct pits, covering the entire surface of the shell. The grooves are straight or slightly wavy, and in some cases are linear, in others broader, the latter giving the appearance of flattened or rounded ribs to the interspaces. The pits in the grooves sometimes extend into the sides of the ribs. New grooves may be introduced near the ventral margin or occasionally near the middle of the valve. In well-preserved specimens very fine concentric ridges are sometimes seen. A few growth-rings are usually present.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Length .	32	32	26	21	21	17	16	12	11 mm.
Height .	37	35	30	24	22	19	19	14	12 ,,

(1) *H. planus* zone, Cuxton.
(2) ,, ,, Cheveley.
(3) ,, ,, Borsted.
(4) *A. quadratus* zone, Whaddon railway cutting, near Salisbury.
(5—7) *A quadratus* zone, East Harnham.
(8) *M. cor-anguinum* zone, Witherington.
(9) *Uintacrinus* band, Devizes Road, Salisbury.

Affinities.—This species is distinguished from *Lima Hoperi* by having a smaller apical angle, by being relatively higher and shorter, with the valves less convex, the anterior area relatively smaller, the entire surface of the shell always ornamented, and the grooves usually deeper.

The specimen figured by d'Orbigny as *Lima Mantelli* is similar in form to some examples of *L. cretacea*, but d'Orbigny states that the furrows are shallow and without pits. A specimen, however, in the d'Orbigny Collection at Paris shows pits in the grooves.

Lima læviuscula, Sowerby (in Dixon) is probably a small example of this species, but its locality and horizon are not stated.

One of the specimens from the Pläner-kalk of Strehlen figured by Geinitz (1872) as *L. Hoperi* (fig. 11) agrees very closely with this species.

Distribution.—Zone of *Terebratulina* of Winchester. Zone of *Holaster planus* of Twyford and Cheveley. Zone of *Micraster cor-testudinarium* of Borstal and Cuxton. Zone of *M. cor-anguinum* of Micheldever, Witherington and Camp Hill (South Wiltshire). Zone of *Marsupites* of Highfield. *Uintacrinus* band of Devizes Road (Salisbury). Zone of *Actinocamax quadratus* of Winchester, East Harnham, West Harnham, and Milford (Salisbury). Zone of *Belemnitella mucronata* of Norwich. Chalk of Trimingham.

LIMA (PLAGIOSTOMA) MARROTIANA, *d'Orbigny*, 1847. Plate V, figs. 6*a*, *b*, 7*a*, *b*.

1847. LIMA MARROTIANA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 561, pl. ccccxxiv, figs. 1—4.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 247.
1889. — (RADULA) MARROTIANA, *O. Griepenkerl.* Senon. von Königslutter (Palæont. Abhandl., vol. iv), p. 39.

Non 1850. — MAROTTIANA, *A. Alth.* Geogn.-pal. Beschreib. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 240, pl. xii, fig. 25. (*L. Althi*, Favre).

Description.—Shell of moderate convexity, oval, more or less trigonal. Antero-dorsal margin rather long, nearly straight; postero-dorsal margin much shorter; the remainder forming a regular curve. Umbones rather small, pointed. Apical angle about 105°. Anterior area large, deeply depressed, sharply limited, ornamented with 10 to 12 strong, rather narrow ribs, which bear, in places, small nodular projections. Ears rather large, with growth-ridges, without ribs; the posterior rather larger than the anterior ear.

Ornamentation consists of 30 to 32 broad ribs with a few smaller ribs near the posterior margin; the ribs are smooth, with flattened or somewhat rounded summits, and are separated by narrow rounded grooves. The grooves show, in places, transverse ridges and grooves which may extend to the sides of the ribs, giving them a notched appearance. Near the ventral margin, especially in old specimens, the ribs become more flattened and the grooves shallower.

Measurements:

	(1)	(2)
Length	59 .	27 mm.
Height	60 .	28 ,,

(1, 2) Upper Chalk (*B. mucronata* zone), Norwich. The measurements of the larger specimen are approximate only.

Affinities.—This is distinguished from other species found in the Chalk by its strong ribs. In *Lima Althi*, Favre, the ribs are more numerous and not so broad.

Lima Marrotiana differs from most of the species which are referred to *Plagiostoma* in having much stronger ribs, but in other respects it agrees closely with that sub-genus.

Remarks.—The only specimens I have seen are from Norwich, where it appears to be rare. The shell is usually more or less crushed, so that its proper outline is distorted.

Types.—D'Orbigny's specimens came from the Lower Senonian of Dordogne, Charente-Inférieure, Cambrai, and Aube.

Distribution.—Zone of *Belemnitella mucronata* of Norwich.

Sub-genus—Acesta, *H. and A. Adams*, 1858.

('Genera of Recent Mollusca,' vol. ii, p. 558.)

Lima (Acesta) longa, *Römer*, 1841. Plate V, figs. 8 *a*, *b*, 9—11, 12 *a*, *b*.

1836. Lima elongata, *F. A. Römer.* Die Verstein. d. nord-deutsch. Oolith.-geb., p. 79, pl. xiii, fig. 11 (non *elongata*, Sowerby).
1841. — longa, *Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 57.
1847. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 529, pl. ccccxiv, figs. 13—16.
1850. — — — Prodr. de Pal., vol. ii, p. 81.
1865. — — *H. Coquand.* Mon. Aptien de l'Espagne, p. 149.
1868. — — *P. de Loriol.* Valangien d'Arzier. (Matér. Pal. Suisse, ser. 4), p. 41, pl. iii, fig. 11.
1869. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 128, pl. clxi, figs. 6, 7.
1871. — — *W. A. Ooster.* Protozoe Helvetica, vol. ii, pp. 104, 123.
1877. — — *G. Böhm.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxix, p. 235.
1883. — — *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 112, pl. v, fig. 6.
1884. — n. sp., *O. Weerth.* Die Fauna des Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 51.
? 1895. — (Plagiostoma) cf. Robinaldina, *F. Vogel.* Holländ. Kreide, p. 56.
1896. — longa, *A. Wollemann.* Zeitschr. der deutsch. geol. Gesellsch., vol. xlviii, p. 836.
1900. — — — Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 27.

Description.—Shell compressed, sub-triangular, rounded, considerably higher than long, of small obliquity. Posterior and ventral margins convex; anterior margin straight. Umbones pointed, close together. Apical angle small—about 70°. Posterior ear large, not separated from the rest of the valve by a depression, ornamented with radial ribs. Anterior ear smaller, much higher than long.

Anterior area lanceolate, depressed, limited by a sharp edge, ornamented with radial ribs.

Ornamentation consists of very numerous, small, somewhat flattened ribs, separated by much narrower grooves. The ribs are usually wavy, and are not all of equal size; posteriorly smaller ribs sometimes alternate with larger. The grooves are punctate and vary somewhat in width. A few distinct growth-lines are seen, below which the direction of the ribs may undergo some deflection.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)
Length . . .	37	35	31	23	21	20 mm.
Height . . .	62	58	56	37	35	32 ,,

(1, 2, 3, 5) Lower Greensand, Upware.
(4) Tealby Limestone, North Willingham.
(6) Speeton Clay, Speeton.

Affinities.—*Lima longa* has a smaller apical angle and is relatively shorter than *L. undata*, Deshayes[1]; it is also clearly distinguished by the absence of the prominent concentric scales, and by the occurrence of pits in the grooves.

Remarks.—In some cases, especially when the specimens are not perfectly preserved, the ribs (as remarked by Wollemann) become indistinct on the middle of the shell. This is the case in specimens from the Tealby Limestone, and in some from the Speeton Clay, in which the middle part of the shell is almost smooth. The outline of the shell and the relative size of the posterior ear are rather variable.

A specimen from West Dereham (Plate V, fig. 13) possesses finer ribs, but may perhaps be only a variety of this species.

Types.—From the Hilsthon of Elligser Brink. A specimen from the same locality (imperfect on the posterior side of the umbo) is figured by d'Orbigny and is preserved in the Museum of Palæontology at Paris. Two of the specimens from Upware figured by Keeping are in the Sedgwick Museum, Cambridge, and another is in the collection of Mr. J. F. Walker.

Distribution.—Lower Greensand of Upware, Potton, and Brickhill. Tealby Limestone (zone of *Belemnites brunsvicensis*) of North Willingham. Upper part of Speeton Series of Speeton.

LIMA (ACESTA) CLYPEIFORMIS, *d'Orbigny*, 1847. Text-figure 5.

1847. LIMA CLYPEIFORMIS, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 543, pl. cccexvii, figs. 9, 10.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 166.

[1] See d'Orbigny, p. 528, pl. cccexiv, figs. 9—12; Pictet and Campiche, p. 133, pl. clxii, fig. 1.

1869. Lima clypeiformis, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse ser. 5), p. 168.

1871. Radula (Acesta) clypeiformis, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.

Description.—Shell very large, compressed, oval, rounded, only slightly oblique. Height equal to or slightly greater than length. Antero-dorsal margin more or less

Fig. 5.—*Lima (Acesta) clypeiformis,* d'Orbigny. Upper Greensand, Chard. Right valve. Taunton Museum. × $\frac{2}{3}$.

straightened and relatively short. Ears rather small, the anterior larger than the posterior. Surface of shell smooth, except for growth-lamellæ at intervals.

Measurements :

Length	160 mm.
Height	168 ,,

Upper Greensand, Chard.

Affinities.—*Lima subclypeiformis*, Futterer,[1] is stated to be related to *L. clypeiformis.*

Remarks.—This is the largest species of *Lima* known in the Cretaceous of England. I have seen two specimens only, one of which is in the Museum of the Somersetshire Archæological and Natural History Society at Taunton, and the other in the Exeter Museum. The occurrence of this species in England was first recorded by Mr. Jukes-Browne.[2]

Type.—D'Orbigny's specimens came from the Cenomanian of Le Mans, etc.

Distribution.—Topmost bed of the Upper Greensand of Chard.

Sub-genus—Mantellum, *J. F. Bolten*, 1798.

('Mus. Bolten.,' 2, p. 160.)

Lima (Mantellum) parallela (*Sowerby*) 1812. Plate V, figs. 14, 15 *a—d*.

1812. Modiola parallela, *J. de C. Sowerby.* Min. Conch., vol. i, p. 31, pl. ix (right-hand top figure).
1842. Lima elegans, *A. Leymerie.* Mém. Soc. géol. de France, vol. v, p. 27, pl. vi, fig. 6. (*Non* Dujardin, *non* Nilsson.)
1845. — elongata, *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 248.
1846. — elegans, *A. Leymerie.* Statist. géol. et min. de l'Aube, pl. vi, fig. 7.
1847. — Cottaldina, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 537, pl. ccccxvi, figs. 1—5.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 119.
1854. — parallela, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 171.
1855. — Cottaldina, *G. Cotteau.* Moll. Foss. de l'Yonne, p. 101.
1858. — — *J. Vilanova-y-Piera.* Mem. geog.-agric. de Castellon, pl. ii, fig. 15.
— — parallela, *F. J. Pictet and E. Renevier.* Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 126, pl. xix, fig. 1.
1865. — — *H. Coquand.* Mon. Aptien de l'Espagne, p. 148.
1869. — Cottaldina, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 151, pl. clxvi, fig. 1.
1883. — farringdonensis, *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 112, pl. v, fig. 12.
1884. — Cottaldina, *O. Weerth.* Die Fauna des Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 52.

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[1] 'Kreidebild. d. Santa Croce in den Venetianer Alpen' (Palæont. Abhandl., vol. vi, 1892), p. 78, fig. 23.

[2] 'Proc. Somerset Archæol. and Nat. Hist. Soc.,' vol. xlix, 1903.

1895. LIMA COTTALDINA, *G. Maas.* Zeitschr. der deutsch. geol. Gesellsch., vo . xlvii, p. 267.
— — (RADULA) COTTALDINA, *F. Vogel.* Holländisch. Kreide., p. 56.
1900. — COTTALDINA, *A. Wollemann.* Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 35, pl. ii, figs. 2, 3.

Non 1847. — PARALLELA, *d'Orbigny.* (See p. 31).

Description.—Shell moderately convex, oblique, oval or rounded-oblong, higher than long. Antero-dorsal margin long, nearly straight, more or less parallel with the postero-ventral margin; postero-dorsal margin short, more or less nearly straight. Anterior margin regularly rounded. Umbones sharp, only slightly curved; apical angle about 90°. Ears of moderate size. Anterior area rather large, slightly convex ventrally, depressed near the umbo, usually smooth except for growth-lines.

Ornamentation consists of 18 to 20 principal ribs, and sometimes of a few smaller ribs near the posterior margin. The principal ribs are roof-like with sharp summits; they are strongest on the antero-dorsal part of the valve and become less elevated and rather more widely separated in passing posteriorly; the two or three anterior ribs (near the anterior area) are rather smaller and closer together. A small rib occurs at the bottom of the furrows between the main ribs; smaller linear ribs may occur on the sides of the principal ribs, especially on the posterior part of the shell. Fine concentric growth-lines are seen on the ribs and furrows.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Length .	26	26	25	23	23	22	19	14 mm.
Height .	21	22	20	19	18	17	16	11 ,,

(1, 4) *Perna*-bed, Atherfield.
(2, 5) Hythe Beds, Lympne.
(3) Lower Greensand, Upware.
(6, 7) Hythe Beds, Hythe.
(8) Ferruginous Sands, Shanklin.

Affinities.—This species is closely allied to *L. Royeriana*, d'Orbigny,[1] but in the latter the ribs do not decrease in size nor become more widely separated on the posterior part of the shell, and the small rib in the furrows is absent or indistinct.

L. parallela is distinguished from *L. gaultina* (p. 31) by being relatively shorter and less compressed, by the ribs on the posterior part of the shell being

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 527, pl. cccexiv, figs. 5—8; Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1869), p. 142, pl. clxiv, figs. 4, 5.

more distinctly smaller than those on the anterior part, and by the presence of the small rib at the bottom of each groove. See also *L. farringdonensis* (below).

L. expansa, Forbes,[1] from the Hythe Beds of Hythe, is known to me only from the type specimen which is preserved in the Museum of the Geological Society (No. 2056). It is an internal cast in clay, somewhat crushed, and shows the ribbing only imperfectly. I think it is probably an example of *L. parallela*, but more specimens from the same horizon are needed before a confident opinion can be given. Similar remarks apply to *L. lingua*, Forbes,[2] which comes from the same horizon and locality, and is likewise preserved in the Museum of the Geological Society (No. 2058).

This and the following eight species are provisionally referred to the sub-genus *Mantellum*, with which they agree in the form of the shell and, in many cases, in the general character of the ornamentation. They differ, however, from the type of *Mantellum* in having the valves closed or almost closed, but there is, as Phillipi has pointed out, every transition from the species in which the valves gape widely to others in which they are closed.

Remarks.—This species shows a fair amount of variation in the proportions of length and height, and also in the obliquity of the shell.

The type-specimen of *L. parallela* is an internal cast, and consequently all writers have found it practically impossible to make out the characters of the species from Sowerby's figure. A comparison of the type with better preserved specimens leaves no doubt in my mind that Sowerby's species is really identical with the form described by d'Orbigny as *L. Cottaldina*. The latter author referred a species found in the Gault (*L. gaultina*, p. 31) to *L. parallela*, Sowerby.

Types.—The type is from the Hythe Beds of Maidstone and is preserved in the British Museum (No. 43,292). The specimen from Upware figured as *L. farringdonensis* by Keeping is in the Sedgwick Museum, Cambridge.

Distribution.—*Perna*-bed and Atherfield Clay of Atherfield. Ferruginous Sands of Shanklin. Hythe Beds of Hythe, Lympne, and Maidstone. Sandgate Beds of Sevenoaks. Folkestone Beds of Folkestone. Lower Greensand of Faringdon and Upware. Speeton Clay of Speeton.

Lima (Mantellum) farringdonensis, *Sharpe*, 1853.

1853.	Lima farringdonensis,	*D. Sharpe.*	Quart. Journ. Geol. Soc., vol. x, p. 198, pl. vi, fig. 2.
Non 1883.	— —	*W. Keeping.*	Foss., etc., Neoc. Upware and Brickhill, p. 112, pl. v, fig. 12.

[1] 'Quart. Journ. Geol. Soc.,' vol. i (1845), p. 249, pl. iii, fig. 11.

[2] Ibid., p. 249, pl. iii, fig. 10.

Remarks.—The chief character in which *Lima farringdonensis* differs from *L. parallela* seems to be in the possession of well-marked ribs over the whole of the anterior area. It also differs from the majority of examples of *L. parallela* in that the ribs only decrease in size to a very small extent in passing from the anterior to the posterior part of the shell; and further, the shell is less inequilateral than is usual in *L. parallela.*

I am inclined to regard *Lima farringdonensis* as not more than a variety of *L. parallela,* but without better material it is impossible to express a confident opinion. Almost all the specimens seen are in the condition of internal casts in a brownish ferruginous sandstone.

Type.—The figure given by Sharpe is taken from a gutta-percha cast of an external mould. It was obtained from Seende and is preserved in the Museum of the Geological Society.

Distribution.—Lower Greensand of Seende and Faringdon.

LIMA (MANTELLUM) GAULTINA, nom. nov. Plate V, figs. 16—20.

? 1827. PLAGIOSTOMA ELONGATA, *J. de C. Sowerby.* Min. Conch., vol. vi, p. 113, pl. dlix, fig. 2 (upper figure only).
1847. LIMA PARALLELA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 539, pl. ccccxvi, figs. 11—14.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 138.
1855. — — *G. Cotteau.* Moll. Foss. de l'Yonne, p. 101.
1854. — ELONGATA, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 171 (*partim*).
1875. — — *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxi, p. 296.
1897. — PARALLELA, *R. B. Newton.* Proc. Dorset Nat. Hist. and Antiq. Field Club, vol. xvii, p. 88, pl. iii, fig. 11.
1900. — — *E. T. Newton* and *A. J. Jukes-Browne.* Cret. Rocks of Britain, vol. i, p. 449.

Non 1850. PLAGIOSTOMA PARALLELUS, *J. de C. Sowerby* in *F. Dixon.* Geol. Sussex, p. 356 (p. 386, ed. 2), pl. xxviii, fig. 16 (=*L. elongata,* Sowerby).

Description.—Shell rather compressed, sub-quadrangular or nearly oblong, very oblique, much longer than high, rounded posteriorly; antero-dorsal margin long and nearly straight, almost parallel with the postero-ventral margin. Apical angle about 100°. Umbones pointed, close together. Ears of moderate size, the anterior larger than the posterior. Anterior area large, slightly concave dorsally, ornamented with fine radial ribs.

Ornamentation consists of 18 to 20 main ribs with a few smaller ribs posteriorly. The ribs are strong, with sharp summits, but become somewhat weaker posteriorly. The sides of the ribs are ornamented with fine radial ribs, and at the summit there is sometimes a rib with pointed projections. Concentric growth-lines are present.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)
Length . .	39	34	29	29	28	17 mm.
Height[1] . .	28	23	20	18	20	12 ,,

(1, 4) Gault, Black Ven.
(2, 3, 5, 6) Gault, Folkestone.

Affinities.—*Lima Iteriana*, Pictet and Roux,[2] appears to differ from this species in having a small rib at the bottom of the groove, and in being relatively shorter. Pictet and Campiche state that the small rib is not always present. I have seen no trace of such a rib in even the best preserved examples of *L. gaultina*. See also *Lima elongata* (p. 36).

Remarks.—One of the specimens figured by Sowerby as *Plagiostoma elongata* (the upper figure 2 of Plate DLIX) is probably an example of this species, but since it is an internal cast only, it is difficult to be sure of its identity without seeing other specimens from the same horizon. The specimen in question, however, agrees in form and in the characters of the ribs with other internal casts which undoubtedly belong to this species. D'Orbigny referred this species to *Lima parallela* (Sowerby) and also included with it *L. elongata*, Sowerby (p. 34).

Types.—The specimen figured by Sowerby, mentioned above, is stated to come from the "Greensand of Folkestone." D'Orbigny's specimens of *Lima parallela*, d'Orbigny *non* Sowerby, came from the Gault of Gérodot and Dienville (Aube).

Distribution.—Gault of Folkestone (zones ii, vii, ix). Gault of Ventnor and Black Ven. Cambridge Greensand (derived). Upper Greensand (zone of *Schlœnbachia rostrata*) of Devizes. Internal casts from the Speeton Clay (zone of *Belemnites jaculum*, C 11) seem to be indistinguishable from this species.

Lima (Mantellum) interlineata, *Jukes-Browne*, 1877. Plate VI, figs. 1 *a*, *b*.

1877. Lima interlineata, *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxiii, p. 502, pl. xxi, fig. 10.

Description.—Shell moderately convex, rounded-oblong. Umbones and ears not seen.

[1] Measured perpendicular to the hinge-line.

[2] 'Moll. Foss. Grès verts de Genève' (1852), p. 484, pl. xl, fig. 5; F. J. Pictet and G. Campiche, 'Foss. Terr. Crét. Ste. Croix' (Matér. Pal. Suisse, ser. 5, 1869), p. 156, pl. clxvi, figs. 4, 5.

Ornamentation consists of 10 to 12 strong ribs with broad interspaces. On the posterior part of the shell the ribs are more widely separated and the interspaces flatter than on the anterior part. In the interspaces there are small radial ribs separated by broad spaces.

Remarks.—The only specimens seen are a few imperfect internal moulds with very small portions of the shell preserved. *L. interlineata* appears to be allied to *L. gaultina* (see above) but is distinguished by possessing fewer ribs with broader and flatter interspaces. The smaller radial ribs are perhaps also better developed than in *L. gaultina.*

Type.—In the Sedgwick Museum, Cambridge.

Distribution.—Cambridge Greensand (derived from the Gault).

LIMA (MANTELLUM) INTERMEDIA, *d'Orbigny*, 1847. Plate VI, figs. 2*a*, *b*, 3, 4*a*—*c*.

1847. LIMA INTERMEDIA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 550, pl. ccccxxi, figs. 1—5.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 167.
1869. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.
? 1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 134, fig. 123.

Description.—Shell moderately compressed, oblique, oval or rounded-oblong, higher than long. Antero-dorsal border rather long and roughly parallel to the slightly curving postero-ventral border; both curve gradually and regularly to join the posterior border. Postero-dorsal shorter than the antero-dorsal border. Umbones inconspicuous, close together. Apical angle about 100°. Ears small, of nearly equal size, the posterior with three or four small radial ribs and with growth-ridges. Anterior area moderately large, slightly convex except near the umbones, smooth or with a few small ribs at the sides.

Ornamentation consists of 20 to 23 ribs. Those on the antero-ventral region are strong and roof-like, and, in old specimens, bear a smaller rib on each side; posterior to this region the ribs become much smaller and less elevated, some being almost linear and with broad and nearly flat interspaces. At the bottom of the furrows and in the middle of the flat interspaces there is a linear rib. In well-preserved specimens very fine radial ribs and concentric lines are seen.

Measurements :

	(1)	(2)	(3)
Length	35	30	30 mm.
Height	31	28	26 „
Thickness	18	17	16 „

(1, 2) Rye Hill Sands, Warminster.
(3) Upper Greensand, Longbridge, Devizes.

Affinities.—This species is closely allied to *Lima parallela*, but is distinguished by being less convex (especially in the region of the umbones), by being rather shorter and higher, and by the ribs decreasing in size rather more rapidly when traced from the antero-ventral region to the posterior region. The fine radial ornamentation is also perhaps rather better marked than in *L. parallela*.

L. intermedia differs from *L. elongata* (see below) in being less convex, relatively shorter, in the ribs being less elevated and decreasing in size posteriorly, and in the absence or indistinct character of the ribs on the anterior area.

It is also relatively shorter and higher than *Lima gaultina*, and the ribs on the posterior half are much smaller and have broader and flatter interspaces. The intermediate rib is distinct in *L. intermedia*, but is absent or indistinct in *L. gaultina*.

Type.—From the Cenomanian of Le Mans.

Distribution.—Upper Greensand (zone of *Pecten asper*) of Longbridge, near Devizes. Rye Hill Sands of Warminster.

LIMA (MANTELLUM) ELONGATA (*Sowerby*), 1827. Plate VI, figs. 5, 6*a*—*c*, 7*a*, *b*.

1822. PLAGIOSTOMA, *G. Mantell.* Foss. S. Downs, p. 129, pl. xix, fig. 1.
1827. — ELONGATA, *J. de C. Sowerby.* Min. Conch., vol. vi, p. 113, pl. dlix, fig. 2 (lower figure).
? 1847. LIMA ASTIERIANA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 549, pl. cccexx, figs. 4—7.
1850. PLAGIOSTOMA PARALLELUS, *J. de C. Sowerby* in *F. Dixon.* Geol. Sussex, p. 356 (p. 386, ed. 2), pl. xxviii, fig. 16.
1854. LIMA ELONGATA, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 171 (*partim*).
1869. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.
1870. — — *F. Römer.* Geol. von Oberschles., p. 343, pl. xxix, fig. 1.
? 1876. — — *H. Deicke.* Tourtia von Mülheim a. d. Ruhr, p. 27.
? 1877. — — *G. Böhm.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxix p. 234.
1897. — — *R. Leonhard.* Kreideformat. in Oberschles. (Palæontographica, vol. xliv), p. 47.
1904. — — *E. T. Newton* and *A. J. Jukes-Browne.* Cret. Rocks of Britain, vol. iii, p. 451.

Non 1836. Lima elongata, *A. Goldfuss.* Petref. Germ., vol. ii, p. 87, pl. cii, fig. 13 (*L. Münsteriana*, d'Orbigny).

— — — — *F. A. Römer.* Verstein. nord-deutsch. Oolith.-geb., p. 79, pl. xiii, fig. 11 (*L. longa*, Römer, 1841).

? — 1841. — — *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 56.

— 1845. — — *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 248 (*L. parallela*, Sowerby).

? — 1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 33, pl. xxxviii, fig. 6, non 9 (= *L. Reussi*, d'Orb.).

— 1863. — — *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 104 (*L. Schmeisseri*, Wollemann).

? — 1872. — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 40, pl. ix, figs. 9, 10.

? — 1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 132, fig. 116.

Description.—Shell of moderate convexity, subquadrangular or nearly oblong, rounded anteriorly, much longer than high. Antero-dorsal margin long, nearly straight, and nearly parallel with the postero-ventral margin; postero-dorsal margin short, nearly straight. Apical angle about 100°. Umbones sharp, close together. Ears of moderate size. Anterior area large, the dorsal part slightly concave, ornamented with from five to seven fairly strong ribs which are crossed by fine growth-ridges.

Ornamentation consists of 19 or 20 very strong ribs, with sharp, and sometimes (especially on the dorsal part of the shell) slightly serrate summits. The ribs have usually at their summits a distinct ridge with a shallow furrow on each side, which sometimes gives rise to the appearance of a ridge on each side of the rib. The grooves between the main ribs are deep, rounded, distinctly limited, and of about the same width as the ribs. On the dorsal portions of the shell fine radial ribs occur on both ribs and grooves; on the ventral portions they are not seen. Fine concentric growth-lines cross both ribs and grooves, and some few (at intervals) are more distinct.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)
Length .	34	27	26	25	24	24 mm.
Height .	24	18	20	20	18	17 ,,

(1. 3, 5, 6) Chalk Marl, Folkestone.
(2) *H. subglobosus* zone, Stoke Ferry.
(4) Chalk Marl, Ventnor.

Affinities.—This species agrees in form with *Lima gaultina* (p. 31), but is distinguished (1) by the stronger ribs on the anterior area, (2) by the grooves being relatively broader and more distinctly limited, (3) by the ribs being more elevated, (4) by the fine radial ribs being usually indistinct except on the dorsal portions of the shell.

The form from the Pläner-kalk (Turonian) of Saxony figured as *Lima elongata* by Geinitz seems to differ from this species in having fewer and more rounded ribs, and in the ribs being more widely separated on the posterior part of the shell than elsewhere. Similar remarks apply to the specimen figured by Fritsch. Without the opportunity of comparing specimens I am unable to give a definite opinion as to the Turonian form being distinct from *L. elongata*.

Lima Astieriana, d'Orbigny, is perhaps identical with *L. elongata*, but the summits of the ribs appear to be somewhat more rounded.

Lima Reussi, d'Orbigny (*L. elongata* of Reuss) seems to differ from *L. elongata* in having a smaller apical angle.

Remarks.—Under the name *Plagiostoma elongata* Sowerby figured two species. It seems advisable to retain the name *elongata* for the one shown in the lower of his two figures, since that form had been previously figured and described (but without a specific name) by Mantell, and Sowerby refers to Mantell's figure as an example of *Plagiostoma elongata.*

Types.—I have not seen the specimen figured by Mantell. Sowerby's type, from the Chalk Marl of Hamsey, and also the specimen figured in Dixon's work are in the British Museum.

Distribution.—The range is from the Chloritic Marl to the zone of *Holaster subglobosus.* Chloritic Marl of Eastbourne and the Isle of Wight. Chalk Marl of Ventnor, Folkestone, and Prince's Risborough. Totternhoe Stone of Arlesey. Zone of *Holaster subglobosus* of Blue Bell Hill (Burham), Stoke Ferry, and Hunstanton.

Lima (Mantellum) elongata, var. echinata, *Etheridge*, 1881. Plate VI, figs. 8, 9 *a—c*.

1881. Lima echinata, *R. Etheridge.* In *Penning and Jukes-Browne,* Geol. Cambridge, p. 144, pl. ii, fig. 2.

Remarks.—The examples described by Etheridge as *Lima echinata* agree perfectly in form, in size, and in the number and character of the ribs with *L. elongata*, but on the ridge at the summit of each rib there is a row of short spines which are frequently rounded and stumpy, and on each side of the rib (outside the shallow groove mentioned in the description of *L. elongata*) there is another row of similar, but slightly smaller spines. In the furrows between the main ribs there are transverse ridges.

On account of the close resemblance in the form and ribbing of *L. echinata* to *L. elongata*, and also from the fact that in some specimens of the former the ornamentation of the ribs is absent from a part of the shell and the ribs are then indistinguishable from those of *L. elongata*, I am led to consider *L. echinata* as not more than a variety of *L. elongata*. Further, in some specimens of *L. elongata* the summits of the ribs are serrate.

L. elongata var. *echinata* presents some resemblance to *L. Schmeisseri*, Wollemann,[1] from the *Rhotomagensis*-Pläner of Lüneburg.

Types.—In the Sedgwick Museum, from Burwell.

Distribution.—Totternhoe Stone (*Holaster subglobosus* zone) of Burwell and Cherry Hinton. Also recorded in the 'Geological Survey Memoirs' from the zone of *Schlœnbachia varians*.

LIMA (MANTELLUM) CANTABRIGIENSIS, nom. nov. Plate VI, figs. 10*a*, *b*, 11, 12.

1881. LIMA ORNATA. *R. Etheridge.* In *Penning and Jukes-Browne*, Geol. Cambridge, p. 144, pl. iii, fig. 2 (non *ornata*, d'Orbigny, 1847; non *ornata*, Buvignier, 1852).

Description.—Shell moderately convex, oval or rounded-oblong. Anterior margin rounded. Umbones and ears not seen.

Ornamentation consists of 16 or 17 main ribs with a few small ribs at the posterior end. The anterior ribs are strong, roof-like, with ridged summits; posteriorly the ribs become less prominent and the interspaces less depressed. Both ribs and grooves are ornamented with fine, well-developed ribs, which are closer together on the ribs than in the grooves; usually three or four occur on each side of a main rib and three in each groove. Numerous concentric ridges occur and give rise to spiny projections where they cross the fine radial ribs.

Affinities.—In form this appears to be similar to *L. parallela* (p. 28), but has fewer ribs and is much more highly ornamented. The small rib at the bottom of the groove is not distinguishable from the other ribs.

It is more convex, has fewer ribs, and has the fine ornamentation better developed than in *L. intermedia*.

Remarks.—This species is known by three specimens only. All are imperfect near the umbo, but the fine ornamentation is well-preserved.

[1] 'Abhandl. d. k. preussisch. geol. Landesanst., N. F.,' Heft 37 (1902), p. 55, pl. vii, fig. 9.

On account of the name *ornata* having been previously used by d'Orbigny and by Buvignier for other species it is necessary to substitute some other name.

Types.—From the Cambridge Greensand (indigenous), preserved in the Sedgwick Museum, Cambridge.

Distribution.—Cambridge Greensand (indigenous). Lower Chalk of Burwell.

LIMA (MANTELLUM) BRITANNICA, sp. nov. Plate VI, figs. 13 *a—d*.

1857. LIMA ELEGANS, *J. W. Salter*. Quart. Journ. Geol. Soc., vol. xiii, p. 85, pl. ii, fig. 3 (non *elegans*, Nilsson).

Description.—Shell moderately convex, sub-quadrate or nearly oblong, very oblique. Antero-dorsal and postero-ventral margins more or less parallel; posterior margin rounded. Ears of moderate size, with a few ribs on the inner portions, and with distinct growth-lines; the anterior larger than the posterior ear. Anterior area not distinctly limited, covered with ribs similar to those on the rest of the valve but of nearly uniform size.

Ornamentation consists of eighteen main ribs, which are strong on the anterior part of the shell, but become smaller in passing to the posterior end. At the summit of each main rib is a narrow, elevated, secondary rib, and on each side of a main rib are two or three similar but rather small ribs. The secondary ribs are separated by broad and rounded furrows. The summits of the secondary ribs are usually sharp and even, but occasionally slightly serrate.

Measurements:

Length	19 mm.
Height	24 ,,

Affinities.—This form, of which I have seen one example only, agrees with the specimen preserved in flint from Moreseat (Aberdeenshire) which was described and figured by Salter as *Lima elegans* (Nilsson). That specimen is now in the Museum of Practical Geology. Nilsson's[1] figure is scarcely sufficient to enable one to determine the species, but from the recent illustrations given by Hennig[2] it is seen that the British specimens differ from *Lima elegans* in being more distinctly oblong and especially in having more numerous secondary ribs.

[1] 'Petrif. Suecana' (1827), p. 26, pl. ix, fig. 7; Hisinger, 'Lethæa Suecica' (1837), p. 55, pl. xv, fig. 10.

[2] Revis. Lamellibr. i Nilsson's 'Petrif. Suecana' (1897), p. 33, pl. ii, figs. 9, 10, 11, 24; *Lima elegans*, Dujardin ('Mém. Soc. géol. de France,' vol. ii, 1837, p. 226, pl. xvi, fig. 1), is apparently distinct from Nilsson's species.

Type.—In the collection of Mr. R. M. Brydone.
Distribution.—Lower part of the zone of *Micraster cor-anguinum* of Seaford.

LIMA (MANTELLUM) REICHENBACHI, *Geinitz*, 1839. Plate VI, figs. 14 *a*, *b*, 15.

1839. LIMA REICHENBACHI, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 24, pl. viii, fig. 4.
1841. — REICHENBACHII, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 57.
1843. — REICHENBACHI, *H. B. Geinitz.* Die Verstein. von Kieslingswalda, p. 23, pl. v, fig. 9.
1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 34.
1847. — REICHENBACHII, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 544, pl. ccccxviii, figs. 1—4.
1850. — REICHENBACHI, *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 190.
— — REICHENBACHII, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 166.
1855. — — *G. Cotteau.* Moll. Foss. de l'Yonne, p. 101.
1867. — — *E. Guéranger.* Album Paléont. de la Sarthe, p. 19, pl. xxiv, fig. 5.
1869. — REICHENBACHII, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.
1872. — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 203, pl. xliii, figs. 1, 2.
1876. — REICHENBACHI, *H. Deicke.* Tourtia v. Mülheim a. d. Ruhr, p. 27.
1882. — REICHENBACHII, *P. de Loriol.* Gault de Cosne, p. 101, pl. xiii, fig. 5.

Description.—Shell convex, oblong, oblique, rounded ventrally; antero-dorsal margin long, nearly straight and almost parallel with the opposite margin. Height considerably greater than length. Anterior area large, smooth, not depressed. Ears rather small, the anterior somewhat larger than the posterior.

Shell ornamented with from seven to ten very strong ribs, which have rounded summits and are separated by rounded grooves of about the same width as the ribs. Small and narrow radial ribs are present on both ribs and grooves.

Measurements :

	(1)	(2)	(3)
Length .	29 .	25 .	21 mm.
Height .	35 .	34 .	27 ,,
Thickness .	19 .	16 .	— ,,

(1—3) Cenomanian, Wilmington.

Remarks.—This species is easily distinguished by the very strong radial ribs. The English specimens, which at present are known from three localities only, are not well-preserved, so that the details of the ornamentation cannot be seen clearly.

The occurrence of *L. Reichenbachi* in England (from Wilmington) was first noted by Mr. Jukes-Browne in 1898. The only specimens which I have seen are now in the Museum of Practical Geology and the Sedgwick Museum.

Types.—From the Lower Pläner (Cenomanian) of Plauen near Dresden.

Distribution.—Upper Greensand (zone of *Pecten asper*) of Warminster. Chloritic Marl of Chard. Cenomanian Sandstone of Wilmington.

LIMA (MANTELLUM), sp. Plate VI, fig. 16 *a*, *b*.

Remarks.—A small specimen in the Museum of Practical Geology (No. 7896) is similar in form and in the general character of its ornamentation to *L. cantabrigiensis* (see p. 37), but the main ribs are not so strongly developed, the interspaces are flatter, and the intermediate ribs are more prominent. It differs from *L. intermedia* in its more distinctly oblong form and in the occurrence of well-developed intermediate ribs.

This specimen resembles closely the lowest of the three figures referred to *Lima elegans* by Guéranger.[1]

Distribution.—Chloritic Marl of Chardstock.

Sub-genus—CTENOIDES, *H. and A. Adams*, 1858 (ex *Klein*, 1753).

('Genera of Recent Mollusca,' vol. ii, p. 557).

LIMA (CTENOIDES) RAPA, *d'Orbigny*, 1847. Plate VI, figs. 17*a*—*c*. Plate VII, fig. 1. Text-fig. 6.

1847.	LIMA	RAPA,	*A. d'Orbigny.*	Pal. Franç. Terr. Crét., vol. iii, p. 546, pl. cccxix, figs. 1—4.
1850.	—	—	*A. d'Orbigny.*	Prodr. de Pal., vol. ii, p. 166.
—	—	—	*H. B. Geinitz.*	Das Quadersandst. oder Kreidegeb. in Deutschland, p. 188.
1855.	—	—	*G. Cotteau.*	Moll. Foss. de l'Yonne, p. 101.
1867.	—	—	*E. Guéranger.*	Album Paléont. de la Sarthe, p. 19, pl. xxiv, figs. 16, 17.

[1] 'Album Paléont. de la Sarthe' (1867), p. 18, pl. xxiv, fig. 1.

1869. Lima rapa, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 168.

1871. Radula (Ctenoides) rapa, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.

1872. Lima rapa, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 206, pl. xliii, fig. 4.

Description.—Shell moderately and regularly convex, with ovate outline, nearly equilateral, considerably higher than long, margins evenly rounded. Umbones small, pointed, close together. Apical angle about 85°. Ears rather large, much

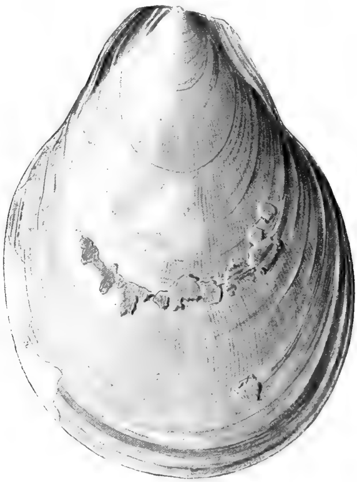

Fig. 6.—*Lima (Ctenoides) rapa,* d'Orbigny. Upper Greensand, Haldon. British Museum, No. L. 15616. Interior of right valve. Natural size.

higher than long, with fine radial ribs; the anterior ear larger than the posterior, the latter with its outer angle obtuse.

Ornamentation consists of numerous fine radial ribs which diverge slightly from a median or nearly median line or sometimes in places from two lines. These ribs are slightly raised and rounded, and are separated by very narrow grooves; near the anterior and posterior margins the ribs become much narrower and sharper, and may bear small pointed projections. The ribs are slightly wavy and their course is often more or less sharply deflected where they pass the growth-lamellæ. Numerous fine linear concentric ridges occur, and also some growth-lamellæ.

Measurements :

	(1)	(2)	(3)
Length .	66 .	43 .	30 mm.
Height .	90 .	59 .	41 ,,

(1—3) Upper Greensand, Haldon.

Affinities.—*L. rapa* is closely related to *L. divaricata* (p. 44) but the valves are less flattened and the anterior part slopes gradually to the margin; the outline is more regularly ovate, and the anterior and posterior ribs are much narrower than the others. *L. rapa* is usually considerably larger than *L. divaricata.*

Types.—From the Cenomanian of Coudrecieux and Le Mans.

Remarks.—The presence of this species in English deposits appears to have been recognised first by the late Mr. C. J. A. Meÿer; it was recorded by Mr. Jukes-Browne in 1896.

Distribution.—Upper Greensand of Haldon. Cenomanian (Meÿer's Bed 10) of Dunscombe.

LIMA (CTENOIDES) TECTA, *Goldfuss*, 1836. Plate VII, figs. 2, 3.

1836. LIMA TECTA, *A. Goldfuss.* Petref. Germ., vol. ii, p. 91, pl. civ, fig. 7.
1837. — FRONDOSA, *F. Dujardin.* Mém. Soc. géol. de France, vol. ii, pp. 216, 227, pl. xvi, fig. 10.
1839. — LAMELLOSA, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 23.
1841. — TECTA, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 58.
1847. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 547, pl. ccccxix, figs. 5—8.
1850. — — *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 188.
— — — *A. d'Orbigny.* Prodr. de Pal., vol. ii, pp. 166, 247.
— — — ?, *A. Alth.* Geogn.-pal. Beschreib. Umgeb. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 243.
? 1852. — — ?, *R. Kner.* Denkschr. d. k. Akad. Wissensch. Math.-nat. Cl., vol. iii, p. 318, pl. xvii, fig. 7.
1867. — — *E. Guéranger.* Album Paléont. de la Sarthe, p. 19, pl. xxiv, fig. 11.
1869. — — *E. Favre.* Moll. Foss. de la Craie de Lemberg, p. 135.
1869–70. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), pp. 168, 170, 173.
1871. RADULA (CTENOIDES) TECTA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 420, pl. xxx, fig. 12.

1872. Lima tecta, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 206, pl. xliii, fig. 3.
1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 130, fig. 113.
1894. — — *B. Lundgren.* Mollusk-faunan i *Mammillatus* och *Mucronata* zonerna (K. Svenska Vet.-Akad. Handl., vol. xxvi, No. 6), p. 43.
1895. — — *F. Vogel.* Holländisch. Kreide, p. 18.
— — cf. tecta, *E. Tiessen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvii, p. 474.
1898. — tecta, *G. Müller.* Mollusk. Untersen. v. Braunschweig u. Ilsede, p. 27.
1902. — — *M. v. Pálfy.* Mittheil. a. d. Jahrb. d. k. ungarisch. geol. Anstalt, vol. xiii, p. 275, pl. xx, fig. 5.

Description.—Shell convex, much flattened, sub-ovate, slightly oblique, considerably higher than long; antero-dorsal part sloping steeply to the antero-dorsal margin which is rather long and straightened. Umbones small, only slightly incurved. Ears rather large, relatively high, the anterior larger than the posterior.

Ornamentation consists of numerous small radial ribs, which are rounded, and smooth or nearly smooth. At fairly regular intervals the course of the ribs is interrupted by strong growth-lamellæ, ventrally to which the direction of the ribs is sometimes deflected. Growth-lamellæ, and sometimes ribs, are present on the ears.

Measurements :

Length	27 mm.
Height	39 ,,

From the Cenomanian (Bed 11) of Dunscombe.

Affinities.—This species is related to *L. divaricata* (see p. 44), but is distinguished by the growth-lamellæ, by the ribs not diverging from a median line, and by the absence of the fine concentric ridges. *Lima essertensis*, de Loriol,[1] from the Urgonian, is a similar form but is distinguished by the growth-lamellæ being more closely placed.

Remarks.—This species has a considerable stratigraphical range, extending from Lower Cenomanian to Senonian. It has been recognised in France, Holland, Scandinavia, Saxony, Bohemia, Hungary, etc. In England it has been found in the Cenomanian of Devon only, having been discovered and identified by the late Mr. C. J. A. Meÿer, and first recorded by Mr. Jukes-Browne. The examples from the Arrialoor Group, described by Stoliczka, seem quite indistinguishable from the European forms.

[1] 'Foss. Corall. Valang. et Urgonien de Mt. Salève' (1866), p. 83, pl. d, fig. 12; also in A. Favre, 'Recherch. géol. Savoie,' vol. i (1867), p. 388, pl. c, fig. 23; Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1869), p. 139, pl. clxiii, fig. 7.

Types.—From the Senonian of Maestricht. D'Orbigny's specimens came from the Cenomanian of Le Mans and from the Senonian of Tours and Loir-et-Cher.

Distribution.—Cenomanian (Bed 11) of Dunscombe.

LIMA (CTENOIDES) DIVARICATA, *Dujardin*, 1837. Plate VII, figs. 4*a*—*d*, 5, 6*a*, *b*.

1837. LIMA DIVARICATA, *F. Dujardin.* Mém. Soc. géol. de France, vol. ii, p. 227, pl. xvi, fig. 7.
1840. — ARCUATA, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 2, p. 57, pl. ix, fig. 7.
1841. — DIVARICATA, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 58.
1850. — — *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 248.
— — GRANOSA, *J. de C. Sowerby* in *F. Dixon.* Geol. Sussex, p. 347 (p. 382, ed. 2), pl. xxviii, figs. 24, 25.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 171.
1859. MYTILUS? SPECTABILIS, *J. Müller.* Petref. der Aachen. Kreidef., supplement., p. 10, pl. vii, fig. 10.
1870. LIMA GRANOSA, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix. (Matér. Pal. Suisse, ser. 5), p. 169.
— — DIVARICATA, *Pictet and Campiche.* Ibid., pp. 171, 173.
1871. RADULA (CTENOIDES) GRANOSA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 415.
— — — DIVARICATA, *Stoliczka.* Ibid., p. 415.
1872. LIMA DIVARICATA, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 205, pl. xlii, fig. 18.
1889. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat.: IV, Teplitz. Schicht., p. 83, fig. 77.
— — — *E. Holzapfel.* Die Mollusk. Aachen Kreide (Palæontographica, vol. xxxv), p. 241, pl. xxvii, fig. 7.
1897. — GRANOSA, *H. Woods.* Quart. Journ. Geol. Soc., vol. liii, p. 383.
1902. — DIVARICATA, *M. v. Pálfy.* Mittheil. Jahrb. d. k. ungarisch. geol. Anstalt, vol. xiii, p. 274, pl. xx, fig. 4.

Description.—Shell convex, flattened, the anterior marginal part sloping steeply, the posterior part more gradually; outline rather variable, more or less ovate or approaching to oblong, considerably higher than long, only slightly unsymmetrical. Umbones rather small, not much incurved. Ears relatively short and high, not sharply limited; the anterior larger than the posterior.

Ornamentation consists of numerous small radial ribs which diverge from a median or nearly median line or sometimes in part from two lines forming an inverted **W**. The ribs are slightly raised and often somewhat wavy or irregular, especially near the growth-ridges. The ribs and grooves are crossed by numerous concentric linear ridges. The ribs are sometimes nodular, the nodules having a concentric arrangement. At intervals, usually rather distant and fairly regular, distinct growth-lamellæ are seen.

Measurements :

	(1)	(2)	(3)
Length .	37 .	20 .	22 mm.
Height .	51 .	37 .	32 ,,

(1) Chalk, Newtimber.
(2) *B. mucronata* zone, Norwich.
(3) *H. planus* zone, Dover.

Affinities.—See *L.* (*Ctenoides*) *rapa* (p. 42) and *L.* (*Ctenoides*) *tecta* (p. 43). *L. divaricata* also presents some resemblance to *Lima Holzapfeli*, Hennig,[1] found in the Danian of Faxe.

Remarks.—This species has hitherto been known in England as *Lima granosa*, Sowerby. After making a careful comparison I feel no hesitation in regarding it as identical with the widely-distributed *L. divaricata*, Dujardin. This form is comparatively rare in England, and the part of the shell near the umbo is usually wanting or imperfectly preserved.

Type.—From the Chalk (? Lower Senonian) of Touraine. Sowerby does not mention the locality or the horizon from which he obtained *Lima granosa*, and I have not succeeded in finding the type.

Distribution.—Zone of *Terebratulina* of Hitchin. Zone of *Holaster planus* of Winchester, Dover, and Cheveley, Blue Bell Hill, Burham (? *H. planus* zone). Chalk Rock of Cuckhamsley. Zone of *Micraster cor-anguinum* of Micheldever. Zone of *Actinocamax quadratus* of Salisbury. Zone of *Belemnitella mucronata* of Salisbury and Norwich.

Sub-genus—LIMATULA, *S. V. Wood*, 1839.

('Mag. Nat. Hist.,' new series, vol. iii, p. 233.)

LIMA (LIMATULA) TOMBECKIANA, *d'Orbigny*, 1847. Plate VII, figs. 7*a*, *b*, 8*a*—*c*, 9*a*, *b*.

1847. LIMA TOMBECKIANA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 534, pl. ccccxv, figs. 13—17.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 82.

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[1] 'Bih. K. Svenska Vet. Akad. Handl.,' vol. xxiv, No. 7 (1899), p. 10, pl. i, figs. 1, 2; Ravn, 'Mollusk. Danmarks Kridtafl I. Lamellibr.' (1902), p. 100, pl. ii, fig. 15.

? 1854. LIMA SEMISULCATA, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 172 (*partim*).
1855. — TOMBECKIANA, *G. Cotteau.* Moll. Foss. de l'Yonne, p. 100.
1861. — — *P. de Loriol.* Anim. Invert. Foss. Mt. Salève, p. 95, pl. xi, fig. 11.
1869. — — *P. de Loriol and V. Gilliéron.* Urgon. infér. de Landeron, p. 19, pl. i, fig. 17.
— — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 148.
1871. RADULA (LIMATULA) TOMBECKIANA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.
— LIMA TOMBECKIANA, *W. A. Ooster.* Protozoe Helvetica, vol. ii, pp. 104, 123, 140.
1883. — — *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 111.

Description.—Shell oval, inflated, higher than long, produced a little more anteriorly than posteriorly. Umbones rather small, close together. Ears equal. Margins of valves rounded, the posterior with a greater curvature than the anterior.

Ornamentation consists of from 13 to 16 strong, rounded or slightly keeled ribs separated by narrow grooves. The ribs are confined to the median part of the shell, and the anterior and posterior parts are without ribs. The ribbed portion is not quite symmetrically placed, the anterior smooth portion being rather larger than the posterior smooth portion. Very fine concentric ridges are present on the shell, and may form scale-like projections where they cross the ribs.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	
Length	9	9	8	8	7	11	mm.
Height	12	11	12·5	13	10	15·5	,,

(1—5) Hythe Beds, Court-at-Street.
(6) Lower Greensand, Brickhill.

Affinities.—Some specimens of *L. Tombeckiana* approach very closely *L. Fittoni* from Blackdown and Haldon (see p. 48), and it is quite possible that the latter is only a local variety of the former since some examples found in the Upper Greensand of Charmouth and Potterne (Plate VII, fig. 10) seem indistinguishable from *L. Tombeckiana*. As a rule *L. Tombeckiana* differs from *L. Fittoni* in having the ribbed part of the shell more nearly symmetrical in position, in the shell being rather longer and rather more convex with the umbonal part more pointed, and in the ribs being more rounded.

L. Tombeckiana differs from *L. semisulcata*, Nilsson, in being smaller, relatively longer, less symmetrical, and with the umbonal part more pointed. In this connection, however, it should be noted that Hennig[1] considers that specimens which

[1] Revis. Lamellibr. i Nilsson's 'Petrific. Suecana' (1897), p. 29.

he has seen from the Lower Greensand of Atherfield and Blackgang belong to *L. semisulcata*. *L. Tombeckiana* also resembles *L. suprajurensis*, Contejean,[1] found in the Upper Jurassic.

Types.—D'Orbigny does not give the locality of the type, but says that he obtained specimens from the Neocomian of Neuchâtel, Auxerre, Saint Sauveur, etc.

Distribution.—Hythe Beds of Court-at-Street near Lympne. Lower Greensand of Brickhill. Tealby Limestone (zone of *B. brunsvicensis*) of North Willingham.

LIMA (LIMATULA) DUPINIANA, *d'Orbigny*, 1847. Plate VII, figs. 11 *a—c*.

? 1845. LIMA SEMISULCATA, *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 248 (non *semisulcata*, Nilsson).
1847. LIMA DUPINIANA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 535, pl. ccccxv, figs. 18—22.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 81.
1854. — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 171.
1855. — — *G. Cotteau*. Moll. Foss. de l'Yonne, p. 100.
1865. — — *H. Coquand*. Mon. Aptien de l'Espagne, p. 151.
1869. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 150.
1871. RADULA (LIMATULA) DUPINIANA, *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 414.

Non 1883. LIMA DUPINIANA, *A. Fritsch*. Stud. im Gebiete der böhm. Kreideformat.: III, Iserschichten, p. 112, fig. 81.

Description.—Shell oval, moderately convex, much higher than long, nearly equilateral, with the posterior margin more convex than the anterior. Umbones very small, pointed, close together. Ears unequal.

Ornamentation consists of from ten to fourteen very narrow radial ribs, usually with sharp summits, separated by broad rounded grooves. The anterior and posterior parts of the shell are without ribs, and the posterior part is considerably larger than the anterior. Very fine concentric ridges are present.

Measurements :

	(1)	(2)	
Length .	11 .	8	mm.
Height .	21 .	14·5	,,

(1) Tealby Limestone, North Willingham.
(2) Ferruginous Sands, Shanklin.

[1] 'Kimmérid. de Montbéliard' (1859), p. 351, pl. xxvii, fig. 9; de Loriol and Cotteau, 'Portland. de l'Yonne' (1868), p. 205, pl. xiv, figs. 1, 2.

Affinities.—This species is easily distinguished from *L. Tombeckiana* (see p. 45) by its relatively higher and less inflated form, by the narrow ribs, and by the less symmetrically placed ribbed area.

In its narrow ribs *L. Dupiniana* resembles *L. subæquilateralis*, d'Orbigny (see page 49) but the ribs in the latter are distributed over the greater part of the shell and are more widely separated and more numerous.

The specimens referred to *L. semisulcata* by Forbes are poorly preserved, but probably belong to this species.

Types.—From the Neocomian of Marolles (Aube) and Saint Sauveur (Yonne).

Distribution.—Tealby Limestone (zone of *B. brunsvicensis*) of North Willingham. Ferruginous Sands of Shanklin. Atherfield Beds of Redhill. Hythe Beds of Hythe (*fide* Topley).

LIMA (LIMATULA) FITTONI, *d'Orbigny*, 1850. Plate VII, figs. 12—14, 15 *a—c*.

1836. LIMA SEMISULCATA, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 336, 359 (*not* 129, 158), pl. xi, fig. 10.
1850. — FITTONI, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 82.
1854. — SEMISULCATA, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 172 (*partim*).
1869. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 166 (*partim*).

Description.—Shell oval, moderately convex, higher than long, slightly inequilateral, with rounded margins, the posterior being more convex than the anterior. Umbones small, close together. Ears equal.

Ornamentation consists of from 13 to 15 radial ribs with sharp summits, separated by narrow grooves. Pointed projections are present on the summits of the ribs, especially near the ventral border of the shell. The anterior and posterior parts of the shell are without ribs. The ribbed area is unsymmetrically placed, and the anterior smooth part of the shell is considerably smaller than the posterior part. Fine concentric ridges are seen on well-preserved specimens.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Length .	10	9	8	8	7	7	6 mm.
Height .	16	14	14	13	12·5	12	10 ,,

(1, 3—7) Upper Greensand, Haldon.
(2) ,, ,, Blackdown.

Affinities.—This form was referred by Sowerby (in Fitton) to the Senonian species *L. semisulcata*, Nilsson,[1] but has been regarded by most later writers as distinct from that species, and was named *L. Fittoni* by d'Orbigny.

L. Fittoni differs, as a rule, from *L. semisulcata* in its smaller size, and in having the ribbed area less extensive and much more asymmetrical in position, though occasionally, however, it is nearly symmetrical. It also appears to differ in having a relatively shorter hinge-line and less equilateral form.

For the relation of *L. Fittoni* to *L. Tombeckiana* see p. 46.

Type.—The type is *Lima semisulcata*, Sowerby (*non* Nilsson) from the Upper Greensand of Blackdown. A specimen in the Bristol Museum is regarded as the type, but does not agree very well with the figure.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown and Haldon. Cenomanian of Axmouth (Bed 12 of Meÿer), Dunscombe (Bed 10), and Pinhay.

Lima (Limatula) subæquilateralis, *d'Orbigny*, 1847. Plate VII, figs. 16*a*, *b*, 17.

1847. Lima subæquilateralis, *A. d'Orbigny.* Pal. Franç. Terr. Cret., vol. iii, p. 558, pl. cccexxiii, figs. 1—5.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 167.
1870. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 169.
1871. Radula (Limatula) subæquilateralis, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 415.

Description.—Shell oval, or rounded oblong, pointed at the umbones, nearly equilateral, about twice as high as long, of moderate convexity. Anterior margin less curved than the posterior. Ears equal, smooth, with pointed ends.

Ornamentation consists of about 20 very narrow ribs separated by broad, slightly concave, interspaces which are crossed by growth-lines. Ribs are absent near the anterior and posterior margins.

Measurements:

Length	10 mm.
Height	19 ,,

Upper Greensand, Warminster.

Affinities.—See *Lima Dupiniana* (p. 48) and *Lima* sp. (p. 52).

Remarks.—I have seen only two English examples of this species, both of

[1] For references, see p. 51, footnote.

which are more or less imperfect, but after an examination of specimens of *L. subæquilateralis* from Le Mans in the Museum of Palæontology at Paris I am inclined to refer them to that species. In the specimens from Le Mans the number of ribs is sometimes greater than is shown in D'Orbigny's figure, also the ears may be less sharply separated from the valve, and in one case the hinge-line was seen to be relatively longer.

Types.—From the Cenomanian of Le Mans. The specimens here figured are in the British Museum.

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

LIMA (LIMATULA) DECUSSATA, *Goldfuss*, 1836. Plate VII, figs. 18*a*, *b*, 19, 20*a*, *b*.

1836. LIMA DECUSSATA, *A. Goldfuss.* Petref. Germ., vol. ii, p. 91, pl. civ, fig. 5.
1837. PLAGIOSTOMA GRANULATUM, *W. Hisinger.* Lethæa Suecica, pl. xv, fig. 7.
1841. LIMA DECUSSATA, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 55.
1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 32, pl. xxxviii, fig. 15.
1847. — SEMISULCATA, *J. Müller.* Petref. der Aachen. Kreidef., pt. 1, p. 33.
1850. — DECUSSATA, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 248.
— — SEMISULCATA, *R. Kner.* Verstein. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 29.
— — DECUSSATA, *A. Alth.* Geogn.-palæont. Beschreib. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 241.
— — SEMISULCATA, *Alth.* Ibid., p. 242.
1863. — DECUSSATA, *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 151.
? — — — *S. Placketko.* Das Becken von Lemberg (Jahresb. d. k. zweite Ober-Gymnas. in Lemberg), p. 20, pl. i, fig. 19.
1866. — — *K. A. Zittel.* Die Bivalven d. Gosaugeb. (Denkschr. d. k. Akad. d. Wissensch. Wien, vol. xxv), pt. ii, p. 105, pl. xvi, fig. 4.
1869. — — *E. Favre.* Moll. Foss. de la Craie de Lemberg, p. 136.
1870. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 174.
1871. RADULA (LIMATULA) DECUSSATA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 415.
1888. LIMA DECUSSATA, *A. Peron.* L'Hist. du Terr. de Craie, p. 145, pl. i, fig. 18.
1889. — — *E. Holzapfel.* Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 242, pl. xxvii, fig. 4.

1900.	LIMA DECUSSATA,	*C. Gagel and F. Kaunhowen.*		Jahrb. d. k. preussisch. geol. Landesanst. für 1899, p. 232.
1902.	—	—	*J. P. J. Ravn.*	Mollusk. i Danmarks Kridtafl.: I. Lamellibr. (K. Danske Vid. Selsk. Skrift., 6 Række, nat. og. math. Afd., vol. xi), p. 96, pl. ii, fig. 11.
—	—	—	*A. Wollemann.*	Fauna d. Lüneburg. Kreide (Abhandl. d. k. preussisch. geol. Landesanst., N. F., Heft 37), p. 57.

Description.—Shell inflated, ovate or rounded-oblong, nearly equilateral. Umbones small. Ears rather small, nearly equal.

Ornamentation consists of numerous sharp ribs, separated by narrow grooves. The ribs become less distinct on the anterior and posterior parts of the shell. Numerous fine concentric ridges occur, and sometimes give rise to a tubercular appearance on the summits of the larger ribs.

Measurements:

		(1)	(2)	(3)	(4)	(5)
Length	.	10	9	7	7	6·5 mm.
Height	.	13·5	12	11	10·5	9·5 ,,

(1, 2, 4, 5) *A. quadratus* zone, East Harnham.
(3) *Uintacrinus* band, Devizes Road, Salisbury.

Affinities.—*L. semisulcata*, Nilsson,[1] is distinguished from *L. decussata* by the ribs being limited to the median part of the shell, and by the relatively higher valves.

Peron thinks that *L. pectinata*, d'Orbigny, may be only a variety of *L. decussata*. It appears to differ from the latter in having the ribs more tubercular and usually fewer in number.

Type.—From the Senonian of Rinkerode, near Münster.

Distribution.—*Uintacrinus* band of Devizes Road, Salisbury. Zone of *Actinocamax quadratus* of East Harnham and Ashley Hill. Zone of *Belemnitella mucronata* of Clarendon.

LIMA (LIMATULA) WINTONENSIS, sp. nov. Plate VII, figs. 21 *a*, *b*, 22 *a*—*d*.

Description.—Shell inflated, ovate, nearly equilateral, pointed dorsally.

Ornamentation consists of 15 or 16 strong, rounded ribs on the median part of the valve only. The ribs are separated by very narrow grooves, and bear many

[1] 'Petrif. Suecana' (1827), p. 25, pl. ix, fig. 3; Hennig, Revis. Lamell. i Nilsson's 'Petrif. Suecana' (1897), p. 28, pl. ii, figs. 14, 17.

strong ridges placed concentrically and regularly. Below a growth-ring the ridges are sometimes situated more closely together. One or two ribs at the margins of the ribbed area are rather smaller than the others. The parts between the ribbed area and the anterior and posterior margins of the valve are smooth except for faint growth-lines.

Measurements :

	(1)	(2)	(3)	(4)	(5)
Length .	7	6	5·5	5·5	5 mm.
Height .	10	8	8	7·5	7 „

(1) Chalk, Clayton.
(2—5) *A. quadratus* zone, Winchester.

Affinities.—This species is distinguished from *L. decussata* (p. 50) by being more pointed dorsally, by having fewer ribs, which also are rounded and confined to the median part of the valve, and by the strong ridges which extend across the ribs.

In outline this species resembles *Lima pectinata*, d'Orbigny,[1] but differs in having fewer ribs, in the absence of ribs on the anterior and posterior parts of the valves, and in the ribs not being carinated and having ridges across them instead of tubercles at the summits.

This species resembles closely the form figured by Geinitz[2] as *L. semisulcata*, Nilsson.

Distribution.—Zone of *Actinocamax quadratus* of Winchester. Upper Chalk (probably zone of *Micraster cor-testudinarium*) of Kenley.

LIMA (LIMATULA), sp. Plate VII, fig. 23 *a*, *b*.

Description.—Shell inflated, oval, nearly equilateral. Umbones small. Hinge-line relatively long. Ears not sharply limited, nearly equal.

Ornamentation consists of about 20 narrow ribs, separated by very broad and shallow interspaces in which very fine radial ribs may be seen. The ribs anterior to the median line are closer together and rather stronger than the others. On the parts of the valves next to the ears ribs appear to be absent.

Measurements :

Length	6·5 mm.
Height	9 „

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 572, pl. ccccxxvii, figs. 15—19.
[2] 'Das Elbthalgeb. in Sachsen,' pt. 2 (1873), p. 53, pl. xvi, fig. 14.

Affinities.—In the character of its ornamentation this form resembles *Lima subæquilateralis*, d'Orbigny (see p. 49), from the Cenomanian of Le Mans, but the shell is not so high, is less pointed in the umbonal region, and has a longer hinge-line.

In outline this form resembles the example figured by Ravn[1] as *Lima Forchhammeri*, von Hagenow, but possesses a much larger number of ribs.

Remarks.—I have seen one specimen only, which is in Dr. Blackmore's collection.

Distribution.—Zone of *Belemnitella mucronata* of Clarendon (Salisbury).

Sub-genus—LIMEA, *H. G. Bronn*, 1831.

('Italiens Tertiär-Gebilde und deren Organische Einschlüsse,' p. 115.)

LIMA (LIMEA?) COMPOSITA (*Sowerby*), 1836. Plate VII, figs. 24*a*, *b*, 25*a*, *b*, 26.

1836. PECTEN COMPOSITUS, *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol. iv, pp. 241, 342, pl. xvii, fig. 20.
1847. LIMA CENOMANENSIS, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 552, pl. ccccxxi, figs. 11—15.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 167.
1867. — — *E. Guéranger*. Album Paléont. de la Sarthe, p. 19, pl. xxiv, figs. 4, 9.
1870. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), pp. 161, 168.
1871. LIMEA — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 416.
1882. LIMA — *R. Windmöller*. Jahrb. d. k. preussisch. geol. Landesanst. für 1881, pp. 24, 29.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	
Length	12·5	11	10	9	9	8	mm.
Height	15	13	11·5	10·25	10	9·5	,,

(1, 3—6) Upper Greensand, Warminster.
(2) Rye Hill Sand, Maiden Bradley.

Affinities.—This form is closely related to *Lima granulata* (see below). The ornamentation appears to have been similar in both cases, but in *L. composita* the scale-like spines on the ribs are much less perfectly preserved and usually appear as tubercles only. In *L. composita* the shell appears to be rather less oblique and

[1] 'Molluskerne i Danmarks Kridtaflej. I. Lamellibr.' (1902), p. 97, pl. ii, fig. 12.

more nearly equilateral than in *L. granulata;* the height is also slightly greater and the umbones rather more prominent; the ribs appear to be narrower and to have sharper summits. The smaller convexity of *L. composita* mentioned by d'Orbigny does not seem to be constant.

Remarks.—An examination of the type of *Pecten compositus*, Sowerby, shows that it is an example of this species (see Vol. I, p. 188, footnote), and consequently the specific name *composita* must take the place of *cenomanensis.*

The French examples which I have seen are, on the average, larger than the English.

Types.—The type of *L. cenomanensis* came from the Cenomanian of Le Mans. The type of *Pecten compositus* is in the Bristol Museum; it is labelled "Blackdown" but is not siliceous and is more probably from Warminster.

Distribution.—Upper Greensand (zone of *Pecten asper*) of Warminster. Rye Hill Sand of Maiden Bradley. I have not seen the specimens recorded in the Memoirs of the Geological Survey from the zones of *Schlœnbachia varians* and *Holaster subglobosus* of Hunstanton.

Lima (Limea?) granulata (*Nilsson*), 1827. Plate VII, figs. 27*a*—*c*, 28, 29*a*, *b*.

1827. Plagiostoma granulatum, *S. Nilsson.* Petrif. Suecana, p. 26, pl. fig. 4.
1833. — granulosum, *S. Woodward.* Geol. Norfolk, pp. 48, 51, pl. v, fig. 26.
1836. Lima granulata, *A. Goldfuss.* Petref. Germ., vol. ii, p. 89, pl. ciii, fig. 5.
1837. Plagiostoma granulatum, *W. Hisinger.* Lethæa Suecica, p. 54 (*not* the figure, pl. xv, fig. 7).
1841. Lima muricata, *F. A. Römer.* Die Versteín. d. nord-deutsch. Kreidegeb., p. 55.
1842. — granulata, *F. v. Hagenow.* Neues Jahrb. für Min., etc., p. 555.
1846. — — *A. E. Reuss.* Die Versteín. der böhm. Kreideformat., pt. 2, p. 32, pl. xxxviii, fig. 21.
1847. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 570, pl. ccccxxvii, figs. 5—9. (Named *L. granosa* on plate.)
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 248.
1851. — pseudocardium, inflata et dentata, *J. Müller.* Petref. der Aachen. Kreidef., pt. 2, pp. 67, 68.
1855. — granulata, *G. Cotteau.* Moll. Foss. de l'Yonne, p. 102.
1870. — — *C. Schlüter.* Neues Jahrb. für Min., etc., p. 950.
— — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 170.

1876. Limæa granulata, *D. Brauns.* Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 386.

? — Lima granulata, *H. Deicke.* Die Tourtia von Mülheim a. d. Ruhr, p. 27.

1881. Limea granulata, *K. A. Zittel.* Handb. d. Palæont., vol. ii, p. 27.

1888. Lima granulata, *A. Peron.* L'Hist. Terr. de Craie, p. 147.

1889. Limea granulata, *O. Griepenkerl.* Senon. von Königslutter (Palæont. Abhandl., vol. iv), p. 41.

— Lima granulosa, *E. Holzapfel.* Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 239, pl. xxvii, fig. 6.

— — granulata, *A. Fritsch.* Stud. im Gebiete der böhm Kreideformat.: IV, Teplitz. Schicht., p. 83, fig. 76.

1893. — — *Fritsch.* Ibid., V, Priesener Schicht., p. 100.

1894. — — *B. Lundgren.* Mollusk-faunan i *Mammill.* och *Mucron.* zonerna (K. SvenskaVet.-Akad. Handl., N. F., vol. xxvi, No. 6), p. 42.

1897. — — *A. Hennig.* Revis. Lamell. i Nilsson's 'Petrific. Suecana' (K. Fys. Sällsk. i Lund. Handl., N. F., vol. viii), p. 26, pl. ii, figs. 6—8.

1898. — — *G. Müller.* Mollusk. d. Untersen. v. Braunschweig u. Ilsede (Abhandl. d. k. preussisch. geol. Landesanst., N. F., Heft 25), p. 29, pl. iv, fig. 6.

1901. — — *A. Wollemann.* Jahrb. d. k. preussisch. geol. Landesanst. für 1900, vol. xxi, p. 16.

1902. — — *Wollemann.* Lüneburg. Kreide (Abhandl. d. k. preussisch. geol. Landesanst., N. F., Heft 37), p. 57.

— — — *J. P. J. Ravn.* Mollusk i Danmarks Kridtaflej. I. (K. Danske Vid. Selsk. Skrift., 6 Række, nat. og. math. Afd., vol. xi), p. 101.

Non 1837. — — *F. Dujardin.* Mém. Soc. géol. de France, vol. ii, p. 226, pl. xvi, fig. 4 (= *L. Meslei,* Peron, 1888).

Description.—Shell very convex, oval, slightly oblique, with rounded outline; height a little greater than length. Apical angle very large. Umbones small, incurved, close together. Ears of moderate size, nearly equal, rather low and long, with a few spiny ribs.

Ornamentation consists of numerous (usually from 22 to 24) strong ribs with sharp summits, separated by narrow furrows. Each rib bears three rows of scale-like spines, one row being at the summit and one on each side. The spines are placed near together, at regular intervals, and curve upwards from the surface of the shell, the terminal parts sometimes becoming quite erect. The middle row is rather larger than the rows on the sides. In some cases the spines are represented by granules. On the anterior and posterior parts of the shell the ribs may be smaller than elsewhere, but the middle rows of spines are here often relatively larger.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
Length	19	16	15	11	10	10	10	8	9·5	16	21	mm.
Height	21	18	16	12·5	11	10·5	11	9	10	18	?24	,,

(1—5) *B. mucronata* zone, Norwich.
(6) ,, ,, Alderbury.
(7) *A. quadratus* zone, East Harnham.
(8) *B. mucronata* zone, Clarendon.
(9—11) Chalk of Trimingham.

Affinities.—The form from the Lower Senonian of Touraine described and figured as *Lima granulata* by Dujardin, is regarded by Peron[1] as belonging to another species which he names *Lima Meslei.* Peron states that *L. Meslei* differs from *L. granulata* in having more numerous ribs ornamented with fine granules of which the middle row is not larger than the lateral rows; further, the ribs disappear on the anterior and posterior parts of the shell, and the ears are without ornamentation.

Radula scabricula, Stoliczka,[2] from the Arrialoor Group, is closely related to *Lima granulata*, but owing to the imperfect preservation of the single valve on which the species is founded, an exact comparison is not possible. The ornamentation, however, seems to differ, since it apparently consists of small tubercles of nearly equal size. It has been suggested by Holzapfel and Hennig that *Lima pseudocardium*, Reuss,[3] may be identical with *L. granulata*, but the ornamentation on the ribs of that species appears to be unknown.

Remarks.—This species has been referred to *Limea* by Brauns, Zittel, and Griepenkerl, but later writers—Holzapfel, Hennig, and Ravn—retain it in the genus *Lima* since they find no evidence of the existence of a taxodont hinge. The specimens which I have seen do not show the hinge.

The outline of the shell varies to some extent in *L. granulata*, depending mainly on the obliquity of the valves. The appearance of the ribs varies considerably and is probably due chiefly to the state of preservation; in the more perfect specimens the terminations of the scale-like spines become erect, in others the spines are in the form of sloping scales, whilst in some cases they are represented by tubercles only. The number of ribs also shows variation.

[1] 'L'Hist. du Terr. de Craie' (1888), p. 148, pl. i, figs. 21—24.

[2] 'Palæont. Indica, Cret. Fauna S. India' (1871), vol. iii, p. 419, pl. xxx, fig. 8.

[3] 'Die Verstein. der böhm. Kreideformat.' (1846), pt. 2, p. 33, pl. xxxviii, figs. 2, 3; Geinitz, "Das Elbthalgeb. in Sachsen" ('Palæontographica,' vol. xx, pt. 1, 1872), p. 204, pl. xlii, figs. 14, 15: see also Brauns (1876), Fritsch (1877, 1883), Michael (1893), Leonhard (1897).

The figures are of natural size *unless the amount of enlargement or reduction is stated.*

PLATE I.

Genus—Lima, *Bruguière.*

Lima canalifera, Goldfuss. Upper Greensand (zone of *Pecten asper*), Ventnor. Sedgwick Museum, Cambridge; except fig. 2, York Museum. (P. 1.)

1, 5, 6 *a*, 7 *a*, left valves; 6 *b*, antero-dorsal view; 7 *b*, portion × 2.
2, 3, 4, right valves.

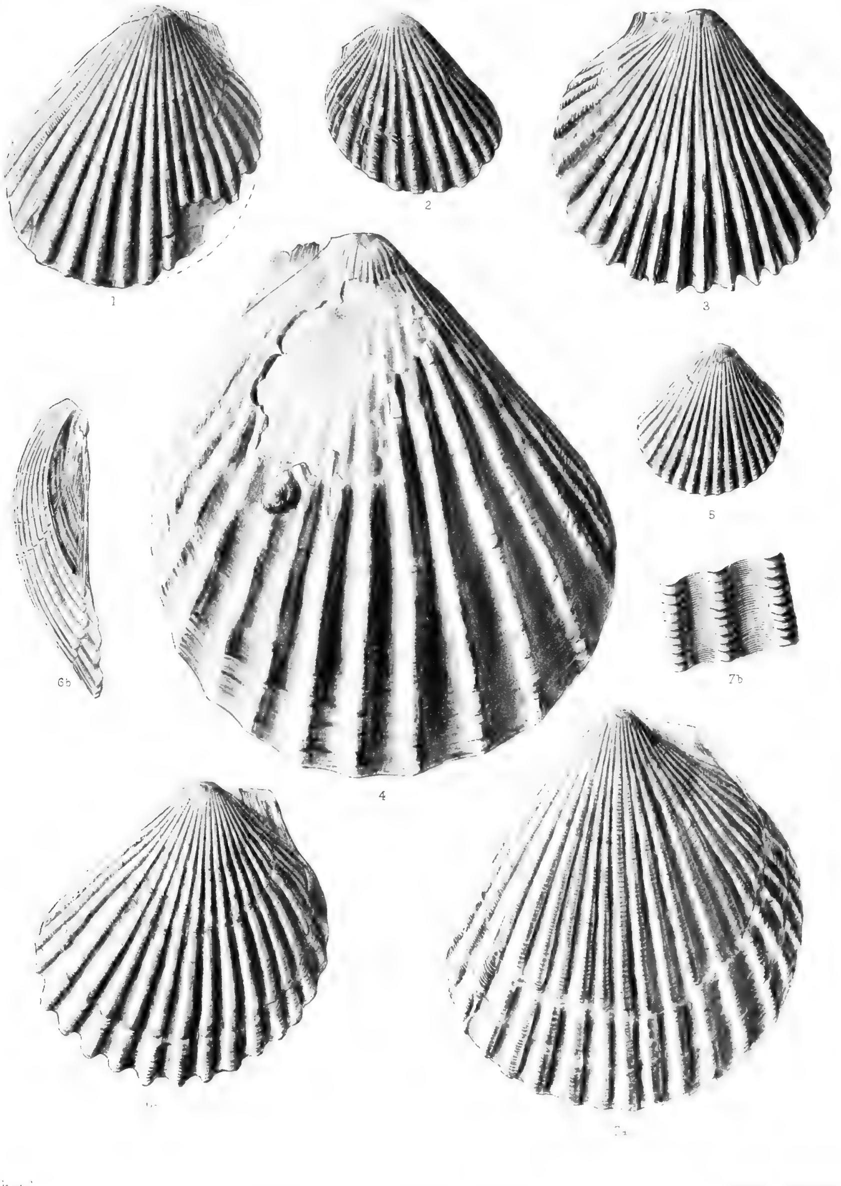

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PLATE II.

Lima (*continued*).

Figs.

1. *L. Galliennei*, d'Orb. Upper Greensand (zone of *Schlœnbachia rostrata*), Devizes. Museum of Practical Geology, No. 8798. *a*, right valve; *b*, antero-dorsal view; *c*, antero-ventral portion × 3. (P. 3.)

2. *L. vectensis*, Woods. Upper Greensand (zone of *Pecten asper*), Isle of Wight. Ventnor Institute. *a*, left valve; *b*, antero-dorsal view; *c*, portion × 3. (P. 4.)

3—7. *L. subovalis*, Sow. (P. 5.)

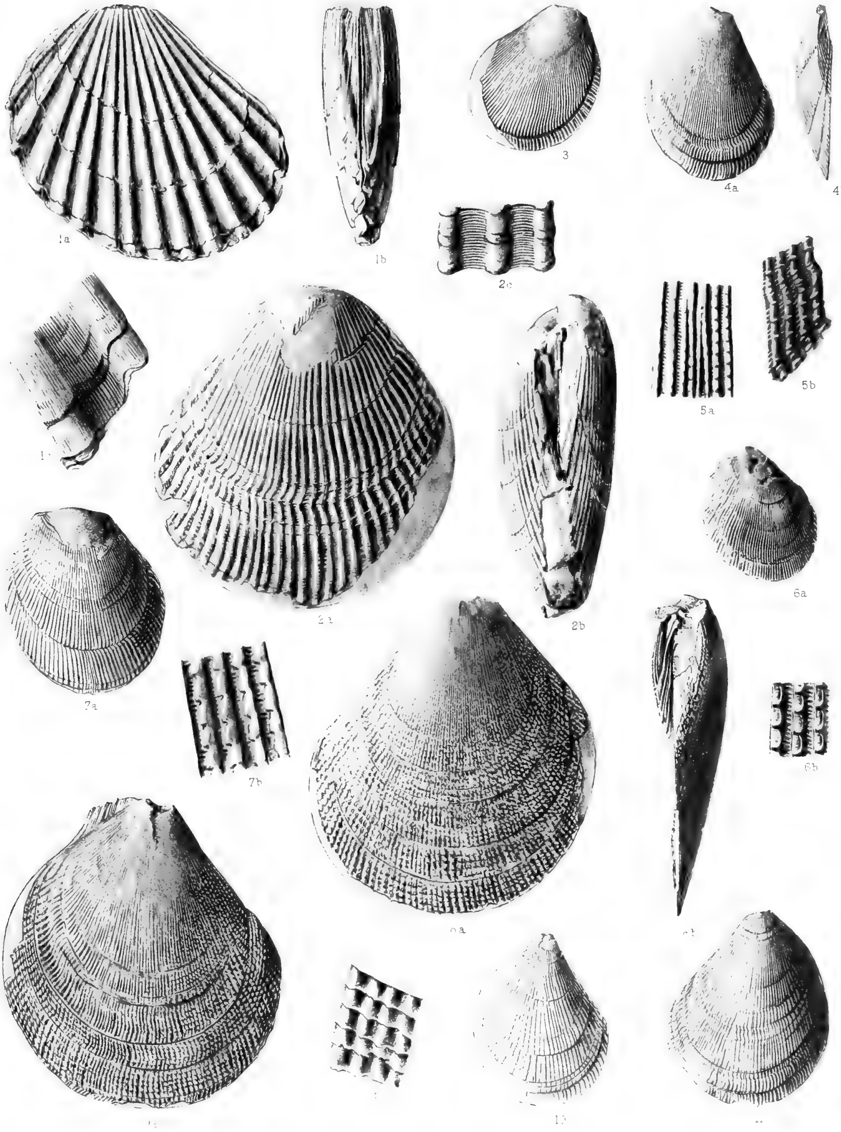
3. Upper Greensand, probably Warminster. Bristol Museum. Left valve × $1\frac{1}{2}$.
4. Upper Greensand, Warminster. Museum of Practical Geology, No. 8805. *a*, right valve × $1\frac{1}{2}$; *b*, antero-dorsal view × $1\frac{1}{2}$.
5. Same horizon, etc. No. 8804. Left valve. *a*, median portion × 8; *b*, posterior portion × 8.
6. Greensand bed at the base of the Chalk, Folkestone. Sedgwick Museum. *a*, right valve; *b*, portion × 8.
7. Cambridge Greensand. Sedgwick Museum. *a*, right valve × $1\frac{1}{2}$; *b*, antero-ventral portion × 8.

8, 9. *L. scabrissima*, Woods. Upper Greensand (zone of *P. asper*), Warminster. Museum of Practical Geology, Nos. 8815, 8816. (P. 7.)

8 *a*, left valve; *b*, antero-dorsal view.
9 *a*, right valve; *b*, portion × 4.

10, 11. *L. aspera* (Mant.). Lower Chalk (Totternhoe Stone). Sedgwick Museum. (P. 8.)

10. Cherry Hinton. Right valve.
11. Cherry Hinton. Left valve.



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CRETACEOUS LAMELLIBRANCHIA

PLATE III.

Lima (*continued*).

Figs.

1—4. *L. aspera* (Mant.). Lower Chalk (Totternhoe Stone). 1—3. Sedgwick Museum. 4. York Museum. (P. 8.)

1. Burwell. *a*, right valve × $1\frac{1}{2}$; *b*, median portion × 6.
2. Cherry Hinton. Left valve.
3. Burwell. Anterior area of right valve × $1\frac{1}{2}$.
4. Burwell. Right valve.

5—9. *L.* (*Plagiostoma*) *subrigida*, Römer. Claxby Ironstone, Benniworth Haven. Sedgwick Museum (P. 10.)

5 *a*. Right valve; *b*, antero-dorsal view.
6. Left valve.
7. Antero-ventral part of right valve.
8. Portion of right valve × 6.
9. Left valve. Portion of a young individual × 8.

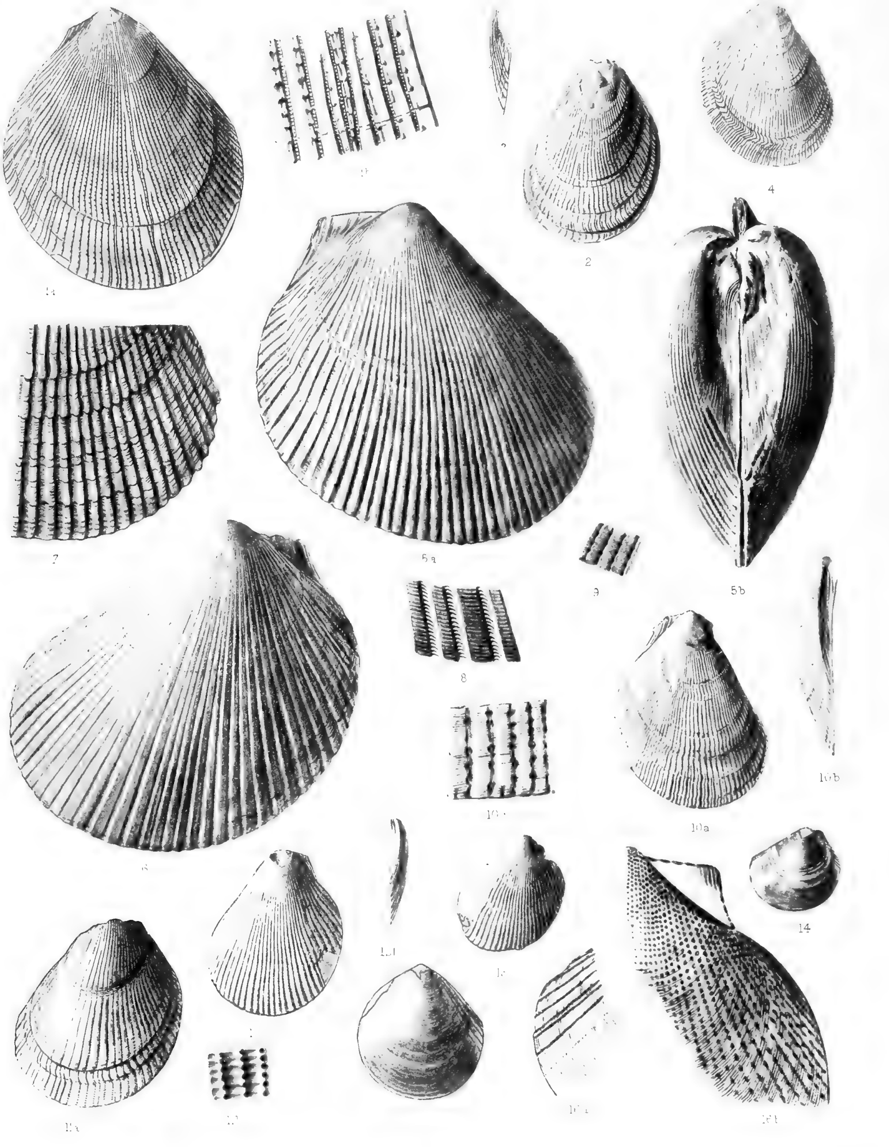
10. *L.* (*Plagiostoma*) sp., cf. *Orbignyana*, Matheron. Lower Greensand (Ferruginous Sands), Shanklin. British Museum, No. L 15754. *a*, right valve × $1\frac{1}{2}$; *b*, anterior view of the same × $1\frac{1}{2}$; *c*, portion × 6. (P. 12.)

11—13. *L.* (*Plagiostoma*) *villersensis ?* Pict. and Camp. Lower Greensand, Faringdon. Sedgwick Museum. (P. 13.)

11 *a*, left valve × $1\frac{1}{2}$; *b*, portion × 4.
12 *a*, left valve × $1\frac{1}{2}$; *b*, anterior view, natural size.
13. Left valve.

14—16. *L.* (*Plagiostoma*) *semiornata*, d'Orb. Upper Greensand, Ventnor. (P. 14.)

14. York Museum. Left valve.
15. Sedgwick Museum. Right valve.
16. York Museum. Left valve. *a*, anterior part × 3; *b*, postero-dorsal part × 3.



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CRETACEOUS LAMELLIBRANCHIA

PLATE IV.

LIMA (*continued*).

FIGS.

1. *L.* (*Plagiostoma*) *semiornata*, d'Orb. Upper Greensand, Ventnor. York Museum. Left valve. Portions of this specimen are enlarged on pl. iii, figs. 16 *a*, *b*. (P. 14.)

2, 3. *L.* (*Plagiostoma*) *Meyeri*, Woods. Upper Greensand, Warminster. (P. 15.)

2. Right valve. Museum of Practical Geology, No. 8839.
3. Left valve. Sedgwick Museum, Cambridge.

4—6. *L.* (*Plagiostoma*) *globosa* (Sow). Lower Chalk. 4, 5. Totternhoe Stone, Burwell. 6. Zone of *Holaster subglobosus*, Fulbourn. Sedgwick Museum. (P. 16.)

4 *a*, left valve; *b*, dorsal view × $1\frac{1}{2}$; *c*, portion × 12.
5 *a*, right valve; *b*, mid-ventral portion × 12.
6 *a*, right valve; *b*, dorsal view; *c*, median portion × 12.

7—12. *L.* (*Plagiostoma*) *Hoperi*, Mant. (P. 17.)

7—10. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's collection 7. Left valve; 8 *a*, right valve; 8 *b*, anterior area of left valve; 9 *a*, left valve 9 *b*, dorsal view; 10, left valve.
11. Zone of *Belemnitella mucronata*, Norwich. Norwich Museum. 11 *a*, right valve; 11 *b*, anterior area of the same.
12. Zone of *Micraster cor-anguinum*, Gravesend. Mr. Dibley's collection. 12 *a*, left valve; 12 *b*, portion × 6.

13—15. *L.* (*Plagiostoma*) *cretacea*, Woods. Dr. Blackmore's collection. (P. 22.)

13, 15. Zone of *Actinocamax quadratus*, East Harnham. 13. Right valve × $1\frac{1}{2}$. 15. Left valve.
14. Upper part of zone of *A. quadratus*, Whaddon railway cutting. *a*, right valve: *b*, antero-dorsal view × $1\frac{1}{2}$; *c*, portion × 6.

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Vol II PLATE IV

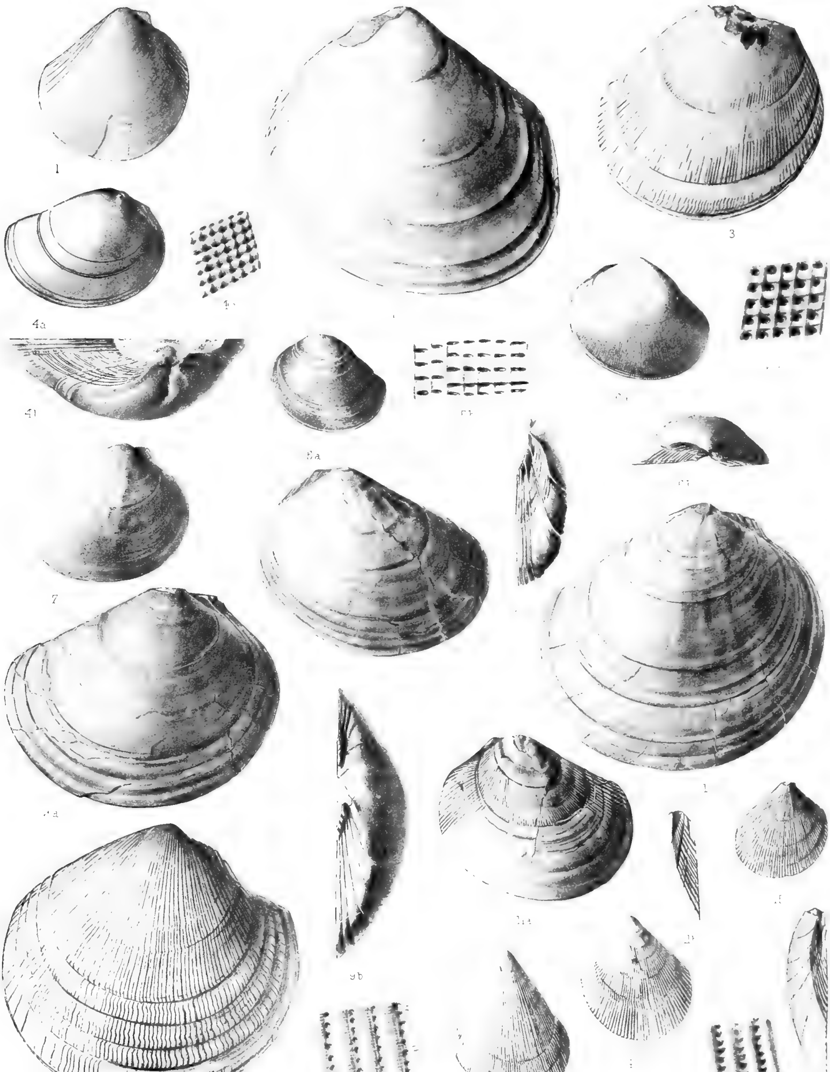

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PLATE V.

Lima (*continued*).

Figs.

1—4. *L.* (*Plagiostoma*) *cretacea*, Woods. (P. 22.)

1. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. *a*, left valve; *b*, portion × 6.
2. Zone of *Micraster cor-testudinarium*, Borstal. Mr. Dibley's Collection. Left valve.
3. Zone of *Holaster planus*, Cheveley. Sedgwick Museum. Left valve.
4. Zone of *Micraster cor-testudinarium*, Cuxton. Mr. Dibley's Collection. *a*, left valve; *b*, postero-ventral portion × 4.

5. *L.* (*Plagiostoma*) sp. (? var. of *cretacea*). Chalk (? zone of *Holaster planus*), Burham. Sedgwick Museum. Left valve.

6, 7. *L.* (*Plagiostoma*) *Marrotiana*, d'Orb. Zone of *Belemnitella mucronata*, Norwich. Norwich Museum. (P. 24.)

6 *a*, left valve; *b*, mid-ventral portion × 3.
7 *a*, anterior area of right valve; *b*, median portion of left valve of same specimen.

8—12. *L.* (*Acesta*) *longa*, Römer. (P. 25.)

8. Lower Greensand, Upware. Mr. J. F. Walker's Collection. *a*, right valve; *b*, portion below the middle of the valve × 5.
9, 10. Lower Greensand, Brickhill. Right valves. Sedgwick Museum.
11. Tealby Limestone (zone of *Belemnites brunsvicensis*), North Willingham. Right valve. Sedgwick Museum.
12. Speeton Clay, Speeton. Museum of Practical Geology, No. 8781. *a*, right valve; *b*, portion × 4.

13. *L.* (*Acesta*) sp. Lower Greensand, West Dereham. Sedgwick Museum (collected by Mr. Jukes-Browne). *a*, right valve; *b*, antero-dorsal view; *c*, portion × 5. (P. 26.)

14, 15. *L.* (*Mantellum*) *parallela*, Sow. Lower Greensand (*Perna*-bed), Atherfield. (P. 28.)

14. Left valve. Sedgwick Museum.
15. British Museum, No. L 5066. *a*, left valve; *b*, dorsal view; *c*, portion at anterior end × 3; *d*, mid-ventral portion × 6.

16—20. *L.* (*Mantellum*) *gaultina*, Woods. Gault. 16—19, Black Ven. 20, Folkestone. Sedgwick Museum. (P. 31.)

16 *a*, left valve; *b*, antero-dorsal view.
17. Right valve.
18*a*, ,, *b*, antero-dorsal view.
19. ,, median portion × 6.
20. Left valve

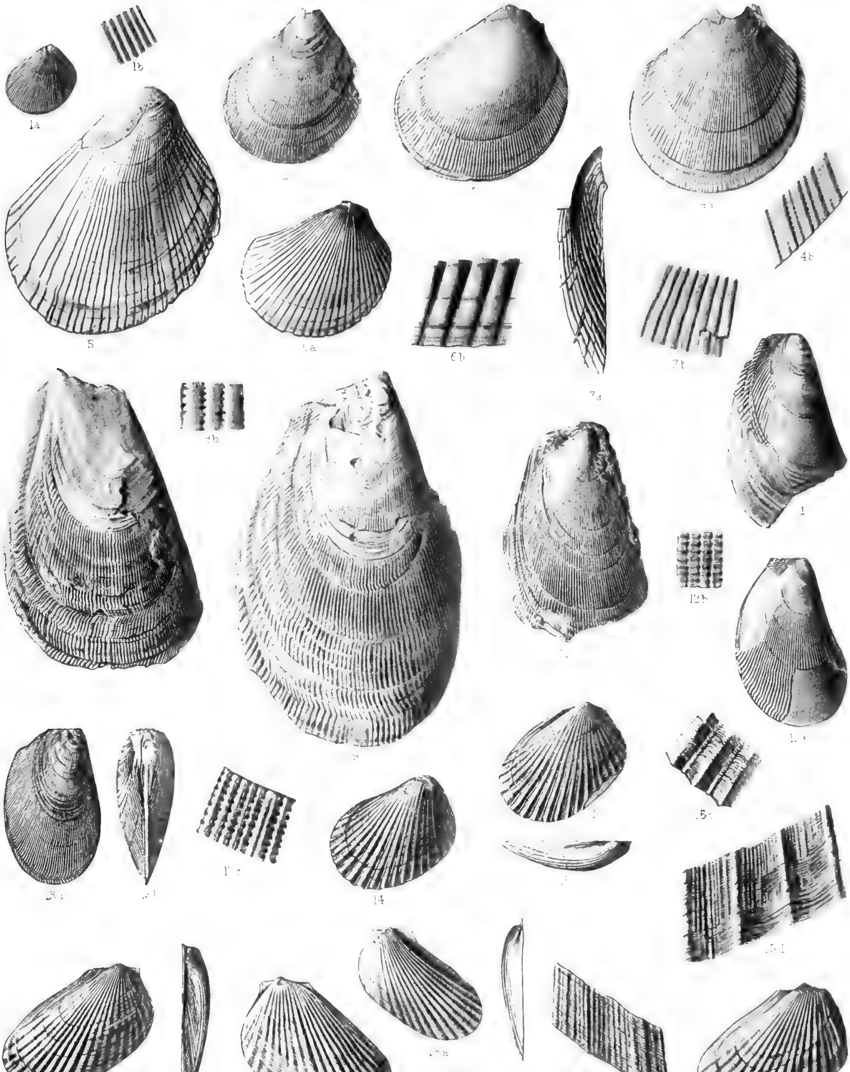
1a
1b
5
4b
6b
7b
7a
8b
12b
14

PLATE VI.

LIMA (*continued*).

FIGS.

1. *L.* (*Mantellum*) *interlineata*, Jukes-Browne. Cambridge Greensand, Cambridge. *a*, right valve; *b*, ventral part of left valve × 3. (P. 32.)

2—4. *L.* (*Mantellum*) *intermedia*, d'Orb. Rye Hill Sands, Warminster. (P. 33.)

2. York Museum. *a*, right valve; *b*, antero-ventral part × 4.
3. Brighton Museum. Left valve.
4. Sedgwick Museum. *a*, right valve; *b*, antero-dorsal view; *c*, posterior ear of right valve × 4.

5—7. *L.* (*Mantellum*) *elongata*, Sow. Chalk Marl, Folkestone. (P. 34.)

5. Mr. J. F. Walker's Collection. Right valve.
6. Sedgwick Museum. *a*, left valve; *b*, antero-dorsal view; *c*, mid-ventral portion × 3.
7. Sedgwick Museum. *a*, right valve; *b*, antero-ventral part × 8.

8, 9. *L.* (*Mantellum*) *elongata*, var. *echinata*, Eth. Sedgwick Museum. (P. 36.)

8. Totternhoe Stone, Burwell. Left valve. One of the types.
9. *H. subglobosus* zone, Burwell. *a*, left valve; *b*, antero-ventral portion × 4; *c*, posterior portion × 4.

10—12. *L.* (*Mantellum*) *cantabrigiensis*, Woods. Sedgwick Museum. (P. 37.)

10. The type. Cambridge Greensand. *a*, left valve; *b*, posterior portion × 6.
11. Antero-ventral portion of left valve × 6.
12. Lower Chalk, Burwell. Right valve × $1\frac{1}{2}$.

13. *L.* (*Mantellum*) *britannica*, Woods. Zone of *Micraster cor-anguinum*, Seaford. Mr. R. M. Brydone's Collection. *a*, right valve; *b*, antero-dorsal view × $1\frac{1}{2}$; *c*, portion at antero-ventral margin × 6; *d*, portion at postero-ventral margin × 6. (P. 38.)

14, 15. *L.* (*Mantellum*) *Reichenbachi*, Geinitz. Sedgwick Museum, Cambridge. (P. 39.)

14. Cenomanian Sandstone, Wilmington. *a*, left valve; *b*, antero-dorsal view.
15. Chloritic Marl, Chard. Right valve.

16. *L.* (*Mantellum*), sp. Chloritic Marl, Chardstock. Museum of Practical Geology, No. 7896. *a*, left valve; *b*, postero-ventral portion × 6. (P. 40.)

17. *L.* (*Ctenoides*) *rapa*, d'Orb. Upper Greensand, Haldon. British Museum, No. L 15612. *a*, right valve; *b*, median portion a short distance above the ventral margin × 3; *c*, portion near the anterior margin × 5. (P. 40.)

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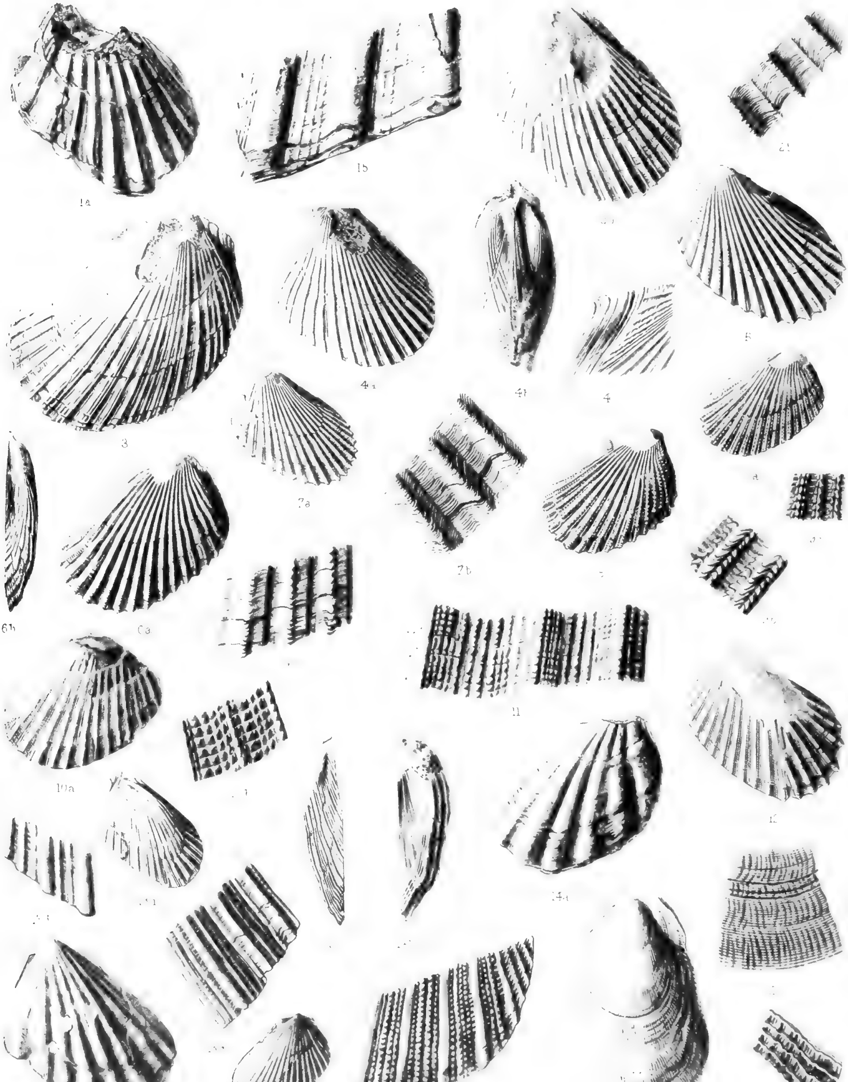

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PLATE VII.

LIMA (*continued*).

FIGS.

1\. *L.* (*Ctenoides*) *rapa*, d'Orb. Upper Greensand, Haldon. British Museum, No. L 15613. Right valve. (P. 40.)

2, 3. *L.* (*Ctenoides*) *tecta*, Goldf. Chalk Marl (Bed 11), Dunscombe. Sedgwick Museum. 2, left valve. 3, mid-ventral portion of another specimen × 2. (P. 42.)

4—6. *L.* (*Ctenoides*) *divaricata*, Duj. (P. 44.)

4\. Chalk, Newtimber. Brighton Museum. *a*, right valve; *b*, median portion above the middle of the valve × 4; *c*, postero-ventral portion × 4; *d*, median portion near the ventral margin × 4.

5\. *Belemnitella mucronata* zone, Norwich. Sedgwick Museum. Left valve.

6\. *Micraster cor-anguinum* zone, Micheldever. Winchester College. *a*, portion of left valve; *b*, portion of the same × 8.

7—9. *L.* (*Limatula*) *Tombeckiana*, d'Orb. Hythe Beds, Court-at-Street. Museum of Practical Geology. (P. 45.)

7\. No. 8821. *a*, left valve × $1\frac{1}{2}$; *b*, ventral portion × 5.

8\. No. 8822. *a*, right valve × $1\frac{1}{2}$; *b*, anterior view × $1\frac{1}{2}$; *c*, ventral portion × 5.

9\. No. 8824. *a*, right valve × 2; *b*, anterior view × 2.

10\. *L.* (*Limatula*) *Tombeckiana ?*, d'Orb. Upper Greensand, Charmouth. Museum of Practical Geology, No. 8818. Right valve × 2. (P. 46.)

11\. *L.* (*Limatula*) *Dupiniana*, d'Orb. Tealby Limestone, North Willingham. Sedgwick Museum. *a*, right valve; *b*, anterior view; *c*, ventral part of ribbed area × 8. (P. 47.)

12—15. *L.* (*Limatula*) *Fittoni*, d'Orb. Upper Greensand, Haldon. (P. 48.)

12\. Sedgwick Museum. Left valve × 2.

13\. Sedgwick Museum. Right valve × $1\frac{1}{2}$.

14\. British Museum, No. L 15615. Right valve × $1\frac{1}{2}$.

15\. British Museum, No. L 15615. *a*, left valve; *b*, posterior view; *c*, ventral portion × 3.

16, 17. *L.* (*Limatula*) *subæquilateralis*, d'Orb. Upper Greensand, Warminster. British Museum, No. 88928. (P. 49.)

16 *a*, left valve × $1\frac{1}{2}$; 16 *b*, anterior view × $1\frac{1}{2}$. 17, ventral portion × 6.

18—20. *L.* (*Limatula*) *decussata*, Goldf. *Actinocamax quadratus* zone, East Harnham. Dr. Blackmore's collection. (P. 50.)

18 *a*, right valve × 2; *b*, ventral portion × 6.

19\. Median portion × 9.

20 *a*, right valve × 2; *b*, anterior view × 2.

21, 22. *L.* (*Limatula*) *wintonensis*, Woods. (P. 51.)

21\. Chalk, Clayton. Brighton Museum. *a*, right valve × 2; *b*, median portion × 6.

22\. *Actinocamax quadratus* zone, Winchester. Dr. Rowe's collection. *a*, right valve × 2; *b*, anterior view × 2; *c*, posterior view × 2; *d*, median portion × 8.

23\. *L.* (*Limatula*) sp. *Belemnitella mucronata* zone, Clarendon. Dr. Blackmore's collection. *a*, right valve × 2; *b*, ventral portion × 9. (P. 52.)

24—26. *L.* (*Limea ?*) *composita* (Sow). Upper Greensand, Warminster. (P. 53.)

24\. Museum of Practical Geology, No. 8786. *a*, right valve × 2; *b*, anterior view × 2.

25\. Museum of Practical Geology, No. 8783. *a*, right valve; *b*, median part × 6.

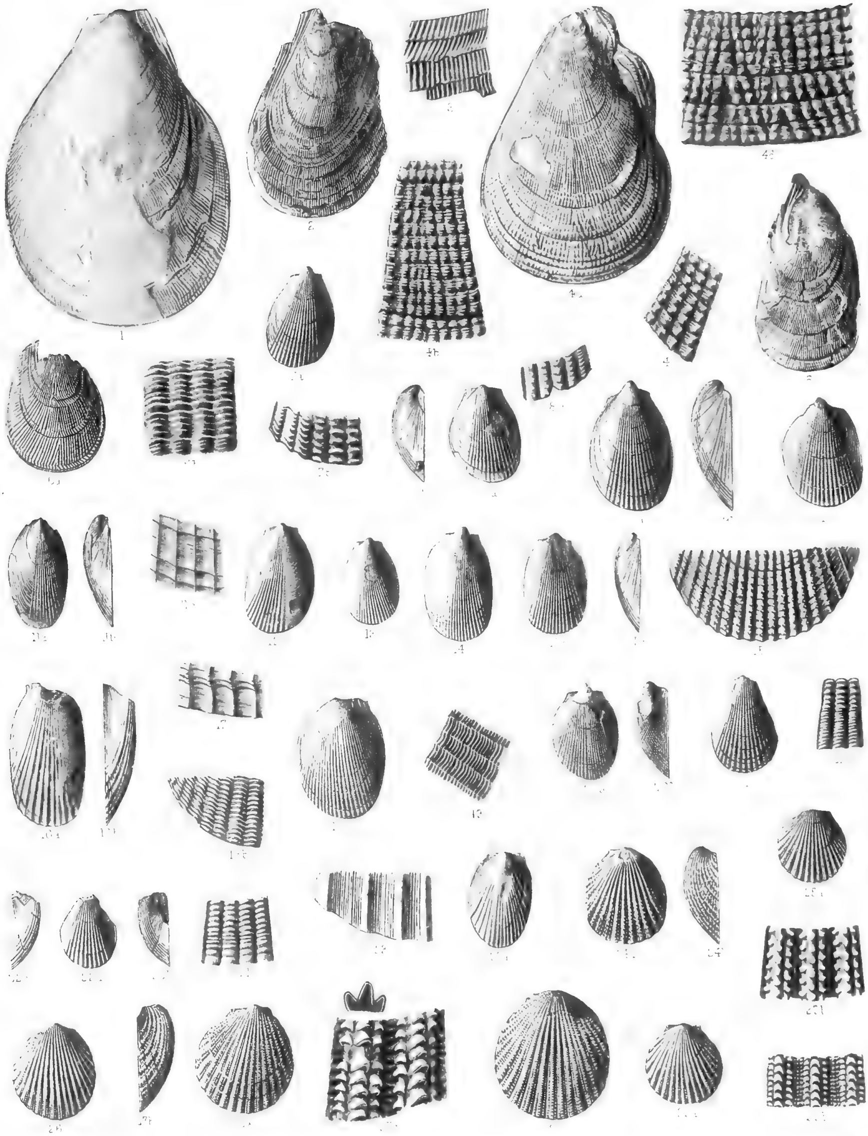
26\. Museum of Practical Geology, No. 8784. Left valve × $1\frac{1}{2}$.

27—29. *L.* (*Limea ?*) *granulata*, (Nilss). *Belemnitella mucronata* zone. (P. 54.)

27\. Norwich. Norwich Museum. *a*, left valve; *b*, anterior view; *c*, portion × 6, with section of a main rib.

28\. Norwich. Sedgwick Museum. Left valve × $1\frac{1}{2}$.

29\. Alderbury. Dr. Blackmore's collection. *a*, right valve × $1\frac{1}{2}$; *b*, median portion × 8.



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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1904.

LONDON

MDCCCCIV.

A MONOGRAPH

OF THE

BRITISH CARBONIFEROUS LAMELLIBRANCHIATA.

BY

WHEELTON HIND, M.D., B.S.Lond., F.R.C.S., F.G.S.,

MEMB. SOC. GEOL. BELG.

VOL. II.

PART III.

Pages 125–216; Plates XXII–XXV.

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APPENDIX.

During the progress of my work on the British Carboniferous Lamellibranchs, species new to Great Britain, or hitherto undescribed, have from time to time occurred. Some of them were described and figured in papers published in the 'Quarterly Journal' of the Geological Society and other journals, but several others are now published for the first time. It has been found necessary to refer some of these new species to six genera not mentioned in the body of the work, four of the six being genera which have not hitherto been recognised in rocks higher than the Devonian, namely, *Megambonia* (Hall), *Palæoneilo* (Hall), *Spathella* (Hall), and *Paracyclas* (Hall). One species is referred to *Pachypteria* (de Koninck), and it has been necessary to create a new genus (*Nothamusium*) for a number of specimens referable to two species.

Family OSTREIDÆ.

Genus Pachypteria, *de Koninck*, 1885.

Generic Characters.—Shell of medium size, sub-oval, slightly inequivalve, and oblique. Cardinal border straight. No ears. Umbones indistinct.

Interior.—Hinge edentulous; left valve with a shallow pit below the umbo corresponding to a tubercle in the right valve (de Koninck). The muscle-scar is placed laterally and bounded by an almost circular crest.

Exterior.—The surface is ornamented with numerous fine imbricating lamellæ.

Observations.—De Koninck established this genus for a single species which he had previously described as *Ostrea*, thinking it had more affinity with the Aviculidæ than with *Ostrea*. I am at a loss to understand why he considered the shell to possess ears, the concentric lines of growth of the valve passing up directly to the hinge-line and terminating there. It seems to me, judging from the characters of the shell, that his original view of its affinity to *Ostrea* was the more nearly correct. I think he was wise to found a new genus for the shell, but the name is an unhappy one, as there is no wing or projection, and the shell is not very thick.

Pachypteria nobilissima, *de Koninck*, sp., 1851. Plate XXV, fig. 7.

Ostrea nobilissima, *de Koninck*, 1851. Descr. Anim. Foss. Terr. Carb. Belg., Suppl., p. 680, pl. lvii, figs. 1, *a*, *b*, *c*.
Pachypteria nobilissima, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tome xi, p. 201, pl. xl, fig. 1.

Specific Characters.—Shell of medium size, flattened, irregular, somewhat twisted on itself, suboval, slightly oblique. Hinge-line straight. Umbones inconspicuous. The anterior border more convex than the posterior, the inferior somewhat irregularly convex.

Interior.—The adductor muscle-scar single, large; surrounded by a subcircular crest.

Exterior.—The surface is ornamented with fine, close, lamelliform, concentric lines of growth.

Dimensions.—Pl. XXV, fig. 7, a right valve, measures—

Antero-posteriorly . . . . 29 mm.
Dorso-ventrally . . . . 35 mm.

Localities.—England: the Carboniferous Limestone of Park Hill, Derbyshire, and Hill Bolton, Yorkshire.

Observations.—The specimen from Park Hill (Pl. XXV, fig. 7) is evidently a young example. It shows the interior of the right valve, and is not very well preserved. The specimen I obtained from Hill Bolton was unfortunately fractured, and I have only the lower half of the valve, which includes half of the adductor muscle-scar. It is part of a much larger shell measuring about 60 mm. transversely. *P. nobilissima* must be very rare, as I have only met with these two examples in Great Britain, unless the *Anomia antiqua* of M'Coy represents the species, though I incline to the view that the type was a valve of some species of *Productus*. De Koninck's specimens were obtained from the Limestone of Visé.

Palæolima Buchiana, *de Koninck*, sp., 1844. Plate XIX, figs. 13—16.

Avicula tumida, *de Koninck*, 1842. Descr. Anim. Foss. Terr. Carb. Belg., p. 138, pl. i, fig. 12; pl. iii, fig. 14.
— lævigata, *de Koninck*, 1842. Ibid., p. 137, pl. ii, fig. 10; pl. iii, fig. 19; pl. iv, figs. 4, 9.
— Buchiana, *de Koninck*, 1844. Ibid., p. 634.

Streblopteria Buchiana, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 208, pl. xxx, fig. 31; pl. xxxix, fig. 9.

Palæolima lævis, *Hind*, 1903. Brit. Carb. Lamell., vol. ii, p. 40, pl. xix, figs. 13—16.

Observations.—I unfortunately overlooked de Koninck's species when I described *Palæolima lævis* as new. Since the publication of vol. ii, pt. 2, I have compared a specimen from Visé with the Irish specimens, and am satisfied of their identity with de Koninck's species. I think, however, that the characters of the shell warrant its inclusion in *Palæolima* rather than in *Streblopteria*.

Streblopteria concentrica, sp. nov. Plate XXV, figs. 1, 1 *a*.

Specific Characters.—Shell of medium size, suborbicular, moderately convex. The margin is almost circular, extending in an unbroken curve from the anterior ear and including the lower two-thirds of the posterior border, where it gradually curves outwards and terminates in a well-marked postero-superior angle. The hinge-line is straight, and prolonged slightly posteriorly. The umbones are small, sub-central. The anterior ear is small and triangular. No posterior ear, but a compressed and expanded postero-superior angle.

Exterior.—The surface is adorned with distinct, distant, subimbricating, concentric lines, which are parallel to the margin and pass over the compressed dorsal slope to the hinge-line.

Dimensions.—Pl. XXV, fig. 1, measures—

Antero-posteriorly	36 mm.
Dorso-ventrally	37 mm.

Locality.—Scotland: Lower Limestone Series of Howrat.

Observations.—Mr. Smith has a single specimen in his collection, probably a right valve, from Howrat. It is not quite perfect at the umbo, and the whole of the anterior ear is not present. I am in doubt as to which valve it is, because if it be the right valve there is no byssal notch. If the convexity of the valve has not been altered by crushing it is apparently a right valve, and the concentric markings favour this view. The character of the posterior part of the hinge-line and absence of posterior ear denote an affinity to *Streblopteria*, M'Coy. I know of no other Carboniferous shell with such well-marked and regular concentric markings.

Pterinopecten pustulosus, sp. nov. Plate XXV, fig. 24.

Specific Characters.—Shell of medium size, quadrato-orbicular. The left valve moderately gibbose. The anterior margin sinuous above, convex below. The lower margin regularly convex, the posterior convex below, concave above. The hinge-line straight, prolonged along the upper margin of both ears. The umbones small, pointed, slightly raised, placed a little in front of the middle of the hinge-line. The anterior ear of the left valve is large and compressed, not pointed in front, its lower margin denoted by a broad space without radiating ribs, below and above which the ribs are closer together. The postero-superior angle of the shell large, compressed above and below with a more convex portion between.

Interior.—Unknown.

Exterior.—The surface of the left valve is ornamented with distinct thick radiating, elevated ribs, which are studded with moniliform enlargements becoming apparent some little distance from the umbo. Between each pair of thick nodulose ribs is a thin linear rib, which becomes sinuous or slightly moniliform near the lower margin. Between the ribs the surface of the shell is crossed by fine equidistant, concentric lines, best marked in the umbonal region. There are three radiating moniliform ribs on the anterior ear, and fine concentric lines of growth. The ornament of the postero-superior portion of the valve resembles that of the surface of the valve.

Dimensions.—Pl. XXV, fig. 24, measures—

Antero-posteriorly	75 mm.
Dorso-ventrally	70 mm.
Convexity of left valve . . .	10 mm.

Localities.—The Carboniferous Limestone of Kniveton and Gluttondale, Derbyshire.

Observations.—This species is founded on two specimens from the upper beds of the Carboniferous Limestone of Derbyshire, both in my collection. The very distinct ornament and arrangement of ribs and more quadrate form distinguish this species from others having moniliform ribs, as *P. eximius* and *P. granosus*. In these the ribs are much finer and more numerous. I have not yet seen the right valve. The ornament resembles closely that of *Aviculopecten Murchisoni*, affording a good example of homœomorphy in two different genera.

Pterinopecten carbonarius, sp. nov. Plate XXV, figs. 14—16.

Specific Characters.—Shell small, quadrato-subcircular, the left valve moderately convex, the right valve flattened. The anterior border curved, the inferior conversely rounded, the posterior oblique and almost straight. The hinge-line is straight, and equals the antero-posterior diameter of the shell in extent. The umbones are small, pointed, not raised, placed slightly in front of the middle line. The anterior ear of the right valve is well marked off from the rest of the valve by the byssal slit, that of the left valve not so deeply notched. The posterior ears are not marked off from the rest of the valve, but are represented by a compressed and expanded postero-superior angle.

Interior.—Unknown.

Exterior.—The surface is ornamented with about eighteen to twenty-four broad raised ribs, separated by flattened spaces. The anterior ribs curve outwards near the lower margin; the median ribs are almost straight and do not bifurcate, and ribs seem to be absent over the postero-superior portion of the right valve. The anterior ears are crossed by a few well-marked radiating ribs.

Dimensions.—Pl. XXV, fig. 14, a right valve, measures—

Antero-posteriorly	13 mm.
Dorso-ventrally	11 mm.

Localities.—Marine Bands below the Gin mine Coal, Nettlebank, Smallthorne; sixty-nine feet below the roof of the 4-feet coal, Cheadle, N. Staffordshire Coalfield; the Pendleside Series, Bosley Minn, Cheshire.

Observations.—This species is distinguished from *P. papyraceus* by its quadrate shape, the possession of fewer broader ribs, and the smooth ribless character of the postero-superior part of the valve.

AVICULOPECTEN JONESII, *M'Coy*, sp., 1844. Plate XXV, figs. 9—11.

PECTEN JONESII, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 95, pl. xvi, fig. 10.

Specific Characters.—Shell below medium size, obovate, convex. The anterior margin is curved, the lower border almost circular, the posterior nearly straight. The hinge-line is straight and of moderate length. The ears are unequal, the anterior the larger and more depressed. The umbo is acute, central, not raised.

Interior.—Unknown.

Exterior.—The surface is ornamented with many fine radiating, linear, wavy lines, which pass from the umbo to the lower margin; occasionally other lines arise between the primary ones about the centre of the valve. These radiating lines are crossed by distinct concentric lines and striæ of growth, and towards the lower margin the intervals between the lines are crossed by concentric, close, wrinkled lines. The concentric striæ are well marked on the anterior ear of both valves, and there are no radiating striæ on the posterior ears.

Dimensions.—Pl. XXV, fig. 10, M'Coy's type, measures—

Antero-posteriorly	11 mm.
Dorso-ventrally	17 mm.

Localities.—England: the Carboniferous Limestone of Hill Bolton, Yorkshire. Scotland: the Upper Limestone Series of Orchard. Ireland: the Carboniferous Limestone of Black Lion, co. Leitrim.

Observations.—The type of this species is a left valve, not very well preserved, contained in the Griffith Collection, Science and Art Museum, Dublin, Pl. XXV, fig. 10. I have fortunately been able to study other examples, namely two very large valves in the collection of Mr. J. Neilson (one figured, Pl. XXV, fig. 9), and a left valve from Hill Bolton, in my collection. The latter, a left valve, shows the characteristic markings very well. I am not sure whether this species should be referred to *Aviculopecten* on account of the short posterior ear.

AVICULOPECTEN CONSTANS, *de Koninck*, 1885. Text-fig. 1.

AVICULOPECTEN CONSTANS, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 226, pl. xxxviii, figs. 13, 14.

Specific Characters.—Shell of medium size, suborbicular, moderately convex. The hinge-line shorter than the transverse diameter, the inferior margin broadly

TEXT-FIG. 1.—*Aviculopecten constans*, de Kon.

subcircular. The umbo acute, central, ears marked off from the valve by well-marked curved lines with the concavity upwards, leaving the umbonal portion triangular. The anterior ear the smaller, triangular, depressed, its anterior border concavo-convex. The posterior ear the larger, with its upper border produced, and its posterior border falciform.

Interior.—Unknown.

Exterior.—The surface of the valve is adorned with numerous fine, close. radiating, raised lines, coarser near each margin, and with secondary lines arising in the interspaces between certain pairs. These lines are often closely imbricate, and here and there are crossed by obscure concentric sulci.

On the ears concentric markings are stronger, faint radiating lines being seen on the anterior ear only.

Dimensions.—Text-fig. 1, p. 130, a left valve, measures:—

Antero-posteriorly	30 mm.
Dorso-ventrally	30 mm.

Locality.—Shale beneath massive limestone, Criobin, Pembrokeshire.

Observations.—The specimen on which the description is based belongs to Dr. Vaughan. It is a left valve in fairly perfect condition, but I doubt if the whole of the posterior ear is exposed. I refer the specimen to *A. constans* (de Koninck), a shell occurring at Panquys, stage II. From the general character of the shell I think it belongs to the group represented by *Aviculopecten stellaris*, Phill., sp., the ears of which have similar characters.

MODIOLA RADIATA, *de Koninck*, 1885. Plate XXII, figs. 13—16.

CARDIOMORPHA RADIATA, *de Koninck*, 1842. Descr. Anim. Foss. Terr. Carb. Belg., p. 109, pl. ii, fig. 6; pl. iii, fig. 9.
CYPRICARDIA OBLONGA, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 60, pl. viii, fig. 21.
MYTILUS KONINCKIANUS, *de Ryckholt*, 1853. Mèlanges Palćontol., pt. ii, p. 89.
MODIOLA RADIATA, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 176, p. xli, figs. 42, 43.

Specific Characters.—Shell of medium size, transversely suboval, obliquely gibbose, very convex and expanded. The anterior end very short, its border rounded. The inferior margin slightly sinuous, with a well-marked byssal opening about the junction of the anterior and middle thirds of its length. The posterior border straight for the greater part of its extent, very oblique, bluntly rounded below, but making a large obtuse angle above with the hinge-line. The latter is straight, much shorter than the antero-posterior diameter of the valves. The umbones are much swollen, pointed, incurved and twisted forwards, contiguous and almost terminal. The dorsal slope is broad and compressed, often hollow. No escutcheon or lunule.

Interior.—The adductor muscle-scars are normal in position. Ligament internal. Surface smooth, with some broad, obscure, concentric, undulations posteriorly.

Exterior.—The surface in the young shell is almost smooth; but in adults well-marked, subimbricating, concentric lamellæ of growth are to be seen, crossed by fine radiating striæ, better marked anteriorly.

Dimensions.—Pl. XXII, fig. 16, the type of M'Coy's *Cypricardia oblonga*, measures—

Antero-posteriorly	38 mm.
Dorso-ventrally	12 mm.
From side to side (estimated from single valve) .	20 mm.

Localities.—England: the Carboniferous Limestone of Park Hill, Thorpe Cloud, and Castleton, Derbyshire. Ireland: Araglin Bridge, co. Cork.

Observations.—This species is easily distinguished by its large comparative transverse diameter. I have obtained five specimens from the localities mentioned above, on what I believe to be the same horizon, viz., the upper beds of the Carboniferous Limestone series of the Midlands. De Koninck did not recognise that M'Coy had described his shell under the name *Cypricardia oblonga.* M'Coy's type (Pl. XXII, fig. 16) is preserved in the Griffith Collection of the Science and Art Museum, Dublin. It is a cast of the interior of the left valve, and it is strange that M'Coy did not recognise this fact. He describes the surface as "smooth, with a few obscure undulations at the posterior end." The radiating ribs described by de Koninck are well marked only in two of my specimens, both right valves. They become finer and closer in character from before backwards.

Modiola Wrightii, sp. nov. Plate XXII., figs. 10—12.

Specific Characters.—Shell below medium size, triangularly ovate, equivalve, oblique. The anterior end well developed, narrow, its border rounded. The inferior border is almost straight and descends rapidly downwards and backwards. The posterior border is obliquely truncate, straight for the upper two-thirds, bluntly rounded below where it passes into the lower border. The hinge-line is straight, of moderate length, meeting the posterior margin at a well-marked obtuse angle. The umbones are small, twisted forwards, pointed and only very slightly elevated above the hinge-line, placed a little in front of the centre of the hinge-line. Passing obliquely downwards and backwards from the umbo is an angular ridge which gradually becomes obsolete as it nears the postero-inferior angle. The valve is compressed and flattened on each side of this ridge. No lunule or escutcheon.

Interior.—Unknown.

Exterior.—The surface is ornamented by numerous subimbricating, flattened lamellæ, which are themselves covered by close-set but somewhat irregular concentric lines of growth.

Dimensions.—Pl. XXII, fig. 10, a left valve, measures—

Antero-posteriorly	27 mm.
Dorso-ventrally (largest diameter) . .	15 mm.
From side to side (estimated) . . .	9 mm.

Locality.—Ireland: the Carboniferous Limestone of Little Island, co. Cork.

Observations.—I find four shells in the cabinet of Mr. J. Wright, from Little Island, labelled *Gervillia inconspicua*; but I have considered the latter to represent *Sanguinolites striato-lamellosus*, de Koninck, *supra*, vol. i, p. 398. These shells appear to me to be new and I now refer them to the genus *Modiola*. A fifth example from the same locality is in the Geological Collection of the British Museum (Natural History). The shell is very well marked, and though at first sight it has a certain resemblance to *S. striato-lamellosus*, de Koninck, it is more nearly triangular and has no escutcheon or lunule, while radiating lines are absent on the dorsal slope.

Genus MEGAMBONIA, *Hall*, 1859.

MEGAMBONIA, *Hall*, 1859. Pal. New York, vol. iii, p. 273.
" " 1885. Geol. Surv. New York, Pal., vol. v, pt. i, Lamellibr. II, p. lv.

Generic Characters.—"Shell equivalve or sub-equivalve, very inequilateral, obovoid, body very oblique; anterior end lobed; posterior large, constituting the principal part of the shell; beaks interior; cardinal line short, subalate posteriorly; umbonal slope ventricose, not defined. Surface marked by fine striæ of growth which in some species are crossed by fine radiating striæ. Hinge-line short, a distinct lateral fold and groove near the post-cardinal angle. Ligament internal. Anterior muscular impression large and strong, posterior impression large."

Observations.—I have quoted Hall's generic diagnosis as given in 1885, which indicates a closer affinity to *Modiola* than to other genera. Hitherto no shells belonging to this genus have been found in Carboniferous rocks, but two specimens which I refer to it have been obtained from the Limestone of Kniveton, Derbyshire.

MEGAMBONIA CARBONIFERA, sp. nov. Plate XXV, fig. 8.

Specific Characters.—Shell below medium size, obliquely gibbose and obovate with an anterior lobe and compressed postero-superior angle. The anterior end very short and compressed, and forming a narrow lobe in front of the gibbose remainder of the valve. The anterior border is convex above, but becomes concave below. The inferior border almost circularly rounded, the posterior obliquely truncate and almost straight. The hinge-line straight, of only moderate length. The umbones are small, gibbose, slightly elevated, and placed at the junction of the anterior and middle thirds of the hinge-line.

Interior.—The anterior adductor muscle-scar is large and placed only a very little distance within the antero-superior angle, oval in form. The hinge-plate leaves a simple elongate groove in casts.

Exterior.—The surface is ornamented with concentric lines and bands of growth, with occasional, obscure, moderately broad, concentric sulci. Shell thin.

Dimensions.—Plate XXV, fig. 8, measures—

Antero-posteriorly . . .	47 mm.
Dorso-ventrally	42 mm.
From side to side . . .	26 mm.

Locality.—The upper beds of the Carboniferous Limestone, Kniveton, Derbyshire.

Observations.—Two specimens of this species have been obtained from Kniveton Quarry, one (Plate XXV, fig. 8) having the left valve complete in front, and the right posteriorly, the valves having slipped over each other. By studying both valves, the real shape and character of each can be ascertained. The second shell has also had the valves dislocated, and it is incomplete in front.

The large anterior adductor scar and the elongate groove of the hinge-plate are seen in the left and right valves respectively (Plate XXV, figs. 8, 8 *a*).

Posidoniella sulcata, sp. nov. Plate XXV, figs. 2—6.

Specific Characters.—Shell of medium size, ovately subquadrate, moderately convex with a small flattened posterior, superior angle. Margin ovately rounded with a continuous pyriform curve from the anterior end of the hinge-line to the postero-superior angle, which is slightly obtuse. Hinge-line short and straight, not produced forwards. The umbones are pointed, moderately convex and placed so far forwards as to appear terminal. The anterior end is obsolete, its border adpressed so that the valve is most convex at this point. There is no projection or ear in front of the umbo.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous well-marked concentric angular ridges, separated by wide concave sulci. Its ridges become crowded and almost obsolete towards the flattened postero-superior angle.

Dimensions.—Plate XXV, fig. 6, a right valve, measures:—

Antero-posteriorly . . .	30 mm.
Dorso-ventrally . . .	40 mm.

Locality.—In a marine band below the Gin mine Coal, Nettlebank Colliery, Smallthorne, North Staffordshire.

Observations.—*Posidoniella sulcata* occurs fairly abundantly in the marine band associated with the Gin mine coal in the locality mentioned above. A list of the fauna which has been recognised in this band was given *supra*, p. 121. The character of the anterior end, the broad sulcations and angular ridges, at once separate the shell from *P. vetusta*, with which species it is most nearly allied. It is generically distinct from *Posidonomya Becheri*, with which I think it has probably been confounded. I remember seeing a specimen in the collection of the late Mr. James Nield, of Oldham, stated to be from the Middle Coal Measures. This was named *P. Becheri.* It was flattened and crushed, and I made a sketch which agrees very much with the character of *P. sulcata.* Mr. Gerrard has endeavoured to trace Mr. Nield's shell for comparison, but has unfortunately not been able to do so. Mr. H. Bolton ('Trans. and Ann. Rep. Manch. Micros. Soc., 1895') quotes *Posidonomya lateralis* (a synonym of *P. Becheri*) as occurring in the Lower Coal Measures of Lancashire. At Nettlebank *P. sulcata* occurs in all stages of growth but seems to be confined to a narrow shale band near the base of the marine deposit, which is itself only eleven feet thick.

PARALLELODON ELEGANS, *M'Coy*, sp., 1844. Plate XXIII, figs. 9, 10.

PULLASTRA ELEGANS, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 54, pl. viii, fig. 16.

Specific Characters.—Shell of medium size, ovate, subquadrate, moderately gibbose, expanded posteriorly. The anterior margin is rounded, the lower border slightly convex, the posterior border obliquely truncate from above, downwards and backwards, almost straight, joining the lower margin with a blunt but regular curvature, and making an obtuse angle above with the hinge-line. The latter is straight and comparatively short. The umbones are moderately gibbose, placed in the anterior third of the valve. The dorsal slope is rapidly compressed and is concave, bounded below by a bluntly rounded oblique ridge, which arises at the umbo, and gradually becomes obsolete as it crosses the valve.

Interior.—Unknown.

Exterior.—The surface is ornamented by numerous equidistant, parallel, linear grooves, which become almost imbricate on the dorsal slope. These lines are separated by flattened, smooth, regular spaces, parallel to the margin.

Measurements.—Plate XXIII, fig. 9, measures :—

Antero-posteriorly . . .	33 mm.
Dorso-ventrally . . .	21 mm.
From side to side (estimated from a single valve)	10 mm.

Localities.—England : the Carboniferous Limestone of Hill Bolton, and Withgill, Yorkshire. Ireland : Bruckless, co. Donegal.

Observations.—Two specimens of this species, right and left valves, have occurred to me from the Craven district of Yorkshire. Unfortunately, in the Griffith Collection I cannot find the type, which was also probably a right valve, though the figure would appear to represent a left valve. None of M'Coy's figures were reversed on the stone, as I have pointed out before, and in each case the opposite valve to that of the specimen is depicted on the Plate.

P. elegans is more nearly allied to *P. Haimeanus* than to any other species of the genus. It is at once distinguished from this species by the absence of fine regular lines on the flat spaces between the concentric grooves and the more regular character of the spaces and grooves.

Parallelodon normalis, *de Koninck*, 1885. Plate XXIII, fig. 8.

Parallelodon normalis, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 145, pl. xxi, figs. 19—21.

Specific Characters.—Shell below medium size, transversely subelliptical, very inequilateral, moderately convex. The anterior broader than the posterior end. The anterior end short and rounded, the antero-superior angle a right angle. The anterior margin rounded below, the inferior gently convex with a byssal sulcus forwards. The posterior margin elliptically curved, the hinge-line straight. The umbones small, not contiguous, placed very far backwards. The valve is rapidly compressed on the dorsal slope, which is bounded below by a bluntly rounded, oblique ridge, separating it from the convex portion of the valve. The valve is constricted by a broad shallow sulcus, becoming wider as it approaches the margin, indicating the byssal sulcus.

Interior.—Normal.

Exterior.—The surface of the valve is ornamented below with several parallel concentric grooves, separating flattened, subimbricating spaces. The younger part of the valve and the dorsal slope are almost smooth.

Measurements.—Pl. XXIII, fig. 8, a right valve, measures—

Antero-posteriorly	23 mm.
Dorso-ventrally	10 mm.
From side to side (estimated from the single valve) ..	12 mm.

Locality.—The upper beds of the Carboniferous Limestone of Castleton, Derbyshire.

Observations.—A single valve, the right, of this species, has occurred to me from Castleton. It is fairly perfect and uncrushed, and shows a well-marked dorsal slope, a character not described or figured by de Koninck. All other species of the genus have this character, and I was at a loss to explain its absence in de Koninck's diagnosis.

The hinge-characters of *P. normalis* were fortunately exposed in one of de Koninck's type specimens, and although lateral teeth of the hinge are described they are not drawn in the normal position. *P. normalis* is much more transverse and more cylindrical than *P. bistriatus*, Portlock, sp., with the ornament of which it has much in common; but I have not discovered zig-zag or radiating lines on the exterior of the valve.

P. normalis occurs at Anseremme, Stage II in the Belgian Carboniferous Limestone, but in England it is found with *P. bistriatus* (which belongs to Stage I Tournaisien) and *P. obtusus*, *P. Lacordaireanus*, *P. Verneuileanus* (found in Belgium in Stage III Visean). The distribution of the species of this genus in Belgian rocks as stated is thus different from that observed in the English Carboniferous Series.

PARALLELODON ANGUSTUS, sp. nov. Plate XXIII, figs. 11—13.

Specific Characters.—Shell of medium size, transversely oblong, very inequilateral, compressed, with a long, hollow, dorsal slope. The anterior end small, narrow, its margin semi-elliptical, the antero-superior angle a right angle. The inferior margin long, almost straight, indented by the byssal sinus. The posterior margin truncate, sinuous, joining the lower border in a bluntly rounded curve. The umbones are small, not raised, placed far forwards. Proceeding obliquely downwards and backwards from the umbo towards the postero-inferior angle is a well-marked ridge which becomes less marked as it crosses the valve, separating a large hollowed dorsal slope from the rest of the valve. The byssal sinus is well marked.

Interior.—The hinge-plate appears to be normal.

Exterior.—The surface is almost smooth, but under the microscope fine concentric lines of growth are to be seen.

Dimensions.—Pl. XXIII, fig. 12, a right valve, measures—

Antero-posteriorly	35 mm.
Dorso-ventrally	14 mm.

Locality.—A bed of shale above the Underset Limestone, Nine Standard Rigg, Westmoreland.

Observations.—*P. angustus* is distinguished from all other species of the genus by its smooth surface and long antero-posterior diameter. It is not rare at the locality mentioned above, where it is associated with the fauna enumerated on p. 358, Vol. I, *supra.* *P. obtusus* has an almost smooth surface, but is not so narrow and elongated as *P. angustus.*

Parallelodon elongatus, sp. nov. Plate XXIV, fig. 16.

Specific Characters.—Shell above medium size, transversely sub-trapezoidal, gibbose. The anterior end rounded. The inferior margin almost straight, parallel to the hinge-line, the posterior margin truncate, slightly oblique, forming well-marked angles with hinge-line above and the inferior border below. The hinge-line long and straight. The umbones are elongate, gibbose, incurved, and placed in the anterior fourth of the valve. Proceeding obliquely downwards and backwards from the umbo to the postero-inferior angle is a well-marked obtuse ridge, above which the shell is so much compressed as to form a hollow dorsal slope. The anterior part of the valve is regularly convex from above downwards.

Interior.—The interior is smooth and shows no indication of radiating ribs.

Exterior.—Unknown.

Dimensions.—Pl. XXIV, fig. 16, a left valve, measures—

Antero-posteriorly (estimated) . . .	70 mm.
Dorso-ventrally	25 mm.

Locality.—From the Knipe Scar Limestone, Shap, Westmoreland.

Observations.—The elongate form and comparatively narrow dorso-ventral diameter, the very strong oblique ridge and hollow dorsal slope, distinguish this species from others of the genus, especially from *P. obtusus*, which is perhaps that one which has most resemblance to it. *P. elongatus* occurs very low down in the Carboniferous Series, the Knipe Scar Limestone being the second limestone from the base of the Carboniferous in Westmoreland.

NUCULA ? CUNEATA. *Phillips*, 1836.

NUCULA ? CUNEATA, *Phillips*, 1836. Geol. Yorks., vol. ii, p. 210, pl. v, fig. 14.

Specific characters.—Shell transversely elongate, cuneiform, equivalve, very inequilateral. Anterior end small and almost sharp. Posterior end slightly expanded and compressed, its border bluntly rounded. Superior and inferior margins subparallel. Umbones small, placed very far forwards, a well-marked broad escutcheon.

Interior.—Details not obvious.

Exterior.—Surface is ornamented with almost obsolete parallel lines and striæ of growth.

Dimensions.—

Antero-posteriorly	10 mm.
Dorso-ventrally	9 mm.

Locality.—Bolland, Yorkshire.

Observations.—I am unable to determine the real generic affinities of this shell. But it is necessary to retain the species, still doubtfully referred to *Nucula*, as the specimen is preserved in the Gilbertson Collection of the Natural History Museum, South Kensington. I do not think that it belongs to *Nucula*, and it is to be hoped that eventually more specimens will be found. The locality of Bolland is so vague that it is impossible to say exactly where or at what horizon the shell occurred.

CTENODONTA PENTONENSIS, *Hind*, 1899. Plate XXII, Figs. 4—7.

CTENODONTA PENTONENSIS, *Hind*, 1899. Quart. Journ. Geol. Soc., vol. lv, p. 369, pl. xxv, figs. 1—3, 3*a*, and 4.

Specific Characters.—Shell transversely and triangularly ovate-acute, moderately gibbose, very inequilateral.

The anterior portion of the shell is about one-third of the valve, and is moderately swollen, its border being elliptically curved. The inferior border is extended, and is very convex. The posterior border is exceedingly small and bluntly pointed, much narrowed by the approximation of the upper and lower borders. The hinge-line is arched, especially in front, but becomes straight, extended, and depressed posteriorly.

The umbones are moderately swollen, incurved, contiguous, elevated, forming the highest point of the shell, and excavated in front, but there is no real lunule.

Above the hinge is a very narrow elongate groove, posterior to the umbo, for the insertion of the external ligament.

The valve is irregularly convex from above downwards and before backwards, and most specimens show that an angular ridge parallel to, but at a higher level than, the hinge-line passes from the umbones backward to the posterior end, indicating a bending of the valve on itself.

Interior.—The muscle-scars are not exposed in any of the specimens yet obtained. The hinge-plate consists of two rows of small triangular teeth which meet at an obtuse angle beneath the umbo. The anterior set are fewer and larger than the posterior, about six in number, the teeth becoming smaller from before backward. The posterior row contains about eighteen to twenty teeth, which increase in size from before backward.

Exterior.—The surface is covered with well-marked concentric lines of growth, one of which occasionally becomes much accentuated. Shell of moderate thickness.

Dimensions.—Pl. XXII, fig. 4, measures—

Antero-posteriorly	30 mm.
Dorso-ventrally	17 mm.
Elevation of valve	7 mm.

Locality.—A bed of marine shale below the highest limestone, Penton Linns (Dumfriesshire).

Observations.—*Ctenodonta pentonensis* differs widely from *Ct. lævirostris* (Portlock, sp.), and the two species are not likely to be mistaken one for the other. The figure of *Ct. Halli*[1] has a much greater resemblance, and, indeed, it is possible that the species may be identical; but in the absence of any specimens of the Spanish shell I have hesitated to refer the Penton shells to that species. They seem to me to be more transverse, more pointed posteriorly, narrower from above downward, and neither in the figure nor in the description of Barrois's shell is any mention made of the angular ridge parallel to the hinge-line which is present in *Ct. pentonensis.*

The dimensions of *Ct. Halli*, Barrois, are here given for comparison—

Antero-posteriorly	32 mm.
Dorso-ventrally	19 mm.

Genus PALÆONEILO, *Hall*, 1870.

NUCULITES, *Conrad*, 1842. Journ. Acad. Nat. Sci. Philad., vol. viii, p. 249.
LEDA, *Stevens*, 1858. Amer. Journ. Sci., ser. 2, vol. xxv, p. 262.

[1] Barrois, "Recherches sur les Terrains anciens des Asturies & de la Galice," 'Mém. Soc. Géol. Nord.,' vol. ii (1882), No. 1, p. 339, and pl. xvii, fig. 3.

PALÆONEILO, *Hall*, 1870. Prelim. Notice Lamellibr. N. Y., pt. ii, p. 6; 1882, Whitfield, Ann. N. Y. Acad. Sci., vol. ii, p. 217; 1885, Hall, Pal. N. Y., vol. v, pt. i, Lamellibr. ii, p. xxvii; 1887, Fischer, Man. de Conchyl., p. 984; 1888, Œhlert, Bull. Soc. géol. France, ser. 3, vol. xvi, p. 653,

CTENODONTA, pars, *Beushausen*, 1895. Abhandl. Königl. Preuss. Geol. Landesanst., ser. ii, pt. xvii, p. 65.

PALÆONEILO, *Hind*, 1900. Quart. Journ. Geol. Soc., vol. lvi, p. 46.

Generic Characters.—"Nuculiform shells, transversely ovate or subelliptical, the posterior end often subrostrate, with a more or less defined sulcus along the umbonal slope. Cardinal line arcuate. Surface marked with striæ of growth, which are often lamellose and elevated into concentric ribs. Hinge furnished with a row of regular small transverse teeth, which is sometimes interrupted beneath the beak by a change in the direction of the teeth, or by several oblique teeth. Ligament external, contained in a shallow and narrow groove along the cardinal border. Muscular scars not strongly impressed, situated below the extremities of the hinge-line. Pallial line simple."

Observations.—The genus *Palæoneilo* was established by Hall for certain Nuculiform shells from the Devonian beds of New York. He selected as the type *Palæoneilo constricta*, which had hitherto been referred to the allied genus *Nuculites* by Conrad. Hall referred twenty species to this genus.

Palæoneilo differs from *Nucula* and *Nuculana* in possessing no internal cartilage-pit, situated beneath the umbo, and between the anterior and posterior lines of teeth. From *Nuculites* it also differs by having the row of hinge-teeth interrupted below the umbo, and by having no shelly process (the clavicle) separating the anterior adductor muscle-scar from the rest of the valve. *Ctenodonta*, however, is much more nearly related to *Palæoneilo*, but the former is nearly equilateral, and has no vertical comb-like hinge-teeth just below the hinge, neither does it possess the characteristic radiating sulcus, on the dorsal slope, nor the well-marked escutcheon.

Beushausen has, however (*op. supra cit.*), referred all the Devonian shells of Rhenish Prussia to *Ctenodonta*, considering that *Palæoneilo* is nothing more than a sub-group of that genus. Œhlert (*op. supra cit.*), on the other hand, considers *Palæoneilo* to be generically distinct from *Ctenodonta*. Whidborne[1] refers certain shells to *Ctenodonta* (*Palæoneilo*).

The Nuculidæ are represented in Carboniferous rocks by the genera *Nucula*, *Nuculana*, and *Ctenodonta*, and to these must now be added *Palæoneilo*. Two fine examples of this genus are in the Museum of Practical Geology, Jermyn Street, labelled "Carboniferous Shale (bottom of Yoredale Shale), beck south of

[1] Monogr. Palæont. Soc., 'Devonian Fauna,' vol. iii, pt. i (1896), p. 98.

Hammerton Hall, Slaidburn, Yorkshire," which I think means that the shells occur above the massif of Mountain Limestone, and at the base of the Pendleside Series, at which horizon the allied genus *Ctenodonta* also occurs.

It is therefore curious that a genus so well developed in Devonian times should appear at the top of the Carboniferous Limestone Series, there being no trace of its existence in intermediate beds. It is also noteworthy that the species attains considerable size, and is remarkably well developed, the shell possessing all the distinctive characters of the genus.

The following is a formal description of the species to which I give the name *Palæoncilo carbonifera.*

PALÆONEILO CARBONIFERA, *Hind*, 1900. Plate XXII, figs. 8, 8*a*, 8*b*.

PALÆONEILO CARBONIFERA, *Hind*, 1900. Quart. Journ. Geol. Soc., vol. lvi, p. 47, figs. 1, 2, 3.

Specific Characters.—Shell of more than medium size, transversely ovate-rhomboidal, oblique, very inequilateral, gibbose. The anterior end is very small, gibbose, narrowed from above downward, with its margin rounded. The inferior border is rounded in front, almost straight posteriorly, forming a well-marked, slightly obtuse, but gently rounded angle with the posterior border. The latter margin is sinuous, convex above and concave below, the upper portion being the larger. The postero-superior angle is very wide. The hinge-line is arched, though the upper margin of the valve, posterior to the umbo, appears straight, and is somewhat depressed as it passes backward.

The umbones are large, tumid, incurved, and markedly twisted forward, contiguous and elevated, placed very far backward, and much excavated in front, but there is no true lunule. Passing downward and backward from the umbo obliquely to the postero-inferior angle is a blunt ridge which separates the dorsal slope from the rest of the valve. In front of the oblique ridge the valve is convex from above downward, and below backward, the dorso-ventral curvature being much greater than the transverse. There is a marked flattening, or broad shallow sinus, in front of the ridge. Immediately above and posterior to the ridge is a well-marked sulcus, commencing as a narrow groove just behind the umbo, but becoming deeper and broader as it approaches the posterior margin, to the concavity in the border of which it corresponds. Above this radiating sulcus the dorsal slope swells, so as to become markedly convex, but this convexity is separated from the upper margin of the valve by a shallow groove forming the outer limit of the escutcheon. The escutcheon is large and well marked; it is bounded internally by the narrow elongate groove for the external ligament, and externally by a slight curved ridge which starts from the umbo, and curving outward, at first gradually approaches the margin, coalescing with it near the postero-superior angle.

The anterior part of the lower margin is much incurved, but gradually, being twisted outward on itself, becomes flattened and depressed in its posterior half.

Interior.—The muscle-scars and pallial line have not been observed. The hinge is multidenticulate, and the hinge-plate is much thickened. Anteriorly there are several (seven) large oblique simple teeth, becoming larger as they approach the front, with the exception of that one which is placed most anteriorly. These pass just behind the umbo into a number of vertical, much smaller, closely-placed, comb-like, simple teeth, which extend for some distance behind the umbo, and then gradually become larger and oblique in position, each tooth slanting downward and forward, and becoming more widely separated from its neighbour, the row of teeth extending to within a small distance of the postero-superior angle.

Exterior.—The surface is ornamented with fine close lines of growth, which follow accurately the contour of the shell, being oblique to its long axis, and are more marked in the region of the umbo, and on the dorsal slope, where they may become subimbricate.

Dimensions.—The specimen figured measures—

Antero-posteriorly	57 mm.
Dorso-ventrally	27 mm.
Convexity of valve	12 mm.

Locality.—England, in shales above the main mass of limestone in the beck, south of Hammerton Hall, Slaidburn (Yorkshire).

Observations.—*Ctenodonta* (*Palæoneilo*) *lirata* (Phill.), from the Devonian of Baggy, has much the same kind of surface-marking as *P. carbonifera*, but differs entirely in shape; indeed, this species is quite distinct from any of the shells belonging to the same genus, either from European or American Devonian localities. I am unable to say anything about the fauna associated with *P. carbonifera* at present, but beds of shale on presumably the same horizon at Whitewell, a few miles farther south, contain the following fossils: *Ctenodonta lævirostris*, *Nuculana attenuata*, *Parallelodon semicostatus*, *Modiola* sp., *Glauconome*, *Fenestella* sp., *Retipora pluma*, Phill., *Glyphioceras spirale*, Phill., sp., and *Orthis Michelini.*

Schizodus obovatus, *M'Coy.*, sp., 1844. Plate XXIV, figs. 14, 15.

Axinus obovatus, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 64, pl. viii, fig. 30.

Specific Characters.—Shell of medium size, obovate, moderately gibbose. The anterior end rounded, the inferior border convex, the posterior obliquely truncate from above downward and backward. The postero-inferior angle almost a right angle, the postero-superior an obtuse angle. The hinge-line is almost straight. The umbones are large, tumid, raised, incurved beaks, prosogyrous, and placed in front of the centre of the hinge-line. The valves are regularly convex, the dorsal slope well marked and concave.

Interior.—Unknown.

Exterior.—The surface is almost smooth, but irregularly distributed lines of growth are to be distinguished.

Dimensions.—Pl. XXIV, fig. 15, M'Coy's type, measures—

Antero-posteriorly	33 mm.
Dorso-ventrally	19 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire. Ireland: Carboniferous Limestone, Mullaghatinny, co. Tyrone.

Observations.—The type of *Axinus obovatus*, M'Coy, is contained in the Griffith Collection, Museum of Science and Art, Dublin, and I refigure it in Plate XXIV, fig. 15. It is crushed and therefore flattened, and otherwise fairly well preserved. One other specimen of the species has occurred to me from Castleton, a right valve (Pl. XXIV, fig. 14), which is not crushed and shows the deep dorsal slope.

S. obovatus is more transverse and regularly obovate than any other species of the genus.

CARBONICOLA VINTI, *Kirkby*, sp., 1864. Plate XXV, figs. 18—20.

? ANCYLUS VINTI, *Kirkby*, 1864. Trans. Tyneside Nat. Field Club, vol. vi (1864), p. 220.

CARBONICOLA VINTI, *Hind*, 1899. Quart. Journ. Geol. Soc., vol. lv, p. 367, pl. xxv, figs. 5—13.

Specific Characters.—Shell very small, inequilateral, ovate, compressed. The anterior end is broad, and its border is regularly rounded. The inferior border is regularly but gently convex. The posterior border is narrowed by the approximation of the upper and lower margins, obliquely truncate from above downward and backward, making a well-marked obtuse angle with the hinge-line above and an acute angle with the inferior margin below. The hinge-line is arched, extended, and depressed posteriorly. The umbones are small, tumid, slightly elevated, and situated in the anterior fourth of the shell.

The valves are regularly and gently convex for the anterior two-thirds, but gradually compressed in the posterior third.

Interior.—The muscle-scars appear to be normal. The hinge has not yet been isolated.

Exterior.—The surface is smooth and glistening, covered with fine concentric lines and folds. Periostracum much wrinkled. Shell thin.

Dimensions.—Pl. XXV, fig. 19, measures:—

Antero-posteriorly	5 mm.
Dorso-ventrally	3 mm.

Localities.—In a calcareous bed some yards above the Bassey Mine Ironstone, in an old marl-hole near Chatterley Station; in calcareous bands about ten yards above the Bassey Mine Ironstone, the Hamil, Burslem, Upper Coal Measures, North Staffordshire; in a bed of ironstone in the northern bank of the Wear, opposite Claxheugh, Upper Coal Measures, Durham.

Observations.—A very full account of the history of the discovery of this fossil is given by Mr. J. W. Kirkby (*op. supra cit.*), who was disposed to admit the lamellibranchiate character of the little shell, which was considered by some high authorities to be a gasteropod (*Ancylus*), by others to be a brachiopod allied to *Discina*, and was thought by yet others to be a crustacean.

I have referred my specimens to Mr. Kirkby, Prof. T. Rupert Jones, and Dr. G. J. Hinde, with the following result: the latter two gentlemen consider that the shell is a lamellibranch, and Mr. Kirkby writes that it is identical with his *Ancylus Vinti*. The specimens that I have of *Ancylus Vinti* from the Durham beds, kindly sent by Mr. Kirkby, seem to me to be simply the closely-compressed remains of the periostracum of a large number of shells, a circumstance which probably accounts for the difficulty in accurately determining the fossil.

Fortunately the North Staffordshire specimens are much better preserved, and, though generally somewhat crushed, show the general outline and character of the shell, and are therefore more easily referred to their real family and genus. After discussing the question of the true affinity of this shell at length (*op. supra cit.*), Mr. Kirkby finishes by saying: "For the present, therefore, it will be as well, perhaps, to retain as a provisional name Prof. Phillips's term of *Ancylus*. This I propose chiefly to get rid of the evil of having an unnamed fossil . . . and not because I am of the opinion that it really belongs to *Ancylus*. For, whether it be an entomostracan or a mollusc, the evidence certainly would appear to go towards proving that it had a bivalvular rather than an univalvular carapace."

Carbonicola Vinti would appear to be the last representative of this well-developed and frequently recurring Carboniferous fresh-water genus, and to occur at a higher horizon than any other species of the genus. As Mr. Kirkby points out is the case in the Durham beds, this fossil is associated in North Staffordshire also with a non-marine fauna. He estimates that *Carbonicola Vinti* occurs at an horizon not much over 50 or 60 feet from the top of the Coal Measures or the base of the Lower Red Sandstone, but in North Staffordshire there is a thickness of several hundred feet of red and purple beds of the Upper Coal Measures above the horizon of this fossil, *C. Vinti* occurring in this coalfield about the middle of the zone of *Anthracomya Phillipsii.*

ANTHRACOMYA CALCIFERA, *Hind*, 1899. Plate XXV, figs. 21—23.

ANTHRACOMYA CALCIFERA, *Hind*, 1899. Quart. Journ. Geol. Soc., vol. lv, p. 365.

Specific Characters.—Shell small transversely, modioliform, very inequilateral, gibbose, expanded and flattened posteriorly, oblique. The anterior end is very short, and narrower than the rest of the shell, and its border is elliptically curved. The inferior border is produced downward and backward, and is almost straight, subparallel with the superior border. The posterior border is comparatively lengthened obliquely, truncate from above downward and backward, and is straight for the greater part of its extent, but joins the inferior border at a somewhat rounded angle.

The hinge-line is straight, much shorter than the inferior border, and the posterior superior angle is well marked and obtuse. The umbones are small, pointed, incurved, and contiguous, placed in the anterior quarter of the shell.

Passing downward and backward from the umbo towards the posterior inferior angle is a well-marked, bluntly rounded fold, in front of which the valve is obliquely compressed, and posterior to this fold the valve is rapidly compressed and expanded to form the dorsal slope.

Interior.—Hinge edentulous. Muscle-scars normal. Pallial line entire, remote from the margin.

Exterior.—The shell appears to be almost smooth, but under the microscope faint concentric lines of growth are to be observed. Periostracum wrinkled. Ligament external, small, lodged in a narrow groove.

Dimensions.—Pl. XXV, fig. 21, measures :—

Antero-posteriorly	6 mm.
Dorso-ventrally	3 mm.
Elevation of valve	1 mm.

Localities.—The Upper Coal Measures of the North Staffordshire Coalfield. A bed of freshwater limestone at Highfield marl-pit, Etruria, and excavation for telegraph-posts, roadside, Bradwell; marl-pit east of Cocknage Hill; railway cutting, Florence Colliery; road cutting, from Trentham to Whitmore, close to Butterton New Farm; Newcastle-under-Lyme railway-cutting; Etruria, road-cutting; quarries near Longport Station; marl-pit, Richmond Hill, Stoke-on-Trent; Upper Coal Measures, Slade Lane, Fallowfield, Manchester coal-field.

Observations.—This species is much more elongate, less oblique, and attains a much smaller size than *Anthracomya Phillipsii.* The species which it most nearly resembles is *A. minima*, Ludwig, which is flatter, more triangular, and has a much shorter hinge-line.

I am of opinion that *A. calcifera* is of distinct value as indicating a special zone, and it appears to be the only molluscan form present in that zone. It has not yet been discovered in beds which contain *A. Phillipsii. A. calcifera* is present in very large numbers at certain horizons in its zone of occurrence, but it is very sparsely distributed through the rest of the rock of its zone.

The zone of *A. Phillipsii* is much more extensive, and altogether below that of *A. calcifera.* The zone of *A. calcifera* occurs 300 feet below the Penkhull Sandstone, estimated to be about 900 feet above the Bassey Mine Ironstone, which itself is filled with crushed specimens of *A. Phillipsii.* The Penkhull Sandstone is underlain by a series of grey sandstones and grey marls with the zone of *A. calcifera* at their base: these were included by the officers of the Geological Survey in the Upper Coal Measures. They are underlain by a series of clays and marls, worked for brick- and tile-manufacture.

It is very difficult to separate *A. calcifera* from the hard matrix of the limestone, and unless this be done its characters are often hidden. With its posterior angle hidden, the shell may be easily mistaken for a species of some other genus, especially *Carbonicola.* In specimens from the limestones, also, little evidence is shown of the wrinkled periostracum, so characteristic of the genus, but when preserved in a more shaly matrix undoubted evidence of this condition obtains. Occasionally, too, the shells are crushed and flattened, and then assume a shape very different from that which really belongs to them, becoming much more triangular; while the posterior end, on account of its natural convexity, appears much expanded from above downward.

EDMONDIA PUNCTATELLA, *Jones*, sp., 1865. Plate XXV, figs. 12, 13.

ESTHERIA PUNCTATELLA, *Jones*, 1865. Trans. Geol. Soc. Glasg., vol. ii, pt. 1, p. 71, pl. i, figs. 5, 5 *a*.

POSIDONOMYA PUNCTATELLA, *Jones*, 1891. Trans. Geol. Soc. Glasg., vol. ix, pt. i, p. 83, pl. v, figs. 7 *a*, 7 *b*.

Specific Characters.—Shell of medium size, transversely sub-ovate, inequilateral. The anterior border is irregularly rounded, passing with a continuous curvature into the inferior margin, which is gently convex. The posterior margin is truncately rounded, sometimes almost straight above, where it meets the hinge-line at a more or less marked obtuse angle. The upper margin is shorter than the lower, nearly straight. The umbones are small, slightly raised, situated a little anterior to the centre of the hinge-line. The posterior end of the shell is not so deep from above downwards as the anterior. Shell thin.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous, somewhat irregular, concentric striæ and rugæ of growth. The microscope shows the surface of the shell to be covered with numerous small pittings.

Dimensions.—Pl. XXV, fig. 12, measures—

Antero-posteriorly	34 mm.
Dorso-ventrally	23 mm.

Localities.—In shale a few feet under the Arden Limestone, Thornliebank, Renfrewshire, and Linn Spout, Dalry, Ayrshire.

Observations.—All the shells of this species that I have seen are crushed and flattened. They are very numerous and occur in all stages of growth. The fossils are in calcite covered by a deposit of iron pyrites, a condition which is of important aid in showing that they belong to the Mollusca rather than to the Crustacea.

The generic affinity is doubtful in the absence of details of the interior, but the shells have none of the special characters of *Posidonomya*, and I am quite at a loss to account for their reference to this very distinct and characteristic genus. The shells are not oblique, and have no posterior wing-like projection. For the present I place the species in the genus *Edmondia*, because there is no lunule and no escutcheon, and the hinge-line appears to be simple and erect. Whatever ligament there was seems to have been internal.

Prof. T. Rupert Jones has lately described some bivalve shells from Russian Carboniferous beds as *Posidonomya subovata* ('Geol. Mag.', dec. iv, vol. viii, p. 434, pl. xvi, figs. 8—15). Judging from the figures, they are exceedingly like *E. punctatella*, only much smaller; and, except that the punctate ornament appears to be absent, they could not be satisfactorily separated from that shell. Whether identical or not, the Russian shell should be removed from the genus *Posidonomya*.

An examination of the very numerous specimens in the collection of Mr. J. Neilson, of Glasgow, shows some considerable variation in the shape of the posterior end, but as much of this may be due to crushing, and may be apparent rather than real, I will do no more than note the fact.

With regard to the environment of *E. punctatella*, Prof. Rupert Jones quotes from a letter of the late Dr. John Young (*op. supra cit.*, p. 84): They "exist in thousands both at Darnley (Thornliebank) and the Linn Spout (Dalry) in a thin shale, in which they seem to be the only organisms present, but in the other shales, lying close to it above and below, we find examples of *Pteronites* (*Actinopteria*) and *Cypricardia*-like shells, having an estuarine or brackish character about them, and immediately below the lower shell is a seam of coal." The idea that the band represents a freshwater stratum has given rise to the view that *E. punctatella* might have been either *Carbonicola* or *Anthracomya.* It has not the transverse shape, with narrow anterior and broad posterior ends, of the latter genus, and the lines of growth are coarser and more rugged than obtains in species of that genus. Neither does the contour recall that of *Carbonicola,* though the coarser marking on the surface is like that which obtains in this genus; but I do not know of any species of the genus which has punctate markings.

If the markings denote a prismatic structure in the outer layers of the shell, the late Dr. John Young found that the prismatic cellular structure is confined to shells belonging to the Aviculidæ, or wing-shells, and the Mytilidæ, or mussels. He found it present in *Pinna, Actinopteria, Posidonomya* and *Myalina.* Quite recently Mr. John Smith informs me that he has met with the structure in *Aviculopecten dissimilis.* Dr. Young was unable to find prismatic structure in *Carbonicola, Anthracomya,* and *Naiadites.*

Edmondia truncata, sp. nov. Plate XXIV, figs. 6—8.

Specific Characters.—Shell small, inequilateral, very moderately gibbose, oval. The anterior end comparatively broad and shorter than the posterior, its margin rounded. The lower margin slightly convex, the posterior blunt and rounded. The hinge-line slightly arcuate. Umbones obtuse, small, very inconspicuous; placed in the anterior third of the hinge-line. The valves are regularly convex, slightly more so from above downwards than antero-posteriorly. Dorsal slope somewhat compressed, no lunule or escutcheon.

Interior.—The cast shows the groove beneath the hinge-plate for the peculiar process characteristic of the genus.

Exterior.—The surface is almost smooth, but fine concentric lines are to be seen with a microscope.

Dimensions.—Pl. XXIV, fig. 6, measures—

Antero-posteriorly	15 mm.
Dorso-ventrally	10 mm.

Locality.—The lower Carboniferous beds of Glencartholm, Eskdale, Dumfriesshire.

Observations.—This little shell is not uncommon in the fossiliferous beds of Glencartholm, which contain *Lithodomus carbonarius,* Hind, and *Leiopteria divisa,* M'Coy, sp., shells which occur in the Calciferous Sandstone Series of Randerston, Fife. The squat form and the absence of special ornament will serve to distinguish the species.

EDMONDIA AMÆNA, *de Koninck*, 1885. Plate XXIV, figs. 1, 2.

EDMONDIA ? AMÆNA, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 47, pl. x, figs. 1, 2, 6, 7.
ANTHRACOSIA ROBUSTA. Mem. Geol. Surv. Scotland, Expl. sheet 22, p. 44.

Specific Characters.—Shell of medium size, equivalve, inequilateral, transversely suboval, gibbose. The anterior end short, its margin rounded. Inferior margin convex; posterior margin obliquely truncate, bluntly rounded. Hinge-line very slightly arched. Umbones large, tumid, incurved and twisted forwards, much raised, placed about the junction of the anterior and middle thirds of the length of the hinge-line. No lunule or escutcheon. Posterior end of the hinge-line elevated. The valve is regularly swollen, except along the dorsal slope, which is so much compressed as to be hollow.

Interior.—The adductor scars are normal in position, very large, and much roughened. The hinge-plate has a large spatulate process beneath the umbo. Pallial line entire. Interior of valve immediately above it, strongly marked by many close rough ridges and grooves at right angles to the line.

Exterior.—Surface ornamented with fine concentric lines and striæ of growth. Shell thin.

Dimensions.—Pl. XXIV, fig. 1, a left valve, measures—

Antero-posteriorly	51 mm.
Dorso-ventrally	42 mm.
From side to side (estimated from one valve) .	22 mm.

Locality.—Calcareous shale, Burn Anne, Ayrshire.

Observations.—Mr. J. Smith kindly sent me some shells which he had recently obtained from Burn Anne, near Galston. They are found with *Myalina* and other marine fossils. Some of the specimens occur as casts and show the adductor muscle-scars and pallial line (Pl. XXIV, fig. 1). It may be noted that de Koninck's description of *E. amæna* does not suit his figures, two of which are not referred to in the text. He says the umbones are small and almost terminal, whereas in the figure they are much larger than is usual in the genus *Edmondia*, and not by any means terminal. The Burn Anne shells have a much more pronounced dorsal slope than is usual in *Edmondia*, and consequently have an elevated, almost erect, upper border posteriorly. On referring to the list of fossils obtained by the Geological Survey of Scotland from Burn Anne, locality 105, the horizon of the beds being given as doubtful (*op. supra cit.*, p. 44), the following fossils are said to occur: *Productus scabriculus; Orthis resupinata; Aviculopecten granosus; Anthracosia robusta; A. ovalis; Axinus carbonarius; Ctenodonta gibbosa; Myalina triangularis; Bellerophon Urei;* and *Orthoceras*, sp.

I have no doubt that the shells referred to *Carbonicola robusta* and *Myalina triangularis* were *Edmondia amæna* and *Myalina Verneuillii.* The former two species do not occur with purely marine forms.

Edmondia acuta, sp. nov. Plate XXIV, figs. 3—5.

Specific Characters.—Shell of medium size, transversely ovate, inequilateral, broad in front, narrow posteriorly, tumid. The anterior end well developed, its border rounded. Inferior margin convex, posterior border narrow. Hinge-line arched and prolonged. Umbones thick, gibbose, incurved, not contiguous, somewhat elevated, placed in front of the middle line. No lunule or escutcheon. Dorsal slope expanded and flattened.

Interior.—Adductor muscle-scars large and rough. Casts show a deep groove below the umbo for the peculiar hinge process.

Exterior.—Surface almost smooth, but fine lines and striæ of growth are visible with the microscope.

Dimensions.—Pl. XXIV, fig. 3, a bivalved example, measures—

Antero-posteriorly	58 mm.
Dorso-ventrally	35 mm.
From side to side (probably less as the valves are gaping)	32 mm.

Locality.—From a bed of Calcareous shale at Burn Anne, Ayrshire.

Observations.—*E. acuta* differs from all the other species of the genus in possessing a very much narrowed posterior end. Casts show the peculiar shell-process beneath the umbo, found in all species of the genus *Edmondia.* The species is founded on three specimens in the collection of Mr. J. Smith, Kilwinning.

Edmondia senilis, *Phillips*, sp., 1836.

The type specimen, a right valve, is preserved in the University Museum, Oxford. It appears to be a very large specimen of *E. rudis*, M'Coy, as I hinted, p. 303, vol. i. The name *E. rudis*, M'Coy, therefore, is superseded by *E. senilis* on the grounds of priority.

Scaldia minuta, *Hind*, 1899. Plate XXV, fig. 17.

Scaldia minuta, 1899. Trans. N. Staff. Field Club, vol. xxxiv, p. 93, pl. iii, figs. 1, 2.

Specific Characters.—Shell equivalve, slightly inequilateral, very small, suborbicularly or broadly ovate, compressed. The anterior end is deep, and has a regularly rounded margin passing with a regular sweep into the inferior border, which is convex. The posterior border is regularly rounded, about the same depth as the anterior margin. The hinge-line is very gently arched, and forms an obscure obtuse angle with the posterior border. The umbones are small, subcentral. The valves are regularly convex, without a ridge, and somewhat compressed along the dorsal slope.

Interior.—Unknown.

Exterior.—The surface of the valve is ornamented with somewhat irregular, concentric grooves and ridges, well marked in the lower half of the valve, but almost obsolete in the umbonal region, few in number, and large compared to the size of the valve. Periostracum thick and wrinkled.

Dimensions.—Pl. XXV, fig. 17, measures—

Antero-posteriorly	3 mm.
Dorso-ventrally	2·5 mm.

Localities.—In nodules of calcareous hæmatite in an indurated clay at Weston Coyney, near Longton, Staffordshire. The real horizon is at present not ascertained.

Observations.—Mr. J. Ward, F.G.S., to whom is due the merit of the discovery of a marine fauna at the horizon mentioned above, has kindly placed specimens of the shell in my hands for description and taken me with him to collect at the spot.

Pterinopecten papyraceus, *Discina nitida*, and a nautiloid shell occur with the little Lamellibranch now described, but the latter is represented by a much larger number of individuals than the other fossils.

In the absence of details of the hinge it is impossible to say with certainty to what genus the shell really belongs, but its general aspect is that of the family *Edmondidæ*, and its suborbicular sulcated form has induced me to place it for the time being in the genus *Scaldia* of de Koninck.

The periostracum is very thick, and in poor specimens often obscures the shape and characters of the valve; indeed it is impossible in many specimens to recognise the specific characters; and, like *Carbonicola Vinti*, owing to crushing and the consequent dislocation of the umbo, some specimens have a Discinoid look. Fortunately a few specimens have been well enough preserved to indicate the Lamellibranch nature of the valve without a shadow of doubt. It must be confessed that up to the present the possession of a periostracum has not been demonstrated in the genus *Scaldia*, but shells preserved in limestone rarely, if ever, have the periostracum developed, and hitherto *Scaldia* has only been found in massive limestone.

Family CŒLONOTIDÆ, *M'Coy.*

Genus SPATHELLA, *Hall*, 1885.

CYPRICARDIA, *M'Coy*, pars, 1844. Synops. Carb. Foss. Ireland, p. 59.
SANGUINOLITES, *M'Coy*, pars, 1844. Ibid., p. 49.
SPATHELLA, *Hall*, 1885. Geol. N. York. Palæontol., vol. v, pt. 1, Lamellibranch. II, p. xxxiii.

Generic Characters.—Shell equivalve, very inequilateral, transversely subcylindrical, dorso-ventral diameter longer behind than in front. The anterior end is short, narrow, elliptically curved. Dorsal and ventral margins subparallel, posterior margin truncate or bluntly rounded. Umbones small, anterior. A well marked elongate escutcheon, apparently no lunule. Dorsal slope well defined, hollowed. A well marked constriction in the anterior part of the valve. Ligament apparently external and small.

Interior.—The anterior adductor muscle-scar small, not bounded posteriorly by a ridge, placed just within the margin of the valve. The posterior adductor scar small, placed immediately beneath the hinge-line and near the posterior margin. Pallial line entire. Hinge with two small cardinal teeth in the right valve, subumbonal, and obsolete lateral teeth.

Exterior.—Surface adorned with concentric lines and rugæ of growth.

Observations.—The type of this genus is *Spathella typica*, a shell from the Devonian series of New York. *Spathella* has a close relationship to *Sanguinolites*, but is separated by the presence of hinge-teeth, the position of the muscle-scars, the absence of a strong ridge bounding the anterior adductor muscle-scar, and the absence of an angular radiating ridge and of secondary radiating ridges on the dorsal slope.

Sphenotus, Hall, another Devonian genus, has two cardinal teeth, but in addition there are two slender lateral teeth, and there is always a strong angular ridge crossing the valve from the umbo to the posterior inferior angle, and a secondary radiating median ridge on the dorsal slope, which characters serve to distinguish *Sphenotus* and *Spathella*.

Two species occur in Carboniferous rocks, one being the *Cypricardia cylindrica*, M'Coy, the other figured by M'Coy as *Sanguinolites plicatus* (*op. cit.*, pl. x, fig. 3 *a*), but evidently distinct from that species.

SPATHELLA CYLINDRICA, *M'Coy*, sp., 1844. Plate XXIII, figs. 1—4.

CYPRICARDIA CYLINDRICA, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 60, pl. viii, fig. 23.
— SOCIALIS, *M'Coy*, 1844. Ibid., p. 61, pl. viii, fig. 12.

Specific Characters.—Shell above medium size, transversely elongate, subcylindrical, obliquely gibbose, dorsal slope well-developed, hollowed, obliquely constricted by a broad shallow sinus in front of the oblique gibbosity. The anterior end is short and narrow, its margin elliptical. The inferior margin is prolonged, slightly convex, marked in front by a shallow sinus corresponding to the constriction of the valve. The posterior end is truncate or bluntly rounded. The hinge-line is straight, shorter than the anterior margin. The postero-superior angle is bluntly rounded. The umbones are small, elongate, slightly raised and placed far forwards, not terminal.

Interior.—Normal.

Exterior.—The surface is ornamented with concentric lines and rugæ of growth.

Dimensions.—Pl. XXIII, fig. 1, a right valve from Redesdale, measures—

Antero-posteriorly	51 mm.
Dorso-ventrally	19 mm.
From side to side (estimated) . . .	16 mm.

Localities.—England; the Carboniferous Limestone of Poolvash, Isle of Man, and Thorpe Cloud, Derbyshire; the Redesdale Ironstone, Redesdale, Northumberland. Ireland: the Carboniferous Limestone of Millicent, Kildare; Araglin Bridge and Kilworth, co. Cork; Leam, co. Fermanagh.

Observations.—The types of *Cypricardia cylindrica*, M'Coy, and *C. socialis*, M'Coy, are preserved in the Griffith Collection, in the Science and Art Museum, Dublin. That of the latter (Pl. XXIII, fig. 3) is a left valve, and the former is a much larger example of a right valve, which has, however, lost its anterior end (Pl. XXIII, fig. 2). Pl. XXIII, fig. 4, the cast of a right valve from Poolvash, shows the anterior adductor muscle, and the cast of the hinge-plate with cardinal teeth and the obsolete posterior lateral teeth. Pl. XXIII, fig. 4 *a*, the Redesdale specimen, a right valve, is evidently a full-grown example, but it is not quite perfect in front. The Irish localities are given on the authority of Griffith ('Journ. Geol. Soc. Dublin,' vol. ix, p. 36 *et seq*).

S. cylindrica is comparatively less transverse and less gibbose than *S. tumida*, its dorsal slope is also more pronounced, and much more extensive; and the gibbosity is much more oblique, due to the much smaller amount of constriction in *S. tumida.*

Spathella tumida, sp. nov. Plate XXIII, figs. 5—7.

Sanguinolites plicatus, *M'Coy*, pars, 1844. Synops. Carb. Foss. Ireland, p. 49, pl. x, fig. 3*a*.

Specific Characters.—Shell of medium size, transversely oval, inequilateral, regularly tumid. The anterior compression is small and only apparent near the margin. Dorsal slope compressed, only slightly hollow, comparatively small. The anterior end short, its border elliptical. The inferior margin gently convex, the posterior margin obliquely truncate, nearly straight above, bluntly rounded below. The hinge-line almost straight. The umbones tumid, incurved and somewhat twisted forwards, slightly raised and placed about the junction of the anterior and middle thirds of the valve. Escutcheon well developed, elongate.

Interior.—Normal, but hinge-line not exposed.

Exterior.—The surface is ornamented with concentric folds and sulci, somewhat oblique to the long axis of the shell.

Localities.—England: the Carboniferous Limestone of Thorpe Cloud and Castleton, Derbyshire. Ireland: (?) Bruckless, co. Donegal.

Dimensions.—Pl. XXIII, fig. 5, a right valve from Thorpe Cloud, measures—

Antero-posteriorly	43 mm.
Dorso-ventrally	18 mm.
From side to side (estimated) . . .	14 mm.

Observations.—The specimen figured by M'Coy (re-figured Pl. XXIII, fig. 6) is evidently distinct from *Sanguinolites plicatus*, Portlock sp., to which he referred it. From the absence of oblique ridges I now refer the shell to *Spathella* under the specific name of *S. tumida.* Several specimens of this shell have been obtained at Thorpe Cloud and Castleton, which have enabled me to study many of the characters of the species; but unfortunately the hinge-plate cannot be completely seen. The shell is much less transverse and more gibbose than that of *S. cylindrica.*

Sanguinolites monensis, sp. nov. Plate XXIII, figs. 14—16.

Specific Characters.—Shell below medium size, transverse, narrow and subcylindrical in front, inequilateral, compressed but expanded in the dorso-ventral diameter posteriorly, equivalve. The anterior end is almost obsolete, and very narrow from above downwards; its border elliptically curved. The inferior border is almost straight and descends rapidly downwards and backwards, meeting the posterior margin in a very obtuse angle. The posterior border is obliquely truncate, and straight above, but below is either polygonal or bluntly rounded. The hinge-line is long and straight, forming an obtuse angle with the posterior border. The umbones are small, obtuse, keeled, almost terminal, twisted forwards. Lunule well marked. Escutcheon long and narrow. Proceeding from the umbo obliquely towards the postero-inferior angle is a strong angular keel, dividing the valve into two unequal triangles, the lower being much the smaller. Below this angular keel the valve is compressed so that the surface is slightly concave. Above it the dorsal slope is traversed by two sub-angular radiating ridges, which extend to the margin, dividing the slope into three sub-equal parts. The hinge-line is thickened, and immediately below it the dorsal slope shows a slight compression.

Interior.—The anterior adductor scar is large and occupies almost the whole of the anterior end, bounded posteriorly by a curved ridge. Normal in other details.

Exterior.—The surface is ornamented by lines and rugæ of growth parallel to the margins, interrupted on the dorsal slope by the radiating ridges.

Dimensions.—Pl. XXIII, fig. 16, a left valve, measures—

Antero-posteriorly . . .	. 31 mm.
Dorso-ventrally (posterior end) . .	. 17 mm.
Transversely (estimated from a single valve)	. 10 mm.

Observations.—I have obtained four specimens of this shell from the shelly limestone of Poolvash, Isle of Man, and I noted one other specimen in the collection of the British Museum (Natural History). *Sanguinolites monensis* differs from all the other species of the genus in its narrow, transverse, triangular form. It resembles *S. striato-granulosus*, but has no lines of radiating dots and is much more cylindrical anteriorly. I can find no shell hitherto described which seems to have the peculiar form and characters of that under discussion; nor have I yet seen specimens from any locality except that noticed above.

SANGUINOLITES VEXILLUM, *de Koninck*, 1885. Plate XXIII, figs. 17—20.

SANGUINOLITES VEXILLUM, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 79, pl. xv, figs. 19, 31, 32.

Specific Characters.—Shell below medium size, transverse, sub-trapezoidal, narrower in front than behind, compressed. The anterior end is short and narrow, its border a semi-ellipse. The inferior margin somewhat sinuous; the posterior obliquely truncate, nearly straight, but at times formed of a longer upper and a shorter lower portion which meet at a very wide angle. The postero-inferior angle is well marked and is almost a right angle. The postero-superior angle is very little larger than a right angle. Hinge-line straight, shorter than the ventral border. The umbones are small, pointed, incurved, and twisted forwards, slightly raised above the hinge-line, and placed in the anterior quarter of the valve. Proceeding obliquely outwards and downwards from the umbo to the postero-inferior angle is an oblique, angular ridge, dividing the valve into two unequal portions; the upper and smaller forms the dorsal slope, which is much compressed, and bisected by a radiating line. The inferior part corresponds to the body of the valve and is compressed by a broad, shallow, oblique sulcation, which is indicated at the inferior margin by a sinus. Lunule and escutcheon elongate and narrow.

Interior.—The adductor muscle-scars are normal in position. Hinge-plate slightly arched. Edentulous.

Exterior.—The surface is ornamented with several coarse, somewhat irregular concentric lines and striæ of growth.

Dimensions.—Pl. XXIII, fig. 18, a left valve, measures—

Antero-posteriorly	23 mm.
Dorso-ventrally	11 mm.
Gibbosity of valve	3 mm.

Locality.—The Upper Limestone Series of Linn Spout, Dalry.

Observations.—*S. vexillum* is not uncommon in the shales beneath the Linn Spout Limestone, Dalry. I have been able to expose the hinge-plate of both valves and find it edentulous. This species has some resemblance to *S. striato-lamellosus*, of which I suggested (*supra*, vol. i, p. 398) it was a synonym; but the latter is more rugged and a much larger shell, and has the posterior border polygonal, and I think it advisable to retain de Koninck's specific name. De Koninck places *S. vexillum* in a group whose surface has three or four diagonal folds, but in the diagnosis describes one main fold and a much less well-marked secondary ridge. I find the species to agree with specific description rather than with that of the group. De Koninck states that he found the species at Craig, Scotland. The hinge-plate is exposed in both valves (Pl. XXIII, figs. 17*a*, 18*a*).

Genus SOLENOMORPHA, *Hind*, 1903.

SOLEN, pars, *Goldfuss*, 1832. H. von Dechen's transl. of the 2nd. ed of de la Beche's Manual of Geognosy, p. 531.

— *Goldfuss*, 1840. Petrefacta Germaniæ, vol. ii, p. 276.

Portlock, 1843. Rep. Geol. Londonderry, etc., p. 441.

Solenopsis, *M'Coy*, 1844. Syn. Carb. Limest. Foss. Ireland, p. 47.
— *W. H. Baily*, 1862. Explan. Sheet 127, Mem. Geol. Surv. Irel., p. 9.
Clidophorus, *H. B. Geinitz*, 1866. Carbonformation u. Dyas in Nebraska, p. 25.
Solenopsis, *F. V. Hayden*, 1871. Final Report of U.S. Geol. Surv. in Nebraska, p. 223.
— *L. G. de Koninck*, 1885. Ann. Mus. Roy. Hist. Nat. Belg., vol. xi, p. 88.
— *Fischer*, 1887. Manuel de Conchyliologie, p. 1112.
— *S. A. Miller*, 1889. North American Geology and Palæontology, p. 512.
— *Beushausen*, 1895. Abhandl. Königl. Preuss. Geol. Landesanst., n. s. pt. xvii, p. 216.
— *Hind*, 1900. Monogr. Brit. Carb. Lamell., pt. v, p. 412 (Pal. Soc., vol. liv).
Solenomorpha, *Hind*, 1903. Quart. Journ. Geol. Soc., vol. lix, p. 334.

Observations.—In 'Nature,' vol. lxvii (1903), p. 559, Prof. T. D. A. Cockerell points out that the name *Solenopsis* was adopted in 1841 for a genus of ants, and therefore must not be used for a genus of Mollusca; he suggests *Solenomorpha.* It is curious that the name has not been challenged since 1844.

Solenomorpha major, *Hind*, 1903. Plate XXII, figs. 1, 2.

Solenomorpha major, *Hind*, 1903. Quart. Journ. Geol. Soc., vol. lix, p. 334, fig. 1.

Specific Characters.—Shell above medium size, transversely elongate, ovato-lanceolate-truncate, very inequilateral, broad and convex in front, narrowed and compressed posteriorly, only slightly convex from before backward, more so from above downward. The anterior border is rounded, the inferior border prolonged and elliptically curved, the posterior short, bluntly obliquely truncate. The hinge-line is curved in front, long, and almost straight posteriorly. The umbones are obtuse, and placed in the anterior fifth of the valve. There seems to have been an elongate, narrow escutcheon.

Interior.—The anterior adductor scar is large and rounded. Other characters and the hinge unknown.

Exterior.—The shell is ornamented with fine, close, concentric lines of growth, which follow the contour of the valve.

Dimensions.—Plate XXII, fig. 1, measures—

Antero-posteriorly	136 mm.
Dorso-ventrally	42 mm.
Gibbosity of valve	5 mm.

Horizon and Locality.—Shales of the Pendleside Series, River Hodder, Hodder

Place, Stonyhurst (Lancashire), and stream running into River Wharf, Burnsall, Yorkshire.

Observations.—This beautiful specimen was found by the Rev. Charles Hildreth, S.J., who has most kindly presented it to the Museum of Practical Geology, Jermyn Street. The specimen is that of a perfect left valve, evidently a full-grown example, somewhat crushed along the hinge-line. The gradually tapering posterior end and general shape point to the genus *Solenomorpha*, to which I now refer it without hesitation. *S. major* is so much larger, more compressed, and deeper than *S. minor*, that there is no danger of the two species being confused. Some half dozen specimens have been obtained from Hodder Place.

I have described and figured two species of *Solenomorpha* in my 'Monograph of the Carboniferous Lamellibranchiata,' vol i, pt. v (1900), pp. 413—14 (Palæont. Soc., vol. liv). At that time I had unfortunately very poor material for study and illustration of *S. minor* and *S. parallela*, the two species described. I have since obtained a very fine, almost complete, example of *S. minor*, from the Carboniferous Limestone of Yeat-House Quarry, near Frizington (Cumberland), which is figured here (Pl. XXII, fig. 3), to compare with *S. major*. In this specimen, which is a cast of the interior, the anterior adductor muscle-scar is well shown, and also the broad upper surface of the shell, with a parallel groove on each side of the hinge-line.

The Shales of Hodder Place have yielded an interesting fauna. I have recognised in them the following organisms: *Phillipsia Van der Grachtii; Phillipsia Polleni; Prolecanites compressus; Glyphioceras spirale; Glyphioceras reticulatum; Glyphioceras platylobum; Orthoceras annuloso-lineatum; Posidonomya Becheri; Solenomorpha major.* Also a few brachiopods and Zaphrentoid corals.

I do not think that the beds can be very far above the top of the Massive Limestone, a fact indicated by the presence of *Prolecanites compressus* and *Posidonomya Becheri.*

Genus NOTHAMUSIUM, novum.

Generic Characters.—Shell of medium size, equivalve, very inequilateral, obliquely ovate, moderately convex. The anterior end gaping and short. The anterior margin is acutely pointed above; it becomes concave as it descends, and then broadly convex. The inferior margin is gently convex, the posterior elliptically rounded. The hinge-line is straight in front, sloping downwards behind the umbo. The umbo is small, pointed, twisted forwards, very slightly raised, placed at the junction of the anterior and middle thirds of the hinge-line.

The valve is hollowed by a broad shallow compression from hinge-line to lower margin, anterior to the umbo, elsewhere it is very gently and evenly convex.

Interior.—The posterior adductor muscle-scar is almost obsolete, placed in the hollow of the dorsal slope, high up and remote from the posterior end. The hinge-plate of the right valve contains a large, thick, prominent, cardinal tooth, immediately posterior to and beneath the umbo, obliquely twisted.

Exterior.—The surface is smooth in front where concentric lines of growth are seen on the anterior portion, elsewhere ornamented by numerous, flattened, radiating ribs, which become almost obsolete at the extreme posterior end. The ribs are separated by shallow sulci, and bifurcate as they cross the valve.

Observations.—This genus has been established on a number of specimens, the majority of which were obtained from the Carboniferous Limestone of Little Island, co. Cork. I find these shells have generally been referred to *Avicula flabellula*, M'Coy, but whatever that species may be, it possessed ears and a short hinge-line, and has the characters of *Pseudamusium.*

It is not easy to make out the affinities of this species, or, indeed, to determine the correct orientation of the shell. I have described the short smooth end as anterior, but am not at all certain that this is correct. A specimen from Auchenmade (Plate XXIV, fig. 13), which I feel sure belongs to the same genus, though the species is perhaps distinct, shows a strong cardinal tooth in the right valve. This forbids any reference to *Pectinidæ* or *Aviculidæ*, and also to *Solenomyidæ.*

The anterior end appears to be thin and gaping. Dr. Kitchin and Mr. E. A. Smith have kindly looked at my specimens and have both stated that the shells are quite unlike any hitherto described, and they are unable to suggest their systematic position.

NOTHAMUSIUM RADIATUM, sp. nov. Plate XXIV, figs. 9—11.

Specific Characters.—The generic description has been drawn up from this species, with the exception that the hinge-plate has not been observed. It therefore need not be repeated here.

Dimensions.—Plate XXIV, fig. 11, measures—

Antero-posteriorly	31 mm.
Dorso-ventrally	21 mm.
Convexity of valve	3 mm.

Localities.—England: the Carboniferous Limestone of Narrowdale, Staffordshire. Ireland: the Carboniferous Limestone of Little Island, Co. Cork.

Observations.—I have only seen one English example (Plate XXIV, fig. 11), and this is much larger than any of the Irish specimens, of which I have seen at least ten. When the shell is young the radiating ribs are almost absent, but they become better marked towards the inferior margin of the valve. The radiating ribs are simple at first, but in old shells bifurcate as they approach the lower margin.

As I mentioned above, this species has generally been referred to *Avicula flabellula* in Irish cabinets, but M'Coy gives the dimensions of his shell as length $7\frac{1}{2}$ lines, width 9 lines, whereas the antero-posterior diameter of *Nothamusium radiatum* is much longer than the dorso-ventral. I am not sure that *N. radiatum* is distinct from *N. transversum.* Dr. Kitchin thought the two specimens belonged to distinct species, but the variation in shape may be due to the fact that we are comparing the cast of an interior with a testate example. The two examples, however, which I refer to *N. transversum* have the antero-posterior diameter comparatively longer than that which obtains in *N. radiatum.*

Nothamusium transversum, sp. nov. Plate XXIV, figs. 12, 13.

Specific Characters.—Shell of medium size, oblique, very slightly convex, transversely ovate, truncate anteriorly, antero-superior angle produced and pointed, anterior margin sinuous. Inferior margin broadly convex, posterior border bluntly rounded. Hinge-line straight and long. The umbones are moderately long, compressed and pointed, placed far forward.

Interior.—The hinge of the right valve has a large, thick, cardinal tooth, projecting obliquely backwards, above which is a narrow, linear sulcus, probably for the attachment of an external ligament.

Exterior.—The surface of the valve is smooth in the umbonal region and in front, this part of the valve being marked by fine concentric lines of growth; elsewhere the valve is covered by numerous fine, flat, simple, rarely bifurcating lines of growth. Shell thin.

Dimensions.—Plate XXIV, fig. 13, measures—

Antero-posteriorly	62 mm.
Dorso-ventrally	37 mm.

Localities.—England: the 4-laws Limestone, the Coomb, Redesdale, Northumberland. Scotland: the Lower Limestone Series of Auchenmade, Ayrshire.

Observations.—Mr. J. Smith, of Kilwinning, sent me some years ago the shell figured in Pl. XXIV, fig. 13. It puzzled me until I came across the specimens of *Nothamusium radiatum* from Little Island; and though Mr. Smith's specimen is much worn, I have no hesitation in referring it to the same genus. This specimen is the more important that it shows the hinge-plate with a large cardinal tooth (Fig. 13 *a*).

N. transversum is more transverse and has more radiating ribs of a finer and closer character than *N. radiatum*. On account of these characters I have established another species for Mr. Smith's shell.

A smaller specimen was found by Mr. Dunn, of Redesdale, some years ago, at the Coomb quarry, a locality which has yielded a rich fauna of the rarer Carboniferous Limestone fossils. This agrees with Mr. Smith's specimen, which has many fine radiating ribs, and is more transverse than *N. radiatum*.

Family LUCINIDÆ.

Genus PARACYCLAS, *Hall*, 1843.

PARACYCLAS, *Hall*, 1843. Geol. Surv. N. York, Ref. 4th district, p. 171.
LUCINA, *Portlock*, 1843. Rep. Geol. Londonderry, p. 571.
— *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 53.
PARACYCLAS, *Hall*, 1885. Geol. Surv. N. York, Pal., vol. v, pt. 1, Lamell. ii, p. xxxviii.
— *Beushausen*, 1895. Die Lamell. des Rheineschen Devon., p. 165; Abh. königl. preuss. geol. Landes., n. s., pt. 17.

Generic Characters.—"Shell equivalve, sub-equilateral, sub-orbicular or broadly sub-elliptical. Anterior end regularly rounded; posterior end rounded or sub-truncate, somewhat more produced below than the anterior. Beaks small and low, generally rising little above the hinge-line. Hinge-line short. Post-cardinal slope more or less defined by an oblique furrow or depression, which sometimes leaves the extremity subalate. Surface concentrically striated, sometimes with strong concentric ridges marking the exterior. Structure of hinge not fully observed. Ligament supported on each side internally by a narrow plate, and leaving in the cast two narrow grooves directed forward from the beak. Muscular impression in the post-umbonal slope. Pallial line parallel with and a little within the margin of the shell."

Observations.—I have quoted Hall's diagnosis of the genus *Paracyclas* in its entirety (*op. cit.*, 1885). Several species occur in the Devonian rocks of N. America and Germany. Beushausen states that the hinge has two little teeth in each valve under the umbo, and no lateral teeth. It is interesting to find the genus persisting up to the Carboniferous Series.

PARACYCLAS DU NOYERI, *Portlock*, sp., 1843. Plate XXII, fig. 9.

> LUCINA DU NOYERI, *Portlock*, 1843. Rep. Geol. Londonderry, p. 571, pl. xxxviii, fig. 12.
> — ANTIQUA, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 53, pl. viii, fig. 9.

Specific Characters.—Shell of medium size, sub-orbicular, very moderately gibbose. The margin is one unbroken curve from the anterior end of the hinge-line to the posterior, the curvature varying somewhat in convexity. The hinge-line is not very long and is arcuate. The umbones are sub-central, pointed, somewhat elevated. The lunule is well marked.

Interior.—Not exposed.

Exterior.—The surface is ornamented with regular, fine, concentric lines of growth, more pronounced on the anterior side of the valve.

Dimensions.—Pl. XXII, fig. 9, the type specimen, measures—

Antero-posteriorly	43 mm.
Dorso-ventrally	42 mm.
From side to side (estimated from a single valve) .	8 mm.

Localities.—Carboniferous Shales near Pettigo and Ballintrillick, Bundoran, co. Donegal.

Observations.—The type of *Lucina Du Noyeri*, Portlock, a right valve, is preserved in the Collection of the Geological Survey Museum, Jermyn Street. It seems to me that this specimen has been flattened by pressure, and consequently the umbo is more pointed and raised than would have been the case normally. The type specimen of *Lucina antiqua*, M'Coy, is in the Griffith Collection, Science and Art Museum, Dublin, but the upper portion of the shell has disappeared. Judging from the figure and description, I think there can be little doubt that M'Coy's shell was identifiable with Portlock's species. M'Coy's description is as follows: " Orbicular, slightly convex, beaks pointed; lunule very small; surface marked with delicate, sharp, concentric striæ." This is a perfect description of the type of *L. Du Noyeri*, Portlock. With regard to the exact horizon at which this species occurs, Portlock says (*op. supra cit.*, p. 571) that " ascending geologically from the Old Red Sandstone, a buff-coloured grit commences the formation, which gives way to shales, with impressions of plants. The shales are at first broken by alternating beds of grit and then by beds of Limestone, possessing characteristic fossils of the true Mountain Limestone, such as *Producta comoides* (Phill.), and then increasing in magnitude, terminating upwards in the Pettigo Limestone. It is remarkable that in this aggregate of highly calcareous shales the characteristic *Modiola* beds do not occur; fossils of any kind are rare in them, and prior to the appearance of a true Mountain Limestone bed are merely traces of plants. The shales nearer to Pettigo contain true Carboniferous fossils, *Producta pustulosa*, etc.; and among them the apparently new species, '*Lucina Du Noyeri*.'" I quote this at length, as it is important if the Carboniferous age of the bed should be called in question.

NOTES ON CERTAIN GENERA AND SPECIES.

Modiola megalcba.—I have grave doubts as to the genus of this species. The interior of the valve and the small lobular anterior end seem to point rather to an affinity with *Naiadites* than with *Modiola.* I am of opinion that the locality at Foynes Island is much below the Coal Measures, and should rather have been given as the lowest part of the Pendleside series in Ireland.

Modiola Macadamii has a much wider horizontal distribution than I gave, occurring in the Calciferous Sandstone series of Roxburghshire and Fife.

Genus *Parallelodon.*—Mr. H. Woods points out in 'Ann. and Mag. Nat. Hist.', ser. 7, vol. iii, p. 47, that the genus *Grammatodon* was founded by Meek and Hayden in 1860 for a species of *Arca* of Jurassic Age. There was a reference to the type, but no description was given until 1864. Mr. Woods considers that *Grammatodon* is synonymous with *Macrodon*, Lycett, which, having been used for a genus of fishes, could not stand; de Koninck, Whidborne, and I adopted *Parallelodon*, M. and W., 1866; but if Mr. Woods is correct, *Grammatodon* has the priority over *Parallelodon*, and should be substituted.

Nucula lævirostris, Portlock sp., should be referred to the genus *Ctenodonta*, and I consider *C. sinuosa*, de Koninck, to be a synonym of this species. It is probable that *N. undulata*, Phill., should also be referred to *Ctenodonta*, but until I have examined the hinge-plate I cannot be certain that this is the case.

Protoschizodus magnus, de Koninck.—An examination of his types showed me that de Koninck had described this species also under the name of *Rutotia lenticularis.* This name should, therefore, be placed as a synonym of the former species.

Edmondia oblonga.—The specimen figured, Vol. I, Pl. XXIX, fig. 4, belongs to this species and not to *E. Lyellii.*

Cardiomorpha obliqua, Hind, appears to be a synonym of *C. Nysti*, de Koninck, and the latter name must therefore be retained.

Mytilimorpha angulata, Hind, proves to be identical with *Sanguinolites angulata*, de Koninck; consequently his name, not mine, should be given as the author of the species. Fortunately, the marked character of the shell induced us both to give it the same specific name, which thus remains unchanged.

Solenopsis having been shown to be already in use for a genus of ants, the name *Solenomorpha* has been substituted for it.

Aviculopecten.—A paper by G. H. Girty appeared in the 'American Geologist,' vol. xxxiii, in May, 1904, pp. 291–296, on "The Typical Species and Generic Characters of *Aviculipecten*, M'Coy." (This is the spelling he affects.) He enters into the question of the type of the species, and considers that *A. flexuosus*, M'Coy, which I have shown (*ante*, p. 69) to be only a synonym of *A. semicostatus*, Portlock, should be the type on the ground that M'Coy states that the hinge-characters were noted first in some specimens from Lowick, and therefore, as this was the Lowick species, it must be the type. I have assumed the type to be the first species described under the generic title, viz., *A. planoradiatus*, M'Coy, a species founded in error on the left valve of the previously described *Pecten tabulatus*, M'Coy, which I therefore recognised as the type of the species. I have no doubt in the future, if hinge-plates of the various species described under *Aviculopecten* occur, that it will be necessary further to subdivide that genus.

Sanguinolites contortus, M'Coy, sp., 1844.—I was in error in mentioning this name as a synonym of *Allorisma Austicei*. I have since examined the type, and find that it agrees with the species I described under the title *S. hibernicus*. This must, therefore, disappear in favour of M'Coy's name.

Table I.

It has been suggested to me that it would be well to indicate in a tabular form the synonomy of the species of Carboniferous Lamellibranchs described by British authors and the names adopted in this monograph, so that any change in nomenclature might be seen at a glance.

1809. Martin, 'Petrefacta Derbiensia.'

Arcites cancellatus	is	*Parallelodon cancellatus.*
,, *rostratus*	,,	*Conocardium rostratum.*
Pinnites flabelliformis	,,	*Pinna flabelliformis.*
Mya ovalis	,,	*Carbonicola ovalis.*

1813–27. Sowerby, 'Mineral Conchology.'

Sanguinolaria gibbosa	is	*Sanguinolites gibbosus.*
Cardium Hibernicum	,,	*Conocardium Hibernicum.*
,, *elongatum*	,,	,, *rostratum.*
,, *aliforme*	,,	,, *aliforme.*
Inoceramus vetustus	,,	*Posidoniella vetusta.*
Isocardia oblonga	,,	*Cardiomorpha oblonga.*
Nucula palmæ	,,	*Nucula palmæ.*

1813–27. Sowerby, 'Mineral Conchology,'—*continued.*

Pecten granosus	is	*Pterinopecten granosus.*
,, *plicatus*	,,	*Aviculopecten plicatus.*
,, *papyraceus*	,,	*Pterinopecten papyraceus.*
Unio acutus	,,	*Carbonicola acuta.*
,, *subconstrictus*	,,	,, *subconstricta.*

1828. Fleming, 'History of British Animals.'

Hiatella sulcata	is	*Allorisma sulcata.*
Corbula limosa	,,	*Cardiomorpha limosa.*
Mytilus crassus	,,	*Naiadites crassa.*
Nucula gibbosa	,,	*Nucula gibbosa.*
,, *attenuata*	,,	*Nuculana attenuata.*
Pecten dissimilis	,,	*Aviculopecten dissimilis.*

1836. Phillips, 'Geology of Yorkshire,' pt. ii.

Sanguinolaria ? angustata	is	*Sanguinolites angustatus.*
,, *? tumida*	,,	,, *tumidus.*
,, *? arcuata*	,,	*Edmondia arcuata.*
,, *? sulcata*	,,	,, *sulcata.*
Solemya primæva	,,	*Solemya primæva.*
**Corbula ? senilis*	,,	*Edmondia senilis.*
Isocardia ? axiniformis	,,	*Schizodus axiniformis.*
Isocardia unioniformis	,,	*Edmondia unioniformis.*
Lucina ? laminata	,,	,, *laminata.*
Venus elliptica	,,	*Allorisma sulcata.*
,, *parallela*	,,	*Cypricardella parallela.*
Cypricardia rhombea	,,	*Mytilomorpha rhombea.*
,, *glabrata*	,,	*Mytilomorpha rhombea.*
Modiola squamifera	,,	*Parallelodon squamiferus.*
* ,, *lingualis*	,,	*Lithodomus lingualis.*
,, *elongata*	,,	*Posidoniella elongata.*
,, *granulosa*	,,	*Lithodomus lingualis.*
Cucullæa obtusa	,,	*Parallelodon obtusa.*
,, *arguta*	,,	*Sanguinolites argutus.*
Nucula cuneata	,,	*Nucula ? cuneata.*
,, *tumida*	,,	,, *gibbosa.*
,, *undulata*	,,	,, *undulata.*
,, *claviformis*	,,	*Nuculana attenuata.*
,, *brevirostris*	,,	,, *brevirostris.*
,, *luciniformis*	,,	*Nucula luciniformis.*
Pleurorhynchus minax	,,	*Conocardium aliforme.*
,, *armatus*	,,	,, ,,
,, *trigonalis*	,,	,, *Hibernicum.*
Pinna inflata	,,	*Productus striatus.*
,, *costata*	,,	*Pinna flabelliformis.*
Avicula cycloptera	,,	*Pterinopecten cycloptera.*

1836. Phillips, 'Geology of Yorkshire,' part ii,—*continued.*

	Avicula tessellata	is	*Pterinopecten tessellatus.*
	,, *radiata*	,,	,, *radiatus.*
*	,, *sublobata*	,,	*Pseudamusium sublobatum.*
	Gervillia lunulata	,,	*Leiopteria lunulata.*
	,, *squamosa*	,,	,, *squamosa.*
	,, *laminosa*	,,	,, *laminosa.*
	,, *inconspicua*	,,	? *Sanguinolites striatolamellosus.*
	Pecten hemisphericus	,,	*Eumicrotis hemisphericus.*
	,, *ellipticus*	,,	*Pseudamusium ellipticum.*
	,, *arenosus*	,,	*Aviculopecten dissimilis.*
	,, *anisotus*	,,	*Pseudamusium anisotum.*
	,, *stellaris*	,,	*Aviculopecten stellaris.*
	,, *simplex*	,,	*Palæolima simplex.*
	,, *interstitialis*	,,	*Aviculopecten interstitialis.*
	,, *deornatus*	,,	,, *deornatus.*
*	,, *fimbriatus*	,,	,, *fimbriatus.*
*	,, *dissimilis*	,,	,, *fallax.*

Phillips's types are preserved in the Gilbertson Collection, Natural History Museum, with the exception of those marked with an *. These are in the Geological Department of the University Museum, Oxford, and have not been lost as I have stated in the text, vol. i, pp. 19, 75, 303; vol. ii, pp. 94, 111.

1840. J. de C. Sowerby in Prestwich's "Geology of Coalbrookdale," 'Trans. Geol. Soc.,' ser. ii, vol. v.

Donax ? sulcata	is	*Schizodus sulcatus.*
Venus ? carbonaria	,,	,, *carbonarius.*
Nucula æqualis	,,	*Nucula æqualis.*
,, *accipiens*	,,	*Edmondia accipiens.*
,, *acuta*	,,	*Nuculana acuta.*
Unio Urei	,,	*Edmondia accipiens.*
,, *Ansticei*	,,	*Allorisma Ansticei.*
,, *parallelus*	,,	*Edmondia accipiens.*
,, *dolabratus*	,,	*Anthracomya dolabrata.*
,, *modiolaris*	,,	,, *modiolaris.*
,, *phaseolus*	,,	*Carbonicola aquilina.*
,, *aquilina*	,,	,, ,,
,, *centralis*	,,	,, *ovalis.*
,, *robustus*	,,	,, *robustus.*
Modiola carinata	,,	*Naiadites carinata.*
,, *triangularis*	,,	,, *triangularis.*
Avicula quadrata	,,	,, *quadrata.*
,, *modiolaris*	,,	,, *modiolaris.*
Pecten gentilis	,,	*Aviculopecten gentilis.*
,, *scalaris*	,,	,, ,,

1843. Portlock, 'Report on the Geology of the Co. of Londonderry, etc.'

Inoceramus pernoides	is	*Myalina pernoides.*
Modiola Macadamii	,,	*Modiola Macadamii.*
,, ,, var. *lata*	,,	,, *lata.*
,, *subparallela*	,,	*Anthracomya subparallela.*
Cypricardia tricostatus	,,	*Sanguinolites tricostatus.*
Sanguinolaria plicata	,,	,, *plicatus.*
,, *undata*	,,	,, ,,
,, *transversa*	,,	,, ,,
,, *maxima*	,	*Allorisma maxima.*
,, *oblonga*	,,	*Edmondia oblonga.*
,, *attenuata*	,,	? (type lost).
Solen peltagicus	,,	*Solenomorpha minor.*
Lutraria primæva	,,	*Edmondia primæva.*
Amphidesma axiniformis	,,	*Protoschizodus axiniformis.*
,, *deltoidea*	,,	, ,,
,, *carbonaria*	,,	,, ,,
Pecten semicostatus	,,	*Aviculopecten semicostatus.*
,, *ottonis*	,,	,, *dissimilis.*
Orthis ombraculum	,,	*Pterinopecten rigidus.*
Nucula lævirostris	,,	*Ctenodonta lævirostris.*
Pullastra ? bistriata	,,	*Parallelodon bistriatus.*
Lucina du Noyeri	,,	*Spathella du Noyeri.*
Posidonomya transversa	,,	*? Allorisma sulcata.* Type lost.
Pterinea Thompsoni	,,	*Leiopteria Thompsoni.*

1844. M'Coy, 'Synopsis of the Carboniferous Fossils of Ireland.'

Teredo antiqua	is	probably an annelid.
Solenopsis minor	,,	*Solenomorpha minor.*
Sanguinolites contortus	,,	*Sanguinolites contortus.*
,, *costellatus*	,,	*Solenomorpha costellata.*
,, *curtus*	,,	*Edmondia expansa* ? young of.
,, *discors*	,,	*Sanguinolites angustatus.*
,, *iridinoides*	,,	,, *plicatus.*
,, *plicatus*	,,	*S. plicatus* and *Spathella tumida.*
,, *radiatus*	,,	*Solenomya primæva.*
Anatina attenuata	,,	too fragmentary to recognise.
,, *deltoidea*	,,	*Protoschizodus nuculoides.*
Pandora clavata	,,	*Sanguinolites clavatus*
Edmondia compressa	,,	*Edmondia compressa.*
Lutraria elongata	,,	not in the Griffith Collection.
,, *prisca*	,,	*Edmondia primæva.*
Mactra incrassata	,,	*Cardiomorpha Egertoni.*
,, *ovata*	,,	*? Protoschizodus nuculoides.*
Kellia gregaria	,,	unrecognisable.
Psammobia decussata	,,	*Parallelodon decussatus.*
Lucina antiqua	,,	*Paracyclas du Noyeri.*

1844. M'Coy, 'Synopsis of the Carboniferous Fossils of Ireland,'—*continued.*

Ungulina antiqua	is	probably the fragment of a Pectiniform shell.
Amphidesma subtruncata	,,	*Protoschizodus subtruncatus.*
Corbis cancellata	,,	?
Venus centralis	is	now unrecognisable, fossil decomposed.
,, *tenuistriata*	,,	,, ,,
Pullastra crassistria	,,	? *Clinopistha* sp.
,, *elegans*	,,	*Parallelodon elegans.*
,, *ovalis*	,,	? *Edmondia primæva.*
Astarte gibbosa	,,	,, *senilis.*
,, *quadrata*	,,	,, *laminata.*
Cyprina Egertoni	,,	*Cardiomorpha Egertoni.*
Donax primigenius	,,	*Nucula brevirostris.*
Cardium orbiculare	,,	*Cardiomorpha Egertoni.*
Cardiomorpha corrugata	,,	,, *corrugata.*
,, *ventricosa*	,,	,, *ventricosa.*
Pleurorhynchus fusiformis	,,	*Conocardium fusiforme.*
,, *giganteus*	,,	,, *hibernicum.*
,, *inflatus*	,,	,, *inflatum.*
,, *nodulosus*	,,	,, *hibernicum.*
Cypricardia alata	,,	*Leiopteria laminosa.*
,, *concinna*	,,	type too fragmentary for determination.
,, *cuneata*	,,	,, ,, ,,
,, *cylindrica*	,,	*Spathella cylindrica.*
,, *modiolaris*	,,	type too fragmentary for determination.
,, *oblonga*	,,	*Modiola radiata.*
,, *quadrata*	,,	?
,, *sinuata*	,,	*Leiopteria laminosa.*
,, *socialis*	,,	*Spathella cylindrica.*
,, *tumida*	,,	?
Sedgwickia attenuata	,,	*Sedgwickia attenuata.*
,, *bullata*	,,	type too poor to determine.
,, *corrugata*	,,	type never in the Griffith Collection.
,, *gigantea*	,,	*Sedgwickia gigantea.*
,, *globosa*	,,	? *Scaldia* sp.
,, *minima*	,,	?
Axinus centralis	,,	type lost.
,, *nuculoides*	,,	*Protoschizodus nuculoides.*
,, *obliquus*	,,	,, *obliquus.*
,, *obovatus*	,,	*Schizodus obovatus.*
,, *orbicularis*	,,	,, *orbicularis.*
Dolabra corrugata	,,	?
,, *equilateralis*	,,	*Protoschizodus equilateralis.*
,, *gregaria*	,,	? cf. *Productus*, but type too poor to determine.
,, *orbicularis*	,,	? *Protoschizodus orbicularis.*
,, *rectangularis*	,,	,, *rectangularis.*
,, *securiformis*	,,	*Sedgwickia gigantea.*

1844. M'Coy, 'Synopsis of the Carboniferous Fossils of Ireland,'—*continued.*

Leptodomus fragilis	is	*Protoschizodus fragilis.*
Venerupis cingulatus	,,	*Parallelodon cingulatus.*
,, *obsoletus*	,,	*Cardiomorpha corrugata.*
,, *scalaris*	,,	*Edmondia scalaris.*
Nucula birostrata	,,	*Nuculana attenuata.*
,, *carinata*	,,	*Cypricardella Selysiana.*
,, *clavata*	,,	*Ctenodonta lævirostris.*
,, *cylindrica*	,,	type too indefinite to determine.
,, *delta*	,,	type not in the Griffith Collection.
,, *leiorynchus*	,,	*Nuculana attenuata.*
,, *longirostris*	,,	,, ,,
,, *oblonga*	,,	*Nucula oblonga.*
,, *rectangularis*	,,	*Cypricardella rectangularis.*
,, *stilla*	,,	*Nuculana stilla.*
,, *unilateralis*	,,	probably a Pectiniform shell.
Arca fimbriata	,,	? *Parallelodon concinnus.*
,, *tenuistria*	,,	,, *tenuistrius.*
Byssoarca clathrata	,,	type has disappeared, de Vil, p. 144.
,, *costellata*	,,	*Parallelodon cancellatus.*
,, *lanceolata*	,,	*Conocardium hibernicum.*
,, *reticulata*	,,	*Parallelodon reticulatus.*
,, *semicostata*	,,	,, *semicostatus.*
Crenella acutirostris	,,	? *Protoschizodus obliquus.*
Modiola concinna	,,	*Parallelodon concinnus.*
,, *divisa*	,,	*Leiopteria divisa.*
,, *megaloba*	,,	*Modiola megaloba.*
,, *patula*	,,	,, *patula.*
Lithodomus dactyloides	,,	*Lithodomus lingualis.*
Lanistes obtusus	,,	cf. *Actinopteria fluctuosa.*
,, *rugosus*	,,	? *Actinopteria persulcata.*
Mytilus comptus	,,	? *Myalina Flemingi.*
Mytilus Flemingi	,,	*Myalina Flemingi.*
Inoceramus auriculatus	,,	*Pseudamusium auriculatum.*
,, *lævissimus*	,,	,, ,,
,, *orbicularis*	,,	*Cardiomorpha corrugata.*
Posidonia costata	,,	? *Posidoniella lævis.*
,, *membranacea*	,,	*Posidonomya membranacea.*
,, *similis*	,,	,, *Becheri.*
Meleagrina alternata	,,	? *Aviculopecten incrassatus.*
,, *echinata*	,,	type never in the Griffith Collection.
,, *lævigata*	,,	*Streblopteria lævigata.*
,, *pulchella*	,,	*Actinopteria persulcata.*
,, *quadrata*	,,	? *Pseudamusium auriculatum.*
,, *rigida*	,,	*Pterinopecten rigidus.*
Pteronites angustatus	,,	*Pteronites angustatus.*
,, *latus*	,,	,, *latus.*

1844. M'Coy, 'Synopsis of the Carboniferous Fossils of Ireland,'—*continued.*

Pteronites semisulcatus	is	*Actinopteria persulcata.*
,, *sulcatus*	,,	,, *sulcata.*
,, *ventricosus*	,,	type has disappeared.
Pterinea desquamata	,,	*Limatulina desquamata.*
,, *intermedia*	,,	,, *intermedia.*
Avicula angusta	,,	*Leiopteria lunulata.*
,, *bicostata*	,,	?
,, *flabellula*	,,	probably a Pecten-like shell distorted by shearing.
,, *gibbosa*	,,	young of *Leiopteria laminosa.*
,, *informis*	,,	*Leiopteria lunulata.*
,, *lævigata*	,,	,, ,,
,, *recta*	,,	,, ,,
,, *Verneuillii*	,,	*Myalina Verneuilii.*
Pinna flexicostata	,,	*Pinna flabelliformis.*
,, *mutica*	,,	,, *mutica.*
Anomia antiqua	,,	*? Productus.*
Malleus orbicularis	,,	? right valve of *Pterinopecten rigidus.*
Lima alternata	,,	*Limatulina alternata.*
,, *concinna*	,,	*? Aviculopecten decussatus.*
,, *decussata*	,,	*Aviculopecten decussatus.*
,, *lævigata*	,,	*Pseudamusium auriculatum.*
,, *obliqua*	,,	*? Parallelodon Haimeanus.*
,, *planicostata*	,,	*Pseudamusium anisotum.*
,, *prisca*	,,	*Limatulina alternata.*
,, *semisulcata*	,,	? ?
Pecten æqualis	,,	*Aviculopecten nobilis.*
,, *asperulus*	,,	type too imperfect to determine.
,, *bellis*	,,	*Aviculopecten knockonniensis.*
,, *cancellatulus*	,,	*Aviculopecten nobilis.*
,, *cingendus*	,,	*Pseudamusium auriculatum.*
,, *clathratus*	,,	*Aviculopecten clathratus.*
,, *cœlatus*	,,	,, *dissimilis.*
,, *cognatus*	,,	,, *nobilis.*
,, *comptus*	,,	the type has disappeared.
,, *concavus*	,,	*Pterinopecten concavus.*
,, *concentrico-striatus*	,,	*Aviculopecten dissimilis.*
,, *conoideus*	,,	*Limatulina desquamata.*
,, *consimilis*	,,	*Pseudamusium anisotum.*
,, *depilis*	,,	*Pseudamusium ellipticum.*
,, *duplicicosta*	,,	too fragmentary to determine.
,, *elongatus*	,,	*Pseudamusium ellipticum.*
,, *exiguus*	,,	type too indistinct to determine.
,, *fallax*	,,	*Aviculopecten fallax.*
,, *filatus*	,,	*Pseudamusium ellipticum.*
,, *flabellulum*	,,	internal cast of *Athyris plano-sulcata.*
,, *flexuosus*	,,	*Aviculopecten semicostatus.*

1844. M'Coy, 'Synopsis of the Carboniferous Fossils of Ireland,'—*continued.*

Pecten Forbesii	is	*Aviculopecten Forbesii.*
,, *gibbosus*	,,	*Pseudamusium gibbosum.*
,, *Hardingii*	,,	type too obscure to determine.
,, *hians*	,,	*Aviculopecten plicatus.*
,, *incrassatus*	,,	,, *incrassatus.*
,, *intercostatus*	,,	,, *clathratus.*
,, *irregularis*	,,	type too imperfect to determine.
,, *Jonesii*	,,	*Aviculopecten Jonesii.*
,, *knockonniensis*	,,	,, *knockonniensis.*
,, *leiotis*	,,	the type has disappeared.
,, *macrotis*	,,	*Aviculopecten macrotis.*
,, *megalotis*	,,	too fragmentary to determine.
,, *meleagrinoides*	,,	*Pterinopecten meleagrinoides.*
,, *micropterus*	,,	*Aviculopecten plicatus.*
,, *mundus*	,,	?
,, *Murchisoni*	,,	*Aviculopecten Murchisoni.*
,, *orbiculatus*	,,	type has disappeared.
,, *ovatus*	,,	*Aviculopecten Murchisoni.*
,, *pera*	,,	,, *pera.*
,, *planicostatus*	,,	*Amusium planicostatum.*
,, *planoclathratus*	,,	*Aviculopecten planoclathratus.*
,, *quinquelineatus*	,,	,, *quinquelineatus.*
,, *rugulosus*	,,	,, *dissimilis.*
,, *sclerotis*	,,	too poor to determine.
,, *Sedgwickii*	,,	*Aviculopecten Sedgwickii.*
,, *segregatus*	,,	,, *interstitialis.*
,, *semicircularis*	,,	*Crenipecten semicircularis.*
,, *semistriatus*	,,	too indefinite to determine.
,, *serratus*	,,	?
,, *Sowerbyi*	,,	*Syncyclonema Sowerbyi.*
,, *spinulosus*	,,	?
,, *tabulatus*	,,	*Aviculopecten tabulatus.*
,, *tripartitus*	,,	,, *decussatus.*
,, *undulatus*	,,	*? Aviculopecten dissimilis.*
,, *variabilis*	,,	*Pseudamusium anisotum.*
Monotis æqualis	,,	*Aviculopecten incrassatus.*

1855. M'Coy, 'British Palæozoic Fossils.'

Pteronites persulcatus	is	*Pterinopecten persulcatus.*
Aviculopecten docens	,,	*Aviculopecten semicostatus.*
,, *planoradiatus*	,,	,, *tabulatus.*
,, *Ruthveni*	,,	,, *Ruthveni.*
Lithodomus Jenkinsoni	,,	*Modiola Jenkinsoni.*
Pinna spatula	,,	*Pinna mutica.*
Edmondia rudis	,,	*Edmondia senilis.*
Sanguinolites variabilis	,,	*Sanguinolites variabilis*, and *Allorisma variabilis.*

1855. M'Coy, 'British Palæozoic Fossils,'—*continued.*

Sanguinolites clava	is	*Sanguinolites maximus.*
,, *subcarinatus*	,,	,, *subcarinatus.*
Leptodomus costellatus	,,	,, *costellatus.*
Cardiomorpha orbicularis	,,	*Cardiomorpha orbicularis.*

DISTRIBUTION.

During my study of the Carboniferous Lamellibranchs certain facts as to their distribution have been forced on my notice, and have led me to publish my views of the Carboniferous succession in Great Britain, and the various homotaxial equivalents of the Carboniferous deposits in each division of the Kingdom. The Carboniferous sequence of Scotland and the North of England differs very materially from that which obtains in the Midlands, where on the top of the Massif of Limestone, some 2000 to 3000 feet thick, some 1000 feet of black shales and limestones occur, characterised by a fauna very different from that which is found in the Limestone below. To this series, which was formerly called Yoredale, in conjunction with my friend Mr. J. A. Howe,[1] I ventured to assign the name *Pendleside Series*, on the ground that its lithological characters and fauna were distinct from those occurring in the series known in Wensleydale and the North as the Yoredale Series.

The Pendleside Series, then, occurs between the Carboniferous Limestone Series and the Millstone grits. The series has a well-defined base, but passes upwards insensibly into the Millstone grits, which contain a similar fauna. The Pendleside Series does not extend farther north than a line passing from Grassington in Craven to the south part of the Isle of Man. Beds with the characteristic fauna are to be traced west to the West of Ireland, where they are present at Foynes Island, Co. Limerick, and in Co. Clare.

Mr. Kidston sent me some months ago a suite of badly preserved fossils from the Arigna mines, Carrick-on-Shannon, which appear to me to indicate a Pendleside horizon, but higher than the base. The fauna is also present in Co. Dublin, Co. Meath, and on each flank of the Kilkenny Coalfield.

In the south of Co. Cork and Co. Kerry the Carboniferous Limestone is absent, and black shales with *Posidonomya Becheri*, which fossil is characteristic of the lowest part of the Pendleside Series, rest on the Coomhola Grits. The latter contain *Cucullæa Hardingi* and *Ptychopteria Damnoniensis*, fossils characteristic of the Upper Devonian, and therefore should not be referred to the Carboniferous Series. It is evident that in S. W. Ireland, at the old head of Kinsale, the same sequence obtains as in North Devonshire. That is to say, the Lower Culm and Venn Limestone Series with *P. Becheri* rest on a series with Upper Devonian fossils, the

[1] 'Quart. Journ. Geol. Soc.,' vol. lvii, p. 347.

Carboniferous Limestone being only represented by some few feet of shales at Fremington; unless the Pilton beds are its homotaxial equivalent.

The Pendleside Series thins out rapidly to the south of Derbyshire, and is only represented by a few feet in Leicestershire and Shropshire. Still further south, I consider that the Bishopton beds in South Wales and the Lower Culm Series of Devonshire are the homotaxial equivalents of the Pendleside Series of the Midlands. The lithological similarity of the series in Devonshire, and especially the peculiar fauna of the Lower Culm, agree so markedly with the characters of the Pendleside Series that one cannot be blind to the evidence. Moreover, the Lower Culm is overlaid by grit beds, which are in turn overlaid by a soft shales with bullions at Instow containing—

Pterinopecten papyraceus,
Posidoniella lævis,
Gastrioceras Listeri,
Gastrioceras carbonarium,
Dimorphoceras Gilbertsoni,
Orthoceras, sp.—

a fauna which is abundant in the Lower Coal Measures of Lancashire and the Midlands; and at Robert's Quarry, near Bideford, immediately above beds containing a fairly rich and typical Coal Measure flora, is a band of fawn-coloured, iron-stained, shale with *Carbonicola acuta*, a characteristic shell of the middle portion of the Coal Measures, so that one may safely infer that the Culm Measures of Devonshire represent the Carboniferous sequence of the Midlands, minus the massif of Carboniferous Limestone.

Eastwards the beds thin out, but at Clavier, near Dinant in Belgium, beds of similar lithological character to the Pendleside Series, with the typical fauna, are found. Still further east, at Magdeburg and Herborn, the Culm of Germany has the peculiar fauna which characterises the Lower Culm and Pendleside Series in England.

Although beds containing the same marine fossils, which are found at much lower horizons, occur here and there throughout the Upper Carboniferous Series, the great faunal break occurs at the base of the Pendleside Series. A new set of Mollusca come in at this horizon for the first time, and by far the larger number of Lower Carboniferous organisms totally disappear. Leaving the Brachiopoda out of the list, because it is doubtful if any forms are confined to the Upper Carboniferous Series, more than three fifths of the fauna of the Pendleside Series are new, *i. e.* they do not occur at horizons lower down. Curiously enough, it would appear that the faunal change took place before the floral, and a lower Carboniferous flora is thus found in beds with an upper Carboniferous fauna. The change in the fish faunas, however, corresponds to that of the Mollusca. Hence palæobotanists would subdivide the Carboniferous Series into an upper and lower at a somewhat higher horizon than zoologists.

The important point in Carboniferous classification is to recognise that the term

"Yoredale series" has been used to denote two dissimilar lithological series, each characterised by a different fauna.

The Yoredale Series of Wensleydale and the north of England represents the upper part of the Carboniferous Limestone, split up by wedges of detrital sands and muds, which came in from the north. The fauna of the true Yoredale Series is identical with that of the upper part of the Carboniferous Limestone, and differs essentially from that contained in the Pendleside Series of the Midlands. In reality, the Pendleside Series is homotaxially superior in position to the Yoredale Series. I regard the following Lamellibranchs as typical of the Pendleside Series and some of the succeeding beds:

Chænocardiola Footii, Baily, sp.
Posidoniella lævis, Brown, sp.
,, *Kirkmani*, Brown, sp.
,, *minor*, Brown, sp.
,, *variabilis*, Brown, sp.
Posidonomya Becheri, Bronn.
,, *membranacea*, M'Coy.
Leiopteria longirostris, Hind.
Pterinopecten papyraceus, Sow., sp.
,, *carbonarius*, Hind.
Pseudamusium fibrillosum, Salter, sp.
Aviculopecten Losseni, v. Koenen, sp.
,, *gentilis*, Sow., sp.

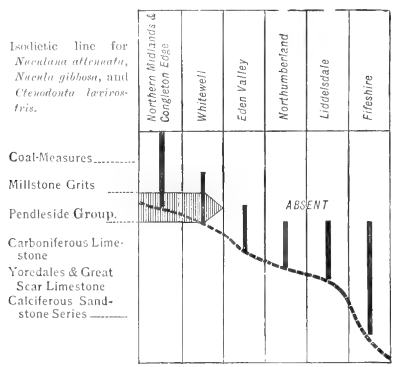
A very important factor in the distribution of Carboniferous Lamellibranchs is the nature of the deposit, whether it is detrital or organic in origin. The fauna of the limestones differs very considerably from that of the shales and grits. The *Nuculidæ* invariably are found in detrital deposits.

In the Midlands the fossils of the Carboniferous Limestone occur very locally at or very near the top of the series. Very little, indeed, is known of the distribution of the fossils throughout the thick mass of limestone. When, however, this mass splits up into beds and becomes the Yoredale Series, the Limestones and the Shales between them can be examined individually, and a certain amount of detailed knowledge exists. In Derbyshire, Staffordshire, and South-west Yorkshire fossils occur plentifully in certain localities, a fact that may be noted in referring to the localities given for each species, and to page 214. At these places, Thorpe Cloud, Park Hill, Hill Bolton, and Settle, the upper beds of the limestone are almost made up of fossils. I consider these localities to have been shell banks, for shells of all sorts of habitats are present, the larger Gasteropods and Cephalopods full of smaller specimens, the Lamellibranchs as a rule with both valves misplaced or detached. The remains of animals which had a different habitat are all crowded together in profusion. Many specimens indicate slight attrition due to rolling. The Brachiopods, on the other hand, found in profusion amongst the other shells, probably lived on these banks, in colonies, for they are nearly always found, with both valves in position, though, of course, this may be due to the fact that the valves were more firmly attached to each other than obtained in the case of the Lamellibranchs.

Many of the Lamellibranch species had a very long existence in Carboniferous times, being found at various horizons, from the Calciferous Sandstone Series to the Coal Measures. *Nucula gibbosa*, *Nuculana attenuata*, *Ctenodonta lævirostris*, Portl. sp., occur first of all in the Calciferous Sandstone Series of Scotland, and persist up to the Coal Measure times, occurring in marine bands of the North Staffordshire Coal Measures.

I drew attention in my paper on the Pendleside Series (*loc. cit.*, p. 380) to the fact that many Lamellibranch species and families which occur in the Calciferous Sandstone Series of Scotland occur at higher and higher horizons for the first time, as the beds pass south, and showed that curves could be constructed showing the earliest known occurrence of each species at a series of localities between Fife and Staffordshire. The name *isodietic line* was given because it was thought that

Fig. 2.



this condition of things was due entirely to environment. The Carboniferous succession in the north was doubtless laid down much nearer to land than the beds further south, a fact demonstrated by the greater amount of detrital material in the deposits.

The above tabular diagram (fig. 2) shows the isodietic line for three species, *Nuculana attenuata*, *Nucula gibbosa*, and *Ctenodonta lævirostris*, but it seems that *N. attenuata* always came in some little time before the others.

The three genera mentioned above all appear in the Calciferous Sandstone Series of Scotland, and reappear in that area at many horizons in the Carboniferous Series of that subdivision.

According to Mr. J. W. Kirkby's tables[1] *Nuculana* (*Leda*) *attenuata* is found 3000 to 3800 feet below the Carboniferous Limestone, at a lower horizon than *Nucula gibbosa*, which comes in from 500 to 2300 feet below that bed. *Ctenodonta*

[1] 'Quart. Journ. Geol. Soc.,' vol. xxxvi (1880), p. 589.

lævirostris is not mentioned by him, and we have been unable to give the exact point at which it first comes in, but in the upper part of the Calciferous Sandstone Series of Fife all these fossils are found together. They never occur in the pure white or grey limestones, only in the shales between them.

In the West of Scotland these species are well represented in the shales of the Carboniferous Limestone series. Mr. J. Smith, of Kilwinning, informs us that they have not been found below the "shale" under the lowest "post" of the Lower Limestone Series.

The Calciferous Sandstone Series in Eskdale, however, does not seem to possess these species, though they all come in in the shales associated with the limestones on the horizon of the Hurlet Limestone. Farther south, in Northumberland, *Nuculana attenuata*, *Nucula gibbosa*, and *Ctenodonta lævirostris* are absent in the Tuedian series; *N. attenuata* comes on alone in the Carbonaceous division, but *N. gibbosa* is found with it in the shales of the Calcareous division above at several horizons.

Still farther south, the lowest horizon at which we have been able to obtain *Nuculana attenuata* and *Ctenodonta lævirostris* in the valley of the Eden is in shales presumably above the Underset Limestone. They probably do occur somewhat lower, however, for we have obtained *Ctenodonta lævirostris* in shales below the Hardraw Scar Limestone, although at present *Nuculana attenuata* and *Nucula gibbosa* are not known so low down in this locality. Farther south, again, in beds presumably immediately above the main mass of limestone at Whitewell, *Nuculana attenuata* and *Ctenodonta lævirostris* appear, the latter being found at more than one horizon in the Pendleside Group.

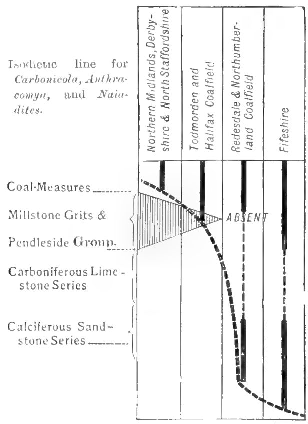
Continuing in a southerly direction, we find in the Marsden Valley, at Eccup, near Leeds, and Congleton Edge (Cheshire), the lowest horizon for *Nucula gibbosa* and *Ctenodonta lævirostris* in the upper part of the Pendleside Group and Shales below the Third Grit; while these shells are found at one or more horizons in the Coal Measures of Lancashire and North Staffordshire. *Nuculana attenuata* has disappeared, but its place has been taken by *Nuculana stilla*.

This peculiar distribution of allied forms of shells is very striking, and seems to us to point conclusively to the fact that the necessary conditions of deposition and environment for the members of the family Nuculidæ did not exist in the south till late on in Carboniferous times, and that the line drawn obliquely across the strata from the lower part of the Calciferous Sandstone Series to the Millstone Grits of the Midlands represents an isodietic line for this family, which is exact for the individual species representing them. It will be seen that similar lines which have an almost identical curve can be constructed for other groups. Details of two groups are given in figs. 2 and 3, one group consisting of the Nuculidæ, the other of those genera—*Carbonicola*, *Anthracomya*, *Naiadites*—which, from the peculiar erosion of the umbones, are justly considered to have been freshwater dwellers;

Naiadites, belonging to a byssiferous group, is chosen because in this case migration was limited naturally by structure and habit.

The genera *Carbonicola* and *Anthracomya* belonging to the Unionidæ, and *Naiadites*—a byssiferous genus belonging to the Mytilidæ—have long been recognised as characteristic of the freshwater beds of the Coal Measures, and have a wide horizontal distribution. An examination of the distribution of these genera during Carboniferous times gives an interesting result. All three genera are represented in the oldest Carboniferous rocks of Fifeshire: *Carbonicola* by two species, *C. antiqua* and *C. elegans*; *Anthracomya* by *A. scotica* and another well-developed form closely allied to, if not identical with, *A. Adamsii*; and *Naiadites* by *N. crassa* and *N. obesa*.

FIG. 3.



These genera are, with the exception of *N. crassa*, absent from the Tuedian Series of Northumberland; but that species occurs in shales in the Carbonaceous and Fell-Sandstone Series at Lewisburn, and a species of the same genus (possibly a dwarf example of *N. crassa*) is found at Sillsburn in the Redesdale district. Prof. Lebour quotes *Anthracosia* (*Carbonicola*) *acuta* from the horizon of the Redesdale Ironstones, but after examination of the specimen I am not able to recognise that it belongs to that genus.

Farther south, in the Yorkshire dales, the three genera have not been found either in the Great Scar or in the Yoredale Series.

Still farther south, in Staffordshire and Derbyshire, these genera only come in at the base of the Coal Measures, but they are each represented by numerous species.

If the horizons at which a large number of the marine fossils of the Calciferous

Sandstone Series of Fife occur in other districts were noted, similar isodietic lines would be shown. In the case of the Lamellibranchs, which we have chosen for the investigation (1) because they are fairly well known, (2) because we were able to distinguish the species with some approach to accuracy, and (3) because in the adult stage they do not possess active means of migration, the isodietic line for the whole Lamellibranch fauna of the Calciferous Sandstone Series lies within very narrow limits. It is practically identical with that of the Nuculidæ: that is to say, as one passes southward, a large part of the fauna of the Calciferous Sandstone Series occurs at continuously higher horizons, showing the gradual southward spread of similar conditions of environment. Many of the Lamellibranchs of the Calciferous Sandstone Series, preferring muddy and turbid waters, evidently could not live in the clear waters where limestones were accumulating. Thus it may be inferred that as Carboniferous times went on, the influence of the land was felt farther and ever farther south, as is shown by the tendency to interruption of the deposition of limestone by detrital shales and sandstones, and eventually the complete cessation of the formation of pure limestones, even in the area of maximum deposition.

With regard to *Pterinopecten papyraceus*, which we have chosen as a zonal form, it is interesting to note that it occurs at a lower horizon in Scotland than it does in England.

It is found in shale at East Kilbride, 2½ feet above the Calderwood Cement-Stone at Glebe Quarry, which is supposed to belong to the Lower Limestone Series of Scotland; but it seems possible that the beds really belong to the Upper Limestone Series, for lithological and palæontological reasons. In Northumberland this species does not seem to go below the base of the Coal Measures, but it occurs in the Pendleside Group and passes up to the Coal Measures in the Northern Midlands.

The byssiferous and always marine genus *Myalina* is represented in the Calciferous Sandstone Series by *M. sublamellosa*, *M. Flemingi*, *M. Verneuilii*, and *M. lamellosa*. In Northumberland this genus comes in the Carbonaceous division, in Northern Yorkshire it is found in the middle of the Yoredale Series, in Southern Yorkshire in the Millstone-Grit Series, and in Derbyshire in the top-beds of the Limestone, while in Cheshire it occurs in the Pendleside Group of Congleton Edge.

Isodietic curves similar to those above described could be traced for *Edmondia unioniformis*, *E. rudis*, *E. sulcata*, *E. M'Coyii*, *E. laminata*, and *E. scalaris*; *Parallelodon bistriatus* and *P. semicostatus*; *Protoschizodus axiniformis*; *Sanguinolites angustatus*, *S. striatolamellosus*, and *S. plicatus*; *Allorisma maxima*, *A. sulcata*, and others.

These isodietic curves, it will be observed, cut the zonal lines obliquely, and in no way run parallel to them; and this must necessarily always be so, for as the littoral beds of a slowly sinking or rising area advance or retreat, migration of faunas must take place along lines which intersect the other life-zones at different horizons. Isodietic lines, therefore, in no way indicate time, but simply physiographical conditions, and in this sense are also life-zones.

A table which I published in the 'Proc. Yorks. Geol. and Poly. Soc.,' vol. xiv, p. 443, and which I reprint here, shows the actual amount of detrital and organic deposits in six localities between Ingleborough and Fife. This table would have been more marked if I had included 2000 to 3000 feet of practically unbroken limestone deposit in Derbyshire.

I.	II.	III.	IV.	V.	VI.
INGLEBOROUGH.	WENSLEY AND SWALE DALES.	WEARDALE AND ALSTON MOOR.	NORTH NORTHUMBERLAND.	WEST OF SCOTLAND.	EAST OF SCOTLAND. FIFE.
Main Limestone, 60 feet. Middle Limestone, 20 feet. Simondstone Limestone, 30 feet. Hardraw Scar Limestone, 40 feet. Great Scar Limestone, 600 feet. Basement beds. Total, 1590 feet, of which 750 feet are limestone.	Red Beds or Crow Limestone. Little Limestone. Main Limestone, 60 feet. Underset Limestone, 20 feet. 3 yards Limestone, ? 6 feet. 5 yards Limestone, 9 feet. Middle Limestone, 30 feet. Simondstone Limestone, 20 to 30 feet. Hardraw Scar Limestone, 50 feet. Gayle Limestone. Great Scar Limestone, 500 feet. Basement beds, 10 feet. Total, about 1600 feet, of which 750 feet are limestone.	Fell Top Limestone, $4\frac{1}{2}$ feet. Little Limestone, 6 feet. Great or Main Limestone, 63 feet. 4 fathom Limestone, 24 feet. 3 yards Limestone, 9 feet. 5 yards Limestone, 15 feet. Scar Limestone, 30 feet. Cockleshell Limestone, 14 feet. Tyne Bottom Limestone, 24 feet. Jew Limestone, 24 feet. Little Limestone, 15 feet. Smiddy Limestone, 31 feet. Robinson's Limestone, 21 feet. Melmerby Scar Limestone, 142 feet. Measures, 519 feet. Total, 2082 feet, of which 480 feet are limestone.	Upper Fell Top, 20 feet. Lower Fell Top, 6 feet. Limestone, 14 feet. Dryburn Limestone, or 10 yards or Ebbs' Nook Limestone, 30 feet. Denwick: Low Dene, or 8 yards, 28 feet. Acre or 6 yards, 22 feet. Thin Limestone, 2 feet. Thin Limestone, 8 feet. Eelwell and Main or 9 yards 27 feet. Several Thin Limestones. Oxford, or 5 yards Limestone, 16 feet. Thin Limestone, 5 feet. Woodend, Hobberlaw, or 4 fathom, 15 feet. Dun or Redesdale Limestone, 6 feet. Total, 1692 feet. Scremerston Coal Series, 998 feet, 8 inches. Total, 2690 feet, of which 240 feet are calcareous.	Linnspout or Castle Cary Limestone, 36 feet. Lower Posts, 36 feet. Arden or Calmy Limestone, 15 feet. Highfield or Index Limestone, 6 feet. Middle Sandstones, Shales with Coals and Ironstones, 600 feet. Kingshaw and Kerrsland Glen Limestone, 7 feet. Hosie Limestone, 4 feet. Hurlet, Beith, Macdonald, or Howrat, 100 to 60 feet. Volcanic Series, 1500 feet. Calciferous Sandstone Series, 1500 feet, with about 40 feet of limestone. Total, 2500 feet of stratified rocks, of which 244 feet are limestone.	Upper Group, 1000 feet, with 10 to 28 feet limestone. Middle Group, Sandstones, Shales, Fireclays, and Coals, 1000 feet. Lower Group, Hosie and Hurlet Limestones, 250 feet, with 26 to 53 feet limestone. Calciferous Sandstone Series, 3800 feet, with 50 feet marine limestones. NOTE.—Passing east in the Carluke district the limestones of the Upper and Lower Divisions thin out, the three beds of the Upper Group only giving $12\frac{1}{2}$ feet of limestone; the 15 beds of the Lower Group are 34 feet thick, so that out of a total thickness of 1032 feet of strata only 46 feet are limestone.

The following table attempts to show the main factors of distribution of the British Carboniferous Lamellibranchs. The Lower Carboniferous Limestone includes all beds below the Hardraw Scar Limestone and its equivalents in the North of England and below the Edge Coal Series in Scotland.

	Carboniferous Limestone.		Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
	Lower.	Upper.					
Family—OSTREIDÆ.							
Pachypteria nobilissima, De Kon.	...	×	...	...	...	...	...
Family—LIMIDÆ.							
Limatulina alternata, M'Coy, sp.	...	×	...	...	...	...	...
,, *desquamata*, M'Coy, sp. ...	...	×	...	...	...	...	...
,, *scotica*, Hind	...	×	...	...	...	...	...
Palæolima Buchiana, de Kon., sp.	...	×	...	...	...	...	...
,, *obliquiradiata*, Hind	...	×	...	...	...	...	...
,, *simplex*, Phill., sp.	...	×	...	...	...	...	...
Family—PECTINIDÆ.							
Eumicrotis hemisphæricus, Phill., sp....	...	×	...	...	...	...	...
,, *ovalis*, de Kon., sp.	...	×	...	...	...	...	...
Streblopteria lævigata, M'Coy...........	...	×	...	...	...	...	...
,, *ornata*, R. Etheridge, jun.	×	...	...	...	...	...	...
,, *concentrica*, Hind	×	...	...	...	...	...	...
Pterinopecten concavus, M'Coy, sp. ...	×	...	...	...	...	...	...
,, *cyclopterus*, Phill., sp. ...	...	×	...	...	...	...	...
,, *carbonarius*, Hind.........	...	...	×	...	...	×	...
,, *Dumontianus*, de Kon., sp.	...	×	...	...	...	...	...
,, *eximius*, de Kon., sp. ...	...	×	...	...	...	...	...
,, *granosus*, Sow., sp.	×	×	...	...	...	...	...
,, *meleagrinoides*, M'Coy, sp.	...	×	...	...	...	...	...
,, *papyraceus*, Sow., sp. ...	...	...	×	×	×	×	...
,, *pustulosus*, Hind	...	×	...	...	...	...	...
,, *radiatus*, Phill., sp.	...	×	...	...	...	...	...
,, *rigidus*, M'Coy, sp.	...	×	...	...	...	...	...
,, *tessellatus*, Phill., sp.......	×	×	...	...	...	...	...
Aviculopecten clathratus, M'Coy, sp. ...	...	×	...	...	...	...	...
,, *Carrolli*, Hind	...	×	...	...	...	...	...
,, *constans*, de Kon....... .	...	×	...	...	...	...	...
,, *decussatus*, M'Coy, sp. ...	...	×	...	...	...	...	...
,, *deornatus*, Phill., sp.......	...	×	...	...	...	...	...
,, *dissimilis*, Fleming, sp. ...	×	×	...	...	...	...	...
,, *eskdalensis*, Hind	×	...	...	...	...	...	...
,, *fallax*, M'Coy, sp.	...	×	...	...	...	...	...
,, *fimbriatus*, Phill., sp. ...	×	×	...	...	...	...	...
,, *Forbesii*, M'Coy, sp.	×	×	...	...	...	...	...
,, *gentilis*, Sow., sp.	...	...	...	×	...	×	...
,, *inequalis*, Hind	...	×	...	...	...	...	...
,, *intermedius*, M'Coy, sp.	?	×	...	...	...	...	...
,, *interstitialis*, Phill., sp. ...	×	×	...	...	...	...	...
,, *incrassatus*, M'Coy, sp. ...	...	×	...	...	...	...	...
,, *Jonesii*, M'Coy, sp.	...	×	...	...	...	...	...
,, *knockonniensis*, M'Coy, sp.	×	×	...	...	...	...	...
,, *Losseni*, v. Koenen, sp....	...	...	×	...	...	...	...
,, *macrotis*, M'Coy, sp.......	...	×	...	...	...	...	...
,, *Murchisoni*, M'Coy, sp....	...	×	...	...	...	...	...
,, *nobilis*, de Kon., sp.	...	×	...	...	...	...	...
,, *pera*, M'Coy	...	×	...	...	...	...	...
,, *perradiatus*, de Kon.......	...	×	...	...	...	...	...
,, *planoclathratus*, M'Coy, sp.	...	×	...	...	...	...	...
,, *plicatus*, Sow., sp.	...	×	...	...	...	...	...

	Carboniferous Limestone. Lower.	Carboniferous Limestone. Upper.	Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
Family—PECTINIDÆ (*continued*).							
Aviculopecten quinquelineatus, M'Coy, sp.	...	×	...	...	...	...	...
,, *Ruthveni*, M'Coy, sp.	?	?	...	...	...	...	...
,, *Sedgwickii*, M'Coy, sp.	...	×	...	...	...	...	...
,, *semicostatus*, Portlock, sp.	×	...	...	...	...	...	...
,, *stellaris*, Phill., sp.	...	×	...	...	...	...	...
,, *subconoideus*, R. Etheridge, jun.	×	...	...	...	...	...	...
,, *tabulatus*, M'Coy, sp.	...	×	...	...	...	...	...
Pseudamusium anisotum, Phill., sp.	×	×	...	...	...	...	...
,, *auriculatum*, M'Coy, sp.	...	×	...	...	...	...	...
,, *concentrico-lineatum*, Hind	...	×	...	...	...	...	...
,, *ellipticum*, Phill., sp.	×	×	...	...	...	...	...
,, *fibrillosum*, Salter, sp.	...	...	×	...	...	×	...
,, *gibbosum*, M'Coy, sp.	...	×	...	...	...	...	...
,, *redesdalense*, Hind	×	...	...	...	...	...	...
,, *sublobatum*, Phill., sp.	...	×	...	...	...	...	...
Crenipecten semicircularis, M'Coy, sp.	...	×	...	...	...	...	...
Obliquipecten lævis, Hind	...	×	...	...	...	...	...
Syncyclonema carboniferum, Hind	...	...	...	...	...	×	...
,, *Sowerbyi*, M'Coy, sp.	×	×	...	...	...	...	...
Amusium concentricum, Hind	...	×	...	...	...	...	...
,, *planocostatum*, M'Coy	...	×	...	...	...	...	...
,, *tenue*, de Kon., sp.	×	...	...	...	...	...	...
Family—AVICULIDÆ.							
Posidonomya Becheri, Bronn	...	×	×	...	...	...	...
,, *corrugata*, R. Etheridge, jun.	...	×	...	...	...	...	...
,, *lamellosa*, de Kon.	...	×	...	...	...	...	...
,, *membranacea*, M'Coy	...	...	×	...	...	...	...
,, *radiata*, Hind	×	...	...	...	...	...	...
Actinopteria fluctuosa, R. Etheridge, jun.	×	...	...	...	...	...	...
,, *persulcata*, M'Coy, sp.	×	×	×	...	...	...	...
,, *sulcata*, M'Coy, sp.	×	...	...	...	...	...	...
Leiopteria divisa, M'Coy, sp.	×	...	...	...	...	...	...
,, *grandis*, Hind	...	×	...	...	...	...	...
,, *hirundo*, de Kon.	...	×	...	...	...	...	...
,, *laminosa*, Phill., sp.	...	×	...	...	...	...	...
,, *longirostris*, Hind	...	...	×	...	...	×	...
,, *lunulata*, Phill., sp.	×	×	...	...	...	...	...
,, *obtusa*, M'Coy, sp.	×	...	...	...	...	...	...
,, *squamosa*, Phill., sp.	...	×	×	...	...	...	...
,, *Thompsoni*, Portlock	...	×	...	...	...	...	...
Pteronites angustatus, M'Coy	×	×	×	...	...	...	...
,, *latus*, M'Coy	...	×	...	...	...	...	...
Pinna flabelliformis, Martin	...	×	...	...	...	...	...
,, *mutica*, M'Coy	×	×	...	...	...	...	...
DIMYARIA.							
Family—MYTILIDÆ.							
Modiola emaciata, de Kon.	...	×	...			...	

	Carboniferous Limestone. Lower.	Carboniferous Limestone. Upper.	Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
DIMYARIA (*continued*).							
Family—MYTILIDÆ (*continued*).							
Modiola Jenkinsoni, M'Coy, sp.	×	...	...	...	...	...	
„ *lata*, Portlock	×	...	...	...	...	...	...
„ *ligonula*, de Kon.	×	×	...	...	...	...	...
„ *Macadamii*, Portlock	×	...	...	...	...	...	...
„ *megaloba*, M'Coy	×	...	×	...	...	...	...
„ *patula*, M'Coy	...	×	...	...	...	...	...
„ *radiata*, de Kon.	...	×	...	...	...	...	...
„ *Wrightii*, Hind	...	×	...	...	...	...	...
„ *transversa*, Hind	...	...	×	...	...	...	...
Lithodomus carbonarius, Hind	×	...	...	...	...	...	...
„ *lingualis*, Phill., sp.	...	×	...	...	...	...	...
„ *lithodomoides*, R. Etheridge, jun., sp.	×	...	...	...	...	...	...
Megambonia carbonifera, Hind	...	×	...	...	...	...	...
Naiadites carinata, Sow., sp.	...	...	...	...	...	×	...
„ *crassa*, Fleming, sp.	×	...	...	...	...	...	...
„ *elongata*, Hind	...	...	...	...	...	×	...
„ *magna*, Hind	...	×	...	...	...	...	...
„ *modiolaris*, Sow., sp.	...	...	...	...	...	×	...
„ *obesa*, R. Etheridge, jun., sp.	×	...	...	...	...	...	...
„ *quadrata*, Sow., sp.	...	...	...	...	...	×	...
„ *triangularis*, Sow., sp.	...	...	...	...	...	×	...
Posidoniella elongata, Phill., sp.	×	×	...	...	...	...	...
„ *gibbosa*, Hind	...	×	...	...	...	...	...
„ *Kirkmani*, Brown, sp.	...	...	×	...	...	...	...
„ *lævis*, Bronn, sp.	...	...	×	×	×	×	...
„ *minor*, Brown, sp.	...	...	×	...	×	...	...
„ *pyriformis*, Hind	...	×	...	...	...	...	...
„ *semiculcata*, Hind	...	...	...	×	...	...	...
„ *sulcata*, Hind	...	...	...	...	...	×	...
„ *subquadrata*, Hind	...	...	...	...	×	...	...
„ *variabilis*, Bronn	...	...	×	...	...	...	...
„ *vetusta*, Sow., sp.	...	×	...	...	...	...	...
Myalina compressa, Hind	...	...	...	...	...	×	...
„ *Flemingi*, M'Coy, sp.	×	×	...	×	...	...	...
„ *lamellosa*, de Kon.	...	×	...	...	...	...	...
„ *peralata*, de Kon.	×	×	×	×	...	...	...
„ *pernoides*, Portlock, sp.	×	...	...	...	...	...	...
„ *redesdalensis*, Hind	×	×	...	...	...	...	...
„ *sublamellosa*, R. Etheridge, jun.	×	...	...	...	...	...	...
„ *Verneuillii*, M'Coy, sp.	×	×	...	×	...	...	...
Family—ARCIDÆ.							
Parallelodon angustus, Hind	...	×	...	...	...	...	...
„ *bistriatus*, Portlock, sp.	...	×	×	...	...	...	...
„ *cancellatus*, Martin, sp.	...	×	...	...	...	...	...
„ *cingulatus*, M'Coy, sp.	...	×	...	...	...	...	...
„ *concinnus*, M'Coy, sp.	...	×	...	...	...	...	...
„ *corrugatus*, de Kon.	...	×	...	...	...	...	...
„ *decussatus*, M'Coy, sp.	...	×	...	...	...	...	...
„ *elegans*, M'Coy, sp.	...	×	...				...

	Carboniferous Limestone.		Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
	Lower.	Upper.					
DIMYARIA (*continued*).							
Family—Arcidæ (*continued*).							
Parallelodon elongatus, Hind	...	×	...	...	...	...	...
„ *fallax*, de Kon.	...	×	...	...	...	...	...
„ *Fraiponti*, de Kon.	...	×	...	...	...	...	...
„ *Geinitzi*, de Kon.	×	×	...	...	...	...	...
„ *Haimeanus*, de Kon.	...	×	...	...	...	...	...
„ *Lacordaireanus*, de Kon.	...	×	...	...	...	...	...
„ *normalis*, de Kon.	...	×	...	...	...	...	...
„ *obtusus*, Phill., sp.	...	×	×	...	...	...	...
„ *ornatissimus*, de Kon.	...	×	...	...	...	...	...
„ *reticulatus*, M'Coy, sp.	...	×	...	...	...	...	...
„ *semicostatus*, M'Coy, sp.	×	×	×	...	...	...	...
„ *squamifer*, Phill., sp.	...	×	...	...	...	...	...
„ *squamosus*, de Kon.	...	×	...	...	...	...	...
„ *tenuistria*, M'Coy, sp.	×	...	...	...	...	...	...
„ *theciformis*, de Kon.	...	×	...	...	...	...	...
„ *Verneuillianus*, de Kon.	...	×	...	...	...	...	...
„ *Walciodorensis*, de Kon.	...	×	...	...	...	...	...
Family—Nuculidæ.							
Nuculana acuta, Sow., sp.	...	...	...	...	...	×	...
„ *attenuata*, Fleming, sp.	×	×	...	...	...	...	...
„ *brevirostris*, Phill., sp.	×	×	...	...	...	...	...
„ *cuneata*, Phill., sp.	...	×	...	...	...	...	...
„ *lævistriata*, Meek and Worth.	×	×	...	...	...	...	...
„ *Sharmani*, R. Etheridge, jun.	×	×	...	...	...	×	...
„ *stilla*, M'Coy	×	...	×	×	...	...	...
Nucula æqualis, Sow.	...	×	×	...	...	×	...
„ *gibbosa*, Fleming	×	×	×	...	...	×	...
„ *luciniformis*, Phill.	...	×	...	...	...	...	...
„ *oblonga*, M'Coy	×	×	...	...	...	...	...
„ *palmæ*, Sow. (from the drift)	...	?	...	...	...	...	...
„ *scotica*, Hind	×	...	...	...	...	...	...
„ *undulata*, Phill.	×	×	...	...	...	...	...
Ctenodonta lævirostris, Portlock, sp.	×	...	×	...	...	×	...
„ *pentonensis*, Hind	...	×	...	...	...	...	...
Palæoneilo carbonifera, Hind	...	...	×	...	...	...	...
Family—Trigonidæ.							
Schizodus antiquus, Hind	...	...	×	×	...	×	...
„ *axiniformis*, Sow., sp.	×	...	×	...	...	×	...
„ *carbonarius*, Sow., sp.	...	...	...	...	...	×	...
„ *obovatus*, M'Coy, sp.	...	×	...	...	...	...	...
„ *pentlandicus*, Rhind, sp.	×	...	...	...	...	...	...
Protoschizodus æquilateralis, M'Coy, sp.	...	×	...	...	...	...	...
„ *axiniformis*, Portlock, sp.	×	×	...	...	...	...	...
„ *fragilis*, M'Coy, sp.	...	×	...	...	...	...	...
„ *impressus*, de Kon.	...	×	...	...	...	...	...
„ *magnus*, Hind	...	×	...	...	...	...	...
„ *nuculoides*, M'Coy, sp.	×	×	...	...	...	...	...
„ *obliquus*, M'Coy, sp.	×	...	...	...	...	...	...
„ *orbicularis*, M'Coy, sp.	...	...	×	...	...	...	...

	Carboniferous Limestone. Lower.	Carboniferous Limestone. Upper.	Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
DIMYARIA (*continued*).							
Family Trigonidæ (*continued*).							
Protoschizodus rectangularis, M'Coy, sp.	×	×	...	...	...	...	...
,, *subæqualis*, de Kon.	...	×	...	...	...	...	...
,, *subtruncatus*, M'Coy, sp.	...	×	...	...	...	...	...
,, *triangularis*, Hind	×	...	...	...	...	...	...
,, *trigonalis*, de Kon.	...	×	...	...	...	...	...
Family—Unionidæ.							
Carbonicola acuta, Sow., sp.	...	...	...	...	×	×	...
,, ,, var. *rhomboidalis*, Hind	...	...	...	...	...	×	...
,, *angulata*, de Ryckholt, sp.	...	...	...	...	...	×	...
,, *antiqua*, Hind	×	...	...	...	...	...	...
,, *aquilina*, Sow., sp.	...	...	...	...	×	×	...
,, *cuneiformis*, Hind	...	...	...	...	...	×	...
,, *elegans*, Kirkby, sp.	×	...	...	...	...	...	...
,, *gibbosa*, Hind	...	...	...	...	...	×	...
,, *nucularis*, Hind	...	...	...	...	...	×	...
,, *obtusa*, Hind	...	...	...	...	...	×	...
,, *ovalis*, Martin, sp.	...	...	...	...	...	×	...
,, *polmontensis*, Rhind, sp.	...	...	...	...	...	×	...
,, *robusta*, Sow., sp.	...	...	...	...	...	×	...
,, *rugosa*, Brown, sp.	...	...	...	...	...	×	...
,, *similis*, Brown, sp.	...	...	...	...	...	×	...
,, *subconstructa*, Sow., sp.	...	...	...	...	...	×	...
,, *subrotunda*, Brown, sp.	...	...	...	...	...	×	...
,, *turgida*, Brown, sp.	...	...	...	...	...	×	...
,, *Vinti*, Kirkby, sp.	...	...	...	...	...	...	×
Anthracomya Adamsii, Salter	...	...	...	...	...	×	...
,, var. *expansa*, Hind	...	...	...	...	...	×	...
,, *calcifera*, Hind	...	...	...	...	...	...	×
,, *dolobrata*, Sow., sp	...	...	...	...	...	×	...
,, *lævis*, var. *scotica*, Hind	×	...	...	...	...	×	...
,, *lanceolata*, Hind	...	...	...	...	...	×	...
,, *minima*, Ludwig	...	...	...	...	...	×	...
,, ,, var. *carinata*, Hind	...	...	...	...	...	×	...
,, *modiolaris*, Sow., sp.	...	...	...	...	...	×	...
,, *obovata*, Hind	...	...	...	...	...	×	...
,, *Phillipsii*, Williamson, sp.	...	...	...	...	...	...	×
,, *pulchra*, Hind	...	...	...	...	...	×	...
,, *pumila*, Salter	...	...	...	...	...	×	...
,, *senex*, Salter	...	...	...	...	...	×	...
,, *subcentralis*, Salter	...	...	...	...	...	×	...
,, *subparallela*, Portlock, sp	×	...	...	...	...	...	...
,, *valenciensis*, Hind	×	...	...	...	...	...	...
,, *Wardi*, Etheridge	...	...	...	...	...	×	...
,, *Williamsoni*, Brown, sp.	...	...	...	...	...	×	...
,, ,, var. *obtusa*, Ludwig	...	...	...	...	...	×	...

	Carboniferous Limestone. Lower.	Carboniferous Limestone. Upper.	Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
DIMYARIA (*continued*).							
Family—Edmondidæ.							
Edmondia accipiens, Sow., sp.	...	...	...	...	...	×	...
,, *acuta*, Hind	×	...	...	...	...	...	...
,, *arcuata*, Phill., sp.	...	×	...	...	...	...	...
,, *amæna*, de Kon.	×	...	...	...	...	...	...
,, *compressa*, M'Coy, sp.	...	×	...	...	...	...	...
,, *expansa*, Hind	×	×	...	...	...	...	...
,, *gigantea*, de Kon.	...	×	...	...	...	...	...
,, *Goldfussi*, de Kon.	...	×	...	...	...	...	...
,, *Josepha*, de Kon.	×	×	...	...	...	...	...
,, *laminata*, Phill., sp.	×	×	...	...	...	...	...
,, ,, var. *sublævis*, Hind	...	×	...	...	...	...	...
,, *lowickensis*, Hind	×	...	...	...	...	...	...
,, *Lyellii*, Hind	×	×	...	...	...	...	...
,, *Maccoyi*, Hind	×	×	...	×	...	...	...
,, *oblonga*, M'Coy	×	...	...	...	...	...	...
,, *pentonensis*, Hind	×	×	...	...	...	...	...
,, *primæva*, Portlock, sp.	...	×	...	...	...	...	...
,, *punctatella*, Rupert Jones, sp.	...	×	...	...	...	...	...
,, *senilis*, Phill., sp.	×	×	×	...	...	×	...
,, *scalaris*, M'Coy	...	×	...	...	...	...	...
,, *sulcata*, Phill., sp.	×	×	×	...	...	...	...
,, *subplicata*, Kirkby, sp.	×	...	...	...	...	...	...
,, *transversa*, Hind	×	×	...	...	...	...	...
,, *truncata*, Hind	×	...	...	...	...	...	...
,, *unioniformis*, Phill., sp.	×	×	...	...	...	...	...
Cardiomorpha communis, de Kon.	...	×	...	...	...	...	...
,, *corrugata*, M'Coy	...	×	...	...	...	...	...
,, *Egertoni*, M'Coy	...	×	...	...	...	...	...
,, *limosa*, Hind	...	×	...	...	...	...	...
,, *obliqua*, Hind	...	×	...	...	...	...	...
,, *oblonga*, Sow., sp.	×	×	...	...	...	...	...
,, *orbicularis*, M'Coy	...	×	...	...	...	...	...
,, *parva*, Hind	×	×	...	...	...	...	...
,, *ventricosa* M'Coy	...	×	...	...	...	...	...
Sedgwickia attenuata, M'Coy	...	...	...	×	...	...	...
,, *gigantea*, M'Coy	×	×	...	...	...	...	...
,, *ovata*, M'Coy	×	...	×	...	...	...	...
,, *scotica*, Hind	×	...	...	...	...	...	...
,, *suborbicularis*, Hind	×	...	...	...	...	...	...
Scaldia Benedeniana, de Ryckholt, sp.	...	×	×	...	...	...	...
,, *fragilis*, de Kon.	×	×	...	...	...	...	...
,, *minuta*, Hind	...	...	...	...	...	×	...
Family—Cyprinidæ.							
Mytilomorpha angulata, de Kon., sp.	...	×	...	...	...	...	...
,, *rhombea*, Phill., sp.	×	×	×	...	...	...	...
Family Crassatellidæ.							
Cypricardella acuticarinata, Armst., sp.	×	×	...	...	...	...	...

	Carboniferous Limestone. Lower.	Carboniferous Limestone. Upper.	Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
DIMYARIA (*continued*).							
Family—CRASSATELLIDÆ (*continued*).							
Cypricardella annæ, de Ryckholt, sp.	...	×	...	...	...	...	...
,, *concentrica*, Hind	×	×	...	...	...	...	...
,, *crebricostata*, Armstrong	...	×	...	...	...	...	...
,, *parallela*, Phill., sp.	×	×	...	...	...	...	...
,, *rectangularis*, M'Coy, sp.	×	×	...	...	...	...	...
,, *Selysiana*, de Kon.	×	×	...	...	...	...	...
Family—CŒLONOTIDÆ.							
Spathella cylindrica, M'Coy, sp.	...	×	...	...	...	...	...
,, *tumida*, Hind	...	×	...	...	...	...	...
Sanguinolites abdenensis, R. Etheridge, jun.	×	...	...	...	...	...	...
,, *angustatus*, Phill., sp.	×	×	...	...	...	...	...
,, *angulatus*, de Kon.	...	×	...	...	...	...	...
,, *argutus*, Phill., sp.	...	×	...	...	...	...	...
,, *clavatus*, R. Etheridge, jun.	×	×	...	...	...	...	...
,, *costellatus*, M'Coy, sp.	×	...	...	...	...	...	...
,, { *contortus*, M'Coy / *hibernicus*, Hind }	...	×	...	...	...	...	...
,, *interruptus*, Hind	...	×	...	...	...	...	...
,, *luxurians*, de Kon.	...	×	...	...	...	...	...
,, *monensis*, de Kon.	...	×	...	...	...	...	...
,, *oblongus*, Hind	...	×	...	...	...	...	...
,, *Omalianus*, de Kon.	...	×	...	...	...	...	...
,, *ovalis*, Hind	...	...	...	×	...	...	...
,, *plicatus*, Portlock, sp.	×	...	...	...	...	...	...
,, *roxburgensis*, Hind	×	...	...	...	...	...	...
,, *striato-granulatus*, Hind	×	×	...	...	...	...	...
,, *striato-lamellosus*, de Kon.	×	×	...	...	...	...	...
,, *striatus*, Hind	×	...	...	...	...	...	...
,, *subcarinatus*, M'Coy	...	×	...	...	...	...	...
,, *tricostatus*, Portlock, sp.	×	×	...	...	...	...	...
,, *tumidus*, Phill., sp.	...	×	...	...	...	...	...
,, *v. scriptus*, Hind, sp.	...	...	×	...	...	...	...
,, *variabilis*, M'Coy	×	...	...	...	...	...	...
,, *visetensis*, de Ryckholt, sp.	×	...	...	...	...	...	...
,, *Walciodorensis*, de Kon.	×	...	...	...	...	...	...
,, *vexillum*, de Kon.	...	×	...	...	...	...	...
Solenomorpha major, Hind	...	...	×	...	...	...	...
,, *minor*, M'Coy, sp.	×	×	...	...	...	...	...
,, *parallela*, Hind	×	...	×	...	...	...	...
Allorisma Ansticei, Sow., sp.	×	×	×	...	...	...	...
,, *maxima*, Portlock, sp.	×	?	...	...	...	...	...
,, *monensis*, Hind	×	...	...	...	...	...	...
,, *sulcata*, Fleming, sp.	×	×	×	...	...	...	...
,, *variabilis*, Hind	×	...	...	...	...	...	...
Tellinomorpha cuneiformis, Hind	×	×	...	...	...	...	...
,, *jucunda*, de Kon., sp.	...	×	...	...	...	...	...

	Carboniferous Limestone. Lower.	Carboniferous Limestone. Upper.	Pendleside Series.	Millstone Grits.	Ganister Series.	Coal Measures.	Upper Coal Measures.
DIMYARIA (*continued*).							
Family—SOLEMYIDÆ.							
Solenomya costellata, M'Coy	×	×	×	...	...	...	...
,, *excisa*, de Kon.	×	×	...	...	...	...	...
,, *primæva*, Phill., sp.	×	×	...	...	...	...	...
Clinopistha abbreviata, de Ryckholt, sp.	×	...	...	...	...	...	...
,, *parvula*, de Kon.	×	...	...	...	...	...	...
Family—CARDIIDÆ.							
Conocardium alatum, de Kon.	×	×	...	...	...	...	...
,, *aliforme*, Sow., sp.	×	×	...	...	...	...	...
,, *decussatum*, R. Etheridge, jun.	×	...	...	...	...	...	...
,, *fusiforme*, M'Coy, sp.	...	×	...	...	...	...	...
,, *hibernicum*, Sow., sp.	...	×	...	...	...	...	...
,, *inflatum*, M'Coy, sp.	...	×	...	...	...	...	...
,, *irregulare*, de Kon.	...	×	...	...	...	...	...
,, *Koninckii*, Baily, sp.	×	...	...	...	...	...	...
,, *rostratum*, Martin, sp.	×	×	...	...	...	...	...
Chænocardiola Footii, Baily, sp.	...	...	×	...	...	...	...
Family—LUCINIDÆ.							
Paracyclas du Noyeri, Portlock, sp.	×	...	...	...	...	...	...
INCERTÆ SEDIS.							
Nothamusium radiatum, Hind	...	×	...	...	...	...	...
,, *transversum*, Hind	×	...	...	...	...	...	...

In the foregoing tables I have included the Calciferous Sandstone Series in the same column as the Lower Carboniferous Limestone, but I now give a list of those species of Lamellibranchs which occur in the Calciferous Sandstone Series, marking with a * those species which do not pass upwards.

Eumicrotis hemisphæricus, Phill., sp.
Streblopteria ornata, R. Eth., jun.
Pterinopecten concavus, M'Coy, sp.
,, *granosus*, Sow., sp.
,, *tessellatus*, Phill., sp.
Aviculopecten dissimilis, Flem., sp.
* ,, *eskdalensis*, Hind.
,, *fimbriatus*, Phill., sp.
,, *Forbesii*, M'Coy.
,, *interstitialis*, Phill., sp.

Aviculopecten subconoideus, R. Eth., jun.
,, *intermedius*, M'Coy, sp. ?
Pseudamusium ellipticum, Phill., sp.
Syncyclonema Sowerbyi, M'Coy, sp.
**Actinopteria fluctuosa*, R. Eth., sp.
,, *persulcata*, M'Coy, sp.
,, *sulcata*, M'Coy, sp.
**Posidonomya radiata*, Hind.
**Leiopteria divisa*, M'Coy, sp.
,, *lunulata*, Phill., sp.
Pteronites angustatus, M'Coy.

Pinna mutica, M'Coy.
**Modiola lata*, Portlock.
* „ *Macadamii*, Portlock.
„ *ligonula*, de Kon.
**Lithodomus carbonarius*, Hind.
**Naiadites crassa*, Flem., sp.
* „ *obesa*, R. Eth., jun., sp.
Myalina Flemingi, M'Coy, sp.
* „ *pernoides*, Portl., sp.
* „ *redesdalensis*, Hind.
„ *sublamellosa*, R. Eth., jun
„ *Verneuillii*, M'Coy.
Parallelodon Geinitzi, de Kon.
„ *semicostatus*, M'Coy, sp.
Nuculana attenuata, Flem., sp.
„ *brevirostris*, Phill., sp.
„ *lævistriata*, M. and W.
„ *Sharmani*, R. Eth., jun.
„ *stilla*, M'Coy.
Nucula gibbosa, Flem.
„ *oblonga*, M'Coy.
„ *scotica*, Hind.
Ctenodonta lævirostris, Portl., sp.
**Schizodus pentlandicus*, Rhind., sp.
Protoschizodus axiniformis, Portl., sp.
* „ *nuculoides*, M'Coy, sp.
„ *obliquus*, M'Coy, sp.
„ *rectangularis*, M'Coy, sp.
**Carbonicola antiqua*, Hind.
* „ *elegans*, Kirkby, sp.
**Anthracomya lævis* var. *scotica*, R. Eth.
**Anthracomya valenciensis*, Hind.
* „ *subparallela*, Portl., sp.
Edmondia Josepha, de Kon.
„ *laminata*, Phill., sp.
„ *Lyellii*, Hind.
„ *Maccoyi*, Hind.
„ *pentonensis*, Hind.
* „ *subplicata*, Kirkby.
„ *sulcata*, Flem., sp.
„ *transversa*, Hind.
* „ *truncata*, Hind.
Cardiomorpha oblonga, Sow., sp.
Sedgwickia gigantea. M'Coy.
„ *ovata*, M'Coy.
„ *suborbicularis*, Hind.
Mytilomorpha rhombea, Phill, sp.
Cypricardella parallela, Phill., sp.
„ *rectangularis*, M'Coy, sp.
Sanguinolites abdenensis, Kirkby.
„ *angustatus*, Phill., sp.
„ *clavatus*, M'Coy, sp.
„ *plicatus*, Portl., sp.
* „ *roxburgensis*, Hind.
„ *striatolamellosus*, de Kon.
„ *striatus*, Hind.
„ *tricostatus*, Portl., sp.
„ *variabilis*, M'Coy, sp.
Allorisma sulcata, Flem., sp.
Solenomya excisa, de Kon.
„ *primæva*, Phill., sp.

Of these only 21 species are, as far as is known, confined to the Calciferous Sandstone beds.

It will be noted that out of 340 species of Lamellibranchs described in this monograph 242 species do not pass above the top of the Carboniferous Limestone, and its equivalent, the upper beds of the Yoredale Series in Wensleydale and the Upper Limestone Series of Scotland. Of the 98 species which occur in the Pendleside Series and Upper Carboniferous Series, comprising the Millstone Grits and the Coal Measures, 67 species are peculiar to those beds, and do not pass downwards, while only 31 species pass up from below. There is a great faunal break, therefore, at the horizon of the top of the Carboniferous Limestone Series. Although I have not worked out the exact figures, the same state of things obtains in the case of the Gasteropoda and Cephalopoda, while the study of the Corals and

Actinozoa would show that a very much smaller percentage of organisms survived after the Carboniferous Limestone epoch.

It will be noted that I have been able to recognise a much larger number of species of Lamellibranchs as common to the Carboniferous Limestone of Belgium and Great Britain and Ireland than de Koninck thought was the case.

He described 461 species as occurring in the Carboniferous Limestone of Belgium; of these he stated that 35 species were found in England and Ireland and 18 species in Scotland.

While on the one hand one cannot help coming to the conclusion that a very large number of de Koninck's species will not bear examination, and that his list includes a number of synonyms, I have recognised 124 species as common to the Carboniferous Limestone Series of both countries. Twenty-five other species occur in the Upper Carboniferous Series, making 149 species. This is notwithstanding the marked difference in lithological character of the lower Carboniferous deposits in Belgium and Great Britain and Ireland, which consist, especially in the North of England and Scotland, of a large amount of detrital material, in the muds of which a somewhat different fauna occurs to that which obtains in the almost purely organic deposit of Limestone.

Species occurring in the Carboniferous Limestone of Belgium and Great Britain and Ireland:

Amusium tenue, de Kon., sp.
,, *concentricum*, de Kon., sp.
Syncyclonema Sowerbyi, M'Coy, sp.
Pseudamusium auriculatum, M'Coy, sp.
,, *anisotum*, Phill., sp.
,, *ellipticum*, Phill., sp.
Aviculopecten Murchisoni, M'Coy, sp.
,, *Ruthveni*, M'Coy, sp.
,, *interstitialis*, Phill., sp.
,, *planoclathratus*, M'Coy, sp.
,, *nobilis*, de Koninck.
,, *incrassatus*, M'Coy, sp.
,, *stellaris*, Phill., sp.
,, *perradiatus*, de Kon.
,, *Forbesii*, M'Coy, sp.
,, *dissimilis*, Fleming, sp.
,, *constans*, de Kon.
Pterinopecten Dumontianus, M'Coy, sp.
,, *tessellatus*, Phill., sp.
,, *eximius*, de Kon.
,, *granosus*, Sow., sp.
,, *radiatus*, Phill., sp.
Streblopteria lævigata, M'Coy.
Eumicrotis hemisphericus, Phill., sp.
,, *ovalis*, de Kon, sp.
Palæolima Buchiana, de Kon, sp.
,, *simplex*, Phill., sp.
Posidonomya lamellosa, de Kon.
Leiopteria Thompsoni, Portlock, sp.
,, *laminosa*, Phill., sp.
,, *lunulata*, Phill., sp.
,, *hirundo*,de Kon.
Pteronites angustatus, M'Coy.
Protoschzodus equilateralis, M'Coy, sp.
,, *subtruncatus*, M'Coy, sp.
Cardiomorpha oblonga, Sow., sp.
,, *communis*, de Kon.
,, *Nysti*, de Kon.
,, *orbicularis*, M'Coy.
,, *ventricosa*, M'Coy.
,, *corrugata*, M'Coy.
,, *Egertoni*, M'Coy.
Edmondia unioniformis, Phill., sp.
,, *Josepha*, de Kon.

?*Edmondia oblonga*, M'Coy.
,, *senilis*, M'Coy.
? ,, *compressa*, M'Coy.
,, *primæva*, Portlock, sp.
,, *gigantea*, de Kon.
,, *Goldfussi*, de Kon.
,, *laminata*, Phill, sp.
,, *scalaris*, M'Coy.
,, *Maccoyii*, Hind.
Scaldia fragilis, de Kon.
,, *Benedeniana*, de Ryckholt.
Mytilomorpha angulata, de Kon., sp.
,, *rhombea*, Phill., sp.
Cypricardella parallela, Phill., sp.
,, *Selysiana*, de Kon., sp.
,, *Annæ*, de Ryckholt, sp.
,, *acuticarinata*, Armstrong, sp.
Sanguinolites angustatus, Phill., sp.
,, *argutus*, Phill., sp.
,, *angulatus*, de Kon.
,, *Omalianus*, de Kon., sp.
,, *Walciodorensis*, de Kon., sp.
? ,, *tricostatus*, Portlock, sp.
,, *visetensis*, de Ryckholt, sp.
,, *striatogranulosus*, Hind.
,, *striatolamellosus*, de Kon., sp.
,, *luxurians*, de Kon.
,, *tumidus*, Phill., sp.
Solenomorpha minor, M'Coy, sp.
Tellinomorpha jucunda, de Kon., sp.
,, *cuneiformis*, de Kon.
Solenomya primæva, Phill.
,, *excisa*, de Kon.
Clinopistha abbreviata, de Ryckholt, sp.
,, *parvula*, de Kon.
Conocardium rostratum, Martin, sp.
,, *irregulare*, de Kon.
,, *inflatum*, M'Coy, sp.
,, *aliforme*, Sow., sp.
,, *Konincki*, Baily, sp.
Conocardium ufsiforme, M'Coy, sp.
,, *hibernicum*, M'Coy, sp.
,, *alatum*, de Kon.
Pinna flabelliformis, Martin, sp.
,, *mutica*, M'Coy.
Modiola patula, M'Coy.
,, *emaciata*, de Kon.
,, *ligonula*, de Ryckholt.
Lithodomus lingualis, Phill., sp.
Posidoniella vetusta, Sow., sp.
,, *pyriformis*, Hind.
,, *elongata*, Phill., sp.
Myalina Flemingi, M'Coy, sp.
,, *peralata*, de Kon.
,, *lamellosa*, de Kon.
Parallelodon Verneuillianus, de Kon.
,, *bistriatus*, Port., sp.
,, *normalis*, de Kon.
,, *squamiferus*, Phill., sp.
,, *squamosus*, de Kon.
,, *corrugatus*, de Kon.
,, *cancellatus*, Martin, sp.
,, *Lacordaireanus*, de Kon.
,, *Walciodorensis*, de Kon.
,, *tenuistria*, M'Coy, sp.
,, *ornatissimus*, de Kon.
,, *decussatus*, de Kon.
,, *fallax*, de Kon.
,, *Haimeanus*, de Kon.
,, *Fraiponti*, de Kon.
,, *obtusus*, Phill., sp.
,, *Geinitzi*, de Kon.
,, *theciformis*, de Kon.
Nucula gibbosa, Fleming.
Ctenodonta lævirostris, Port., sp.
Protoschizodus axiniformis, Port., sp.
,, *impressus*, de Kon.
,, *trigonalis*, de Kon.
,, *subæqualis*, de Kon.
,, *magnus*, de Kon.

The following other species do not occur below the Pendleside Series of Belgium and Great Britain and Ireland:

Pseudamusium fibrillosum, Salter, sp.
Aviculopecten Losseni, V. Kœnen, sp.
Pterinopecten papyraceus, Sow., sp.
Posidonomya Becheri, Sow.[1]
,, *membranacea*, M'Coy.
Leiopteria squamosa, Phill., sp.[1]
Posidoniella lævis, Brown, sp.
,, *minor*, Brown, sp.
Modiola transversa, Hind.
Chænocardiola Footii, Baily, sp.

[1] Is found below also in England.

The following species are found in the British and Belgian Coal Measures :

Carbonicola acuta, Sow., sp.
,, *aquilina*, Sow., sp.
,, *turgida*, Brown, sp.
,, *robusta*, Sow., sp.
,, *similis*, Brown, sp.
,, *nucularis*, Hind.
,, *obtusa*, Hind.
Anthracomya modiolaris, Sow., sp.
Anthracomya lanceolata, Hind.
,, *Wardi*, Eth.
,, *Williamsoni*, Brown, sp.
,, *lævis*, var. *scotica*, Eth.
Naiadites carinata, Sow., sp.
,, *modiolaris*, Sow., sp.
Posidoniella minor, Brown, sp. } in a marine band.
Parallelodon semicostatus, M'Coy, sp. }

At the present time a comparison of European and North American Carboniferous Lamellibranchs is impossible, but I cannot help being struck by the great similarity of shells occurring in the two areas. I am of opinion that when species from both areas are studied a large number will be found to be identical.

Mr. J. Smith and Mr. D. Tait have kindly drawn up for me lists of the Carboniferous Lamellibranchs found in the west and east of Scotland respectively, showing the range of each species, and I beg to acknowledge fully my great indebtedness to each of these gentlemen for this and other help in my work.

List of Carboniferous Lamellibranchiata from the East of Scotland, by D. Tait.

	Lower Carboniferous.				Upper Carboniferous.			
	Calciferous Sandstone.	Lower Limestones.	Edge Coals.	Upper Limestones.	Roslin Sandstone.	Lower Coal Measures.	Middle Measures.	Locality Numbers. (See p. 196.)
Actinopteria fluctuosa, Eth., sp.	...	×	...	...	...	...	...	132.
,, *persulcata*, M'Coy, sp.	×	×	...	×	...	...	...	34, 38, 90, 118, 126, 151, 176, 183, 191, 204, 206, 207.
,, *sulcata*, M'Coy, sp.	×	×	×	×	...	...	...	34, 38, 62, 92, 95.
Allorisma maxima, Portl., sp	×	...	...	...	...	...	...	34.
,, *sulcata*, Flem., sp.	×	×	×	...	...	...	...	50, 53, 54, 83, 88, 90, 94, 107, 111, 114, 143
Anthracomya lævis, var. *scotica*, Eth.	×	...	...	...	...	...	...	32, 33, 90, 141, 164, 166, 167, 168, 175, 177, 178.
,, *minima*, Hind	×	...	...	...	...	...	...	159.
,, *modiolaris*, Sow., sp.	...	...	...	...	...	...	?	43.
,, *Phillipsii*, Williamson, sp.	...	×	×	...	...	...	...	9, 22, 23.
,, *valenciensis*, Hind	×	...	...	...	×	...	...	163, 210.
,, *Wardi*, Eth., senr.	...	...	×	...	...	×	×	43, 45, 145.
,, *Williamsoni*, Brown, sp.	...	...	...	...	...	×	...	42, 138.
Aviculopecten cf. *clathratus*, M'Coy	...	×	...	...	...	...	...	204, 227.

	Lower Carboniferous.				Upper Carboniferous.			
	Calciferous Sandstone.	Lower Limestones.	Edge Coals.	Upper Limestones.	Roslin Sandstone.	Lower Coal Measures.	Middle Coal Measures.	Locality Numbers. (See p. 196.)
Aviculopecten dissimilis, Flem., sp.	×	×	×	×	×	...	...	1, 9, 30, 34, 38, 41, 89, 99, 122, 126, 134, 135, 137, 147, 180, 192, 193, 194, 196, 197, 201, 203, 204, 206, 207, 208, 209, 222, 224, 225, 227.
,, *fimbriatus*, Phill., sp.	×	×	...	...	...	...	...	49, 89, 117.
,, *Forbesi*, M'Coy, sp.	...	×	...	...	...	...	...	227.
,, *granosus*, Sow., sp.	×	×	...	...	...	...	...	21, 35, 66, 71, 73, 74, 89, 125.
,, *inæqualis*, Hind	...	...	×	...	...	...	...	142.
,, cf. *intermedius*, M'Coy, sp.	×	...	...	...	...	...	...	111 ?.
,, *interstitialis*, Phill., sp.	×	×	...	×	...	...	...	28, 34, 92, 122, 125, 126, 146, 194, 204, 226.
,, *knockonniensis*, M'Coy, sp.	...	×	...	×	...	...	...	139, 198, 227.
,, *semicostatus*, Portl., sp.	...	×	...	...	...	...	...	30, 41.
,, *subconoideus*, Eth., sp.	×	×	...	...	...	...	...	34, 50, 126, 156, 158, 204, 205 ?.
,, *tabulatus*, M'Coy, sp.	...	×	...	...	...	...	...	41, 197.
Carbonicola acuta, Sow., sp.	...	...	...	...	?	×	...	42, 45, 179, 216, 220 ?.
,, *aquilina*, Sow., sp.	...	...	×	...	...	×	...	45, 140.
,, *antiqua*, Hind	×	...	...	...	...	...	...	80, 83, 84, 89 ?, 165 ?.
,, *elegans*, Kirkby	×	...	...	...	...	...	...	68, 76, 78*a*, 86.
,, *robusta*, Sow., sp.	...	...	...	...	...	×	...	138, 179, 187, 188 ?, 189, 190, 214, 218.
,, *turgida*, Brown, sp.	...	...	...	...	...	×	...	42.
Cardiomorpha limosa, Flem., sp.	...	...	...	×	...	...	...	139.
,, *oblonga*, Sow., sp.	×	...	...	×	...	...	...	38, 90.
Conocardium aliforme, Phill., sp.	...	×	...	...	...	...	...	30, 31, 41, 49.
,, *inflatum*, M'Coy, sp.	...	×	...	...	...	...	...	204.
Ctenodonta lævirostris, Portl., sp.	×	×	×	×	...	...	...	17, 38, 142.
Cypricardella acuticarinata, Armstrong, sp.	...	×	...	...	×	...	...	9, 200, 209.
,, *concentrica*, Hind	...	×	...	...	...	...	...	30, 49, 181.
,, *parallela*, Phill., sp.	×	×	...	...	...	...	...	9, 18, 19, 41, 79.
,, *rectangularis*, M'Coy, sp.	×	×	...	×	...	...	...	30, 31, 47, 59 ?, 93, 158, 200.
,, *Selysiana*, de Kon.	...	×	...	...	...	...	...	93.
Edmondia arcuata, Phill., sp.	...	×	...	...	...	...	...	95.
,, *expansa*, Hind	...	×	...	×	...	...	...	139, 204.
,, *Josepha*, de Kon.	×	×	...	×	...	...	...	9, 28, 34, 38, 39, 49, 50, 51, 52, 53, 54, 56, 64, 66, 88, 89, 90, 92, 111, 113.
,, *laminata*, Phill., sp.	×	×	...	...	...	...	...	50, 51, 171, 204.
,, *Lyelli*, Hind	×	?	...	×	...	...	...	34, 38, 207.
,, *MacCoyii*, Hind	×	×	...	...	×	...	...	52, 107, 137, 197, 211.
,, cf. *oblonga*, M'Coy	...	...	...	×	...	...	...	222.
,, *pentonensis*, Hind	×	...	...	...	...	...	..	89.
,, *primæva*, M'Coy, sp.	...	×	...	...	...	...	...	224.

	Lower Carboniferous.				Upper Carboniferous.			
	Calciferous Sandstone.	Lower Limestones.	Edge Coals.	Upper Limestones.	Roslin Sandstone.	Lower Coal Measures.	Middle Coal Measures.	Locality Numbers. (See p. 196.)
Edmondia scalaris, M'Coy, sp.	...	×	...	...	...	...	...	9, 30.
,, *subplicata*, Kirkby	×	...	...	...	...	...	...	50, 64, 71, 74.
,, *sulcata*, Flem., sp.	×	×	...	...	...	...	...	31, 41, 49, 50, 83, 103, 111, 143, 197.
,, *transversa*, Hind	×	...	...	...	...	...	...	50, 51, 54, 114.
,, *unioniformis*, Phill., sp.	×	×	...	×	...	...	...	1 ?, 9, 21, 28, 30, 34 ?, 38, 39 ?, 51, 52, 65, 67, 79, 83, 88, 89, 92, 93, 110.
Eumicrotis hemisphæricus, Phill., sp.	×	...	...	...	...	...	...	35.
Leiopteria divisa, M'Coy, sp.	×	...	...	...	...	...	...	56, 78*a*, 87, 154, 171.
,, *lunulata*, Phill., sp.	×	×	...	...	...	...	...	73*a*, 87, 90 ?, 207.
,, *Thompsoni*, Portl., sp.	...	×	...	...	×	...	...	209, 212.
Limatulina simplex, Phill., sp.	...	...	...	...	×	...	...	209.
Lithodomus carbonarius, Hind	×	...	...	...	...	...	...	34, 55, 71, 75, 78*a*.
,, *lingualis*, Phill., sp.	...	×	×	...	...	...	...	30, 143, 204.
,, *lithodomoides*, Eth., sp.	...	×	...	...	...	...	...	30, 98, 99, 112, 135.
Modiola lata, Portl.	×	...	...	...	...	...	...	61.
,, *ligonula*, de Rych.	×	...	...	...	...	...	...	90.
,, *Macadamii*, Portl.	×	...	...	...	...	...	...	90 ?, 107, 108, 109.
Myalina Flemingi, M'Coy, sp.	×	...	...	×	...	...	...	34, 38, 90, 139.
,, *pernoides*, Portl., sp.	×	...	...	...	...	...	...	111.
,, *redesdalensis*, Hind	×	...	...	...	...	...	...	62.
,, *sublamellosa*, Eth.	×	×	...	...	...	...	...	34, 50, 58, 60, 87, 90, 154, 197.
,, *Verneuillii*, M'Coy, sp.	×	×	×	...	...	...	...	50, 90, 96, 142, 143, 171.
Mytilomorpha rhombea, Phill., sp.	×	×	...	...	...	...	...	41, 88, 98, 100, 102.
Naiadites carinata, Sow., sp.	...	...	×	...	...	×	...	45, 144, 213, 219, 223.
,, *crassa*, Flem., sp.	×	×	...	...	...	...	...	34, 49, 50, 53, 54, 58, 60, 62, 63, 64, 67, 73, 90, 110, 111, 112, 113, 114, 122, 170, 171.
,, *elongata*, Hind	...	...	...	...	...	...	×	218.
,, *obesa*, Eth.	×	...	×					2, 50, 59 ?, 63, 65, 67, 69, 71, 72, 73, 74, 77, 81, 82, 84, 85 ?, 86, 87, 106, 109, 115, 116, 142, 145, 145A, 152, 153, 155, 156, 157, 158, 160, 161, 162, 165, 173, 174, 221, 228.
,, *quadrata*, Sow., sp.	...	...	...	...	...	×	...	42.
Nucula æqualis, Sow.	...	...	...	×	...	...	...	217,
,, *gibbosa*, Flem.	×	×	×	×	...	...	...	1, 7, 8, 11, 16, 17, 18, 19, 20, 24, 28, 34, 38, 39, 40, 47, 51, 83, 89, 92, 96, 97, 101, 102, 103, 119, 121, 124, 125, 127, 129, 133, 142, 149, 155, 184 ?, 197, 200, 222.
,, *luciniformis*, Phill., sp.	...	×	...	...	...	...	...	1, 17.
,, *oblonga*, M'Coy	×	...	...	...	...	...	...	172.
,, *scotica*, Hind	×	×	...	...	...	...	...	19, 20, 92, 93, 171.
,, *undulata*, Phill., sp.	...	×	...	...	...	...	...	102 ?.

	Lower Carboniferous.				Upper Carboniferous.			
	Calciferous Sandstone.	Lower Limestones.	Edge Coals.	Upper Limestones.	Roslin Sandstone.	Lower Coal Measures.	Middle Coal Measures.	Locality Numbers. (See p. 196.)
Nuculana acuta, Sow., sp.	...	×	...	...	...	...	...	8 ?, 28.
,, *attenuata*, Flem., sp.	×	×	...	×	...	...	...	1, 8, 9, 10, 11, 12, 16, 17, 18, 19, 20, 21, 24, 28, 30, 34, 35, 38, 39, 47, 50, 51, 53, 54, 56, 58, 64, 66, 83, 87, 89, 90, 92, 93, 100, 102, 105, 121, 123, 124, 133, 136, 171, 181A, 195, 197, 198, 199, 200, 204, 222, 224.
,, *brevirostris*, Phill., sp.	×	×	...	...	...	...	...	11, 17, 19, 20, 65, 102, 124, 134, 171.
,, *lævistriata*, M. and W.	×	×	...	×	...	...	...	5, 8, 9, 11, 24, 38, 101, 170.
,, *Sharmani*, Eth., sp.	×	...	...	...	...	...	...	171.
,, *stilla*, M'Coy, sp.	×	...	...	...	...	...	...	50.
Parallelodon bistriatus, Portl., sp.	...	?	...	...	...	...	...	30.
,, *cancellatus*, Mart., sp.	...	×	...	...	...	...	...	147, 227.
,, *Geinitzi*, de Kon.	×	×	...	...	×	...	...	171, 191, 209.
,, *Lacordaireanus*, de Kon.	...	×	...	...	...	...	...	98, 99 ?, 101.
,, *semicostatus*, M'Coy, sp.	×	×	...	×	...	...	...	19, 28, 47, 49, 92 ?, 94, 102.
Pinna flabelliformis, Mart., sp.	...	×	×	...	...	...	...	9, 30, 31, 41, 120, 128, 142, 147, 196, 204, 207, 227.
,, *mutica*, M'Coy	×	...	...	×	...	...	...	89, 194.
Posidoniella elongata, Phill., sp.	...	×	...	...	...	...	...	49, 94.
Posidonomya corrugata, Eth.	...	×	...	...	...	...	...	9, 181.
Protoschizodus æquilateralis, M'Coy, sp.	...	×	...	...	...	...	...	136.
,, *axiniformis*, Portl., sp.	×	×	×	×	×	...	...	21, 28, 30, 34, 38, 47, 49, 54, 56, 66, 89, 90, 94, 96, 111, 143, 184, 207 ?, 209, 222.
,, *nuculoides*, M'Coy, sp.	×	...	...	...	...	...	...	53, 58, 65, 66, 67, 90, 156.
,, *obliquus*, M'Coy, sp.	×	×	×	×	...	...	...	21, 38, 50, 53, 54, 58, 66, 90, 96, 137, 142.
Protoschizodus rectangularis, M'Coy, sp.	×	...	...	...	...	...	...	90.
Pseudamusium anisotum, Phill., sp.	...	×	...	...	...	...	...	206.
,, *ellipticum*, Phill., p.	×	...	...	...	...	...	...	92.
Pterinopecten concavus, Phill., sp.	×	×	...	...	...	...	...	25, 30, 51, 52, 54.
,, *granosus*, Sow., sp.	...	×	...	...	...	...	...	224, 225, 227.
,, *tessellatus*, Phill., sp.	...	×	...	...	...	...	...	206.
Pteronites angustatus, M'Coy	×	...	...	...	×	...	...	50, 56, 58, 171, 209.
,, *latus*, M'Coy	...	×	...	...	...	...	...	207 ?.
Sanguinolites abdenensis, Kirkby	×	×	...	...	...	...	...	4, 34, 50, 63, 65, 71, 74, 87, 137, 156 ?, 172, 202.
,, *angulatus*, de Kon.	...	...	...	×	...	...	...	198.
,, *angustatus*, Phill., sp.	×	×	...	...	...	...	...	21, 51, 151.

	Lower Carboniferous.				Upper Carboniferous.			Locality Numbers. (See below.)
	Calciferous Sandstone.	Lower Limestones.	Edge Coals.	Upper Limestones.	Roslin Sandstone.	Lower Coal Measures.	Middle Coal Measures.	
Sanguinolites clavatus, M'Coy, sp.	×	×	×	...	...	...	...	50, 51, 67, 87, 90, 96, 136, 142, 152, 155, 156, 158, 160, 171, 197.
,, *costellatus*, M'Coy, sp.	×	×	×	×	...	...	...	1, 9, 10, 11, 12, 17, 20, 21, 49, 88, 89, 125, 139, 143, 181.
,, *oblongus*, Hind	...	?	...	...	...	...	...	30.
,, *plicatus*, Portl., sp....	×	×	×	...	...	...	...	48, 49, 90, 136, 142, 149, 172?, 197.
,, *roxburgensis*, Hind	×	...	...	...	...	...	...	156.
,, *striato-lamellosus*, de Kon.	×	×	...	×	...	...	...	28, 34, 38, 118.
,, *striatus*, Hind.........	×	×	...	...	...	...	...	49, 50, 51, 54, 56, 58, 62, 63, 65, 92, 155.
,, *tricostatus*, Portl., sp.	×	×	...	...	...	...	...	14, 30, 49, 92, 98?, 181, 227.
,, *variabilis*, M'Coy, sp.	×	...	...	...	...	...	...	53, 54, 58, 63, 64, 65, 112.
,, cf. *visetensis*, de Ryck., sp.	...	×	...	...	...	...	...	9.
Schizodus antiquus, Hind	...	...	...	...	×	...	...	209.
,, *carbonarius*, Sow., sp. ...	...	...	×	...	...	...	...	143.
,, *pentlandicus*, Rhind, sp.	×	...	×	...	...	...	...	52, 54, 68, 71, 72, 73, 73A, 74, 75, 87, 88, 112, 142, 152, 153, 155, 156, 160?, 169, 170, 171.
Sedgwickia gigantea, M'Coy	×	×	...	...	×	...	...	41, 50, 71, 74, 75, 83, 89, 110, 181, 209?.
,, *ovata*, M'Coy	×	×	...	...	...	...	...	51, 54, 65, 78, 87, 89, 94, 181.
,, *suborbicularis*, Hind ...	×	×	...	...	...	...	...	30, 34, 35, 36, 41, 137.
Solenomya costellata, M'Coy, sp. ...	...	×	...	...	×	...	...	151, 204?, 209.
,, *excisa*, de Kon.	×	×	...	...	...	...	...	9, 92?, 226.
,, *primæva*, Phill., sp. ...	×	×	...	...	...	...	...	9, 34, 89, 96, 118, 130, 134, 136, 185, 204, 207, 212, 225, 227.
Solenomorpha minor, M'Coy, sp. ...	...	×	×	×	...	...	...	38, 98, 143.
Streblopteria ornata, Eth., sp.	×	×	×	×	...	...	...	7, 30, 34, 35, 38, 41, 90, 122, 134, 143, 151, 183, 197, 202.
Syncyclonema Sowerbyi, M'Coy, sp.	×	×	...	...	...	...	...	13, 26, 34, 41, 94, 98, 99, 118, 123, 125, 126, 131, 134, 136, 137, 181, 191, 199, 204, 207, 212, 224, 225, 226.
Tellinomorpha cuneiformis, de Kon.	...	×	...	...	...	...	...	147.

Localities from which Lamellibranchs have been obtained in Fife and Mid and East Lothian, chiefly on Sheets 32, 33, 40, 41 of the Ordnance and Geological Survey's one-inch maps :

1. Charleston Limestone Quarry.
2. Rosyth, W. of Queensferry.
3. St. David's, W. of, on shore under Seafield Cottage.

4. Port Haven, $\frac{1}{2}$ mile S.W. of Aberdour.
5. Creechy Pit, $1\frac{1}{2}$ miles N.W. of Oakley, 6 miles N.W. of Dunfermline.
6. Burn at Moreland, $2\frac{1}{2}$ miles S.S.E. of Crook of Devon.
7. Lochornie Burn, shale above second Limestone.
8. Lathalmond Quarry, 4 miles N.W. of Dunfermline.
9. Roscobie Quarry, 4 miles N. of Dunfermline.
10. Dolly Limestone Quarry, near Drumfod, 4 miles N.W. of Dunfermline.
11. Linn Quarry, 4 miles N.W. of Dunfermline.
12. Cowdens Quarry, 3 miles N.W. of Dunfermline.
13. Craigluscar Quarry, 3 miles N.W. of Dunfermline.
14. Lassodie Quarry, N. of Loch Fitty.
15. Touch Mains, right bank of Burn below Touch Bleachfield, S.E. of Dunfermline.
16. Sunnybank Quarry, Dunfermline.
17. Blacklaw Quarry, 1 mile S.E. of Dunfermline.
18. South Fod Quarry, 2 miles E. of Dunfermline.
19. Duloch Quarry, E. of Dunfermline.
20. Woodend Quarry, Parkend Farm, S. of Fordel, 5 miles E. of Dunfermline.
21. Easter Bucklyvie Quarry, Donibristle, 5 miles E.N.E. of Dunfermline.
22. Lochgelly Ironworks, No. 16 pit, E. of Ironwork, 7 miles N.E. of Dunfermline.
23. Kelty Colliery, Lindsay Pit, Lochgelly B.B. ironstone.
24. Capeldrae and Rasewell Collieries, E. of Ballingry, 1 mile S.E. of Loch Leven.
25. Clattering Well, Bishop Hill, Kinnesswood.
26. Walton Quarry, 1 mile S. of Lochgelly, shale above No. 1 Limestone.
27. Glenniston Quarry, 4 miles N.W. of Kirkcaldy.
28. Leslie Limeworks.
29. Chapel Quarry, 3 miles N.W. of Kirkcaldy.
30. Potmetal Plantation, $2\frac{1}{2}$ miles N.W. of Kirkcaldy.
31. Bogie Quarry, 2 miles N.W. of Kirkcaldy.
32. Brosyhall Sandstone Quarry.
33. Pettycur, S. of Kinghorn.
34. Abden, Kinghorn; Abden Limestone and beds associated with it, lowest limestone E. of Kinghorn.
35. Abden, Kinghorn, second limestone on shore E. of Kinghorn.
36. Kinghorn, third limestone; shale below limestone.
37. Kinghorn, Seafield Tower; shale above sandstone on which tower is built.
38. Pathhead, on shore near; Lower Limestone (Gair).
39. ,, ,, Upper Limestone (Levenseat), 200 yards E. of Lower Limestone.
40. Carberry Quarry, Dunnikier, $1\frac{1}{2}$ miles N. of Pathhead.
41. Invertiel Quarry, W. of Linktown, Kirkcaldy.
42. West Wemyss.
43. Methil, on shore W. of (Red Beds, Middle Coal Measures).
44. Pirnie Colliery Leven; Parrot Coal.
45. Durie and Leven Collieries; roof of Eight-foot Coal.
46. Methil and Leven marine bands.
47. Kennoway Den.
48. Forthar Limeworks, $1\frac{1}{2}$ miles S. of Kettle.
49. Pitlessie and Cults Limeworks; Hurlet Limestone and shales associated with it.

Localities in Eastern Fife, chiefly on Sheet 41 of the Ordnance and Geological Surveys:

50. Newton Quarry, Knockhill, 4 miles W. of St. Andrews.
51. Knockhill, first quarry below sandstone quarry.
52. Millstone Quarry, Nydie Muir, S.W. from the smithy at Knockhill.
53. Den Quarry, near Kincaple, $3\frac{1}{2}$ miles W. of St. Andrews.
54. Nydie Quarry, Knockhill, 4 miles W. of St. Andrews.
55. Kinness Burn, right bank below New Mill, $\frac{3}{4}$ miles W. of St. Andrews.
56. St. Andrews, Witch Lake, west end of cliff, south side of lake.
57. ,, shore in front of, near Baths (Encrinite bed).
58. ,, shore, E. side of castle.
59. Maiden Rock, shore 30 yards E. of, 1 mile E. of St. Andrews.
60. ,, ,, 300 yards E. of Encrinite bed.
61. ,, ,, shore at sheep fence, E. of.
62. ,, ,, shore, 600 yards E. of (Myalina bed).
63. Rock and Spindle, shore outside or seawards of, 2 miles E. of St. Andrews.
64. ,, ,, E. of the volcanic necks on the Kinkell shore.
65. ,, ,, shore, 6 yards E. of volcanic neck at Kinkell.
66. Rock and Spindle, E. of (Encrinite bed)
67. ,, ,, a few yards E. of the volcanic agglomerate.
68. Pitmilly Burn, shore W. of, 5 miles E. of St. Andrews.
69. Airbow Point, shore at, W. of Kingsbarns Harbour.
70. Kingsbarns Harbour, shore 100 yards W. of.
71. Cambo Burn, shore E. of, E. of Cambo Ness (Sedgwickia limestone and shales associated with it).
72. Old Haiks, shore E. side of, opposite East Newhall Farm road.
73. Randerston Farm, road to, shore opposite old limestone quarry in field E. of road.
73*a*. ,, ,, a few yards E. of locality 73.
74. ,, ,, road, shore E. of Schizodus bed, eastern outcrop.
75. ,, ,, ,, shore E. of Sedgwickia Limestone.
76. ,, Castle, shore W. of "Buckie limestone" at anticline on one-inch map
77. ,, ,, shore at (Myalina bed).
78. ,, ,, ,, "Seed" limestone.
78*a*. ,, ,, shore immediately E. of (Orthoceras Limestone).
79. Balcomie Rocks under Balcomie Links (loose stones).
80. Kilminning Castle, shore W. of, N.E. from Crail.
81. Crail, Harbour Cliff under Cottage Row (Leaia shale) and ironstone bands under Myalina bed.
82. ,, ,, ,, ,, Myalina limestone and shale above.
83. ,, on shore one mile W. of and E. of the Pans.
84. Kilrenny Mill, on shore E. of Burn.
85. Anstruther, shore W. end of (Myalina bed).
86. Billow Ness, Anstruther, shore E. side of.
87. ,, ,, ,, shore W. of.
88. ,, ,, ,, shore under shooting platform and W. of target.
89. Pittenweem, E. of, Encrinite bed in cliff.
90. Coal Farm, shore E. of, midway between St. Monans and Pittenweem, third limestone under "St. Monans White Limestone."

91. Coal Farm, shore E. of, second limestone under St. Monans White Limestone.
92. „ „ „ first limestone under St. Monans White Limestone.
93. „ shore under E. of St. Monans, shale above No. 2 limestone.
94. St. Monans, shore under Round Tower, E. of.
95. „ Harbour, shore W. of, Rhynchonella shale above limestone.
96. Ardross Castle, shore E. of, shale underlying bands and nodules of limestone.
97. „ „ shore W. of shale above and below limestone.
98. Teasses Limeworks, old quarry N. of Backbraes, N. of Largo, shale above limestone.
99. „ „ new quarry, S. of Teasses House, N. of Largo.
100. Woodtop Quarry, The Den, Teasses.
101. Greigstone Quarry, 3 miles W. of Ceres.
102. Wilkieston Quarry, 5 miles S.W. of St. Andrews.
103. Ladeddie Quarry, N.E. of Cupar and $5\frac{1}{2}$ miles W. of St. Andrews.
104. Shore, Viewforth, Largo, Upper Limestones, probably the Index Limestone.
105. Bed of Hatton Burn, about 120 yards N. of the smithy at Thomsford Bridge.

Localities in East Lothian, chiefly on Sheet 33:

106. Shore 50 yards W. of the Black Rocks, 1 mile E. of Dunbar (Cement Stone Series).
107. Shore E. of Belhaven Bay and W. of Longcraigs, Dunbar (Cement Stone Series).
108. Shore 1 mile E. of Tyningham Links (Cement Stone Series).
109. Shore 150 yards W. of St. Baldreds House, Tantallon Castle.
110. Sandersdean at the Limestone exposure 2 miles S. by E. of Haddington.
111. Letham Burn, W. of Letham House, W. of Haddington.
112. „ „ first limestone below Letham House, 1 mile W. of Haddington.
113. Burn at Inglisfield near Gifford (Sandersdean Limestone).
114. Humbie Water, a few yards above railway bridge, Salton Station.
115. River Tyne, opposite Distillery, Haddington.
116. „ at footbridge, Clerkington House, Haddington.
117. Burn in glen close to the Haddington and Longniddry Railway.
118. Old Quarry at Lennoxlove, 1 mile S. of Haddington.
119. Kidlaw Quarries, $3\frac{1}{2}$ miles S.E. of East Salton, shale above No. 2 limestone.
120. Crichton Quarry, $1\frac{1}{2}$ miles S.W. of Cathhead.
121. Shore at Skateraw, a few yards E. of the limekilns (Middle Skateraw Limestone).
122. Catcraig Sea Quarry (Upper Longcraigs Limestone).
123. Shore opposite Catcraig Land Quarry (shale above Skateraw Limestone).
124. Oxwell Mains Quarry, E. of Dunbar (Middle Skateraw Limestone).
125. East side of Dalskelly Craigs, under Bogle Hill, $\frac{3}{4}$ mile N.E. of Longniddry (shale underlying No. 3 limestone).
126. Salton Limeworks, Middle Mains Farm, 1 mile N.W. of East Salton (shale above and below No. 1 limestone).
127. Little Kinchie Quarry, west side of road, 3 miles S.W. of East Salton (shale above No. 2 limestone).
128. Blance Burn Quarries, 1 mile N.E. of East Salton.
129. East Salton Old Quarry, N. of East Salton Village.
130. Quarry N. of Manse, East Salton.
131. Spilmersford Quarry, 2 miles N.W. of East Salton.
132. West Quarry, Salton.

133. Lampland Quarry, N. of the Kiln, 3 miles N.E. of Pathhead.
134. ,, ,, S. of the Kiln.
135. Paiston Quarry, 2 miles E. of Pathhead.
136. Magazine Limestone Quarry, N. of lime kiln, 1 mile E. of Pathhead.
137. Hope Quarry near Pathhead.
138. Port Seton Harbour, west division (Lower Coal Measures).
139. ,, ,, Shore, east of the harbour, shale 4–6 feet below No. 6 limestone (Upper Limestone Series).
140. Prestonpans Bankton Coal Pit bing, about 200 yards E. of Prestonpans Railway Station, said to be shale from above Jewell coal (Edge Coal Series).

Localities in Midlothian, chiefly on Sheet 32 :

141. Inchkeith Island, Firth of Forth.
142. Bo'ness, 1 mile S. of Chance Pit, No. 21 Kinneil (Roof of Smithy Coal).
143. ,, S. of No. 18 pit (Roof of Smithy Coal).
144. ,, No. 6 pit above Red Coal.
145. ,, 2 miles S.E. of Cowsie Mine, Lower Ironstone of Bo'ness.
145*a*. ,, ,, ,, Duncan Shale pit, No. 9 Bonhard, shale above ironstone.
146. Cauldhame Old Quarry, $1\frac{1}{4}$ miles S.E. of Bo'ness.
147. Hillhouse Quarries, $1\frac{1}{2}$ miles S. of Linlithgow.
148. Whitebaulks Quarry, $1\frac{1}{2}$ miles S.S.E. of Linlithgow.
149. Tartraven Old Quarry, 4 miles S. of Linlithgow.
150. Baadsmill, limestone exposed on left bank of Harwood Burn, S. of Addiewell, and $1\frac{1}{4}$ miles N.W. of Cobinshaw Reservoir.
151. Cobinshaw Reservoir, Limestone Pit at S.W. end (Hurlet List).
152. City of Edinburgh, water of Leith at Drumsheuch.
153. ,, ,, under Dean Bridge.
154. Craiglockhart Hill Quarry, N. side of Colinton Road.
155. Edinburgh Suburban Railway Cutting, north side of canal, S.W. of city.
156. Craigleith Quarry, W. side of the city of Edinburgh.
157. Barnton Old Pavement Quarry (under whin sill), N. side of Corstorphine Hill, and $\frac{1}{4}$ mile S.W. of Davidson's Mains.
158. Wardie Shore, between Trinity and E. side of Granton Harbour.
159. Granton Harbour, shore between western breakwater and pier.
160. ,, Shore, W. of harbour at telegraph cable.
161. Cramond Shore, W. of mouth of River Almond and W. of Eagle Rock.
162. Dalmeny Shore, between Longcraigs Pier and Forth Bridge.
163. ,, Railway cutting, N. of Western Dalmeny Farmhouse.
164. Midhope Burn, 100 yards below sawmill near Abercorn, 4 miles W. of Forth Bridge.
165. Hailes Quarry near Kingsknowe Railway Station, 4 miles S.W. of Edinburgh.
166. Railway cutting on left bank of Water of Leith midway between Boags Mill and Kates Mill, 4 miles S.W. of Edinburgh.
167. Railway cutting opposite Kates Mill, midway between Slateford and Colinton.
168. Water of Leith, opposite Kates Mill.
169. Colinton, railway tunnel at, 4 miles S.W. of Edinburgh.
170. Water of Leith, left bank above Spylaw House. Schizodus limestone.
171. Woodhall, Water of Leith, right bank at ford below weir, near Juniper Green, 5 miles S.W. of Edinburgh.

172. Clubbiedean Reservoir, south side, $1\frac{1}{2}$ miles E.S.E. of Currie and 6 miles S.W. of Edinburgh.
173. Midcalder, sandstone quarry on left bank of Linnhouse Water, opposite Oakbank Oil Works.
174. „ „ right bank of Linnhouse Water, below Oakbank Oil Works.
175. „ Linnhouse Water, above and below Felstone Dyke, between Calderhall and Calderwood.
176. West Calder, 17 miles S.W. of Edinburgh, near the Chemical Works.
177. Straiton Oil Works, near Burdiehouse, $4\frac{1}{2}$ miles S.S.E. of Edinburgh.
178. Burdiehouse Limestone Quarry, $4\frac{1}{2}$ miles S.S.E. of Edinburgh.
179. Niddrie, 3 miles E. of Edinburgh, Klondyke Pit shale above "15-feet Coal."
180. Gilmerton Limestone Quarry, 4 miles S.E. of Edinburgh.
181. Gilmerton, Ferniehill Old Limestone Quarry.
181*a*. „ railway cutting $\frac{1}{2}$ mile S.E. of village. (Upper Limestones.)
182. Woolmet, new pit sinking, $1\frac{1}{4}$ miles S.E. of Niddrie House, and $1\frac{1}{2}$ miles N.E. of Gilmerton.
183. Bilston Burn, near Loanhead, at Dryden shale below No. 1 limestone. (Lower Limestones.)
184. „ „ „ „ No. 2 „ „
185. „ „ left bank below Pathhead Farmhouse, shale in middle of No. 3 limestone. (Lower Limestones.)
186. Bilston Burn, at junction with Dryden Burn. (Upper Limestones.)
187. Broomieknowe Railway Station, 7 miles S.E. of Edinburgh; shale above the Parrot Rough Coal exposed at the steps on W. side of station-house.
188. Polton Colliery, Eldendean Pit from roof of Parrot Rough Coal.
189. „ No. 3 pit, pavement of Parrot Rough Coal.
190. „ pit presently working $\frac{1}{2}$ mile S. of Bonnyrigg, roof of Parrot Rough Coal.
191. Hebershaw House, old quarry S.E. of, 2 miles S.E. of Penicuik. (Lower Limestones.)
192. Mount Lothian, old limestone quarries 3 miles S.E. of Penicuik.
193. Fullarton Limestone Quarries, $3\frac{1}{2}$ miles S.E. of Penicuik.
194. Hare Burn, $1\frac{1}{2}$ miles S.W. of Penicuik, 70 to 80 yards W. of east margin of Hurly Wood.
195. Ninemile Burn, about 4 miles S.W. of Penicuik, right bank opposite Unthank.
196. River North Esk, Habbies Howe, left bank below Peggie's Pool. (Lower Limestones.)
197. Brunstane Colliery, 3 miles S.W. of Penicuik. (Lower Limestones.)
198. Harken Burn, 2 miles S.W. of Penicuik, opposite Cornton. (Upper Limestones.)
199. Braidwood Burn, S.W. of Penicuik, right bank above Matthew's Linn. (Lower Limestones.)
200. Carlops Quarry, $4\frac{1}{2}$ miles S.W. of Penicuik. (Sh. 24, 1 inch.)
201. Kitly Bridge, Carlops, right bank of River N. Esk. (Lower Limestones.)
202. „ above in small burn on right bank of Esk. (Lower Limestones.)
203. Deep Syke, near Whitefield Macbiehill, from Talla water tunnel near here.
204. Whitefield Limestone Quarries, between Carlops and Macbiehill Railway Station.
205. Whim, old limestone quarry about midway between Leadburn and Macbiehill Railway Stations. (Sh. 24, 1 inch.)
206. Hillhead Quarry, near Cockmuir Bridge. (Lower Limestones.)
207. Esperston Limestone Quarries $6\frac{1}{2}$ miles S.E. of Dalkeith.
208. Arniston, near Gorebridge, $\frac{1}{4}$ mile W. of Arniston House, right bank of River South Esk on lower side of bridge $\frac{3}{4}$ mile S. of Carrington.
209. Arniston Glen, in the steep slope on left bank 100 to 150 feet above the stream at bend about 50 yards up stream from the wooden foot-bridge. (Roslin Sandstone).
210. Arniston Glen, left bank 1 mile W.S.W. of Gorebridge and $\frac{1}{2}$ mile W.S.W. of Arniston Bridge, at sharp bend of stream W. of, and down stream from the old stone bridge W. of Shank.

211. Arniston Glen, $\frac{1}{2}$ mile N.W. of Arniston Bridge, $\frac{1}{4}$ mile S.E. of Kirkhill. Nodular Limestone (Roslin Sandstone.)
212. Blinkbonny Quarry, 1 mile N.N.E. of Gorebridge. (Lower Limestones.)
213. Newbattle Colliery, Lady Victoria and Lingerwood Pits (top of Parrot Coal—Edge Coal Series).
214. Eskbank, River North Esk, up stream from Elginhaugh, and down stream from weir (shale above Parrot Rough Coal, L. Coal Meas.).
215. Smeaton old coal pit, 1 mile N.E. of Dalkeith.
216. Balaclava old coal pit, Shawfair Farm 2 miles N. of Dalkeith.
217. Joppa Sandstone Quarry, shale overlying No. 4 limestone.
218. Joppa shore, E. of the Salt Pans; 193 feet E. of E. corner of retaining wall of the garden on E. side of Salt Pans (Carbonicola bed, L. Coal Meas.).
219. Musselburgh, Olivebank Pit sinking S. of Fisherrow Harbour.
220. Levenhall shore at E. end of West Pans. (Roslin Sandstone.)
221. Wallyford Colliery, $1\frac{1}{2}$ miles E. of Musselburgh. (Edge Coals.)
222. Prestongrange, shore opposite at Bankfoot, W. of Prestonpans. (Upper Limestones.)
223. Prestonpans, Northfield Pit, on S. side of town.
224. Cousland Quarries, 3 miles E.N.E. of Dalkeith. (Lower Limestones.)
225. Mayfield Quarry, 2 miles S.E. of Dalkeith.
226. Mansfield Quarry, 3 miles S.E. of Dalkeith.
227. Currielee, No. 2 quarry right bank River Tyne. (Lower Limestones.)
228. Borthwick Castle, near, 2 miles S.E. of Gorebridge; Middleton South Burn, left bank, a few yards up stream from the bridge to the castle.

Table showing the Vertical Range of the Carboniferous Lamellibranchiata in the West of Scotland. By John Smith.

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland).
	Lower.	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Carbonicola robusta, Sow., sp.	...	...	...	...	...	...	...	×
„ *rugosa*, Brown, sp.	...	...	...	...	...	...	...	...
„ *acuta*, Sow., sp.	...	...	...	×	...	...	...	×
„ *ovalis*, Sow., sp.	...	...	...	...	...	...	...	×
„ *polmontensis*, Rhind, sp.	...	...	...	...	...	...	...	×
„ *subconstricta*, Sow., sp.	...	...	...	...	...	...	...	...
„ *obtusa*, Hind	...	...	...	...	...	...	...	...
„ *nucularis*, Hind	...	...	...	...	...	...	...	...
„ *gibbosa*, Hind	...	...	...	...	...	...	...	...
„ *turgida*, Brown, sp.	...	...	...	...	...	...	...	×
„ *aquilina*, Sow., sp.	...	...	...	...	...	...	...	×
„ *angulata*, Sow., sp.	...	...	...	...	...	...	...	...
„ *similis*, Brown, sp.	...	...	...	..	...	..	...	×
„ *cuneiformis*, Hind	...	...	...	..	...	..	..	...

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland).
	Lower	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Carbonicola antiqua, Hind	...	...	...	...	...	...	...	...
,, *elegans*, Kirkby, sp.	...	...	...	...	...	...	...	...
Anthracomya Adamsii, Sow., sp.	...	...	...	...	...	...	...	...
,, *dolabrata*, Sow., sp.	...	...	...	...	...	...	...	...
,, *modiolaris*, Sow., sp.	...	...	...	...	...	...	...	×
,, *Williamsoni*, Brown, sp.	...	...	...	...	...	...	...	×
,, *lanceolata*, Hind	...	...	...	...	...	...	...	...
,, *Wardi*, Eth.	...	...	...	×	...	...	...	...
,, *pumila*, Salter	...	...	...	...	...	...	...	...
,, *subcentralis*, Salter	...	...	...	...	...	...	...	...
,, *obovata*, Hind	...	...	...	...	...	...	...	...
,, *senex*, Salter	...	...	...	...	...	...	...	×
,, *valenciensis*, Hind	...	...	...	...	...	...	...	...
,, *pulchra*, Hind	...	...	...	...	...	...	...	...
,, *minima*, Hind	...	...	...	×	...	...	...	×
,, *Phillipsii*, Williamson, sp.	...	...	...	...	...	...	...	×
,, *lævis*, var. *scotica*, Eth.	...	...	...	...	...	...	...	...
,, *subparallela*, Portl., sp.	...	...	...	...	...	...	...	...
Naiadites modiolaris, Sow., sp.	...	...	...	...	...	...	...	×
,, *triangularis*, Sow., sp.	...	...	...	...	...	...	...	×
,, *carinata*, Sow., sp.	...	...	...	×	...	...	...	×
,, *quadrata*, Sow., sp.	...	...	...	...	...	...	...	×
,, *elongata*, Hind	...	...	...	...	...	...	...	×
,, *obesa*, Eth., sp.	...	...	...	...	...	...	...	...
,, *crassa*, Flem., sp.	...	...	×	×	×	...	...	...
,, *magna*, Hind	...	...	...	×	...	...	...	...
Modiola patula, M'Coy	...	...	...	...	...	...	...	...
,, *megaloba*, M'Coy	...	...	...	...	...	...	...	...
,, *Macadamii*, Portl.	...	× ?	...	...	...	...	...	...
,, *lata*, Portl.	...	...	...	...	...	...	...	...
,, *transversa*, Hind	...	...	...	...	...	...	...	...
,, *emaciata*, de Kon.	...	...	×	...	...	...	...	...
,, *lingonula*, de Ryckholt	...	...	...	...	...	...	...	...
,, *Jenkinsoni*, M'Coy, sp.	...	...	...	×	...	...	...	...
Lithodomus lingualis, Phill., sp.	...	...	×	...	...	×	...	...
,, *lithodomoides*, Eth., sp.	...	...	×	...	...	×	...	...
,, *carbonarius*, Hind	...	...	...	...	...	...	...	...
Posidoniella vetusta, Sow., sp.	...	...	×	...	...	×	...	...
,, *pyriformis*, Hind	...	...	...	...	...	...	...	...
,, *elongata*, Phill., sp.	...	...	...	...	...	...	...	...
,, *gibbosa*, Hind	...	...	...	...	...	...	...	...
,, *semisulcata*, Hind	...	...	...	...	...	...	...	...
,, *lævis*, Brown, sp.	...	...	...	×	...	...	...	...
,, *Kirkmani*, Brown, sp.	...	...	...	...	...	...	...	...
,, *minor*, Brown, sp.	...	...	...	...	...	...	...	...
,, *variabilis*, Brown, sp.	...	...	...	...	...	...	...	...
,, *subquadrata*, Hind	...	...	...	...	...	...	...	...
Myalina redesdalensis, Hind	...	...	...	...	...	...	...	...

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland).
	Lower.	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Myalina Flemingi, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *Verneuillii*, M'Coy, sp.	...	...	×	×	...	×	...	...
,, *pernoides*, Portl., sp.	...	...	...	...	...	...	...	...
,, *peralata*, de Kon.	...	...	×	...	...	...	...	...
,, *sublamellosa*, Eth.	...	...	...	...	...	...	...	...
,, *compressa*, Hind	...	...	...	...	...	...	...	...
,, *lamellosa*, de Kon.	...	...	...	...	...	...	...	...
Parallelodon squamifer, Phill., sp.	...	...	...	...	...	...	...	...
,, *Verneuilianus*, de Kon.	...	...	...	...	...	...	...	...
,, *bistriatus*, Portl., sp.	...	...	...	...	...	...	...	...
,, *cingulatus*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *squamosus*, de Kon.	...	...	...	...	...	...	...	...
,, *corrugatus*, de Kon.	...	...	×	...	...	...	...	...
,, *reticulatus*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *cancellatus*, Martin, sp.	...	...	...	...	...	...	...	...
,, *Lacordaireanus*, de Kon.	...	...	...	...	...	...	...	...
,, *Walciodorensis*, de Kon.	...	...	...	...	...	...	...	...
,, *tenuistria*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *concinnus*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *ornatissimus*, de Kon.	...	...	...	...	...	...	...	...
,, *semicostatus*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *decussatus*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *fallax*, de Kon.	...	...	...	...	...	...	...	...
,, *Haimeanus*, de Kon.	...	...	...	...	...	...	...	...
,, *Fraiponti*, de Kon.	...	...	...	...	...	...	...	...
,, *obtusus*, Phill., sp.	...	...	×	...	...	...	...	...
,, *Geinitzi*, de Kon.	...	...	×	...	...	×	...	...
,, *theciformis*, de Kon.	...	...	...	...	...	...	...	...
Nucula gibbosa, Flem.	...	...	×	×	...	×	...	...
,, *undulata*, Phill.	...	...	×	...	...	...	...	...
,, *palmæ*, Sow.	...	...	...	...	...	...	...	...
,, *luciniformis*, Phill.	...	...	×	×	...	×	...	...
,, *oblonga*, M'Coy	...	...	×	...	...	×	...	...
,, *æqualis*, Sow.	...	...	×	...	...	×	...	...
,, *scotica*, Hind	...	...	×	...	...	×	...	...
Nuculana attenuata, Flem., sp.	...	...	×	×	...	×	...	...
,, *Sharmani*, Eth.	...	...	...	...	...	×	...	...
,, *stilla*, M'Coy, sp.	...	...	...	...	...	×	...	...
,, *brevirostris*, Phill., sp.	...	...	×	...	...	×	...	...
,, *lævistriata*, Meek and Worthen	...	...	×	...	...	×	...	...
,, *acuta*, Sow., sp.	...	...	...	...	...	...	...	...
Ctenodonta lævirostris, Portl., sp.	...	...	×	...	...	×	...	...
Schizodus pentlandicus, Rhind, sp.	...	...	...	...	...	...	...	...
,, *axiniformis*, Sow., sp.	...	...	...	...	...	×	...	...
,, *carbonarius*, Sow., sp.	...	...	...	...	...	...	...	...
,, *antiquus*, Hind	...	...	...	...	...	...	...	...
Protoschizodus axiniformis, Portl., sp.	...	...	×	...	...	×	? ×	...
,, *impressus*, de Kon.	...	...	×	...	...	×	...	...

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland).
	Lower.	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Protoschizodus obliquus, M'Coy, sp.	...	...	×	...	...	...	...	...
,, *rectangularis*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *subæqualis*, de Kon.	...	...	...	...	...	...	...	...
,, *orbicularis*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *triangularis*, Hind	...	...	×	...	...	...	...	...
,, *nuculoides*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *magnus*, de Kon.	...	...	...	...	...	...	...	...
,, *æquilateralis*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *subtruncatus*, M'Coy, sp.	...	...	×	...	...	...	...	...
,, *fragilis*, M'Coy, sp.	...	...	...	...	...	...	...	...
Cardiomorpha oblonga, Sow., sp.	...	...	×	...	...	...	...	...
,, *communis*, de Kon.	...	...	...	...	...	...	...	...
,, *Nysti*, de Kon.	...	...	...	...	...	...	...	...
,, *orbicularis*, M'Coy	...	...	×	...	...	×	...	...
,, *ventricosa*, M'Coy	...	...	...	...	...	...	...	...
,, *limosa*, Flem.	...	...	×	...	×	×	...	...
,, *parva*, Hind	...	...	×	...	...	×	...	...
,, *corrugata*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *Egertoni*, M'Coy, sp.	...	...	...	...	...	...	...	...
Sedgwickia gigantea, M'Coy	...	...	...	...	...	...	...	...
,, *ovata*, M'Coy	...	...	...	...	...	...	...	...
,, *scotica*, Hind	...	...	×	...	...	...	...	...
,, *suborbicularis*, Hind	...	...	...	...	...	...	...	...
,, *attenuata*, M'Coy	...	...	...	...	...	...	...	...
Edmondia unioniformis, Phill., sp.	...	...	×	...	...	...	...	...
,, *Josepha*, de Kon.	...	...	×	...	...	×	...	...
,, *Lowickensis*, Hind	...	...	×	...	...	×	...	...
,, *oblonga*, M'Coy	...	...	×	...	...	...	...	...
,, *Lyellii*, Hind	...	...	×	...	...	...	...	...
,, *rudis*, M'Coy	...	...	×	...	...	×	...	...
,, *compressa*, M'Coy	...	...	...	...	...	...	...	...
,, *primæva*, M'Coy	...	...	×	...	...	...	...	...
,, *gigantea*, de Kon.	...	...	×	...	...	...	...	...
,, *Goldfussi*, de Kon.	...	...	...	...	...	...	...	...
,, *arcuata*, Phill., sp.	...	...	...	...	...	...	...	...
,, *pentonensis*, Hind	...	...	...	...	...	...	...	...
,, *subplicata*, Kirkby, sp.	...	...	...	...	...	...	...	...
,, *transversa*, Hind	...	...	×	...	...	×	...	...
,, *sulcata*, Flem., sp.	...	...	×	...	...	...	...	...
,, *expansa*, Hind	...	...	...	...	...	...	...	...
,, *laminata*, Phill., sp.	...	...	...	...	...	...	...	...
,, *scalaris*, M'Coy	...	...	×	...	...	...	...	...
,, *MacCoyii*, Hind	...	...	×	...	...	...	...	...
,, *accipiens*, Sow., sp.	...	...	...	...	...	...	...	...
Scaldia fragilis, de Kon.	...	...	...	...	...	×	...	...
,, *Benedeniana*, de Ryckholt	...	...	...	...	...	...	...	...
Mytilomorpha rhombea, Phill., sp.	...	...	×	...	...	...	...	...
,, *angulata*, de Kon., sp.	...	...	...	...	...	...	...	...

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland)
	Lower.	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Cypricardella parallela, Phill., sp.	...	...	...	...	...	...	...	...
„ *concentrica*, Hind	...	...	×	...	...	×	...	...
„ *crebricostata*, Armstrong, sp.	...	...	...	...	...	×	...	...
„ *Selysiana*, de Kon.	...	...	×	...	...	×	...	...
„ *annæ*, de Ryckholt, sp.	...	...	...	...	...	...	...	...
„ *rectangularis*, M'Coy, sp.	...	...	×	...	...	×	...	...
„ *acuticarinata*, Armstrong, sp	...	...	×	...	...	×	...	...
Sanguinolites angustatus, Phill., sp.	...	...	×	...	...	...	...	...
„ *argutus*, Phill., sp.	...	...	...	...	...	...	...	...
„ *angulatus*, de Kon.	...	...	...	...	...	...	...	...
„ *Omalianus*, de Kon.	...	...	×	...	...	...	...	...
„ *contortus*, M'Coy, sp.	...	...	...	...	...	...	...	...
„ *Walciodorensis*, de Kon.	...	...	...	...	...	...	...	...
„ *costellatus*, M'Coy, sp.	...	...	×	...	...	×	...	...
„ *variabilis*, M'Coy, sp.	...	...	×	...	...	...	...	...
„ *V-scriptus*, Hind	...	...	...	...	...	...	...	...
„ *interruptus*, Hind	...	...	...	...	...	...	...	...
„ *clavatus*, M'Coy, sp.	...	...	...	...	...	...	...	...
„ *plicatus*, Portl., sp.	...	...	...	...	...	×	...	...
„ *tricostatus*, Portl., sp.	...	...	×	...	...	...	...	...
„ *striato-granulatus*, Hind	...	...	×	...	...	×	...	...
„ *visetensis*, de Ryckholt, sp.	...	...	...	...	...	...	...	...
„ *oblongus*, Hind	...	...	×	...	...	...	...	...
„ *striato-lamellosus*, de Kon.	...	...	×	...	...	×	...	...
„ *striatus*, Hind	...	...	...	...	...	...	...	...
„ *luxurians*, de Kon.	...	...	...	...	...	...	...	...
„ *tumidus*, Phill., sp.	...	...	...	...	...	...	...	...
„ *roxburgensis*, Hind	...	...	...	...	...	...	...	...
„ *abdensis*, Kirkby	...	...	×	...	...	...	...	...
„ *subcarinatus*, M'Coy	...	...	×	...	...	...	...	...
„ *ovalis*, Hind	...	...	...	...	...	...	...	...
Solenomorpha minor, M'Coy, sp.	...	...	...	...	...	...	...	...
„ *parallela*, Hind, sp.	...	...	...	...	...	...	...	...
Allorisma maxima, Portl., sp.	...	...	...	...	...	...	...	...
„ *sulcata*, Flem., sp,	...	...	×	...	...	×	...	...
„ *variabilis*, M'Coy, sp.	...	...	×	...	...	×	...	...
„ *monensis*, Hind	...	...	...	...	...	...	...	...
„ *Ansticei*, Sow., sp.	...	...	×	...	...	...	...	...
Tellinomorpha jucunda, de Kon., sp.	...	...	...	...	...	...	...	...
„ *cuneiformis*, de Kon.	...	...	×	...	...	×	...	...
Solenomya primæva, Phill., sp.	...	...	×	...	...	×	...	...
„ *excisa*, de Kon.	...	...	×	...	...	...	...	...
„ *costellata*, M'Coy, sp.	...	...	×	...	...	...	...	...
Clinopistha abbreviata, de Ryckholt	...			...	...	...	...	...
„ *parvula*, de Kon.	...			...	...	...	...	...
Conocardium rostratum, Marl., sp.	...	...	×	...	...	...	...	...
„ *irregulare*, de Kon.	...	...	...	...	...	...	...	...
„ *inflatum*, M'Coy, sp.	...	...	×	...	...	...	...	...

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland).
	Lower.	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Conocardium aliforme, Phill., sp.	...	...	×	...	...	...	...	...
,, *Konincki*, Baily, sp.	...	...	...	...	...	...	...	...
,, *fusiforme*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *hibernicum*, Sow., sp.	...	...	...	...	...	...	...	...
,, *decussatum*, Eth.	...	...	×	...	...	×	...	...
,, *alatum*, de Kon.	...	...	×	...	...	...	...	...
Chænocardiola Footi, Baily, sp.	...	...	...	...	...	...	...	...
Pinna flabelliformis, Mart., sp.	...	...	×	...	...	×	...	...
,, *mutica*, M'Coy	...	...	×	...	...	...	...	...
Pteronites angustatus, M'Coy	...	...	...	...	...	...	...	...
,, *latus*, M'Coy	...	...	×	...	...	...	...	...
Leiopteria lunulata, Phill., sp.	...	...	×	...	...	...	×	...
,, *hirundo*, de Kon.	...	...	...	...	...	...	...	...
,, *laminosa*, Phill., sp.	...	...	×	...	...	×	...	...
,, *squamosa*, Phill., sp.	...	...	×	...	...	×	...	...
,, *Thompsoni*, Portl., sp.	...	...	...	...	...	×	...	...
,, *grandis*, Hind	...	...	...	...	...	...	...	...
,, *longirostris*, Hind	...	...	...	...	...	...	...	...
,, *obtusa*, M'Coy	...	...	×	...	...	...	...	...
,, *divisa*, M'Coy	...	...	×	...	...	...	...	...
Actinopteria persulcata, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *fluctuosa*, Eth., sp.	...	...	×	...	...	...	...	...
,, *sulcata*, M'Coy, sp.	...	...	...	...	...	...	...	...
Posidonomya Becheri, Bronn	...	...	...	...	...	...	...	...
,, *corrugata*, Eth.	...	...	×	...	...	×	...	...
,, *radiata*, Hind	...	...	...	...	...	...	...	...
,, *membranacea*, M'Coy	...	...	...	...	...	...	...	...
,, *lamellosa*, de Kon.	...	...	...	...	...	...	...	...
Limatulina scotica, Hind	...	...	×	...	...	×	...	...
,, *alternata*, M'Coy, sp.	...	...	...	...	...	×	...	...
Limatulina desquamata, M'Coy, sp.	...	...	×	...	...	×	...	...
Palæolima simplex, Phill., sp.	...	...	×	...	...	...	...	...
,, *Buchiana*, de Kon.	...	...	...	...	...	...	...	...
,, *obliquiradiata*, Hind	...	...	...	...	...	...	...	...
Eumicrotis hemisphæricus, Phill., sp.	...	...	...	...	...	×	...	...
,, *ovalis*, de Kon., sp.	...	...	...	...	...	...	...	...
Streblopteria ornata, Eth., sp.	...	...	×	...	...	×	...	...
,, *lævigata*, M'Coy	...	...	...	...	...	×	...	...
,, *concentrica*, Hind	...	...	×	...	...	...	...	...
Pterinopecten papyraceus, Sow., sp.	...	...	...	...	...	×	...	×
,, *concavus*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *radiatus*, Phill., sp.	...	...	×	...	...	...	...	...
,, *granosus*, Sow., sp.	...	...	×	...	...	...	...	...
,, *eximius*, de Kon., sp.	...	...	...	...	...	...	...	...
,, *rigidus*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *meleagrinoides*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *tessellatus*, Phill., sp.	...	...	...	...	...	...	...	...
,, *cyclopterus*, Phill., sp.	...	...	...	...	...	...	...	...

	Calciferous Sandstone Series.		Carboniferous Limestone.				Millstone Grit.	Coal Measures (Scotland).
	Lower.	Upper.	Lower Limestone Series.	Ironstone Series.	Coal Series.	Upper Limestone Series.		
	1	2	3	4	5	6	7	8
Pterinopecten Dumontianus, de Kon., sp.	...	...	...	...	...	...	...	...
Aviculopecten tabulatus, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *semicostatus*, Portl., sp.	...	...	...	...	...	? ×	...	...
,, *dissimilis*, Flem., sp.	...	...	×	...	...	×	...	...
,, *plicatus*, Sow., sp.	...	...	...	...	...	...	...	...
,, *eskdalensis*, Hind	...	...	...	...	...	...	...	...
,, *fallax*, M'Coy, sp.	...	...	? ×	...	...	...	...	...
,, *subconoideus*, Eth., sp.	...	...	×	...	...	...	...	...
,, *pera*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *decussatus*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *Losseni*, v. Koenen, sp.	...	...	...	...	...	...	...	...
,, *intermedius*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *clathratus*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *Forbesii*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *macrotis*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *knockonniensis*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *gentilis*, Sow., sp.	...	...	...	...	...	...	...	...
,, *perradiatus*, de Kon.	...	...	...	...	...	...	...	...
,, *stellaris*, Phill., sp.	...	...	×	...	...	...	...	...
,, *incrassatus*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *nobilis*, de Kon.	...	...	...	...	...	×	...	...
,, *planoclathratus*, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *quinquelineatus*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *fimbriatus*, Phill., sp.	...	...	...	...	...	...	...	...
,, *interstitialis*, Phill., sp.	...	...	×	...	...	×	...	...
,, *Ruthveni*, M'Coy	...	...	...	...	...	...	...	...
,, *Carrolli*, Hind	...	...	...	...	...	...	...	...
,, *Murchisoni*, M'Coy, sp.	...	...	...	...	×	×	...	...
,, *inequalis*, Hind	...	...	...	...	...	...	...	...
,, *deornatus*, Phill., sp.	...	...	...	...	...	...	...	...
,, *Sedgwicki*, M'Coy, sp.	...	...	...	...	...	...	...	...
Pseudamusium ellipticum, Phill., sp.	...	...	×	...	...	×	...	...
,, *anisotum*, Phill., sp.	...	...	×	...	...	×	...	...
,, *gibbosum*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *fibrillosum*, Salter, sp.	...	...	...	...	...	...	...	...
,, *auriculatum*, M'Coy, sp.	...	...	...	...	...	...	...	...
,, *redesdalense*, Hind	...	...	...	...	...	? ×	...	...
,, *sublobatum*, Eth., sp.	...	...	...	...	...	...	...	...
,, *concentrico-lineatum*, Hind	...	...	...	...	...	...	...	...
Crenipecten semicircularis, M'Coy, sp.	...	...	×	...	...	...	...	...
Obliquipecten lævis, Hind	...	...	...	...	...	...	...	...
Syncyclonema Sowerbyi, M'Coy, sp.	...	...	×	...	...	×	...	...
,, *carboniferum*, Hind	...	...	...	...	...	...	...	×
Amusium concentricum, Hind	...	...	×	...	...	×	...	...
,, *tenue*, de Kon., sp.	...	...	×	...	...	...	...	...
,, *planicostatum*, M'Coy, sp.	...	...	...	...	...	...	...	...

Generalised Section of the Carboniferous Formation of the West of Scotland.

8. *Coal Measures.*—With a Spirorbis bed in upper part, *Lingula mytiloides*, Labyrinthodonts, Crustaceans, Scorpions, Eurypterids, Myriopods and Annelids scarce; Cyprids and Fish-remains abundant at parts; Plants not common except in upper beds.

Volcanic Series.—Cuts out part of Coal Measures and Millstone Grit.

7. *Millstone Grit.*—Feebly developed.

6. *Upper Limestone Series.*—With few Corals, Cephalopods and Fish-remains; Gastropods, Brachiopods, Polyzoa, Crinoids, Foraminifera, and Sponge-remains abundant; Conodonts rare.

5. *Coal Series.*—With a *Naiadites*-bed.

4. *Ironstone Series.*—With Fish-remains, Lingula, Naiadites and freshwater Ostracoda.

3. *Lower Limestone Series.*—With abundance of Corals, Crinoids, Brachiopods, Polyzoa, Ostracoda, Annelids, Foraminifera and Sponge-remains; Fishes, Cephalopods, and Conodonts scarce.

Great Volcanic Series.—Cuts out a large part of the Calciferous Sandstone Series and Lower Limestone Series.

Calciferous Sandstone Series:

2. *Upper Part.*—Shales and Cement stones with Cyprids, Plants, Fish-remains and Spirorbis.
1. *Lower Part.*—Sandstones with unfossiliferous Cornstones, and Footprints of a large animal.

Notes.—No. 8 at Drumpark near Coatbridge there is a stratum containing Marine fossils.

Nos. 6 and 3.—There is a Coal bed a short distance under each of the principal beds of Limestone in both the Upper and Lower Series. A freshwater Ostracoda-bed occurs in No. 3.

No. 5.—The Naiadites-bed in this Series contains no other kind of shells. Oolitic structure is rarely seen in the Limestones.

The Lowick Limestones, from which the Rev. E. Jenkinson made his Collection, now in the Sedgwick Museum, Cambridge, comprise limestones between the Dun Limestone, or the equivalent of the Redesdale Limestone and the Dyburn Limestone, which probably is the representative of the Main Limestone of Weardale.

	Redesdale Limestone.	Four Laws Limestone.	The Main Limestone.	Lowick.
Limatulina desquamata, M'Coy, sp.	×	...	...	...
Streblopteria lævigata, M'Coy	...	...	...	×
Pterinopecten granosus, Sow., sp.	×	...	...	×
,, *concavus*, M'Coy, sp.	...	...	...	×
,, *Dumontianus*, de Kon., sp.	...	...	...	×
Aviculopecten semicostatus, Portl., sp.	×	...	×	×
,, *dissimilis*, Flem., sp.	...	×	×	×
,, *nobilis*, de Kon.	...	...	...	×
,, *interstitialis*, Phill., sp.	...	...	...	...

	Redesdale Limestone.	Four Laws Limestone.	The Main Limestone.	Lowick.
Aviculopecten incrassatus, M'Coy, sp.	×	...	...	...
Pseudamusium redesdalense, Hind	×	...	...	...
Actinopteria persulcata, M'Coy, sp.	×	...	...	×
Pinna flabelliformis, Martin	×	×	×	×
,, *mutica*, M'Coy, sp.	×	...	...	×
Modiola Jenkinsoni, M'Coy, sp.	...	×	...	...
Posidoniella elongata, Phill., sp.	×	...	...	...
Myalina pernoides, Portl., sp.	×	...	...	...
,, *redesdalensis*, Hind	×	...	...	...
,, *Verneuillii*, M'Coy	×	...	...	
Parallelodon reticulatum, M'Coy, sp.	...	×	...	...
Nucula gibbosa, Flem., sp.	×	...	...	×
,, *undulata*, Phill.	×	...	...	...
Ctenodonta lævirostris, Portl., sp.	×	...	...	...
Nuculana attenuata, Flem., sp.	×		...	×
,, *brevirostris*, Phill., sp.	×	...	...	×
Schizodus axiniformis, Phill., sp.	×	...	...	...
Protoschizodus axiniformis, Portl., sp.	×	...	...	×
,, *impressus*, de Kon.	...	...	...	×
,, *fragilis*, M'Coy, sp.	×		...	...
Cardiomorpha parva, Hind	×	...	...	...
Edmondia arcuata, Phill., sp.	×	×	...	...
,, *lowickensis*, Hind	...	×	...	×
,, *Maccoyi*, Hind	...	×	...	×
,, *oblonga*, M'Coy	...	×	...	×
,, *pentonensis*, Hind	×	...	...	...
,, *rudis*, M'Coy	...	×	...	×
,, *sulcata*, Phill., sp.	×	×	×	×
,, *unioniformis*, Phill., sp.	×	×	...	×
Sedgwickia ovata, Hind	×	...	...	...
Cypricardella annæ, de Ryck., sp.	...	...	×	...
Sanguinolites clavatus, M'Coy, sp.	×	...	...	...
,, *plicatus*, Portl., sp.	×	...	×	×
,, *striatogranulosus*, Hind	×	...	...	...
,, *tricostatus*, Portl., sp.	×	×	...	...
,, *variabilis*, M'Coy, sp.	×	×	×	×
,, *V. scriptus*, Hind		...	...	...
,, *visetensis*, de Kon.	×	...	...	...
Allorisma monensis, Hind	...	...	×	...
,, *sulcata*, Flem.	×	×	×	×
,, *variabilis*, Hind	×	×	×	×
Solenomya costellata, Phill.	...	×	×	×
,, *primæva*, M'Coy	...	...	×	×
Clinopistha abbreviata, de Ryckholt, sp.	...	×	...	...
,, *parvula*, de Kon.	...	×	...	...
Nothamusium radiatum, Hind	...	×	...	...
Conocardium aliforme, Sow., sp.	...	×	...	×

The net results of the distribution of the Lamellibranchs in Carboniferous rocks are important, because many species occur only at certain definite horizons, and therefore are of value as zonal indices.

For example, *Modiola Macadamii*, *M. lata*, *Lithodomus carbonarius*, *Leiopteria divisa*, *Edmondia truncata*, *Posidonomya radiata*, *Aviculopecten eskdalensis* occur only in the lowest series, and the first two species have been found over a wide horizontal area of distribution.

Unfortunately, no species of Lamellibranchs seem to characterise any horizon in the Carboniferous Limestone Series, including the Yoredale Limestones, but the largest number of species occur in the upper beds of the division.

In the Upper Carboniferous beds which succeed the Carboniferous Limestone Series the Lamellibranchs afford the most definite and important zonal indices.

The most important in this respect are *Posidonomya Becheri*, *P. membranacea*, *Posidoniella lævis*,* *P. minor*, *P. Kirkmani*, *P. variabilis*, *Pterinopecten papyraceus*,* *Aviculopecten gentilis*, *A. Losseni*, *Pseudamusium fibrillosum*, *Chænocardiola Footii*. Those species marked with * have a much wider vertical distribution than the others. *P. Becheri*, it is true, does occur at a lower horizon, but its maximum is at the lower part of the Pendleside Series.

In the Coal Measures the distribution of several species of *Anthracomya*, *Carbonicola* and *Naiadites* is so constant that I have been able to draw up a fossil chart of the North Staffordshire coalfield for practical use by mining engineers in ascertaining the horizon of beds in sinking and other mining operations.

In the North Staffordshire coalfield several marine bands occur intercalated amongst the freshwater beds containing *Carbonicola*, *Anthracomya* and *Naiadites*. Two of the marine Lamellibranchs are of importance—*Syncyclonema carboniferum*, which occurs below the Gin Mine Coal; *Myalina compressa* is an index of the Marine bed 77 yards below the Moss coal.

Of the species of *Carbonicola* and *Anthracomya*:

Zone 1. *A. calcifera* is typical of the upper division of the Upper Coal Measures.

Zone 2. *A. Phillipsii* with *Carbonicola Vinti* indicates the Black Band Series immediately below Zone 1.

Zone 3. The important shells in this zone are *Carbonicola turgida*, *C. robusta*, *C. subconstricta*, *Naiadites modiolaris* and *N. carinata*, *Anthracomya Wardi*, *A. Adamsii*, *A. modiolaris*, *A. Williamsoni*.

The accompanying table of Life Zones in Carboniferous rocks (p. 212) has been evolved from time to time. In it I have made use chiefly of Lamellibranchs and Cephalopoda. It is found that certain species of the one group are accompanied by certain of the other.

The most unsatisfactory part is that of the great Massif of Limestone, which is characterised by *Productus giganteus*, probably about 3000 feet thick. I had hoped by a careful examination of this formation, where it was split up into separate beds, in the North of England and the South of Scotland, that the distribution of fossils might have afforded some evidence that species characterised certain definite horizons; but this is not the case with any group of fossils which I have collected and examined from those rocks. For the present, then, I cannot

Table of Life-Zones suggested for the British Carboniferous Rocks.

	Zones.	England.	Scotland.	Ireland.	Isle of Man.	Devonshire.	Belgium.	N. Wales.	S. Wales.
Upper Coal Measures.	Zone of *Anthracomya calcifera.*	*Spirorbis* - limestones, Upper Coal Measures.	Upper Coal Measures of Ayrshire.	? Wanting.	Wanting.	? Wanting.	?		
	Zone of *Anthracomya Phillipsii.*	Upper Coal Measures of Lancashire, Yorkshire, Staffordshire, and Bristol.	The Red Measures of Fifeshire.	? Wanting.	Wanting.	? Wanting.	?		
Middle Coal Measures.	Zone of *Naiadites modiolaris* and *Anthracomya modiolaris*: containing sub-zones of *Anthracomya Wardi*, *A. Adamsii*, and *A. Williamsonii.*	Middle Coal Measures, universally.	Coal Measures of Fifeshire.	Coal Measures. Castlecomer and Leinster.	Wanting.	Roberts Quarry, Bideford. Middle Culm.	Coal Measures.	Coal Measures.	Coal Measures.
Ganister Group Lower Coal Measures. Millstone Grits. Pendleside Group.	Zone of *Pterinopecten papyraceus*, *Gastrioceras Listeri*, *G. carbonarium*, *Glyphioceras reticulatum*, *Gl. bilingue*, *G. diadema*, *Posidoniella lævis*, *P. minor*, with a sub-zone near the base of *Posidonomya Becheri*, *Posidonomya membranacea*, and *Prolecanites compressus.*	Ganister Group of Lower Coal Measures. Millstone Grit. Pendleside Group.	? Wanting. *Pterinopecten papyraceus*, said to be found above the Ell Coal, Wishaw, and in the Lower Limestone Series of Kilbride.	? Coal Measures of Foynes Island (Co. Limerick). Upper Limestone Shales, Co. Dublin and Co. Meath. Co. Clare. Arigna, Co. Leitrim. Co. Kilkenny.	The *Posidonomya*-schists of Poolvash.	Instow and Clovelly beds. *Posidonomya Becheri* beds. Venn. Coddon Hill beds.	Chokier beds. Clavier. Visé.	Hollywell Shales. With *P. Becheri.*	Bishopton beds.
Carboniferous Limestone Series.	Zone of *Productus giganteus*, *Pr. Cora*, *Chonetes papilionacea*, and *Amplexus coralloides.*	The Carboniferous Limestone of Derbyshire and Staffordshire. Measures from the Great Scar Limestone to the Fell top Limestone, N.W. Yorkshire. Carboniferous and Calciferous divisions of Northumberland. Carboniferous Limestones of North and South Wales, the Mendips, and Bristol.	Carboniferous Limestone Series (Upper, Middle, Lower) of both the East and West of Scotland and Roxburghshire.	The Upper Limestone. The Calp. The Lower Limestone.	The limestones of Poolvasht. Scarlett, and Ballasalla.	?	Viséan. Waulsortlian. Tournaisian.	Upper Grey Limestone. Upper White Limestone. Lower White Limestone.	Limestone of Gower.
	Zone of *Modiola Macadamii.*	The Lower Limestone Shales of the Mendips.	Calciferous Sandstone Series of Fifeshire, Haddingtonshire, and Eskdale.	The Moyola beds (Co. Tyrone); Co. Down.	? Basement conglomerate.	Absent.	Absent.	Absent.	Absent.
				Coomhola beds.		Baggy.		Old Red Sandstone.	Old Red Sandstone.

say that any Lamellibranch has any special or definite importance as a zonal index in the Carboniferous Limestone Series.

The oft-repeated localities of Thorpe Cloud, Park Hill, and Castleton, Derbyshire; Narrowdale and Wetton, Staffordshire; Settle; Hill Bolton; Hill Stebden, Yorkshire; Clitheroe, Lancashire; and Poolvash, Isle of Man, I consider to be at or about the same horizon. The fossil beds in all these localities occur at the top of the series, almost immediately below the base of the Pendleside Series. It is surprising how rare are macroscopic fossils of any sort in the rest of the thick Limestone of the North Midlands. Of course their absence may be due to metasomatic changes, such as we know go on below the surface in coral reefs. Where the Limestone is split up into several beds by intercalations of Shale and Sandstone, and the Yoredale phase is well developed, fossils are found more frequently in all the Limestones, but never in very great profusion. Fossils are much more common in the shales between the Limestones, but here the mud-loving genera of *Nuculidæ*, and some pectens, replace the other genera which were suited by the mudless waters of the sea in which the Carboniferous Limestone was laid down.

The shales and sandstones of the Yoredale Series indicate land erosion, and, consequently, the area in which they are found corresponds to the more or less semicircular or pyriform area opposite the mouth of a river which receives the detrital material brought down by its waters. Hence by careful mapping of areas of detrital and organic deposits, with measurements of the varying thicknesses of the beds, a fairly accurate idea can be obtained of the physical geography of the period of any deposit, and of the habitus of the faunas in them.

It is found that detrital beds increase in number and thickness to the north and north-east; that during the deposit of the Limestone of the Midlands no detrital deposits of any amount were laid down south of a line from Grassington in Craven to the south part of the Isle of Man; that after the completion of the great Limestone deposit in the Midlands detrital measures, first shales and impure organic black Limestones, representing the lighter forms of detritus which would have been carried farther out to sea, and finally grits of various degrees of coarseness, were laid down over the Limestone area. Hence it may be inferred that the Carboniferous continent existed to the north and east, with probably islands in the Lake Country and a long Midland east to west ridge of land separating the basin of the South Wales, Mendip, and Culm areas from that of the Midlands. The proximity to land, and the gradual filling up and shallowing of the sea bed from east to west, accounts for the varying character of the Carboniferous deposits in different parts of Great Britain, and for the peculiar distribution and repetition of faunas, which followed isobathymetric lines to a large extent.

THE FOLLOWING LIST SHOWS THE DISTRIBUTION OF CERTAIN LAMELLIBRANCHS IN THE UPPER

	North Staffordshire Upper Beds, Carb. L.	Thorpe Cloud.	Park Hill.	Castleton.	Clitheroe.	Withgill.	Ashnott.	Cracoe and Thorpe.	Settle.
LAMELLIBRANCHIATA.									
MONOMYARIA.									
Actinopteria persulcata, M'Coy	...	...	*	*	...	...	...	*	...
Amusium concentricum, Hind	*	*	*	*	...	...	...	*	...
Aviculopecten interstitialis, Phill., sp.	...	...	...	*	...	...	...	...	...
A. clathratus, M'Coy, sp.	*	...	*	*	...	...	...	...	*
Leiopteria lunulata, Phill., sp.	*	*	*	*	...	*	*	*	*
L. squamosa, Phill., sp.	*	*	...	*	...	...	...	*	...
Pinna mutica, M'Coy	...	...	*	*	...	...	...	*	...
P. flabelliformis, Mart.	*	...	*	*	...	...	...	*	...
Posidonomya Becheri, Bronn	...	...	...	*	...	...	...	...	...
Pseudamusium ellipticum, Phill., sp.	*	*	*	*	...	...	...	*	*
Pteronites angustatus, M'Coy	...	*	...	...	...	...	...	...	...
Syncyclonema Sowerbyi, M'Coy, sp.	...	*	...	*	...	...	...	*	...
DIMYARIA.									
Cardiomorpha Egertoni, M'Coy	*	...	*	*	...	...	...	*	...
C. oblonga, Sow.	...	*	*	*	*	...	...	...	...
C. orbicularis, M'Coy	*	*	*	*	*	...	...	...	*
Ctenodonta lævirostris, Portl., sp.	...	...	...	...	...	...	...	...	...
Cypricardella Annæ, de Ryckholt, sp.	...	...	...	...	...	...	...	...	*
C. rectangularis, M'Coy, sp.	...	...	...	...	...	...	...	...	...
Edmondia laminata, Phill., sp.	*	*	*	*	...	...	...	*	*
E. Lyellii, Hind	...	...	...	...	...	...	...	...	...
E. Maccoyi, Hind	*	*	*	*	...	...	...	*	*
E. primæva, M'Coy	...	*	...	*	...	...	...	*	...
E. senilis, M'Coy	...	...	...	*	...	...	...	*	...
E. sulcata, Flem.	...	...	...	?	...	...	...	...	...
E. unioniformis, Phill., sp.	*	*	*	*	*	*	*	...	...
Lithodomus lingualis, Phill., sp.	*	*	*	*	...	...	...	*	*
Myalina lamellosa, de Kon.	*	*	*	*	...	...	...	*	*
Nucula gibbosa, Flem.	...	.	...	...	...	...	...	...	...
N. luciniformis, Phill., sp.	.	.	...	...	...	...	...	...	...
Nuculana attenuata, Flem.	.		...	...	...	...	...	...	...
Parallelodon cancellatus, Mart., sp.	...	...	*	*	...	...	...	...	*
P. fallax, de Kon.	*	...	...	...	...	...	...	*	*
P. obtusa, Phill., sp.	*	*	*	*	...	...	...	*	*
P. reticulatus, M'Coy, sp.	...	...	...	*	...	...	...	...	...
P. semicostatus, M'Coy, sp.	...	...	...	...	...	...	...	...	...
P. squamifer, Phill., sp.	...	...	*	*	..	...	..	...	*
P. walciodorensis, de Kon.	...	...	*	*	...	...	...	*	*
Posidoniella elongata, Phill., sp.	...	*	...	...	...	...	...	*	*
P. pyriformis, Hind	*	*	*	*	...	...	...	*	*
P. vetusta, Sow., sp.	*	...	*	*	...	...	...	*	...
Protoschizodus impressus, de Kon.	...	...	...	...	...	...	...	...	...
Pr. axiniformis, Portl., sp.	..	...	...	...	...	...	...	...	*
Sanguinolites angustatus, Phill., sp.	*	*	*	*	...	...	...	*	...
S. striatolamellosus, de Kon.	*	*	*	*	...	...	...	*	*
S. tricostatus, Portl., sp.	...	..	...	...	...	...	...	...	...
S. variabilis, M'Coy	...	...	...	...	...	...	...	...	...
Scaldia Benedeniana, de Ryckholt	...	...	...	...	...	...	...	...	...
Solenomya primæva, Phill., sp.	...	...	...	...	...	...	...	...	*

E. = Eden Valley, Swarth, Wild Boar, Nine Standard Fells, Mallerstang. G. = Garsdale.

PART OF THE CARBONIFEROUS LIMESTONE AND IN THE YOREDALE SERIES OF NORTH YORKSHIRE.

Scarlett (Isle of Man).	Poolvash (Isle of Man).	Great Scar Limestone.	Intervening Shales.	Hardraw Scar Limestone.	Intervening Beds.	Simonstone Limestone.	Intervening Beds.	Middle Limestone.	Intervening Beds.	Underset Limestone.	Overlying Beds.	Main Limestone.	Overlying Beds, including the Crow Limestone.
...	...	...	W.	...	W.	...	...	...	...	...	...	...	...
...	...	...	...	...	W.	...	W.	...	...	...	...	...	E.
...	*	...	...	...	...	...	...	...	...	...	...	...	E.
...	...	...	W.	...	W.	...	...	...	...	...	...	...	...
...	*	...	W.	...	...	...	W.	...	W.	E.	...	...	...
...	*	...	...	...	W.	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	E.	...	...
...	*	...	...	...	...	...	...	...	...	...	...	We.	...
...	...	...	G.W.	...	...	...	...	...	...	...	...	...	...
...	*	...	W.	...	W.	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	E.	...	...
...	*	...	W.	...	W.	...	...	...	S.	...	E.	...	E.
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	W.	...	...	...	...	...	...	...	W.	...	E.
...	*	...	...	...	...	...	...	...	...	...	...	We.	E.We.
...	...	...	...	...	...	...	...	...	...	...	...	...	We.E.
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	W.	...	...	W.	...	...	E.	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	E.W.
...	*	...	...	...	...	...	...	...	...	...	...	...	E.
...	*	...	...	...	...	...	...	...	...	...	...	...	...
*	...	...	...	...	W.	...	...	...	...	...	...	We.	E.W.We
...	...	...	...	...	W.	...	...	...	...	...	E.	...	We.
...	*	...	...	...	...	...	...	...	...	...	E.	We.	E.We.
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	E We.
...	...	...	...	...	W.	...	...	...	...	...	E.	...	E.
...	...	...	...	...	...	...	...	...	...	...	E.	...	E.We.
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	E.
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	E.W.S.
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	E.	...	E.
...	*	...	...	...	...	...	...	...	...	...	E.	...	E.We.
...	*	...	...	...	...	...	...	...	...	...	E.	...	...
...	*	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	E.	...	...	...	E.
...	...	...	...	...	...	...	...	...	...	...	...	We.	E.
...	*	...	...	...	W.	...	...	...	...	...	...	...	E.
...	*	...	...	...	...	...	...	...	...	...	...	We.	E.

R. = Ravenstonedale. S. = Swaledale. W. = Wensleydale. We. = Weardale.

In conclusion, my thanks are due, and most gratefully given, to the late Prof. Wiltshire, Prof. Rupert Jones, and Dr. Smith Woodward, who have given much valuable advice and assistance while this monograph has been passing through the press; also to Mrs. Smith Woodward for aid in preparing the indexes.

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PLATE XXII.

Fig. 1.—*Solenomorpha major.* A left valve, from the Pendleside Series, River Hodder. In the Collection of the Geological Survey, Jermyn Street. (Page 158.)

Fig. 2.—*Solenomorpha major.* A young example, right valve. Same locality. My Collection. (Page 158.)

Fig. 3.—*Solenomorpha minor.* A full-grown shell. The specimen is a cast of both valves, of which the left is figured, somewhat incomplete at the posterior end. Showing the anterior adductor muscle scar. Yeat House Quarry, Cumberland. My Collection. (Page 159.)

Fig. 4.—*Ctenodonta Pentonensis.* A left valve, from Penton Linns, Liddlesdale. My Collection. (Page 139.)

Fig. 5.—*Ctenodonta Pentonensis.* A right valve, same locality and Collection. (Page 139.)

Fig. 6.—*Ctenodonta Pentonensis.* Showing the hinge-plate of a left valve, with 6 *a*, an enlarged view. Same locality and Collection. (Page 139.)

Fig. 7.—*Ctenodonta Pentonensis.* A left valve, same locality and Collection. (Page 139.)

Fig. 8.—*Palæoneilo carbonifera.* A left valve, showing Fig. 8 *a*, the hinge plate, and Fig. 8 *b*, a view from the anterior end, from shales immediately above the Carboniferous Limestone, Hammerton Hall, Slaidburn. In the Collection of the Geological Survey, Jermyn Street. (Page 142.)

Fig. 9.—*Paracyclas du Noyeri.* The original of *Lucina du Noyeri*, Portlock, from Pettigo, co. Donegal. In the Collection of the Geological Survey, Jermyn Street. (Page 163.)

Figs. 10 and 12.—*Modiola Wrightii.* Left valves from Little Island, co. Cork, in the Collection of Mr. J. Wright, Belfast. (Page 132.)

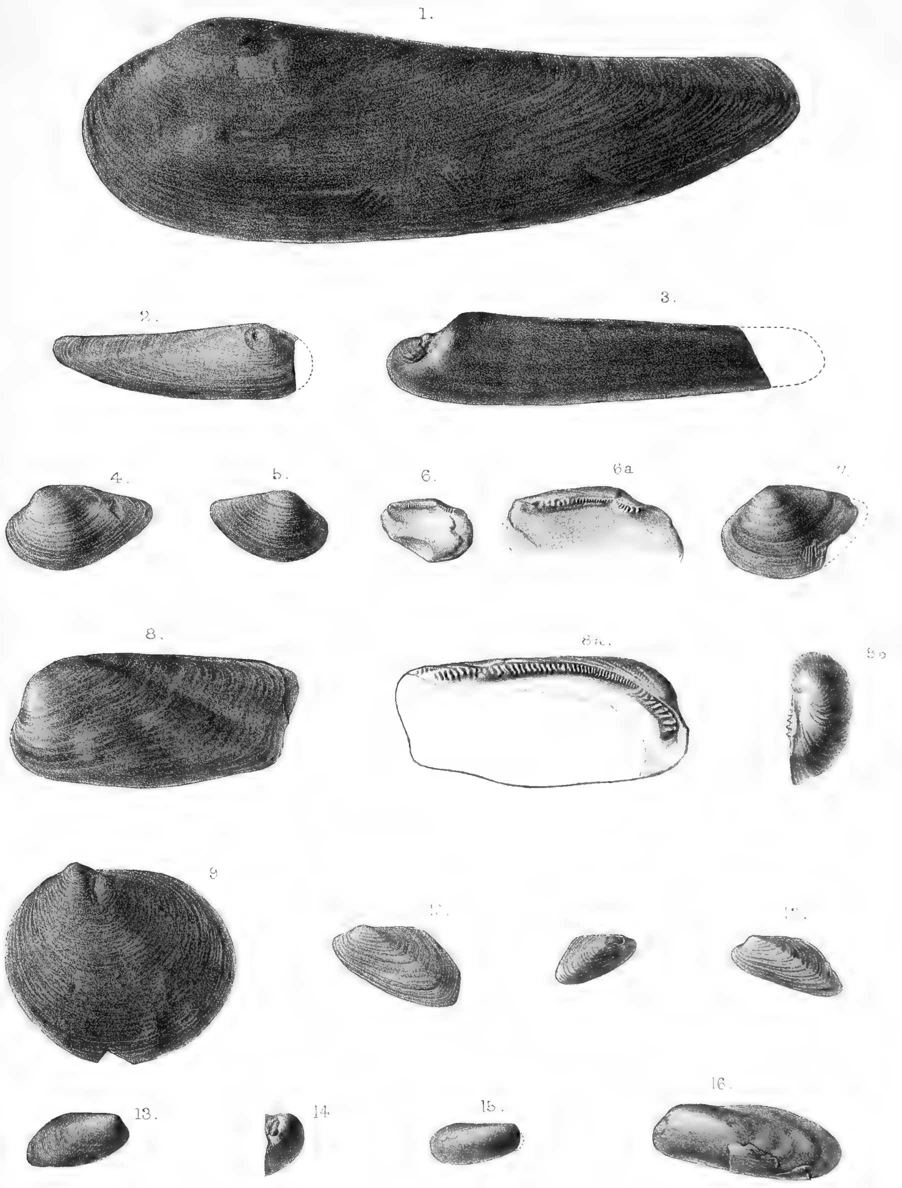
Fig. 11.—*Modiola Wrightii.* A right valve. Same locality and Collection. (Page 132.)

Fig. 13.—*Modiola radiata.* A right valve from Castleton showing radiating lines. My Collection. (Page 131.)

Fig. 14.—*Modiola radiata.* A left valve viewed from the anterior end from Park Hill. My Collection. (Page 131.)

Fig. 15.—*Modiola radiata.* A right valve. Same locality and Collection. (Page 131.)

Fig. 16.—*Modiola radiata.* A left valve, the type of M'Coy's *Cypricardia oblonga* from Araglin Bridge, co. Cork. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 131.)



A. H. Searle del. et lith

Mintern Bros. imp

PLATE XXIII.

Fig. 1.—*Spathella cylindrica.* A right valve from the Redesdale Ironstone. My Collection. (Page 154.)

Fig. 2.—*Spathella cylindrica.* A right valve. The type of M'Coy's *Cypricardella cylindrica* in the Griffith Collection, Museum of Science and Art, Dublin. (Page 154.)

Fig. 3.—*Spathella cylindrica.* A left valve, the type of *Cypricardia socialis*, M'Coy. Same Collection. (Page 154.)

Fig. 4.—*Spathella cylindrica.* The cast of a right valve, showing, Fig. 4 *a*, the cast of the hinge plate and cardinal teeth, from Poolvash, Isle of Man, and Redesdale, Northumberland. My Collection. (Page 154.)

Fig. 5.—*Spathella tumida.* A right valve from Thorpe Cloud, with view of escutcheon and umbo (Fig. 5 *a*). My Collection. (Page 155.)

Fig. 6.—*Spathella tumida.* One of the specimens figured as *Sanguinolites plicatus* by M'Coy. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 155.)

Fig. 7.—*Spathella tumida.* A bivalve example from Castleton, incomplete posteriorly. My Collection. (Page 155.)

Fig. 8.—*Parallelodon normalis.* A right valve from the Carboniferous Limestone of Derbyshire. My Collection. (Page 136.)

Fig. 9.—*Parallelodon elegans.* A right valve from the Carboniferous Limestone of Hill Bolton, Yorkshire. My Collection. (Page 135.)

Fig. 10.—*Paralleledon elegans.* A left valve from the Carboniferous Limestone of Withgill, Yorkshire. My Collection. (Page 135.)

Fig. 11.—*Parallelodon angustus.* A right valve, incomplete in front, from Nine Standard Rigg, Westmoreland. My Collection. (Page 137.)

Fig. 12.—*Parallelodon angustus.* A right valve, showing the anterior end. Same locality and Collection. (Page 137.)

Fig. 13.—*Parallelodon angustus.* A left valve, showing the hinge plate posteriorly, of which Fig. 13 *a* is an enlarged view.

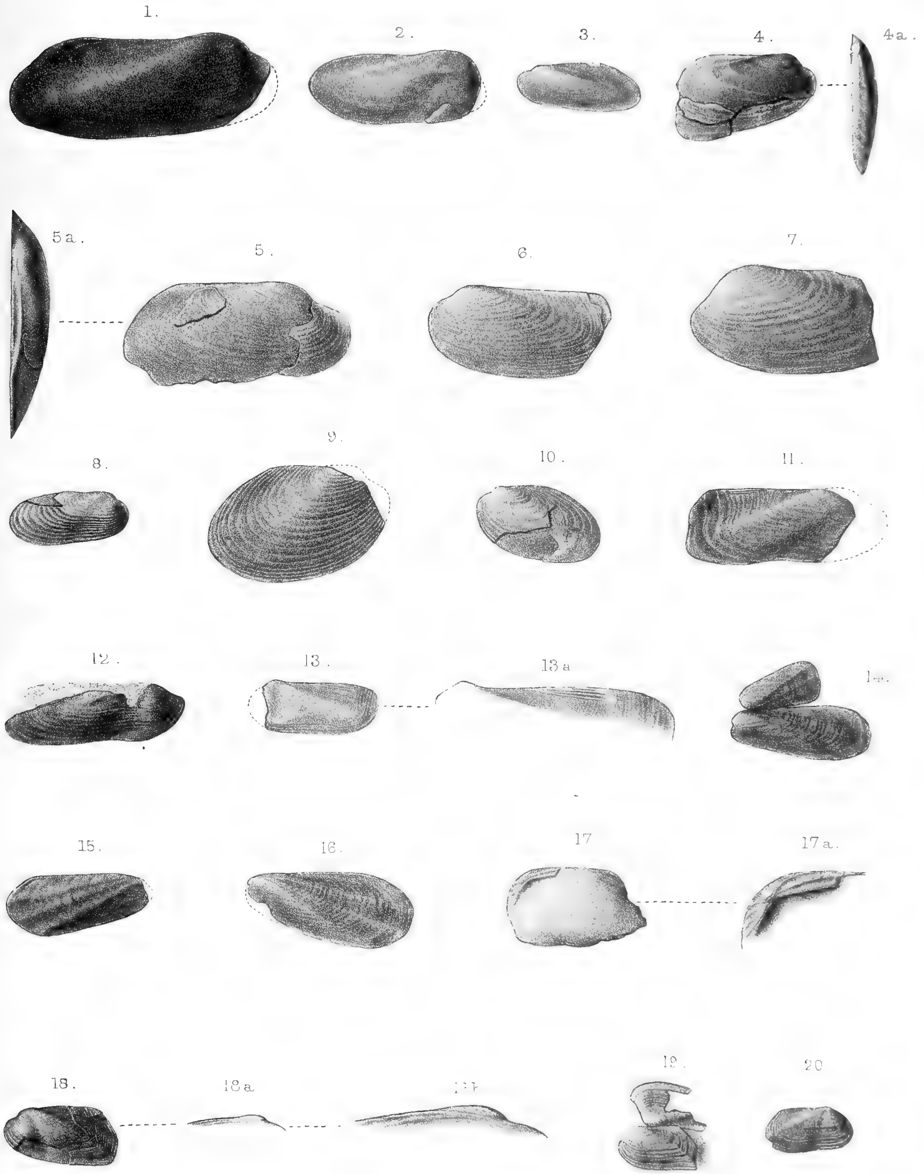
Fig. 14.—*Sanguinolites Monensis.* The left and a portion of the right valves, from Poolvash, Isle of Man. My Collection. (Page 155.)

Figs. 15, 16.—*Sanguinolites Monensis.* Right and left valves. Same locality and Collection. (Page 155.)

Fig. 17.—*Sanguinolites vexillum.* The edentulous hinge plate of a right valve, from Linn Spout, Dalry, with enlarged view (Fig. 17 *a*). My Collection. (Page 156.)

Fig. 18.—*Sanguinolites vexillum.* A left valve, showing the hinge plate, Figs. 18 *a* and 18 *b*. Same locality and Collection. (Page 156.)

Figs. 19, 20.—*Sanguinolites vexillum.* Same locality and Collection. (Page 156.)



A. H. Searle del. et lith.

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PLATE XXIV.

Fig. 1.—*Edmondia amæna.* A left valve, almost denuded of shell, showing pallial line and adductor scars. Lower Limestone Series, Burn Anne. Collection of Mr. J. Smith. (Page 150.)

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Fig. 3.—*Edmondia acuta.* The cast of a left valve, with Fig. 3 *a* its right valve, and Fig. 3 *b* a view of the umbones and hinge line. Same locality and Collection. (Page 151.)

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Hind, Carboniferous Lamellibranchiata. Vol. II. Pl. XXIV

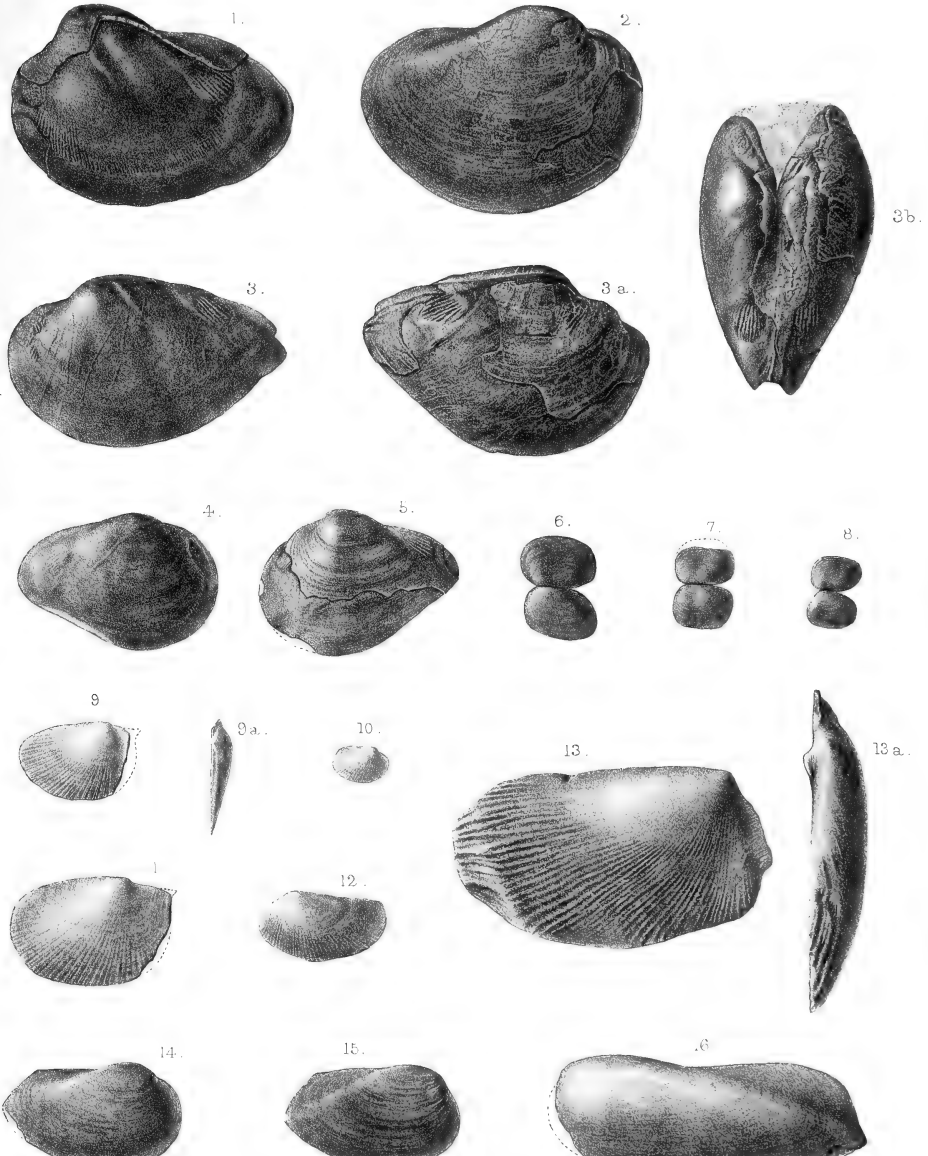

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PLATE XXV.

Figs. 1 and 1 *a*.—*Streblopteria concentrica.* Apparently a right valve. The counterparts of the same shell. From the Lower Limestone Series of Howrat, in the Collection of Mr. J. Smith, Kilwinning. (Page 127.)

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Fig. 9.—*Aviculopecten Jonesii.* A right valve. The Upper Limestone Series of Orchard. In the Collection of Mr. J. Neilson. (Page 129.)

Fig. 10.—*Aviculopecten Jonesii.* The type, a left valve, in the Griffith Collection. From Black Lion, co. Leitrim. (Page 129.)

Fig. 11.—*Aviculopecten Jonesii.* A left valve, from Hill Bolton, Yorks. My Collection. (Page 129.)

Figs. 12 and 13.—*Edmondia punctatella.* A left and right valve. From Thornliebank. In the Collection of Mr. J. Neilson. (Page 147.)

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Fig. 15.—*Pterinopecten carbonarius.* A right valve from the Pendleside Series, Bosley Minn, Cheshire. My Collection. (Page 128.)

Fig. 16.—*Pterinopecten carbonarius.* A left valve. From a marine band below the Gin Mine, Nettlebank, North Staffordshire. (Page 128.)

Fig. 17.—*Scaldia minuta.* A left valve from Coal Measures, Weston Coyney, North Staffs. My Collection. (Page 152.)

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Fig. 19.—*Carbonicola Vinti.* A left valve. Same locality, my Collection. (Page 144.)

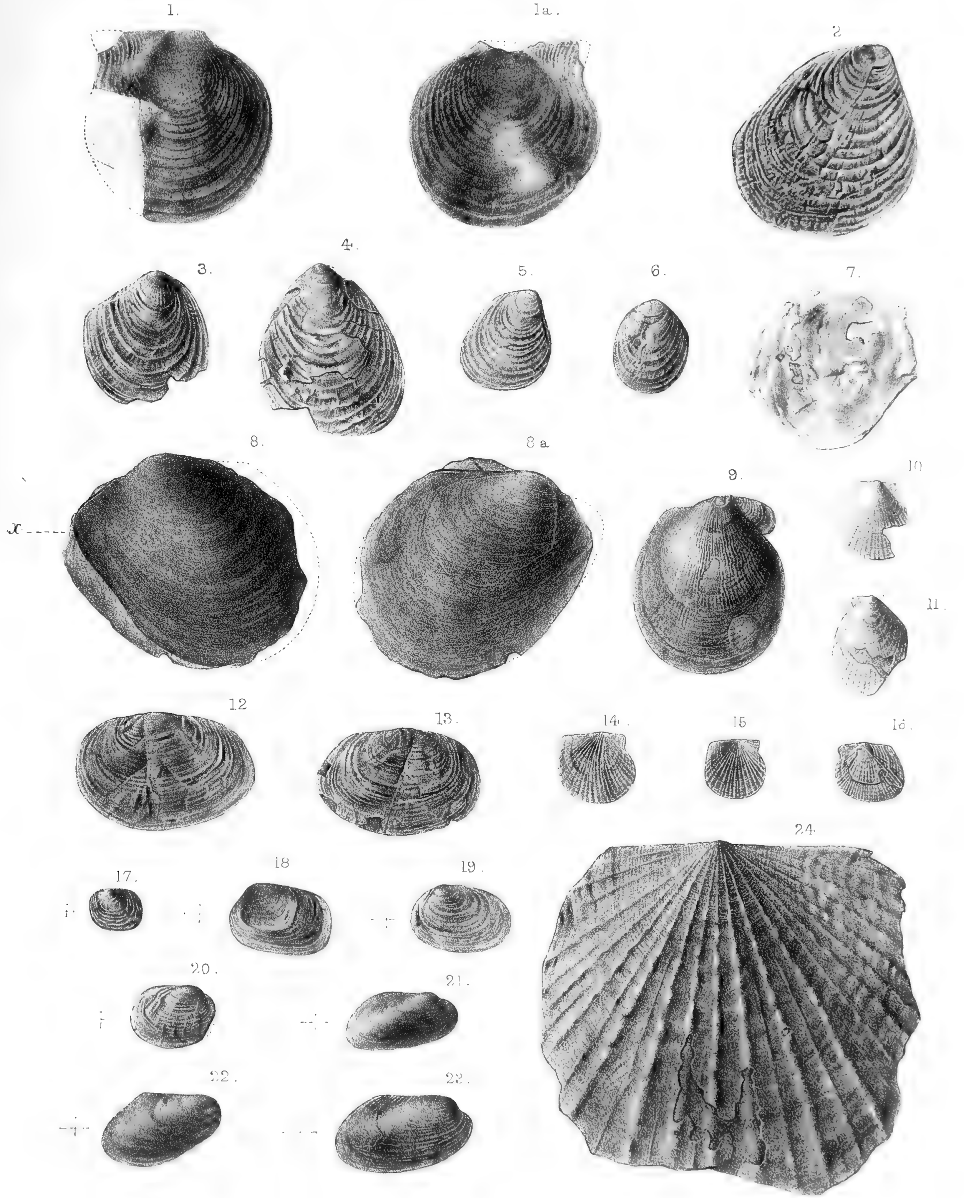
Fig. 20.—*Carbonicola Vinti.* A right valve. Same locality and Collection. (Page 144.)

Fig. 21.—*Anthracomya calcifera.* The type, a right valve, roadside, Bradwell, North Staffordshire. My Collection. (Page 146.)

Fig. 22.—*Anthracomya calcifera.* A right valve, roadside Bradwell, North Staffordshire. My Collection. (Page 146.)

Fig. 23.—*Anthracomya calcifera.* Etruria Marls, Hem Heath, Chesterton, North Staffordshire. My Collection. (Page 146.)

Fig. 24.—*Pterinopecten pustulosus.* The left valve. From Kniveton, Derbyshire. My Collection. (Page 128.)



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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1904.

LONDON:

MDCCCCIV.

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 XII.

SUPPLEMENT.

I.—REVISION OF, AND ADDITION TO, THE HILDOCERATIDÆ.

PAGES lxv—clxviii; PLATES XV—XIX.

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but there is less compression and a more tabulate periphery. The radial curve differs.

Geological Position.—The Pea-grit series of Gloucestershire, and lower part of the so-called Inferior Oolite Limestone of Dorset-Somerset.

FIG. 22 *a.*—Radial line of *Kiliania laciniosa.* Substitute for Fig. 22, which is radial line of *Ludwigia* inserted by mistake.

a. Periphery tabulate.

1. KILIANIA ARMIPOTENS, *S. Buckman.* Fig. 23 in text.

Description.—Platy-subpachygyral, subangustumbilicate, bullate changing to costate.

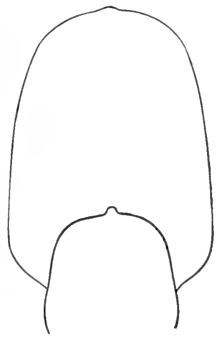


FIG. 23.—*Kiliania armipotens.* Chideock.

Note.—The tuberculate stage is very strongly developed ; some of the tubercles are almost spines.

Remarks.—This species, with its strongly tuberculate umbilicus, has the appearance of a *Sonninia*, or a *Hammatoceras ;* but the radial curve is a good distinction.

Localities and Strata.—Dorset: Chideock Quarry Hill, in the "Wild Bed;" Gloucestershire: Birdlip, in the Pea-grit, two rather small, inferior specimens (one from Mr. J. F. Walker, F.G.S.).

Date of Existence.—*Murchisonæ* hemera.

2. KILIANIA LACINIOSA, *S. Buckman.* Suppl., Plate XV, figs. 4—6.

Description.—Platy-subpachygyral, gradumbilicate; costate.

Note.—Instead of bullæ there are stout costæ on the inner whorls. The stout costæ bifurcate, and there is also an occasional intermediate costa, obsolete on the inner area.

Distinction.—A rather smaller umbilicus and the difference of ornament are sufficient characters of distinction from *K. armipotens.*

Localities and Strata.—Dorset: Chideock Quarry Hill, in the "Wild Bed;" Somerset: Dundry (Castle Farm) brown limestone (Mr. L. Richardson); Gloucestershire: Leckhampton Hill, and Puckham Farm, Pea-grit; Whittington, Lower Freestone—these places all near Cheltenham.

Date of Existence.—*Murchisonæ* hemera.

β. *Periphery subtabulate.*

3. KILIANIA ? TUBERATA, *S. Buckman.* Suppl., Plate XV, figs. 1—3.

Description. — Subplaty-subpachygyral, gradumbilicate; bullati-costate to costate.

Note.—There are generally two ribs springing from a bulla, and sometimes also an intermediate rib, which, however, is not developed just in the space between the bullæ.

Affinity.—A form presumably of this genus, and allied to the present species, is *Am. Murchisonæ obtusus*, Quenstedt, 'Amm. Schwäb. Jura,' pl. lix, fig. 2.

Locality and Stratum.—Gloucestershire: probably Brockhampton Quarry, near Andoversford, in the Pea-grit series.

Date of Existence.—*Murchisonæ* hemera.

History of the Figured Specimen—Seen on the window-sill of a cottage at Sevenhampton, the parish of which Brockhampton is a hamlet, and about half a mile from the quarry. The cottager was uncertain as to its origin; but Brockhampton Quarry, where there is a development of the Pea-grit series, from which the pisolite character is almost absent, is a likely place.

2. *Latilobate.*

XXII. *Genus*—PAQUIERIA,[1] *S. Buckman.*

(Type—*Paquieria angulata*, sp. n.)

1899. PAQUIERIA, This Monogr., Expl. of Suppl., Pl. x.

Definition. — Platy-subleptogyral, subangustumbilicate; densiseptate, subbrevilatilobate; laterally anguliradiate; peripherally obtusanguliradiate, fastigate, parvi-nonsepti-carinate.

[1] In honour of Mr. V. Paquier, Faculté des Sciences, Grenoble.

Distinction.—From *Kiliania*, greater compression, the brevi-latilobate character, the fastigate periphery.[1]

1. Paquieria angulata, *S. Buckman*. Woodcut fig. 24 in text.

Description.—Platy-subleptogyral, costati-gradumbilicate; costate to striate.

Note.—The costate stage is well shown in the early whorls. The decline to striæ is rather rapid.

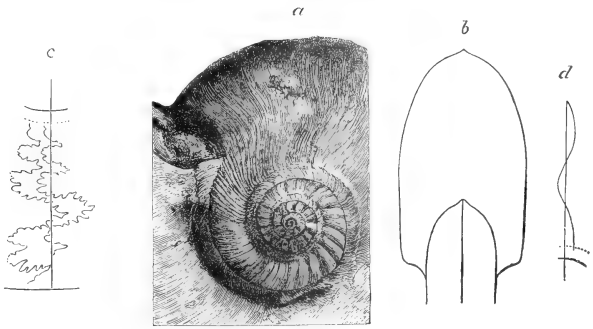


Fig. 24.—*Paquieria angulata*. *a*, side view; *b*, whorl section; *c*, suture lines; *d*, radial line. Haselbury.

Locality and Stratum.—Somerset: Haselbury, from the white limestone of the "lower beds."

Date of Existence.—*Murchisonæ* hemera.

2. Paquieria floccosa, *S. Buckman*. Suppl., Plate X, figs. 20—22.

Description.—Platy-subleptogyral, subconcavumbilicate; striate.

Note.—*P. floccosa* may be called an *Opalinoid* in point of shape and ornament, but the radial curve forms an easy means of discrimination from *Lioceras*.

Distinction.—From *P. angulata*, smaller umbilicus.

Locality and Stratum.—Somerset: Stoford, in a somewhat ironshot matrix.

Date of Existence.—*Bradfordensis* hemera, probably.

[1] Fastigation of the periphery is a feature varying with degree of development; but it seems doubtful if the fully costate species of this genus would have possessed such a tabulate periphery as that of *Kiliania laciniosa*.

B. Magnilobate.

XXIII. *Genus*—Wiltshireia,[1] *S. Buckman.*

(Type—*Wiltshireia gigantea,* S. Buckman.)

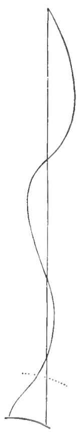


Fig. 25.—Radial line of *Wiltshireia gigantea.*

1888. Lioceras (pars), This Monogr., p. 21.
1899. Wiltshireia, This Monogr., Expl. of Suppl. Pl. XI (misprint).

Definition. — Platy-subpachygyral, angustumbilicate; paucisep-tate, longi-sublatilobate; laterally subanguliradiate; peripherally obtusanguliradiate, subfastigate, parvi-nonsepti-carinate.

Distinction.—This genus resembles *Kiliania* in general mode of growth and proportions; any difference in the definition is due to the generic types not being in the same stages of phyletic deve-lopment. Even the radial curve is the same, but the suture-line is entirely distinct; it is of a bold type with a large superior lateral lobe. Comparing the homœomorphs of the two genera, namely *Wiltshireia gigantea* and *Kiliania? gallica,*[2] at almost the same diameter, the superior lateral lobe of the former is twice as long and broad as that of the latter, so that one loculus in the former occupies the space of two loculi in the latter.

1. Wiltshireia gigantea (*S. Buckman*). Plate XI, fig. 1; Plate XII, fig. 4; Plate A, fig. 12; Suppl., Plate XI, fig. 31; Plate XV, figs. 7, 8.

1888. Lioceras bradfordense, *var.* giganteum, This Monogr., Pl. xi, fig. 1; Pl. xii, fig. 4; Pl. A, fig. 12.

Description.—Platy-subpachygyral, gradumbilicate; costate, declining to lævigate.

Note.—The type specimen (Pl. XI, fig. 1) was, judging by the position of its last septum, as much as 330 mm. in diameter when alive.

Localities and Strata.—Dorset: Stoke Knap, near Broad Windsor, in the base

[1] In compliment to the Rev. Dr. T. Wiltshire, F.G.S.

[2] *Kiliania? gallica,* sp. n. I give this name to a remarkable homœomorph, a foreign specimen kindly presented to me by Mr. L. Brasil. Suppl., Pl. XV, figs. 7 and 8 *a,* may represent it, but not fig. 8. It is parvilobate. The character of suture-line, shown in figs. 3 or 6, of Suppl., Pl. XV, must be added to figs. 7 and 8 *a* to get a correct representation. "Bradfordensis beds, May-sur-Orne, Calvados."

of the Building Stone; Horn Park, near Beaminster, in an ironshot matrix, which is really the same bed.

Date of Existence.—*Bradfordensis* hemera.

XXIV. *Genus*—LUDWIGIA, *Bayle.*

(Type—*Ludwigia Murchisonæ,* Sow., sp.)

1887. LUDWIGIA, This Monogr., p. 16 (pars).

Definition.—Platy-subleptogyral, subangustumbilicate; sub-pauciseptate, longi-angustilobate; laterally anguliradiate; peripherally latanguliradiate, subtabulate, parvi-nonsepti-carinate.

Distinction.—From *Kiliania,* radial line, with more lateral bend; mode of growth, greater umbilication with greater compression; from *Paquieria* persistence of costæ, suture-line; from *Wiltshireia,* suture-line; from *Welschia* and *Cosmogyria,* radial line and mode of growth.

FIG. 26.—Radial line of *Ludwigia Murchisonæ.*

Remarks.—Bayle selected *Am. Murchisonæ* as the type of his genus *Ludwigia,* but what he figured by that name did not agree with Sowerby's type example. That was pointed out in the body of this work, though the matter did not seem of so much importance as at present. However, it was then decided to recognise Sowerby's and not Bayle's *Murchisonæ* as the type of the genus, and it is undesirable to alter that arrangement. Still it is doubtful whether any of Bayle's "*Murchisonæ*" belong to the genus *Ludwigia* as now defined: one has some similarity but differs in septation. (See *Ludwigia gradata,* p. lxxi.)

1. LUDWIGIA TUBERCULATA, *S. Buckman.* Plate III, figs. 4, 5; Plate A, fig. 2; Suppl., Plate XI, fig. 30.

1887. LUDWIGIA MURCHISONÆ, *var.* OBTUSA, This Monogr., Pl. iii, figs. 4, 5; Pl. A, fig. 2.

Description.—Subplaty-subpachygyral, sublatumbilicate; bullati-costate.

Note.—The bullæ are somewhat irregularly developed.

Distinction.—From *Hyattia bullifera,* a smaller umbilicus.

Localities and Strata.—Dorset: Beaminster, towards the base of the "Inferior Oolite" limestone. Another specimen unlocalised, probably from Haselbury, Somerset, and certainly from the horizon of *Zeilleria anglica,* for there is an example thereof in the matrix.

Date of Existence.—*Murchisonæ* hemera.

2. Ludwigia Haugi, *Douvillé*. Suppl., Plate XIV, figs. 8—10.

1884. Ludwigia Haugi, *Douvillé*, Zone *Am. Sowerbyi;* Bull. Soc. géol. France, 3e série, vol. xiii, p. 26.
1885. — — *Haug*, Beiträge Monogr. *Harpoceras;* Neues Jahrbuch für Mineral., &c., Beil.-Bd. iii, pl. xii, fig. 9 (type-figure).

Description.—Subplaty-subpachygyral, sublatumbilicate, subbullati-costate.

Remarks.—Douvillé proposed the name *Ludwigia Haugi* as a specific designation for *Ammonites Murchisonæ obtusus;* but, in the first place, in using the restricted genus *Ludwigia* instead of *Ammonites* there was no need to give a name other than *obtusus*. However, under the name *Am. Murchisonæ obtusus*, palæontologists had been accustomed to group several different forms; so that fixing Quenstedt's name *obtusus* on his original figure, it is possible to keep Douvillé's name *Haugi* for one of the others. As to which it shall be there need be no doubt, for in the following year (1885) Haug gave a figure under the name *Ludwigia Haugi;* and as this is the first figure given under this name, and as it is certainly one of the forms which would have been called "*Am. Murchisonæ obtusus*," and as Haug was well qualified to interpret Douvillé in this matter, it may be taken as the type-figure of the present species. The specimen now depicted agrees with Haug's figure in proportions; but it has not quite such a rursicostate character of the outer portion of the ribs. It almost seems as if this character had been somewhat exaggerated in his figure.

Distinction.—From *L. tuberculata*, less ornament.

Localities and Strata.—Bradford Abbas, in the Paving Bed. Foreign: Normandy (Calvados), "May-sur-Orne, *Murchisonæ* [beds]" (Dr. L. Brasil).

Date of Existence.—*Murchisonæ* hemera.

3. Ludwigia Murchisonæ (*J. de C. Sowerby*). Plate II, figs. 1, 2, 5; Plate III, figs. 1, 2; Plate A, fig. 8; Suppl., fig. 26.

1829. Ammonites Murchisonæ, *J. de C. Sowerby*, Min. Conch., pl. dl.
1887. Ludwigia Murchisonæ, This Monogr., Pl. ii, figs. 1, 2, 5; Pl. iii, figs. 1, 2 Pl. a, fig. 8.

Description.—Platy-subleptogyral, gradumbilicate; costate declining to striate.

Distinction.—From *L. Haugi*, rather thinner; less strongly costate; and in the adult the regular costæ fail about half a whorl earlier.

Localities and Strata.—Isle of Skye: Holme, near Portree, in "Micaceous sandstone" (Sowerby's original).[1] Dorset: Bradford Abbas, in the Paving Bed.

Date of Existence.—*Murchisonæ* hemera.

[1] "Coast of Trotternish, near islet of Holm," J. W. Judd, Sec. Rocks; 'Quart. Journ. Geol. Soc., vol. xxxiv, p. 720.

4. LUDWIGIA GRADATA, *S. Buckman.* Fig. 27 in text.

? 1878. LUDWIGIA MURCHISONÆ, *Bayle* (non *Sowerby*), Explic. carte géol. France, pl. lxxxv, fig. 1 only.

Description.—Platy-subleptogyral, gradumbilicate; parvicostate.

Distinction.—From *L. Murchisonæ*, less coarse ornament, and a smaller umbilicus.

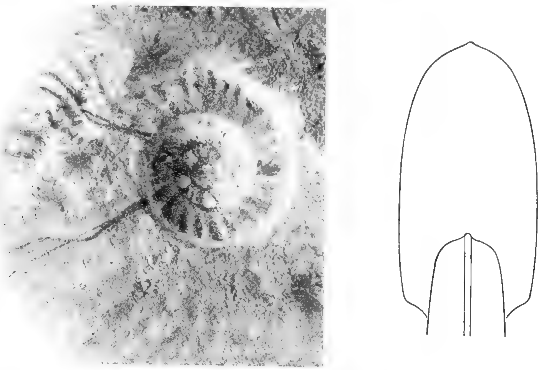


FIG. 27.—*Ludwigia gradata.* Near Sherborne.

Remarks.—The agreement with Bayle's figure seems to be close, yet our specimens are more densiseptate.

Localities and Strata.—Dorset: near Sherborne, from a bluish stone; Bradford Abbas [Paving Bed] (Monk Collection); Somerset: Haselbury, from the "lower beds." Foreign: Normandy, "May-sur-Orne, *Murchisonæ* [beds]" (Dr. L. Brasil).

5. LUDWIGIA LÆVIGATA, *S. Buckman.* Suppl., Plate XI, figs. 13—15.

Description.—Platyleptogyral, subangusti-gradumbilicate, parvicostate declining to levigate.

Distinction.—From *L. gradata*, smaller umbilicus, less definite costæ.

Note.—The interest attaching to this species is its homœomorphy to *Wiltshireia gigantea*, to the specimen figured in Suppl., Pl. XV., figs. 7, 8. It differs, however, markedly in the size of its superior lateral lobe.

Locality and Stratum.—Dorset: Stoke Knap, in the bed below the Building Stone.

Date of Existence.—*Murchisonæ* hemera.

6. Ludwigia ambigua (*S. Buckman*). Plate VII, figs. 1, 2; Suppl., Plate XVII, figs. 31 *a*, *b*.

1888. Lioceras ambiguum, This Monogr., Pl. vii, figs. 1, 2.

Description.—Platyleptogyral, excentrumbilicate; parvicostate declining to striate.

Distinction.—From *L. lævigata*, the mode of coiling the umbilicus. There is also a difference in the curve of the radial line.

Remarks.—The placing of this species in the genus *Ludwigia*, which is another way of expressing its direct genetic affinity with *L. Murchisonæ*, may not be justifiable, and the genetic affinity may be doubted. Of the two curves of the radial line given, the first or earlier one (fig. 31 *a*) requires consideration; it should agree with that of *L. Murchisonæ*. It has a certain resemblance. The later radial curve is interesting for its hypostrophic character—the loss of peripheral projection. It is associated with the striate stage, the umbilical expansion, and the decline of the carina, which are also hypostrophic characters.

Locality and Stratum.—Dorset: Bradford Abbas, in the Paving Bed or its associated marl. Foreign: Normandy (Calvados), "Feuguerolles, *Murchisonæ* [beds], upper part" (from Dr. L. Brasil, two specimens).

Date of Existence.—*Bradfordensis* hemera, in all probability.

XXV. *Genus*—Rhæboceras,[1] *S. Buckman.*

(Type—*Rhæboceras tortum*, sp. n.)

1899. Rhæboceras, This Monogr., Expl. of Suppl. Pl. XI.

Fig. 28.—Radial line of *Rhæboceras tortum.*

Definition.—Platysubpachygyral, sublatumbilicate; laterally anguliradiate; peripherally anguliradiate, subfastigate, parvinonsepti-carinate.

Distinction.—From *Ludwigia*, more compression in proportion to umbilication, and the radial line not quite so bent laterally.

1. Rhæboceras tortum, *S. Buckman.* Suppl., Plate XI, figs. 1—3.

1874. Ammonites Murchisonæ, *Dumortier*, Études pal. Bassin Rhône, pt. 4, pl. li, figs. 5, 6 (non 3, 4).

1874. — tolutarius, *Dumortier*, in Coll., p. 256.

Description.—Platysubpachygyral, sublatumbilicate, costate.

Locality and Stratum.—Burton Bradstock, in the greyish-blue limestone above the sands, the *Lioceras uncinatum* bed.

Date of Existence.—*Scissi* hemera.

[1] Ραιβός, crooked, bent.

2. RHÆBOCERAS TOLUTARIUM (*Dumortier*). Suppl., Plate XI, figs. 4—6.

1874. AMMONITES MURCHISONÆ, *Dumortier*, Études pal. Bassin du Rhône, pt. 4, pl. li, figs. 3, 4 (non 5, 6).
1874. — TOLUTARIUS, *Dumortier*, in Coll., p. 256.

Description.—Platysubleptogyral, subangustumbilicate, subparvicostate.

Distinction.—From *Rh. tortum*, greater compression and less coarse ornament.

Remarks.—Dumortier says,[1] "The compressed regular Ammonite of Verpillière which is abundant at Crussol, and of which I give a drawing in pl. li, figs, 3, 4, is remarkable for the shape of its ornament, and for its angular ribs. These ribs appear as if articulated in front at the places where they bifurcate, and they thus represent very fairly the arm and shank of a horse on the trot. Accordingly I placed this shell, in my collection, under the name of *A. tolutarius*, and though I only refer to it here as a variety of *A. Murchisonæ* I am not averse from believing that, later on, it will be convenient to separate this form as a distinct type; the fear of overmultiplying species alone prevents me from so doing at present." He considered this and the preceding species to belong to *tolutarius;* but the one from la Verpillière (his figs. 5, 6) is certainly coarser ribbed and nearly twice as thick as that from Crussol (his figs. 3, 4). The latter, which he says is common, I have chosen as the type.

Locality and Stratum.—Burton Bradstock, in the *L. uncinatum* bed.

Date of Existence.—*Scissi* hemera.

XXVI. *Genus*—CRICKIA,[2] *S. Buckman.*

(Type—*Crickia reflua*, sp. n.)

1899. CRICKIA. This Monogr., Explan. of Suppl. Pl. xi.

Definition.—Subplatysubleptogyral, sublatumbilicate; subdensiseptate, longi-subangusti-lobate; laterally anguliradiate; peripherally latanguliradiate, subtabulate, parvi-nonsepti-carinate.

Distinction.—From *Rhæboceras*, the radial line has rather less peripheral projection, and the lateral bend falls further forward of the straight line. From *Ludwigia*, the mode of growth is different; there is a wider umbilicus and greater compression.

FIG. 29.—Radial line of *Crickia reflua.*

1. CRICKIA REFLUA, *S. Buckman.* Suppl., Plate XI, figs. 16—18.

Description.—Subplatysubleptogyral, sublatumbilicate, costate.

Remarks.—Two costæ are generally joined on the inner lateral area to form a

[1] Pp. 256, 257, pt. iv.

[2] In honour of Mr. G. C. Crick, F.G.S.

larger rib, and sometimes there is an intermediate costa which becomes obsolete on the inner part of the lateral area.

Localities and Strata.—Dorset: Broad Windsor, probably from the lower beds of the road-cutting at the entrance to the village; Chideock Quarry, "Wild Bed;" a remarkable specimen showing arrested development in youth, so that the umbilical stout ribs are absent. Somerset: Stoford is the likely locality of a small unlabelled specimen. Foreign: Normandy (Calvados), May-sur-Orne, "Concavum bed" (Dr. L. Brasil).

Date of Existence.—*Murchisonæ* hemera.

TORTIRADIATE.

In the species assigned to the following genera there is a peculiar form of radial line: it recalls with the guide-line the representations of the ivy-twined staff of Dionysus. Hence such radial line may for distinction be termed the caduceiform; and the genera bearing it may be grouped as tortiradiate. Among the species the caduceiform radial line changes sooner or later to a biarcuate style.

Generic distinction may depend on the time of this change. Thus:

1. Changes when lati-gradumbilicate and costate, *Depaoceras.*
2. Changes when gradumbilicate and subcostate, *Lucya.*
3. Changes when gradumbilicate and striate, *Paineia.*

Remarks.—The tortiradius is an earlier type than the anguliradius of the preceding genera. The evolution may be seen torti-, anguli-, and biarciradius in several species—for instance, *Paineia nitens.*

Of the present series *Lucya* retains the tortiradiate character longest, *Depaoceras* loses it earliest.

In the degree of the elaboration of costæ *Lucya* and *Depaoceras* are similar, while *Paineia* is quite distinct. In septation there are several differences.

XXVII. *Genus*—LUCYA,[1] *S. Buckman.*

(Type: *Lucya caduceifera*, sp. n.)

1887. LUDWIGIA, pars, This Monogr., p. 16.
1902. LUCYA, Emend. Amm. Nom., p. 4.

FIG. 30.—Radial line of *Lucya caduceifera*

Definition.—Platy-subleptogyral, subangustumbilicate; subpauci-septate, sublongi-subangustilobate; laterally flexiradiate; peripherally latanguliradiate, subtabulate, parvi-nonsepti-carinate.

Distinction.—From *Wiltshireia*, by the radial and suture lines; from *Kiliania*, by the more flexed radial line and heavier style of costation.

[1] In memory of the late W. C. Lucy, F.G.S., ex-President of the Cotteswold Naturalists' Field Club.

1. LUCYA CADUCEIFERA, *S. Buckman.* Plate XXI, figs. 10, 11, Plate A, fig. 5; Suppl., Fig. 30 in text.

1889. LUDWIGIA LUCYI, var. This Monogr., Pl. xxi, figs. 10, 11; Pl. A, fig. 5.
1902. LUCYA CADUCIFERA, Emend. Amm. Nom., p. 4.

Description.—Platysubleptogyral, costati-gradumbilicate, subcrassicostate, subobsoleticarinate.

Remarks.—The very inconspicuous carina on a somewhat flattened periphery is a noticeable feature.

Locality and Stratum.—Presumably from the neighbourhood of Halfway House, Dorset, and from the *Rh. ringens*-bed (Collection, W. C. Lucy).

Date of Existence.—*Bradfordensis* hemera, presumably.

2. LUCYA MARGINATA, *S. Buckman.* Fig. 31 in text.

Description.—Platyleptogyral, gradumbilicate, subcrassicostate to striate.

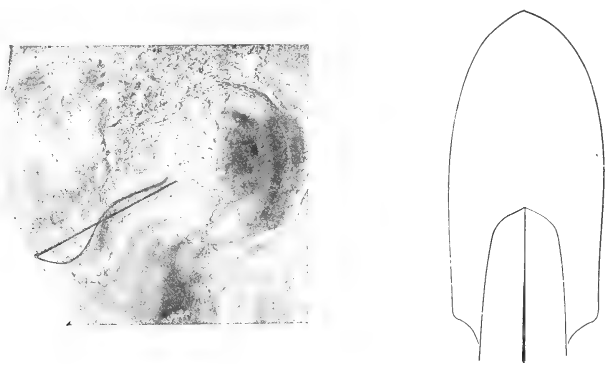


FIG. 31.—*Lucya marginata.* Bradford Abbas.

Remarks.—The radial line changes to biarcuate in the striate stage.

Distinction.—From *Lucya caduceifera*, smaller umbilicus, more acute periphery, greater compression.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, presumably lower part; Stoke Knap, Building Stone.

Date of Existence.—*Concavi* hemera, presumably.

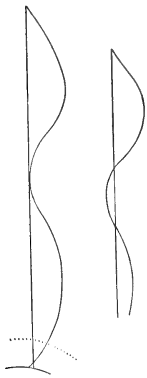


Fig. 32.—Radial lines of *Lucya magna*.

3. Lucya magna, *S. Buckman*. Plate VI; Suppl., Fig. 32 in text.

1887. Lioceras concavum, var. a, This Monogr., Pl. vi.
1902. Lucya magna, Emend. Amm. Nom., p. 4.

Description.—Platyleptogyral, concavumbilicate, subobscuri-crassicostate to striate.

Distinction.—From *Luc. marginata*, the concavumbilicus.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, presumably lower part.

Date of Existence.—*Concavi* hemera, presumably.

4. Lucya ? cavata, *S. Buckman*. Plate IX, figs. 1—4; Suppl., Plate XV, fig. 20.

1888. Lioceras concavum, *var.* v-scriptum, This Monogr., Pl. ix, figs. 1—4 only.
1902. Lucya cavata, Emend. Amm. Nom., p. 4.

Description.—Platyleptogyral, concavumbilicate, striicostate to striate.

Distinction.—From *Luc. magna*, the concavumbilicus is larger, exposing more of the inner whorls; the character of the costation is less coarse.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part, judging by matrix.

Date of Existence.—*Discitæ* hemera, presumably.

XXVIII. *Genus*—Paineia,[1] *S. Buckman*.

(Type: *Paineia nitens*, sp. n.)

Definition.—Platyleptogyral, subangustumbilicate; subdensiseptate, subbrevi-subangustilobate; laterally flexiradiate; peripherally latanguliradiate, subfastigate, parvi-nonsepti-carinate.

Distinction.—From *Lucya*, the characters of the suture-line and the proportions of the costæ.

Notes.—The suture-lines are closer together, there being about three in *Paineia* where there are two in *Lucya;* and the lobes of *Paineia* are distinctly shorter. With the same sized umbilicus the costæ are developed on a much less liberal plan in *Paineia* than in *Lucya*.

[1] In honour of the late Dr. T. Paine, for many years Hon. Secretary of the Cotteswold Field Club.

1. Paineia nitens, *S. Buckman.* Fig. 33 in text.

Description.—Platyleptogyral, subangustumbilicate, subcostate to striate.

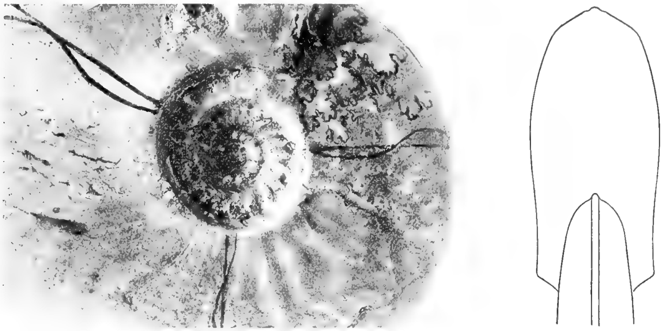


Fig. 33.—*Paineia nitens.* Sherborne. The carina is rather too prominent in the outline view.

Remarks.—From the costate to the striate stage the radial line changes.

Two or three costæ are connate to form single costæ in the inner area. The costæ of the outer lateral area decline as soon as those of the inner.

Localities and Strata.—Dorset: presumably Sherborne, Ambers Hill, *Rh. ringens*-bed (my father's collection). Somerset: Stoford, in a yellow matrix.

Date of Existence.—*Bradfordensis* hemera, presumably.

XXIX. *Genus*—Depaoceras,[1] *S. Buckman.*

(Type, *Depaoceras fallax,* S. Buckman.)

1902. Depaoceras, Emend. Amm. Nom., p. 3.

Definition.—Platysubleptogyral, subangustumbilicate; subdensiseptate, sublongi-subangustilobate; laterally subanguliradiate; peripherally anguliradiate, subacutifastigate, subparvi-nonsepti-carinate.

Distinction.—From *Lucya*, earlier time of changing radial line, more acute periphery. From *Lioceras*, stouter mode of growth, smaller umbilicus, more distinct carination at one stage.

Note.—This genus is in many respects comparable with *Lioceras. L. uncinatum* shows a kind of anguliradius, indicative perhaps of a tortiradiate ancestor common to *Lioceras* and the present series.

Fig. 34.—Radial line of *Depaoceras fallax.*

[1] Δέπας, a bowl.

1. Depaoceras fallax (*S. Buckman*). Plate XIV, figs. 10, 11 (Type); Plate XXI, figs. 7—9; Suppl., Plate XVI, figs. 1—3; figs. 34—36 in text.

1888. Lioceras fallax, This Monogr., Pl. xiv, figs. 10, 11.
1889. Ludwigia Lucyi, ibid., Pl. xxi, figs. 7—9.
1902. Depaoceras fallax, Emend. Amm. Nom., p. 3.

Fig. 35.

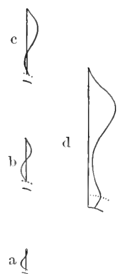


Fig. 36.

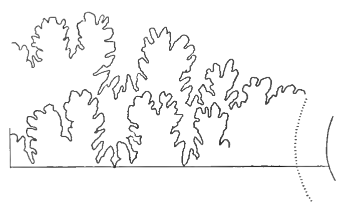


Fig. 35.—Radial lines of *Dep. fallax*, showing development: *a*, from specimen in Pl. xxi, figs. 8, 9; *b*, *c*, from Pl. xxi, fig. 7; *d*, from Suppl., Pl. xvi, fig. 1.
Fig. 36.—Suture-lines of *Dep. fallax*, from the adult, Pl. xiv, figs. 10, 11.

Description.—Platysubleptogyral, excentrigradumbilicate, subcrassicostate.

Remarks.—The costæ are rather coarse, somewhat distant, but not very distinct. Pl. XIV, fig. 10, shows them rather too plainly. If the series of specimens be rightly identified as the examples of the different stages of growth, then it may be remarked that the radial line becomes with age more and more biarcuate by the increasing length of the peripheral projection. On the other hand, the carina decreases in relative importance, being most pronounced in the middle-aged form, Suppl., Pl. XVI, figs. 1—3.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, from the upper part; Stoke Knap, Building Stone.

Date of Existence.—*Discitæ* hemera.

2. Depaoceras hamatum, *S. Buckman*. Fig. 37 in text.

Description.—Platyleptogyral, subgradumbilicate, subparvicostate.

Distinction.—From *D. fallax*, smaller umbilicus, less coarse costation.

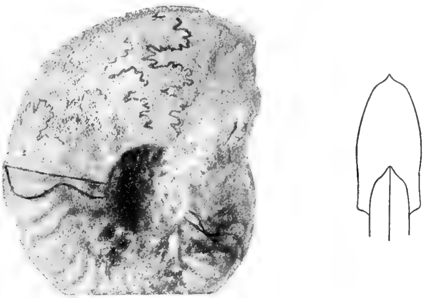


FIG. 37.—*Depaoceras hamatum.* Bradford Abbas.

Localities and Strata.—Dorset: Bradford Abbas (E. Wilson), Fossil Bed, presumably upper part; Halfway House (Mr. D. Stephens), from the "Blue beds."

Date of Existence.—*Discitæ* hemera, presumably.

3. DEPAOCERAS FORMOSUM (*S. Buckman*). Plate X, figs. 1, 2; Suppl., Fig. 38 in text.

1888. LIOCERAS CONCAVUM, *var.* FORMOSUM, This Monogr., Pl. x, figs. 1, 2.
1902. DEPAOCERAS FORMOSUM, Emend. Amm. Nom., p. 3.

Description.—Platyleptogyral, subgradumbilicate, subobsoleticostate.

Note.—The costæ are broad and rather distant, but they are not prominent; the figure shows them rather too pronounced.

Distinction.—From *Dep. hamatum*, smaller umbilicus, which is not costate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part.

Date of Existence.—*Discitæ* hemera, presumably.

FIG. 38.—Radial line of *Depaoceras formosum.*

SUBFALCI- AND BIARCIRADIATE.[1]

The radial line has a subfalcate form, passing to more or less of a double bow; in some cases it is distinctly so. Antcedeent stages, of torti- or anguliradius, are presumable; but as yet there is no evidence as to the time of such changes of radial line in these genera.

[1] This term denotes a radial line with a form like a Greek bow. There are really three curves, one forward in the middle of the lateral area, and two backward on outer and inner thirds.

XXX. *Genus*—Brasilia, *S. Buckman.*

(Type, *Brasilia bradfordensis*, S. Buckman.)

Fig. 39.—Radial line of *Brasilia bradfordensis.*

1887. Lioceras, pars, This Monogr., p. 21.
1899. Brasilia, 'Jurass. Time;' Quart. Journ. Geol. Soc., vol. liv, p. 458.

Description.—Platysubleptogyral, subangustumbilicate; [subdensiseptate, brevilatilobate?]; laterally subanguliradiate; peripherally acutanguliradiate, subparvi-nonsepti-carinate.

Distinction.—From *Welschia*, more flexed radial line, ornament of smaller character, relatively narrower whorls.

a. Convexifastigate.

1. Brasilia bradfordensis (*S. Buckman*). Plate IV, figs. 5, 6; Suppl., Plate XVII, fig. 28; Fig. 39 in text.

1887. Lioceras bradfordense, This Monogr., Pl. iv, figs. 5, 6.

Description.—Platysubleptogyral, gradumbilicate, parvicostate.

Locality and Stratum.—Dorset: Bradford Abbas, in the marl overlying the Paving Bed.

Date of Existence.—*Bradfordensis* hemera.

2. Brasilia sublineata, *S. Buckman.* Plate VIII, figs. 5, 6; Suppl., Fig. 40 in text.

1888. Lioceras concavum, This Monogr., Pl. viii, figs. 5, 6.
1902. Brasilia sublineata, Emend. Amm. Nom., p. 3.

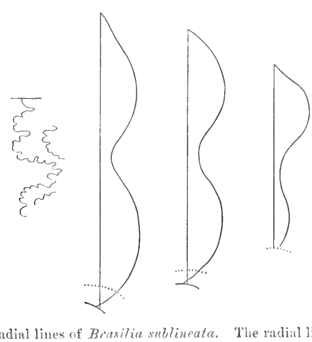


Fig. 40.—Suture-line and radial lines of *Brasilia sublineata.* The radial lines are from different parts of the same specimen, and show progressive decline of rostration.

Description.—Platyleptogyral, concavumbilicate; brevilatilobate; parvicostate to striate.

Distinction.—From *B. bradfordensis*, the concavumbilicus.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, lower part presumably.

Date of Existence.—*Concavi* hemera, presumably.

3. BRASILIA ? PULCHRA, *S. Buckman.* Plate X, figs. 3, 4; Suppl., Fig. 41 in text.

1888. LIOCERAS CONCAVUM, This Monogr., Pl. X, figs. 3, 4.
1902. BRASILIA PULCHRA, Emend. Amm. Nom., p. 3.

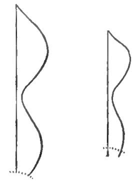


FIG. 41.—Radial lines of *Brasilia ? pulchra*.

Description.—Platyleptogyral, concavumbilicate, parvicostate.

Distinction.—From *B. sublineata*, the subcostation more closely set.

Date of Existence.—*Discitæ* hemera, presumably.

4. BRASILIA ? PINGUIS (*S. Buckman*). Plate XII, figs. 1—3; Suppl., Fig. 42 in text.

1888. LIOCERAS CONCAVUM, *var.* PINGUIS, This Monogr., Pl. xii, figs. 1—3.
1902. BRASILIA PINGUIS, Emend. Amm. Nom., p. 3.

Description.—Platysubleptogyral, concavumbilicate, parvicostate.

Remarks.—The generic position of this species is quite unsatisfactory. It is probably the representative of a series of comparatively stout-whorled forms which have yet to be discovered.

FIG. 42.—Radial line of *Brasilia ? pinguis*.

Locality and Stratum.—Dorset: Halfway House, near Sherborne, presumably from the *Rhynchonella ringens* bed.

Date of Existence.—*Bradfordensis* hemera, presumably.

β. *Planifastigate.*

I put some of the following species to *Brasilia* in the explanation of Suppl., Pl. XI, and therefore it is not advisable to make any change now. But they will have to be separated. They are planifastigate, there being a more or less distinctly defined, sloping, planate surface each side of the carina; while true *Brasilia* is convexifastigate without any defined area bordering the carina. Further, these species are distinguished by the very early date at which the smooth character appears, whereas *Brasilia* maintains small costæ.

Quite possibly the series is akin to *Lucya*, and the costate species, which have yet to be discovered, would show the tortiradiate character, but less costation than *Lucya* and more carina. Radial line and periphery separate them from *Paquieria.*

5. BRASILIA SIMILIS (*S. Buckman*). Plate XV, figs. 1, 2; Plate A, fig. 13; Suppl., Plate XI, fig. 36.

1889. LIOCERAS DECIPIENS, *var.* SIMILE, This Monogr., Pl. xv, figs. 1, 2.

Description.—Platyleptogyral, gradumbilicate, strii-parvicostate to lævigate.

Locality and Stratum.—Dorset: Beaminster district, from the ironshot stone, equivalent in date to the Stoke Knap Building Stone.[1]

Date of Existence.—*Bradfordensis* hemera, presumably.

6. BRASILIA DECIPIENS (*S. Buckman*). Plate XII, figs. 8, 9; Suppl., Plate XI, fig. 35; Fig. 43 in text.

1888. LIOCERAS DECIPIENS, This Monogr., Pl. xii, figs. 8, 9.

FIG. 43.—Radial line of *Brasilia decipiens.*

Description.—Platyleptogyral, excentri-gradumbilicate, lævigate.

Note.—Small costæ are visible in the umbilicus.

Distinction.—From *Br. similis*, more compressed, more excentrumbilicate, smoother.

Note.—*Cosm. cirrata* is angustilobate, less carinate, begins the excentricity of umbilicus earlier.

Locality and Stratum.—Dorset: Sherborne, from the *Rhynchonella ringens* bed. In the type there is a specimen of that fossil imbedded.

Date of Existence.—*Bradfordensis* hemera.

7. BRASILIA EFFRICATA, *S. Buckman*. Plate VII, figs. 3, 4.

1888. LIOCERAS AMBIGUUM, This Monogr., Pl. vii, figs. 3, 4.
1902. BRASILIA EFFRICATA, Emend. Amm. Nom., p. 3.

Description.—Platyleptogyral, subexcentri-gradumbilicate, lævigate.

Note.—Judging by a younger specimen, small costæ change to striæ before a diameter of 40 mm. is attained, and these soon become very faint. Excentricity of the umbilicus begins at about 80 mm. diameter.

Distinction.—From *Br. decipiens* greater compression, and a larger, though less excentric umbilicus.

[1] Better acquaintance with the lithic characters of the deposits in the Beaminster district enables me to say this.

Localities and Strata.—Dorset: Bradford Abbas with *Rhynchonella ringens;* "near Sherborne," probably Ambers Hill; Stoke Knap, in the Building Stone (from Mr. Tutcher).

Date of Existence.—*Bradfordensis* hemera.

XXXI. *Genus*—Brasilina, *S. Buckman.*

(Type: *Brasilina Tutcheri*, sp. n.)

1899. Brasilina. This Monogr., Explan. Suppl., Pl. x, xi.

Definition.—Platyleptogyral, subangustumbilicate; densiseptate, subbrevi-sublatilobate; laterally anguliradiate; peripherally subacutanguliradiate, fastigate, carinate.

Distinction.—From *Brasilia*, greater compression in proportion to umbilication.

Remarks.—It would have been desirable to make *Baylii* the type of the genus, as it seems preferable to choose the least retrogressive species of a series for that office; but there was the difficulty of obtaining details of the suture-line.

Fig. 44.—Radial line of *Brasilina Tutcheri.*

1. Brasilina Baylii (*S. Buckman*). Plate III, figs. 6, 7; Suppl., Plate XI, fig. 34.

1887. Ludwigia Murchisonæ, *var.* Baylii, This Monogr., Pl. iii, fig. 6.

Description.—Platysubleptogyral, gradumbilicate, parvicostate.

Remarks.—So far as it can be observed the suture-line seems to show the subbrevi-sublatilobate character.

Distinction.—From *Am. Murchisonæ falcatus*, Quenstedt[1], a larger umbilicus and rather coarser costæ.

Note.—*Am. Murchisonæ falcatus* would seem to be another species of the same genus.

Locality and Stratum.—Dorset: Bradford Abbas, in the Paving Bed.

Date of Existence.—*Murchisonæ* or *Bradfordensis* hemera.

2. Brasilina Tutcheri, *S. Buckman.* Suppl., figs. 44, 45 in text.

Description.—Platyleptogyral, subconcavumbilicate, parvicostate to striate.

Distinction.—From *B. Baylii*, smaller umbilicus and less costation.

Localities and Strata.—Dorset: Stoke Knap, near Broad Windsor, evidently from the Building Stone (Mr. J. W. Tutcher); Bradford Abbas, from the Paving

[1] 'Am. Schwäb. Jura,' pl. lix, fig. 15.

Bed, or associated marl (Mr. D. Stephens); Burton Bradstock, in a somewhat ironshot matrix—a bed I have not met with there (Mr. Tutcher).

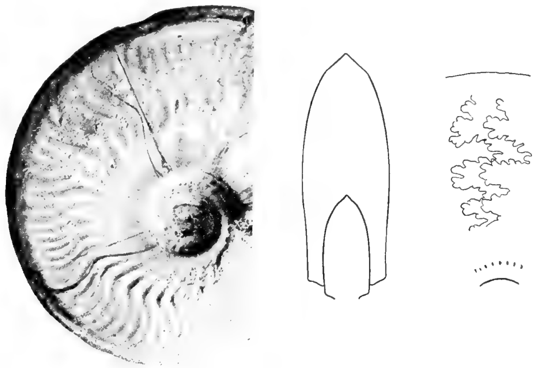


Fig. 45.—*Brasilina Tutcheri.* Stoke Knap.

Date of Existence.—*Bradfordensis* hemera, presumably.

3. Brasilina crinalis, *S. Buckman.* Suppl., Plate X, figs. 29—31.

Description.—Platyleptogyral, concavumbilicate, striate.

Distinction.—From *B. Tutcheri*, decline of ornament.

Localities and Strata.—Dorset: Halfway House, from a somewhat ironshot matrix; Sherborne, evidently from the *Rhynchonella ringens* bed—an adult specimen 140 mm. in diameter, with mouth border; its test is quite smooth.

Date of Existence.—*Bradfordensis* hemera.

XXXII. *Genus*—Ludwigella, *S. Buckman.*

(Type: *Ludwigella arcitenens*, sp. n.)

1887. Ludwigia (pars), This Monogr., p. 16.
1901. Ludwigella, Proc. Cotteswold Club, vol. xiii, p. 266.
1902. Ludwigella, Emend. Amm. Nom., p. 4.

Definition.—Platyleptogyral, subangustumbilicate; subdensiseptate, subbrevisubangustilobate; laterally anguliradiate; peripherally anguliradiate, subacutifastigate, carinate.

Fig. 46.—Radial line of *Ludwigella arcitenens.*

Distinction.—From *Brasilina*, a more biarcuate radial line, greater compression, coarser character of ornament.

Note.—The above details apply only to the *arcitenens* series—the *Ludwigellæ veræ.* The other series, into which the species arranged provisionally under *Ludwigella* are divided, have their own characters (see below). With better knowledge, to be derived from more material, they will doubtless require generic distinction.

Series A—Ludwigellæ veræ.

1. Ludwigella impolita, *S. Buckman.* Suppl., Plate XIX, figs. 25—27.

Localities and Strata.—Dorset: Stoke Knap, in the Building Stone; Bradford Abbas, from a yellow marly bed, perhaps that above Paving Bed.

Date of Existence.—*Bradfordensis* hemera, perhaps.

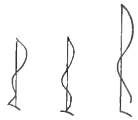
2. Ludwigella rudis (*S. Buckman*). Plate XV, figs. 11, 12 (type); fig. 13; Suppl., Fig. 47 in text.

1889. Ludwigia rudis, This Monogr., Pl. xv, figs. 11—13.

Distinction.—From *Ludl. impolita*, thinner, and not such coarse ornament.

Localities.—Dorset: Louse Hill;[1] near Halfway House, Sherborne; Somerset: North Coker.

Date of Existence.—*Bradfordensis* hemera, presumably.



a b c

Fig. 47.—Radial lines of *Ludwigella rudis*. *a*, from specimen in Pl. XV, figs. 11, 12; *b*, *c*, from specimen in Pl. XV, fig. 13.

3. Ludwigella arcitenens, *S. Buckman.* Plate IV, figs. 1, 2; Suppl., Fig. 46 in text.

1885. Hildoceras (Ludwigia) cornu, *Haug*, Monogr. *Harp.*; Neues Jahrbuch Mineral., Beil.-Bd. iii, pl. xii, fig. 11.
1887. Ludwigia cornu, This Monogr., Pl. iv, figs. 1, 2.
1902. Ludwigella arcitenens, Emend. Amm. Nom., p. 4.

Distinction.—From *Ludl. rudis*, more compressed, and the less pronounced ornament.

Localities and Strata.—Dorset: Wyke Quarry; Halfway House, in the Blue Beds; Bradford Abbas, in lower part of Fossil Bed.

Date of Existence.—*Concavi* hemera.

4. Ludwigella cornu (*S. Buckman*). Plate IV, figs. 3, 4; Plate A, fig. 6; Suppl., Figs. 48—50 in text.

1887. Ludwigia cornu, This Monogr., Pl. iv, figs. 3, 4; and see syn., p. 20, under year 1881.

Notes.—The specimen figured by my father is the one to which I first gave the name, so that is really the holotype. Accordingly I give a figure of it now, a reproduction of a photograph.

[1] Presumably Bed 8, 'Quart. Journ. Geol. Soc.,' vol. xlix, p. 489.

Distinction.—From *Ludl. arcitenens,* smaller umbilicus, less coarse ornament.

Fig. 48.

Fig. 49.

Fig. 50.

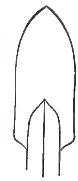


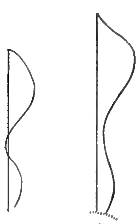
Fig. 48.—Radial line of *Ludwigella cornu,* from specimen in Pl. IV, figs. 3, 4.
Figs. 49, 50.—*Ludwigella cornu.* Holotype. Bradford Abbas.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, lower part; Louse Hill; Sandford Lane, near Sherborne, in sandy stone.

Date of Existence.—*Concavi* hemera.

5. Ludwigella concava (*J. Sowerby*). Plate II, figs. 5, 6; Plate VIII, figs. 1, 2; Suppl., Fig. 51 in text.

1815. Ammonites concavus, *J. Sowerby,* Min. Conch., pl. xciv.
1887. Lioceras concavum, This Monogr., Pl. ii, figs. 6, 7; 1888, Pl. viii, figs. 1, 2.
1901. Ludwigella concava, Proc. Cotteswold Club, vol. xiii, p. 266.



a b

Fig. 51.—*Ludwigella concava.* *a*, from an impression kindly furnished by Mr. G. C. Crick, F.G.S., of the type specimen, Pl. II, figs. 6, 7; *b*, from specimen in Pl. VIII, figs. 1, 2.

Description.—Platyleptogyral, concavumbilicate, subcostate.

Distinction.—From *Ludl. cornu,* the concavumbilicus.

Notes.—The umbilicus of Plate VIII, fig. 1, is quite incorrect.

The size of this specimen seems to be quite out of agreement with that of other *Ludwigellæ.* Perhaps the association with *Ludl. concava* is incorrect.

Localities and Strata.—Somerset: "Not a rare species in the neighbourhood of Ilminster"[1] (Sowerby's specimen). Dorset: Bradford Abbas, in the lower part of the Fossil Bed with *Ludwigella arcitenens,* etc.; Stoke Knap, in the Building Stone.

Date of Existence.—*Concavi* hemera.

[1] 'Min. Conch.,' vol. i, p. 214. Ilminster is most likely a mistake for Yeovil. I have not found any *concavus* strata within miles of Ilminster. The localities of the two species in Sowerby's Plate xciv were perhaps transposed.

Series B—Ludwigellæ compressæ.

A somewhat parallel series, more compressed and more umbilicate than the preceding.

6. Ludwigella subrudis, *S. Buckman.* Plate XV, figs. 14, 15; Suppl., Fig. 52 in text.

1889. Ludwigia rudis, This Monogr., Pl. xv, figs. 14, 15.
1902. Ludwigella subrudis, Emend. Amm. Nom., p. 4.

Distinction.—From *Ludl. rudis*, more compressed and more umbilicate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Sandford Lane, near Sherborne, grey sandstone.

Date of Existence.—*Concavi* hemera.

Fig. 52.—Radial line of *Ludwigella subrudis.*

7. Ludwigella attenuata, *S. Buckman.* Suppl., Plate XIX, figs. 10—12.

Distinction.—From *Ludl. cornu*, more compressed and more umbilicate; from *L. subrudis*, less coarse ornament.

Localities and Strata.—Dorset: Bradford Abbas, in the lower part of the fossil bed; Halfway House, in the "Blue Beds."

Date of Existence.—*Concavi* hemera.

8. Ludwigella tenuis, *S. Buckman.* Suppl., Plate XX, figs. 37—39.

Remarks.—A thin, delicate, and elegant shell, easily separated from *Ludl. concava* by its more compressed whorls, less distinct costation, and more acute periphery.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone.

Date of Existence.—*Concavi* hemera, perhaps.

Series C—Ludwigellæ paucicostatæ.

The costæ are further apart and proportionately rather coarser than in Series A.

9. Ludwigella attracta, *S. Buckman.* Suppl., Plate XIX, figs. 31—33.

Locality.—Dorset: Louse Hill, near Sherborne.

Date of Existence.—*Bradfordensis* hemera, presumably.

10. Ludwigella blanda, *S. Buckman.* Suppl., Plate XIX, figs. 22—24.

Distinction.—From *Ludl. attracta*, smaller umbilicus, less ornament. It is a species parallel with, but presumably preceding, *L. cornu*, wherefrom it differs by stouter whorls, fewer though rather more marked ribs, and more costate umbilicus.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone.
Date of Existence.—*Bradfordensis* hemera, presumably.

11. Ludwigella subobsoleta, *S. Buckman.* Suppl., Plate XIX, figs. 4—6.

Description.—Gradumbilicate, subobsoleticostate.
Remarks.—The small costæ are few and distant; they are almost obsolete inside the bend.
Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part.
Date of Existence.—*Discitæ* hemera, presumably.

Series D—Ludwigellæ curvæ.

Similar to Series A, but the ornament coarser in proportion, and the radial line more curved.

12. Ludwigella flexilis, *S. Buckman.* Suppl., Plate XIX, figs. 28—30.

Remarks.—The inner whorls up to about 6 mm. diameter are smooth.
Distinction.—Is like young *Ludwigina patula*, but has more rounded, slightly thicker whorls, and a more fastigate periphery. The whorl of young *L. patula* is subquadrate with subtabulate periphery, that of *Ludl. flexilis* rounded with arched periphery. From *Ludl. impolita*, larger umbilicus.
Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone.
Date of Existence.—*Bradfordensis* hemera, presumably.

13. Ludwigella callosa, *S. Buckman.* Suppl., Plate XIX, figs. 16—18.

Distinction.—From *L. impolita*, thinner, and the more distant ornament is rather coarser.
Locality and Stratum.—Dorset: Sandford Lane, Sherborne (Bed 11, sect. ix, p. 493, 'Quart. Journ. Geol. Soc.,' vol. xlix, as "*Lud. rudis*").
Date of Existence.—*Concavi* hemera.

14. Ludwigella vibrata, *S. Buckman.* Suppl., Plate XIX, fig. 13—15.

Distinction.—Something like *Ludl. subrudis*, but with more curved ribs.
Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Somerset: Stoford (Bed 11).
Date of Existence.—*Concavi* hemera.

15. Ludwigella micra, *S. Buckman.* Suppl., Plate XIX, figs. 7—9.

Localities and Stratum.—Dorset: Louse Hill; Bradford Abbas, in the Fossil Bed.

Date of Existence.—*Concavi* hemera.

Series E—Ludwigellæ pingues.

Somewhat stout whorls distinguish this series.

a. Biarciradiatæ.

Radial line in curves.

16. Ludwigella glevensis, *S. Buckman.* Suppl., Plate XX, figs. 25—27.

Locality and Stratum.—Gloucestershire, from the Cheltenham district, and evidently from the Pea-grit series, by attached matrix. Purchased from the collection of the late Dr. T. Wright, F.R.S.

Date of Existence.—*Murchisonæ* hemera.

17. Ludwigella arcuata, *S. Buckman.* Suppl., Plate XX, figs. 28—30.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone. One specimen has exact position recorded; it is layer 6, that is the bottom.

Date of Existence.—*Bradfordensis* hemera.

18. Ludwigella casta, *S. Buckman.* Suppl., Plate XX, figs. 31—33.

Note.—Costæ are mostly connate in pairs, in middle of lateral area. Lateral lappet is small and short.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone. A small specimen has the position recorded; it is 5, that is a layer above *Ludl. arcuata.*

Date of Existence.—*Concavi* hemera.

Note.—The three species, *L. glevensis, L. arcuata, L. casta,* are distinguished by showing a progressive decline in coarseness of costation, in size of umbilicus, and in compression. *L. glevensis* has a few rather distant coarse ribs in the umbilicus suggestive of the ornament of *L. impolita.*

β. Anguliradiatæ.

19. Ludwigella rugosa, *S. Buckman.* Suppl., Plate XX, figs. 34—36.

Distinction.—From *Ludl. impolita*, more closely set, less conspicuous costæ, which show an angulate radial line.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone.

Date of Existence.—*Bradfordensis* hemera, perhaps.

Series F—Ludwigellæ carinatæ.

A fairly distinctly separated carina and coarser ornament distinguish these species from Series E. They represent, however, two groups; one being somewhat thick-whorled with small umbilicus, the other more compressed, but with larger umbilicus.

20. Ludwigella nodata, *S. Buckman.* Suppl., Plate XIX, figs. 34—36.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone.

Date of Existence.—*Bradfordensis* hemera, presumably.

21. Ludwigella carinata, *S. Buckman.* Suppl., Plate XIX, figs. 40—42.

Distinction.—From *Ludl. nodata*, a wider umbilicus, a more compressed whorl, and less conspicuous ornament.

Locality and Stratum.—Dorset: Stoke Knap, in the Building Stone (rather common)—more than one specimen has the exact layer recorded; it is 6; Bradford Abbas [marl of Paving Bed ?] (Monk Collection).

Date of Existence.—*Bradfordensis* hemera.

Series G—Ludwigellæ subrectæ.

Close-set and nearly straight ribs are the distinctions in this case.

22. Ludwigella opaca, *S. Buckman.* Suppl., Plate XIX, figs. 19—21.

Description.—Subplatysubleptogyral, sublatumbilicate; subparvicostate.

Localities and Strata.—The figured specimen is from my father's collection. It is mostly of a blackish colour from a dark calcareous matrix. I do not know the locality, unless it be Yorkshire; but the matrix is so distinctive that it should be recognisable by those acquainted with the strata. Dorset: Burton Bradstock, from a grey matrix, but I do not know the horizon. This specimen is 26 mm. in diameter, and shows a lateral auricle, like so many of the other species.

Date of Existence.—Uncertain; *Murchisonæ* to *discitæ* hemera.

23. LUDWIGELLA MODICA, *S. Buckman.* Suppl., Plate XIX, figs. 37—39.

Description.—Platyleptogyral, sublatumbilicate; subspissi- and parvicostate, often connaticostate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

V-SCRIPTIRADIATE.

In the following genera the radial line has, on the lateral area, a noticeable **V**-form, made the more conspicuous by a want of projection on the periphery. Such a radial line is a kind of exaggeration of the tortiradiate feature; and just as that gradually changes, so this one develops to a biarcuate style. Generally, however, the V-script form is very persistent.

XXXIII. *Genus*—PSEUDOGRAPHOCERAS, *S. Buckman.*

(Type: *Pseudographoceras literatum*, sp. n.)

1899. PSEUDOGRAPHOCERAS. This Monogr., Explan. Suppl. Pl. xi.

FIG. 53.—Radial line of *Pseudographoceras literatum.*

Definition.—Subplatysubleptogyral, sublatumbilicate; (subdensiseptate, subbrevi-sublatilobate);[1] laterally anguliradiate; peripherally rectiradiate, tabulate, parvi-nonsepti-carinate.

1. PSEUDOGRAPHOCERAS LITERATUM, *S. Buckman.* Suppl., Plate XI, figs. 19—21.

Description.—Sublatumbilicate, costate.

Remarks.—The ribs are mostly bifurcate just inside the lateral angle. In size they are very regular, and though numerous they are rather prominent.

Localities and Strata.—Dorset: Bradford Abbas, from the Paving Bed; Chideock Quarry Hill, from the "Wild Bed."

Date of Existence.—*Murchisonæ* hemera.

2. PSEUDOGRAPHOCERAS DELETUM, *S. Buckman.* Suppl., Plate XI, figs. 22—24.

Description.—Subangustumbilicate, striate, parvi- becoming obsoleti-carinate.

Remarks.—The costate stage in a reduced form is seen at the beginning of the

[1] From a specimen of *Ps. deletum.*

last whorl of the figured specimen. Then there is the change to the striate stage. The carina, though small at the commencement of the last whorl, is distinct; it gradually becomes less so, and is finally a mere ridge on a subtabulate periphery.

Distinction.—There is no need to point out how it differs from *Psgr. literatum;* rather, attention may be directed to how it agrees in the radial curve, mode of costation, and general figure.

Locality and Stratum.—Dorset: Bradford Abbas, in a rather soft, yellow, iron-shot marl (two specimens, one passing a little towards next species).

Date of Existence.—*Bradfordensis* hemera, probably.

3. Pseudographoceras limatum, *S. Buckman.* Suppl., Fig. 54 in text.

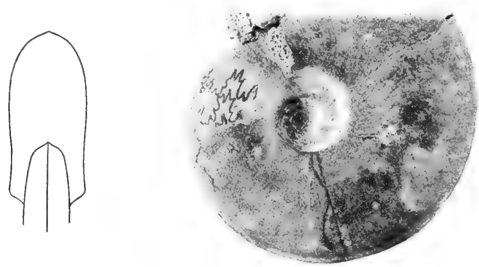


Fig. 54.—*Pseudographoceras limatum.*

Description.—Angustigradumbilicate, striate, obsoleticarinate.

Distinction.—From *P. deletum*, smaller umbilicus, earlier failure of costæ.

Note.—The tendency to increase the peripheral projection of the radial line noticeable in *P. deletum* is continued in this species.

Locality and Stratum.—Dorset: Stoke Knap in the Building Stone, layer 6.

Date of Existence.—*Bradfordensis* hemera.

Pseudographoceras ? sp. *Foreign.*

1886. Harpoceras, sp. indet., Vacek, Ool. Cap. S. Vigilio; Abh. k. k. geol. Reichsanstalt, Bd. xii, No. 3, pl. viii, fig. 1.

Remarks.—This is a foreign species of a series akin to *Pseudographoceras.* It has the V-script, and close-set, regular costæ, as well as the subdistinct carina like *P. literatum*, but it is more compressed and more umbilicate.

4. PSEUDOGRAPHOCERAS ? COMPRESSUM, *S. Buckman.* Plate XV, figs. 5, 6; Suppl., Plate XV, fig. 21.

1888. LIOCERAS CONCAVUM, var., This Monogr., Pl. xv, figs. 5, 6.
1902. PSEUDOGRAPHOCERAS COMPRESSUM, Emend. Amm. Nom., p. 5.

Description.—Subconcavumbilicate, parvicostate.

Remarks.—This species has some resemblance to the one figured by Vacek, dealt with in the last article, so far as the general shape and the direction of the costæ are concerned. But the style of ribbing is different—it is of a more distant pattern. So it is doubtful if this species is the involute mutation of Vacek's, or if it belongs strictly to the same series.

Locality and Stratum.—Dorset: Bradford Abbas, from the Fossil Bed.

Date of Existence.—*Concavi*, or *Discitæ* hemera.

5. PSEUDOGRAPHOCERAS ? CARINIFERUM, *S. Buckman.* Suppl., Plate XX, figs. 13—15.

Description.—Gradumbilicate, parvi- and spissicostate.

Remarks.—The umbilicus shows connaticostæ. This species has ornament of a similar character to that of *Pseudographoceras*, and to Vacek's species; but it is more compressed than any of the foregoing, and is distinguished by an elevated carina.

It is generically distinct from *P. literatum;* but as there is no other species close akin to be associated, it may retain this generic title for present convenience.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

XXXIV. *Genus*—PLATYGRAPHOCERAS, *S. Buckman.*

(Type: *Platygraphoceras apertum*, S. Buckman.)

1902. PLATYGRAPHOCERAS, Emend. Amm. Nom., p. 4.

Definition. — Platyleptogyral, subangustumbilicate; subdensiseptate, sublongiangustilobate; laterally anguliradiate; peripherally subrecti-radiate, subplanifastigate, subobsoleticarinate.

Distinction.—From *Pseudographoceras*, difference in proportions, difference in character of costation, subobsolete carina at all stages.

Remarks.—Definition and distinction apply only to the typical or paucicostate series.

FIG. 55.—Radial line of *Platygraphoceras apertum.*

A. Paucicostatæ.

1. Platygraphoceras carbatinum, *S. Buckman.* Suppl., Plate XX, figs. 16—18.

Description.—Subplaty-subpachygyral;[1] sublatumbilicate; connaticostate, with nodate junctions.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

2. Platygraphoceras latum, *S. Buckman.* Suppl., Plate XX, figs. 19—21.

Description.—Subplaty-subleptogyral, sublatumbilicate, connaticostate.

Distinction.—From *P. carbatinum*, thinner and more closely costate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part, fairly common. Stoke Knap, Building Stone.

Date of Existence.—*Discitæ* hemera, presumably.

3. Platygraphoceras apertum (*S. Buckman*). Plate X, figs. 10, 11; Suppl., Plate XV, fig. 23; Fig. 55 in text.

1888. Lioceras apertum, This Monogr., Pl. x, figs. 10, 11.
1902. Platygraphoceras apertum, Emend. Amm. Nom., p. 4.

Description.—Platyleptogyral, gradumbilicate, semicostate, *i. e.* striicostate.

Distinction.—From *P. latum*, smaller umbilicus.

Remarks.—Young forms (25 to 40 mm. diameter), including therein those slightly more and slightly less umbilicate than the type, are common. They show pointed lateral lappets at different sizes: in one case the lappet is 8 mm. long and incomplete. No counterpart, however, of the type in size has been found.

Locality and Stratum.—Dorset: Bradford Abbas, from the Fossil Bed, presumably from the upper part. Stoke Knap, in the Building Stone.

Date of Existence.—*Discitæ* hemera, probably.

4. Platygraphoceras, sp. A. Plate XV, figs. 9, 10.

1889. Lioceras apertum, This Monogr., Pl. xv, figs. 9, 10.

Fig. 56.—Radial line of *Platygraphoceras*, sp. A.

This differs from type *P. apertum* in being thicker, having more gibbous-sided whorls, and stronger ribs.

Localities and Strata.—Dorset: Bradford Abbas, apparently lower part of Fossil Bed. Sandford Lane, near Sherborne, in greyish sandstone, below the *Hyperlioceras* horizon.

Date of Existence.—*Concavi* hemera.

[1] In this and other cases the difference of terms between the description of the species and the definition of the genus is due partly to the age of the specimen, and partly to the stage of specific development in relation to the species selected as the type of the genus.

B. Spissicostatæ.

5. Platygraphoceras ? compactum, *S. Buckman.* Plate XV, figs. 3, 4; Plate A, fig. 17; Suppl., Fig. 57 in text.

1889. Lioceras apertum, This Monogr., Pl. xv, figs. 3, 4.

Description.—Gradumbilicate, spissiparvicostate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, upper part (common).

Date of Existence.—*Discitæ* hemera.

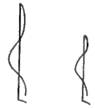


Fig. 57.—Radial lines of *Platygraphoceras ? compactum.*

XXXV. *Genus*—Graphoceras,[1] *S. Buckman.*

(Type: *Graphoceras v-scriptum*, S. Buckman.)

1888. Lioceras (pars), This Monogr, p. 21.
1898. Graphoceras, S. Buckman. 'Jurassic Time;' Quart. Journ. Geol. Soc., vol. liv, p. 458.

Definition.—Platysubleptogyral, angustumbilicate; subdensiseptate, sublongilatilobate; laterally anguliradiate; peripherally subrectiradiate, fastigate, parcicarinate.[2]

Remarks.—The broad V-shaped course of the radial line is a very noticeable feature. There is hardly any peripheral projection of the radial line.

Distinction.—Comparable only with *Pseudographoceras* and *Platygraphoceras* so far as the radial line is concerned. Separable from the former by the style of ornament, the paucicostation, wherein it agrees with the latter, but is distinct therefrom on account of less compression and less umbilication.

The species now ranged in this genus are capable of division into distinct groups.

Fig. 58.—Radial line of *Graphoceras v-scriptum.*

I. Parcicarinatæ.

a. Subpaucicostatæ.

1. Graphoceras robustum, *S. Buckman.* Suppl., Plate XV, figs. 9—11.

Description.—Subconcavumbilicate, pauci-subcrassicostate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Concavi* hemera.

[1] Γράφος, a written character, a letter.

[2] Scarcely carinate; the term "obsoleticarinate" might convey an idea of degeneration which may or may not be the case.

2. Graphoceras v-scriptum, *S. Buckman.* Plate X, figs. 5, 6; Plate A, fig. 16; Suppl., Plate XV, fig. 18; Fig. 58 in text.

1888. Lioceras concavum, *var.* v-scriptum, This Monogr., Pl. x, figs. 5, 6; 1889. Pl. A, fig. 16, p. 75 (pars).

Description.—Concavumbilicate, subcostate.

Distinction.—From *Gr. robustum*, the umbilicus is smaller, and the ribs are less conspicuous.

Localities and Strata.—Dorset; Bradford Abbas, Fossil Bed; Beaminster, from an ironshot matrix; Stoke Knap, from the Building Stone. Somerset: Stoford, from an ironshot matrix; Dundry, from the "Limestone and Marl beds."

Date of Existence.—*Concavi* hemera.

3. Graphoceras debile, *S. Buckman.* Suppl., Plate XX, figs. 22—24.

Description.—Concavumbilicate, subcostate, declining to striate.

Distinction.—From other species, by a very small umbilicus and its general dwarfed form.

Remarks.—This is evidently a dwarf form, distinguished by its "old age in youth" appearance.

Locality and Horizon.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

β. *Subspissicostate.*

4. Graphoceras limitatum, *S. Buckman.* Plate X, fig. 7 (type); Plate IX, fig. 7; Suppl., Plate XV, fig. 22.

1888. Lioceras concavum, var. v-scriptum, This Monogr., Pl. ix, fig. 7; Pl. x, fig. 7.

1902. Graphoceras limitatum, Emend. Amm. Nom., p. 4.

Description.—Subgradumbilicate, parvicostate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

II. Subcarinate.

The character of the periphery is different; a small carina is raised on the fastigate area.

5. Graphoceras mirabile, *S. Buckman.* Suppl., Plate XV, figs. 12—14.

Description.—Subconcavumbilicate, pauci-subcrassicostate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed (Collection of Mr. D. Stephens). Somerset: Dundry, limestone and marl beds (Collection of Mr. E. Wilson), not so costate, leading towards *G. stigmosum.*

Date of Existence.—*Concavi* hemera, perhaps.

6. Graphoceras stigmosum, *S. Buckman.* Plate IX, figs. 5, 6; Fig. 59 in text.

1888. Lioceras concavum, var. v-scriptum, This Monogr., Pl. ix, figs. 5, 6.
1902. Graphoceras stigmosum, Emend. Amm. Nom., p. 4.

Fig. 59.—Radial line of *Graphoceras stigmosum.*

Description.—Concavumbilicate, costate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Sandford Lane, near Sherborne, with *G. undulatum.*

7. Graphoceras *aff.* stigmosum. Plate IX, figs. 8—10.

1888. Lioceras concavum, abnormal form. This Monogr., Pl. ix, figs. 8—10.

Remarks.—Accompanying *G. stigmosum* are specimens similar, but with a smaller umbilicus. In Pl. IX, fig. 8 is given a representation of the form.

The specimen is abnormal on one side. It may be noted that the abnormality is hypostrophic—a return to the wider umbilicus, and to the coarse costæ of the inner area seen in *G. robustum* and *G. mirabile.*

Localities and Strata.—As mentioned for *G. stigmosum;* and Somerset: Dundry.

8. Graphoceras undulatum, *S. Buckman.* Plate X, fig. 9; Plate A, fig. 19.

1888. Lioceras concavum, var., This Monogr., Pl. x, fig. 9; 1889, Pl. A, fig. 19.
1902. Graphoceras undulatum, Emend. Amm. Nom., p. 4.

Description.—Concavumbilicate, striicostate with median undulations.

Remarks.—In the middle of the lateral area, where the radii form their angles, are a series of wave-like bulgings, and from each of them proceed generally two of the costæ belonging to the outer area.

Distinction.—From any other species of the genus, the undulate character of the costæ on the median part of the lateral area.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed: the two largest specimens nearly 110 mm. in diameter; Sandford Lane, near Sherborne (' Q. J. G. S.,' vol. xlix, p. 493, sect. ix, bed 11 or 13).

Date of Existence.—*Concavi* hemera.

9. GRAPHOCERAS FLACCIDUM, *S. Buckman.* Plate VIII, figs. 7, 8; Suppl., Fig. 60 in text.

1888. LIOCERAS CONCAVUM, This Monogr., Pl. viii, figs. 7, 8.
1902. GRAPHOCERAS FLACCIDUM, Emend. Amm. Nom., p. 4.

FIG. 60.—Radial line of *Graphoceras flaccidum.*

Description.—Concavumbilicate, striiparvicostate, with obscure median undulations.

Remarks.—Along the median part of the lateral area are obscure bulgings after the pattern of those seen in *G. undulatum.* They are drawn too distinctly in the figure. The costæ of the outer area are also somewhat obscure. They are drawn rather too distinct, and certainly too numerous in the figure.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

10. GRAPHOCERAS ? INCLUSUM, *S. Buckman.* Suppl., Plate XV, figs. 15—17.

Description.—Concavumbilicate, subcostate to striicostate.

Distinction.—From similar species of the genus, the decidedly smaller umbilicus.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Frogden Quarry, Sherborne ('Q. J. G. S.,' vol. xlix, p. 500, sect. xv, bed 14. This bed is entered as *concavi* hemera, but compare fossils with sect. ix, bed 9).

Date of Existence.—*Discitæ* hemera.

11. GRAPHOCERAS ? DECORUM, *S. Buckman.* Plate VIII, figs. 3, 4; Suppl., Plate XV, fig. 19.

1888. LIOCERAS CONCAVUM, This Monogr., Pl. viii, figs. 3, 4, only.
1902. GRAPHOCERAS DECORUM, Emend. Amm. Nom., p. 3.

Description.—Subconcavumbilicate, densiparvicostate.

Distinction.—From *G. inclusum*, the more open, not truly concave umbilicus; the more numerous ribs.

The genus *Graphoceras* contains many examples of what may be called *concavus*-like species—platyleptogyral forms with the little basin-shaped umbilicus, made by the regular superposition of the concave inner margins. There are many more examples of these *concavus*-like or concavumbilicate species, but to describe all these forms adequately would swell this already large Supplement to an inordinate length. Sufficient has been done for the present to show that these concavumbilicate forms are polygenetic, distinguishable from one another not by shape, but by the curves of the radial lines; that they are, in fact, the terminals of different gradumbilicate stocks, whereof the majority are recognisable by their characteristic radial lines. Of certain concavumbilicate forms the gradumbilicate species are not known. Still some of such concavumbilicate species have been described, *Graphoceras* is a case in point; but others have not been described, because, lacking the distinctness of *Graphoceras*, they are difficult to classify until their gradumbilicate connections are known. On the other hand, to certain gradumbilicate species the angustumbilicate terminals have not been allotted; some of the undescribed concavumbilicate species will probably be found to be these required angustumbilicate terminals. This is a matter for future work; neither time nor space permits full investigation now, while so many families of Inferior Oolite Ammonites remain untouched.

XXXVI. *Genus*—Braunsina, *S. Buckman.*

(Type: *Braunsina contorta*, sp. n.)

1902. Braunsina, Emend. Amm. Nom., p. 3.

Definition.—Platyleptogyral, sublatumbilicate; subdensiseptate, sublongi-subangustilobate; laterally anguliradiate; peripherally anguliradiate (increasingly acute), fastigate, parvicarinate.

Distinction.—From *Pseudographoceras*, the persistence of the costæ and the fastigate periphery. The latter character and the less V-script radial line are features of distinction from *Platygraphoceras*. From *Graphoceras*, the less V-script line, and the relatively larger umbilicus.

Fig. 62.—Radial lines of *Braunsina contorta.*

1. Braunsina aspera, *S. Buckman.* Suppl., Plate XVII, figs. 13—15.

Description.—Subplaty-subpachygyral, costate (not adult ?).

Note.—In some cases the costæ are connate, in pairs, on the inner margin.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

2. Braunsina contorta, *S. Buckman.* Suppl., Plate XVII, figs. 16—18.

Description.—Costate to subcostate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

3. Braunsina cornigera, *S. Buckman.* Suppl., Plate XX, figs. 4—6.

Description.—Gradumbilicate, costate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part.

Date of Existence.—*Discitæ* hemera, presumably.

In species 4 to 7 connate costæ are more in evidence than in species 2 and 3. *Braunsina elegantula* is stouter whorled and more distinctly costate than *B. cornigera;* its costæ are also more definitely V-script.

4. Braunsina elegantula, *S. Buckman.* Suppl., Plate XIX, figs. 1—3.

Description.—Gradumbilicate, connaticostate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

5. Braunsina projecta, *S. Buckman.* Suppl., Plate XX, figs. 7—9.

Description.—Subconcavumbilicate, subparvicostate.

Remarks.—The umbilicus shows ornament of the connaticostate character.

Distinction.—From *B. elegantula*, smaller umbilicus, less pronounced ornament.

Localities and Strata.—Somerset: "Dundry Hill, West End," from E. Wilson, from upper part grey Limestone and Marl Beds, about Nos. 10 to 13, 'Q. J. G. S.,' vol. lii, p. 677. Gloucestershire: Cheltenham district, evidently from the Lower *Trigonia*-grit. It is from my father's collection, and is marked "*A. canaliculatus*, Bronn," which, however, is entered in 'Geol. Cheltenham,' ed. 2, p. 89, as from Middle Lias, Dumbleton: that is certainly a mistake.

Date of Existence.—*Discitæ* hemera.

6. Braunsina fastigata, *S. Buckman.* Suppl., Plate XX, figs. 1—3.

Description.—Subconcavumbilicate, parvicostate.

Distinction.—From *B. projecta*, rather more compression, much smaller ornamentation.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part.

Date of Existence.—*Discitæ* hemera.

Radial line very angulate.

7. Braunsina ? angulifera, *S. Buckman.* Plate XV, figs. 16, 17; Fig. 63 in text.

1889. Ludwigia rudis, This Monogr., Pl. xv, figs. 16, 17.
1902. Braunsina ? angulifera, Emend. Amm. Nom., p. 3.

Description.—Sublatumbilicate, costate.

Distinction.—From *B. elegantula*, more umbilicate, more compressed.

Localities and Strata.—Dorset: presumably Halfway House; Bradford Abbas, Fossil Bed, upper part; and a small specimen labelled Beaminster. Somerset: Stoford, from a brownish matrix.

Date of Existence.—*Discitæ* hemera.

Fig. 63.—Radial line of *Braunsina ? angulifera.*

The two following species, which have several characters in common, do not belong to *Braunsina*. They are only placed here because the material for examination is insufficient for a proper definition. The common characters are as follows:—subplaty-subleptogyral, latumbilicate, laterally anguliradiate, peripherally rectiradiate, subtabulate. In other words, subquadrate whorls, V-script ribs, open umbilicus, flattened periphery, are the common features. The first species is more coarsely costate than the other.

8. Braunsina ? subquadrata, *S. Buckman.* Suppl., Plate XX, figs. 10—12.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

9. Braunsina ? futilis, *S. Buckman.* Plate XV, figs. 7, 8; Suppl., Fig. 64 in text.

1889. Lioceras apertum, This Monogr., Pl. xv, figs. 7, 8.
1902. Braunsina futilis, Emend. Amm. Nom., p. 3.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

Fig. 64.—Radial line of *Braunsina ? futilis.*

Levigation pronounced.

The species of the two next genera show somewhat rapid decline of costæ, and consequently a marked levigate stage, resembling in this matter *Pseudographoceras*, which has, however, more of a striate stage.

A. Sublatumbilicate.

XXXVII. *Genus*—BRAUNSELLA, *S. Buckman.*

(Type: *Braunsella semilenis*, sp. n.)

1902. BRAUNSIA, Emend. Amm. Nom., p. 3.

FIG. 64*a*.—Radial line of *Braunsella semilenis.*

Definition.—Platysubleptogyral, sublatumbilicate; laterally anguliradiate; peripherally subrectiradiate, subtabulate, parvicarinate.

Distinction.—From other V-script genera by smoothness appearing while the species are sublatumbilicate. In *Pseudographoceras*, which is stouter and less umbilicate, smoothness is not present till angustumbilication is attained.

Remarks.—The name has to be changed on account of prior use.

1. BRAUNSELLA SEMILENIS, *S. Buckman.* Suppl., Plate XVII, figs. 19—21.

Description.—Costate to levigate.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

2. BRAUNSELLA LENIS (*S. Buckman*). Plate VII, figs. 5, 6; Suppl., Plate XVII, fig. 32.

1888. LIOCERAS AMBIGUUM, This Monogr., Pl. vii, figs. 5, 6, only.
1902. BRAUNSIA LENIS, Emend. Amm. Nom., p. 3.

Description.—Subcostate to levigate.

Distinction.—From *B. semilenis*, a smaller umbilicus and smoother whorls.

Remarks.—Confounded with *Ludwigia* (olim *Lioceras*) *ambigua*, but is far more umbilicate and has a different radial line.

Localities and Strata.—Dorset: Bradford Abbas, perhaps from Fossil Bed, upper part, and the idea of Paving Bed erroneous. Somerset: Dundry (E. Wilson), evidently from beds below "White Ironshot;" specimen 78 mm. in diameter, wholly septate, but from indications it must have been of a diameter of nearly 130 mm.

Date of Existence.—*Discitæ* hemera, perhaps.

3. BRAUNSELLA ? ROTABILIS, *S. Buckman.* Suppl., Plate XVII, figs. 7—9.

Description.—Subplaty-subleptogyral; sublatumbilicate; costate, seldom connaticostate; periphery subtabulate, parvicarinate.

Remarks.—A morphic equivalent of *B. semilenis*, but more compressed, and with a less angulate radial line. That, in its series, costæ would fail rapidly as in *Braunsella* may be doubted: hence the query after the generic name.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

B. Angustumbilicate.

(More or less.)

XXXVIII. *Genus*—Reynesia, *S. Buckman.*

(Type: *Reynesia intermedia*, S. Buckman.)

1902. Reynesia, Emend. Amm. Nom., p. 5.

Definition.—Platysubleptogyral; subangustumbilicate; laterally anguliradiate; peripherally anguliradiate (increasingly acute), convexifastigate, parvicarinate. (Radial line, fig. 65, p. clxv.)

Distinction.—From *Braunsella* and *Pseudographoceras*, radial line, more definitely carinate periphery; and, from the former, relatively smaller umbilication. From *Braunsina*, the radial line, the carina more definitely separated, the earlier failure of costæ.

α. *Convexifastigate.*

1. Reynesia amœna, *S. Buckman.* Suppl., Plate XX, figs. 40—42.

Description.—Sublatumbilicate, costate.

Distinction.—From *Braunsina contorta*, stouter whorls with more convex sides and periphery, area around umbilicus more compressed, earlier decline of costæ.

Locality and Strata.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

2. Reynesia intermedia (*S. Buckman*). Plate XI, figs. 2, 3; Suppl., Plate XVIII, fig. 27.

1888. Lioceras decipiens, *var.* intermedium, This Monogr., Pl. xi, figs. 2, 3.
1902. Reynesia intermedia, Emend. Amm. Nom., p. 5.

Description.—Subangustumbilicate; subcostate to levigate.

Distinction.—From *R. amœna*, smaller umbilicus.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Somerset: Dundry, "limestone and marl beds."

Date of Existence.—*Discitæ* hemera.

β. *Subtabulate.*

3. Reynesia laxa, *S. Buckman.* Plate XI, figs. 6, 7; Suppl., Plate XVIII, fig. 28.

1888. Lioceras decipiens, *var.* intermedium B, This Monogr., Pl. xi, figs. 6, 7.
1902. Reynesia laxa, Emend. Amm. Nom., p. 5.

Description.—Subangustumbilicate, subcostate, striicostate to smooth.

Distinction.—From *R. intermedia*, a larger umbilicus, rather less costate; more persistent costæ on the whorl.

Localities of Strata.—Dorset: Bradford Abbas, Fossil Bed; Stoke Knap, Building Stone.

Date of Existence.—*Discitæ* hemera, presumably.

4. REYNESIA CŒLA, *S. Buckman.* Plate XVI, figs. 10, 11; Suppl., Plate XVIII, fig. 26.

1889. HYPERLIOCERAS WALKERI, This Monogr., Pl. xvi, figs. 10, 11 only.
1902. REYNESIA CŒLA, Emend. Amm. Nom., p. 5.

Description.—Angustumbilicate; subcostate.

Distinction.—From *R. laxa*, a smaller umbilicus, also the costæ are rather more distinct, especially on the inner part of the whorl.

Remarks.—A possible angustumbilicate development of *R. laxa*; but the association may not be justified.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Gloucestershire: Frith Quarry, near Stroud, Lower *Trigonia*-grit.

Date of Existence.—*Discitæ* hemera.

5. REYNESIA LEPIDA, *S. Buckman.* Plate XI, figs. 4, 5; Suppl., Plate XVIII, fig. 29.

1888. LIOCERAS DECIPIENS, *var.* INTERMEDIUM A, This Monogr., Pl. xi, figs. 4, 5.
1902. REYNESIA LEPIDA, Emend. Amm. Nom., p. 5.

Description.—Subangustumbilicate, levigate.

Distinction.—From *R. laxa*, the greater smoothness.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

6. REYNESIA FURCILLATA, *S. Buckman.* Suppl., Plate XXII, figs. 1—3.

Description.—Platy-subleptogyral; subangustumbilicate; connaticostate, costæ declining in strength.

Remarks.—The umbilication and ornament suggest that this species represents the costate, more umbilicate, relative of *R. benigna.* Against this are the small carina and the less flexed radial-line.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

7. Reynesia benigna, *S. Buckman.* Suppl., Plate XXII, figs. 10—12.

Description.—Parvicostate, subexcentrumbilicate, compressed around umbilicus.

Distinction.—From *R. laxa*, less marked, less persistent costæ; from *R. lepida*, more persistent costæ; from both, less concentric umbilicus, less distinct carina.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

Carinatitabulate.

In the series of genera now to be described the carinatitabulate periphery is a particular feature of distinction. It is more distinct than the term implies, because the peripheral area is not only flat, but it is, even in the costate stage, levigate—the periphery appears as a flat, smooth band, fairly defined from the lateral area, and on this band is set a more or less prominent carina. The ribs end somewhat abruptly at the edge of this smooth band, and this smoothness forms a distinction from tabulate peripheries formerly noted: such peripheries are costate. Therefore the term would in the present case be more correctly "carinati- and levigati-tabulate."

Another distinction about this tabulate periphery is its persistence. In other cases the tabulate periphery changes to fastigate, especially as degeneration proceeds and the periphery narrows—there being a falling in of the angle between the lateral and peripheral areas. In the present case the tabulation remains until the periphery is extremely acute; the angle between the lateral and peripheral areas being well maintained, often the increased compression rather accentuates the angle than otherwise.

The carina on the tabulate periphery is found in all degrees of development, from the barely distinct median ridge of *Darellella* to the pronounced alticarina of *Toxolioceras.* In the genera where the carina is much developed, the peripheral area looks very like the tongued edge of a matched board.

When the carina declines, the tabulate passes to the rounded periphery, without any very distinct fastigate stage.

The relative size of the carina forms a feature of distinction among the following genera; and to a certain degree it has been used in their grouping. But for the more complete systematic arrangement other features have been taken into account; because owing to the different sizes of the specimens and the allowance that has to be made for keel degeneration, the relative sizes of the carina, when their degrees of differences are not very pronounced, is difficult of comparison and not easy of description. For the latter purpose the following terms are employed: Parvi-, distincti-, subalti-, and alticarinate. These must be qualified thus: subject to old age of individual or race.

Note.—In above remarks "tabulate" includes "penetabulate." True tabulation of the area, at exact right angles to the keel line, is, of course, hardly found. A slight departure therefrom may be included as "tabulate," a little further departure from rectangularity as "penetabulate," the separation between lateral and peripheral areas being fairly maintained; while "subtabulate" denotes a flattish area with the separation not so distinct.

Parvicarinate.

XL. *Genus*—Darellina, *S. Buckman.*

(Type: *Darellina planaris*, sp. n.)

Definition.—Platyleptogyral, sublatumbilicate; subdensiseptate, sublongi-subangustilobate; laterally latanguliradiate; peripherally anguliradiate (increasingly acute),[1] penetabulate, parvicarinate. (Radial line, Fig. 66, p. clxv.)

Remarks.—The plate-like form and wide, shallow umbilicus are features specially distinctive of this genus. The radial line is biarcuate, becoming increasingly so with age. Species biogenetically earlier than the type might show a V-script line.

1. Darellina planaris, *S. Buckman.* Suppl., Plate XVII, figs. 22—24 (Type); Plate XXII, figs. 7—9.

Description.—Sublatumbilicate, costate to levigate.
Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.
Date of Existence.—*Discitæ* hemera.

2. Darellina dorsetensis, *S. Buckman.* Suppl., Fig. 67.

Fig. 67.—*Darellina dorsetensis*, Bradford Abbas.

Description.—Subangustumbilicate, parvicostate, occasionally connaticostate.

Distinction.—From *D. planaris*, a smaller umbilicus and smaller costæ.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed; Stoke Knap, Building Stone, layer 3.

Date of Existence.—*Discitæ* hemera.

[1] Increase of rostration during development alters the radial line considerably; it changes from latangulate at end of costate stage to biarcuate in levigate stage.

3. Darellina (?) docilis, *S. Buckman.* Suppl., Plate XXII, figs. 4—6.

Description.—Subangustumbilicate, parvi- and subspissicostate, connaticostate, costæ declining.

Remarks.—Radial line like that of *Darellina*, but less distinctly biarcuate; costæ more numerous and more distinctly connate; whorls less compressed. More numerously costate and more distinctly carinate than *Reynesia furcillata.*

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

XLI. *Genus*—Darellella, *S. Buckman.*

(Type: *Darellella recticostata*, sp. n.)

Definition.—Like *Darellina*, but the radial line almost coincides with the guide line, the costæ being noticeably straight. (Radial line, fig. 68, p. clxv.)

Darellella recticostata, *S. Buckman.* Suppl., Plate XVII, figs. 10—12.

Remarks.—This is one of the most distinct species of the Bradford Abbas Fossil Bed; its straight ribs, with so little peripheral projection, are an unusual feature among the Hildoceratidæ. Twenty years ago I recognised this species as new, but I have not figured it before on account of doubts as to its affinities. It is a rare form, not simply scarce because easily confounded as others may be. Only a few specimens much smaller than the figured example have rewarded diligent search.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

Distincticarinate.

In the following genera the carina stands out definitely from the tabulate periphery. Gerontic decline may affect its prominence somewhat, as in *Œdania.*

Falcate to biarcuate.
Body-chamber has a tendency to thicken.
Angustumbilicate.

XLII. *Genus*—Œdania,[1] *S. Buckman.*

(Type: *Œdania falcigera*, sp. n.)

Definition.—Platysubleptogyral, angustumbilicate; laterally anguliradiate; peripherally anguliradiate, tabulate, distincticarinate. (Radial line, fig. 69, p. clxv.)

[1] Ὀιδάνω, to swell, in reference to the body-chamber.

Remarks.—A swelling or inflation of the body-chamber characterises the species of this genus; hence the name. The carina tends to decline on the swollen body-chamber, both this decline and the swelling whorls being really atavic features. The radial line is somewhat falcate to more or less biarcuate.

1. ŒDANIA INFLATA, *S. Buckman.* Suppl., Plate XXI, figs. 13—15.

Description.—Gradumbilicate, costate.
Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.
Date of Existence.—*Discitæ* hemera.

2. ŒDANIA DELICATA, *S. Buckman.* Suppl., Plate XXI, figs. 10—12.

Description.—Gradumbilicate, subcostate.
Distinction.—From *Œd. inflata*, smaller ornament.
Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.
Date of Existence.—*Discitæ* hemera.

3. ŒDANIA LEPTA, *S. Buckman.* Suppl., Plate XXI, figs. 4—6.

Description.—Gradumbilicate parvidensicostate.
Distinction.—From *Œd. delicata*, smaller umbilicus, closer set, smaller costæ.
Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, not uncommon; Stoke Knap, Building Stone.
Date of Existence.—*Discitæ* hemera.

4. ŒDANIA FALCIGERA, *S. Buckman.* Suppl., Plate XXI, figs. 1—3*a*.

Description.—Subgradumbilicate, obsolete-parvicostate to striate.
Distinction.—From *Œd. lepta*, the more distant costæ.
Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.
Date of Existence.—*Discitæ* hemera.

5. ŒDANIA PARVICOSTATA, *S. Buckman.* Suppl., Plate XXI, figs. 7—9*a*.

Description.—Subgradumbilicate, parvisubspissicostate.
Distinction.—From *Œd. falcigera*, more numerous costæ which are more per-

sistent; a slightly smaller umbilicus. From *Œd. lepta*, more distant, more distinct costæ.

Localities and Strata.—Somerset: Dundry, Limestone and Marl Beds; not uncommon; 1 specimen marked horizon 4, *i.e.* counting down from *Sauzei* (see 'Quart. Journ. Geol. Soc.,' vol. lii, p. 681). Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

Subfalcate to subarcuate.
Body-chamber has a slight tendency to thicken.

XLIII. *Genus*—Reynesella, *S. Buckman.*

(Type: *Reynesella juncta*, sp. n.)

1902. Reynesella, Emend. Amm. Nom., p. 5.

Description.—Subplatysubleptogyral, sublatumbilicate; laterally flexiradiate; peripherally subacutanguliradiate, penetabulate, distincticarinate. (Radial line, fig. 70, p. clxv.)

Distinction.—From *Darellella*, the flexed radial line, and the more distinct carina.

Remarks.—The umbilicus is smaller relatively to development, and the joined costæ are a distinct feature, both characters of separation from *Darellella.*

1. Reynesella juncta, *S. Buckman.* Suppl., Plate XVII, figs. 4—6.

Description.—Sublatumbilicate; costate; many costæ connate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Stoke Knap, Building Stone, near the top. Somerset: Dundry, Limestone and Marl Beds (E. Wilson).

Date of Existence.—*Discitæ* hemera.

2. Reynesella piodes, *S. Buckman.* Plate XVI, figs. 7, 8 (Type), fig. 9; Suppl., Plate XVIII, figs. 24, 25.

1889. Hyperlioceras Walkeri, This Monogr., Pl. xvi, figs. 7—9.
1902. Reynesella piodes, Emend. Amm. Nom., p. 5.

Description.—Subangustumbilicate; subcostate to parvicostate.

Distinction.—From *R. juncta*, a rather smaller, less costate, umbilicus; less coarse costæ.

Remarks—A tendency to plump up the body-chamber is seen in figs. 7, 8, Plate XVI.

Corrections.—Plate XVI, fig. 7, umbilicus is shown too concentric; the penultimate whorl should be broader. Fig. 8, carina at top is too prominent.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Stoke Knap, Building Stone, layer 3.

Date of Existence.—*Discitæ* hemera.

3. Reynesella inops, *S. Buckman*. Suppl., Plate XXI, figs. 37—39.

Description.—Subangustumbilicate; parvicostate to obscuricostate.

Distinction.—From *Reynesella piodes*, smaller ornamentation.

Localities and Strata.—Dorset: Stoke Knap, near Broad Windsor, Building Stone; Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

4. Reynesella? rodburgensis, *S. Buckman*. Suppl., Plate XVII, figs. 1—3.

Description.—Subangustumbilicate; costate to subcostate; many connaticostæ, particularly in the umbilicus; distinct carina, declining on body-chamber.

Distinction.—From *R. juncta*; stouter whorls, a smaller umbilicus, more con-conspicuous, rather more distant, costæ.

Remarks.—In ornament the species has much the appearance of *Reynesella*, but the build of the whorls indicates a different stock.

Localities and Strata.—Gloucestershire: Rodborough Hill, near Stroud, Lower *Trigonia*-grit, 1 foot 10 inches from base. Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

5. Reynesella? lineata, *S. Buckman*. Suppl., Plate XVII, figs. 25—27.

Description.—Parvicostate, the costæ mostly bifurcate; gradumbilicate; periphery subtabulate, distincticarinate.

Remarks.—Like *R. inops*, but the radial line is more curved and more projected peripherally. The costæ are less distinct in the umbilicus, but they remain more persistent. The umbilicus is slightly less concentric; the periphery is less distinctly tabulate, the angle between lateral area and periphery being less definite.

Locality and Stratum.—Dorset: Bradford Abbas, in the Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

Subalticarinate.

The carina stands out more prominently than in the genera of the distincticarinate division.

Falcate.

XLIV. *Genus*—HUGIA,[1] *S. Buckman.*

(Type: *Hugia curva*, sp. n.)

Definition.—Platyleptogyral, angustumbilicate; subbrevi-subangustilobate; laterally flexiradiate; peripherally subacutanguliradiate, tabulate, subalticarinate. (Radial line, fig. 71, p. clxv.)

Distinction.—Like *Reynesella*, but more strongly carinate and less umbilicate.

1. HUGIA CURVA, *S. Buckman.* Suppl., Plate XVIII, figs. 19—21*a* (Type); Suppl., Plate XXI, figs. 25—27.

Description.—Parvicostate, connaticostate, but the connate portion of the costæ not prominent.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, upper part.

Date of Existence.—*Discitæ* hemera.

2. HUGIA MICCA, *S. Buckman.* Suppl., Plate XXI, figs. 28—30.

Description.—Obscuricostate, passing towards levigate.

Distinction.—From *H. curva*, decline of ornament.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

Biarciradiate; subspissicostate.

XLV. *Genus*—LOPADOCERAS,[2] *S. Buckman.*

(Type: *Lopadoceras arcuatum*, sp. n.)

Definition.—Platyleptogyral subangustumbilicate; laterally arciradiate; peripherally sublatanguliradiate, penetabulate, subalticarinate. (Radial line, fig. 72, p. clxv.)

[1] In compliment to Dr. Otto Hug. [2] Λοπάς, a flat dish.

Distinction.—From *Hugia*, biarcuate pattern of radial line, costation closer and more persistent.

1. LOPADOCERAS FURCATUM, *S. Buckman.* Suppl., Plate XXI, figs. 16—18.

Description.—Sublatumbilicate subspissicostate, mostly connaticostæ.

Remarks.—This species is the morphic equivalent of *Reynesella juncta*, but is particularly distinguished therefrom by the stouter whorls, especially round the umbilicus, also by the more numerous ribs.

Locality and Stratum.—Dorset: Stoke Knap, Building Stone.

Date of Existence.—*Discitæ* hemera, presumably.

2. LOPADOCERAS ARCUATUM, *S. Buckman.* Suppl., Plate XXI, figs. 19—21.

Description.—Spissisubcostate, with tendency towards parvicostate.

Localities and Strata.—Dorset: Stoke Knap, Building Stone, some specimens *in situ*, layer 3; Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

3. LOPADOCERAS EUIDES, *S. Buckman.* Suppl., Plate XXI, figs. 22—24.

Description.—Spissi-parvicostate, with tendency to striation.

Distinction.—From *L. arcuatum*, the decline of ornament.

Localities and Strata.—Dorset: Stoke Knap, Building Stone, some specimens *in situ*, layer 3; Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

Carina Variable.
Distincticarinate (type series).
Subalticarinate (similar series).

XLVI. *Genus*—DARELLIA,[1] *S. Buckman.*

(Type: *Darellia semicostata*, S. Buckman.)

1898. DARELLIA, *S. Buckman*, 'Jurassic Time'; Quart. Journ. Geol. Soc., vol. liv, p. 459.

[1] In honour of Mr. Darell Stephens, F.G.S., whose assiduous collecting has added so many new species to the Dorset fauna. Since this was written he has taken the surname of Darell.

Definition.—Platy-subleptogyral,[1] subangustumbilicate (subdensiseptate, sub-brevi-subangustilobate)[2]; laterally arciradiate; peripherally sublatanguliradiate, tabulate, distincticarinate. (Radial line, Fig. 73, p. clxv.)

Distinction.—From *Lopadoceras*, which has a similar biarcuate radial line—costate stage is coarser, but less persistent, decline to levigate stage being rapid; build of whorls rather stouter, carina less distinct.

1. Darellia semicostata, *S. Buckman.* Plate XII, figs. 10, 11; Suppl., Plate XVIII, fig. 30.

1888. Lioceras decipiens, *var.* intermedium, This Monogr., Pl. xii, figs. 10, 11.
1898. Darellia semicostata, *S. Buckman*, 'Jurassic Time'; Quart. Journ. Geol. Soc., vol. liv, p. 459.

Description.—Costati-gradumbilicate, parvicostate to levigate.

Note.—The carina becomes less prominent after about 55 mm. diameter.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Somerset: Dundry, Limestone and Marl Beds (E. Wilson).

Date of Existence.—*Discitæ* hemera, presumably.

2. Darellia lævis, *S. Buckman.* Plate XVIII, figs. 4, 5; Suppl., Fig. 74, p. clxv, Fig. 75 in text.

1889. Hyperlioceras discites, This Monogr., Pl. xviii, figs. 4, 5 only.
1902. Darellia lævis, Emend. Amm. Nom., p. 3.

Description.—Subgradumbilicate; obsoleticostate to levigate.

Note.—There are costæ in the umbilicus, indicating a costate stage in youth.

Remarks.—Radial line and general details agree with *D. semicostata*, but the thickness is actually greater; so that, proportionately to umbilication it is much more. This would throw doubt on its being an angustumbilicate derivative from *D. semicostata.*

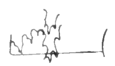


Fig. 75.—Suture line of *Darellia lævis.*

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

3. Darellia toxeres, *S. Buckman.* Suppl., Plate XVIII, figs. 13—15.

Description.—Angustumbilicate, levigate.

Distinction.—From *D. semicostata*, smaller umbilicus.

[1] Almost leptogyral. [2] Seen obscurely through test of *D. semicostata.*

Locality and Stratum.—Dorset: Stoke Knap, Building Stone, layer 3.

Date of Existence.—*Discitæ* hemera.

4. Darellia concinna, *S. Buckman.* Suppl., Plate XVIII, figs. 16—18.

Description.—Subconcavumbilicate, levigate.

Distinction.—From *D. toxeres*, the smaller umbilicus.

Locality and Strata.—Dorset: Bradford Abbas, Fossil Bed, upper part. Somerset: Dundry, Limestone and Marl Beds.

Date of Existence.—*Discitæ* hemera.

In the next species the radial line is less regularly biarcuate, tabulation of periphery is more pronounced, and the carina is more prominent (subalticarinate).

5. Darellia (?) polita, *S. Buckman.* Plate XVI, figs. 3, 4, (Type); figs. 5, 6; Suppl., Plate XVIII, fig. 31.

1889. Hyperlioceras Walkeri, This Monogr., Pl. xvi, figs. 3—6 (not figs. 1, 2, 7—11).

1898. Darellia polita, *S. Buckman*, 'Jurassic Time'; Quart. Journ. Geol. Soc., vol. liv, p. 459.

Description.—Angustumbilicate; costate to semicostate and to levigate.

Remarks.—The example figured in Plate XVI, figs. 5, 6, does not agree with the type in umbilication, and ought, perhaps, to be distinguished as a separate species.

The largest example of this species in my cabinet measures 110 mm. incomplete; it attained a size of 135 mm. It is very like *Toxolioceras Walkeri* (Pl. XVI, figs. 1, 2) in general appearance, but distinguishable by a narrower periphery.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Stoke Knap, Building Stone.

Date of Existence.—*Discitæ* hemera.

Subalticarinate, with tendency to decline.
Relatively stout whorls.

The two following genera differ from any of the preceding carinatitabulate series, in the stouter proportions of the whorls, and in their radial lines; these characters suggest relationship with the genera *Lucya* and *Depaoceras*.

The genera are distinguished from each other (1) by the radial line, of which the outer part is so much more bowed in *Deltoidoceras*, (2) by the cross section—in *Deltoidoceras*, subtriangulate, in *Dissoroceras*, subquadrate; (3) by earlier decline of costate stage in *Dissoroceras*.

The character of the periphery enables these genera to be separated from *Lucya* and *Depaoceras*; but this character is not inconsistent with close relationship thereto. It is almost certain that the carinati-tabulate periphery is polyphyletic.

Subfalciradiate.

XLVII. *Genus*—Dissoroceras,[1] *S. Buckman.*

(Type: *Dissoroceras tabulatum*, S. Buckman.)

1902. Dissoroceras, Emend. Amm. Nom., p. 3.

Definition.—Platysubleptogyral, subangustumbilicate (subdensiseptate, sublongiangustilobate)[2]; laterally anguli- to flexi-radiate; peripherally sublatanguliradiate, tabulate, subalticarinate. (Radial line, Fig. 76, p. clxv.)

1. Dissoroceras tabulatum, *S. Buckman.* Plate XXI, figs. 5, 6; Suppl., Fig. 76, p. clxv.

1889. Ludwigia Lucyi, This Monogr., Pl. xxi, figs. 5, 6 only.
1902. Dissoroceras tabulatum, Emend. Amm. Nom., p. 5.

Description.—Subcrassi-subobscuricostate to levigate with age; subgradumbilicate.

Remarks.—Smoothness appears with some rapidity, so that in a specimen 111 mm. in diameter the costate umbilicus is the only indication of the costate youth.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part.

Date of Existence.—*Discitæ* hemera, presumably.

2. Dissoroceras subornatum, *S. Buckman.* Suppl., Fig. 77 in text.

Description.—Gradumbilicate, connaticostate, declining early to levigate.

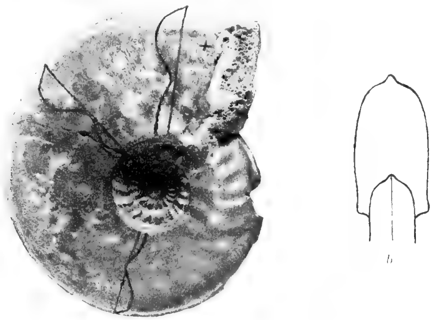
Remarks.—Inner whorls show costæ connate near to the inner margin. The costæ decline to become obscure and subdistant. Smoothness of test commences at about 38 mm. diameter.

Distinction.—From *D. tabulatum*, more compressed whorls, a smaller, less costate, umbilicus, earlier commencement of smoothness.

[1] Δισσός, double; ὅρος, border.

[2] Seen imperfectly on a specimen of *D. tabulatum*.

Localities and Strata.—Dorset: Stoke Knap in the Building Stone; Bradford Abbas, Fossil Bed, presumably upper part; one specimen 126 mm. in diameter,



a

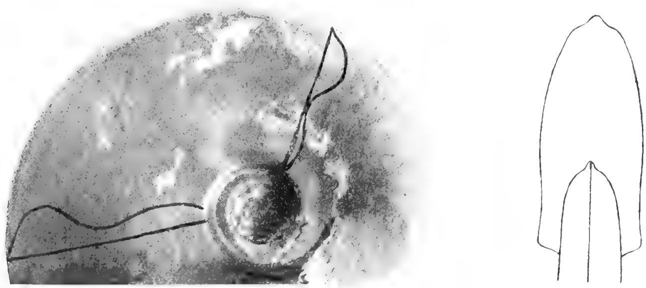
Fig. 77.—*Dissoroceras subornatum.* Stoke Knap.

showing decline of carina and lengthening of peripheral bend of radial line—collected by Mr. D. Stephens; another specimen in Mr. Monk's collection.

Date of Existence.—*Discitæ* hemera, presumably.

3. Dissoroceras excavatum, *S. Buckman.* Suppl., Fig. 78 in text.

1889. Hyperlioceras discites, ε (pars), This Monogr., p. 95.



a b

Fig. 78.—*Dissoroceras excavatum.* Bradford Abbas.

Description.—Subconcavumbilicate; obscuricostate to levigate.

Distinction.—The smaller, less costate, subconcavumbilicus; the more compressed whorls, the narrower periphery.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, presumably upper part.

Date of Existence.—*Discitæ* hemera, presumably.

Deltiradiate.

XLVIII. *Genus*—Deltoidoceras,[1] *S. Buckman.*

(Type: *Deltoidoceras astrictum*, sp. n.)

1902. Deltoidoceras, Emend. Amm. Nom., p. 3.

Definition.—Platysubleptogyral,[2] angustumbilicate; sublongi-subangustilobate; laterally subflexiradiate; peripherally subacutanguliradiate, subtabulate, subalticarinate. (Radial line, fig. 79, p. clxv.)

Distinction.—From *Depaoceras*, radial line; relatively smaller umbilication; more definite tabulation and carination of periphery.

Remarks.—The similarity of this genus to *Depaoceras* is suggestive of a common descent from a not very remote ancestor, one akin to *Lucya caduceifera*. But in this genus the carination and tabulation of the periphery, and the rostration have been carried to a further degree of development.

1. Deltoidoceras idoneum, *S. Buckman.* Suppl., Fig. 80 in text.

a

Fig. 80.—*Deltoidoceras idoneum.*

[1] Δελτοειδής, delta-shaped. The cross section is deltoid in shape, and the radial line makes with the guide line a somewhat deltoid figure.

[2] Medianly subleptogyral, but whorl triangulate.

Description.—Subgradumbilicate, costate.

Locality and Stratum.—The locality of an unlabelled specimen is presumably Somerset: Stoford, from well-grained ironshot—my father's collection. Another specimen, showing costate umbilicus, Bradford Abbas, Dorset, Collection Damon.

Date of Existence.—*Discitæ* hemera, presumably.

2. DELTOIDOCERAS ASTRICTUM, *S. Buckman.* Suppl., Fig. 81 in text.

Description.—Subconcavumbilicate, costate.

Distinction.—From *D. idoneum*, the narrower periphery; the more compressed whorls; the smaller umbilicus.

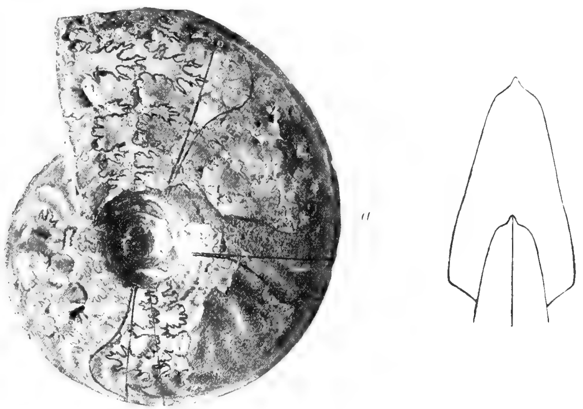


FIG. 81.—*Deltoidoceras astrictum.*

Locality and Stratum.—Dorset: Bradford Abbas, in a bluish matrix, from the Fossil Bed.

Date of Existence.—*Discitæ* hemera.

3. DELTOIDOCERAS SUBDISCOIDEUM, *S. Buckman.* Plate XIX, figs. 5, 6 (type); Plate XX, figs. 1, 2. Suppl., Fig. 82, p. clxv.

1889. HYPERLIOCERAS SUBDISCOIDEUM, This Monogr., Pl. xix, figs. 5, 6; Pl. xx figs. 1, 2.

1902. DELTOIDOCERAS SUBDISCOIDEUM, Emend. Amm. Nom., p. 3.

Description.—Subgradumbilicate; obscuri-subcrassicostate to levigate.

Note.—The inner whorls of the umbilicus show coarse costæ.

Distinction.—From *Deltoid. astrictum*, earlier failure of costæ, slightly more compressed whorls, with less deltoid cross section.

Remarks.—In the two figured examples the suture lines, obscurely seen, appear to be sublongi-subangustilobate. The radial line on the smaller specimen agrees with this genus; in the larger one it cannot be satisfactorily followed. The cross section in the larger example agrees with that of the genus—gradual decline of the deltoid figure by compression around umbilicus would be expected. That the two examples are specifically identical might be questioned.

Date of Existence.—*Discitæ* hemera, presumably.

Alticarinate.

The carina is a very marked feature.

XLIX. *Genus*—Deltotoceras,[1] *S. Buckman.*

(Type: *Deltotoceras cuneatum*, sp. n.)

1902. Deltoceras, Emend. Amm. Nom., p. 3.

Definition.—Platygyral, in cross section deltoid; angustumbilicate; subdensiseptate, longi-subangustilobate; laterally perflexiradiate, peripherally acutanguliradiate, tabulate, alticarinate (septicarinate). (Radial line fig. 83, p. clxv.)

Remarks.—Technical terms fail in the definition, the thickness of the whorls being so different on inner and outer areas. They are convergent-sided, with a deltoid figure. In the genotype the carina is distinctly septate; but as I have not observed this character in other species of this or of allied genera, it may be doubted if it be a character of generic distinction.

The species of this genus are clearly allied to *Deltoidoceras*, but rostration has been carried further, and the whorl thickness is greater.

Distinction.—From *Deltoidoceras*, stouter whorls with more pronounced deltoid section, a larger and more developed carina, radial line with more peripheral projection.

Note.—The name first proposed was occupied.

Crassicarinate.

1. *Septicarinate.*

1. Deltotoceras cuneatum, *S. Buckman.* Suppl., Plate XVI, figs. 7—9.

Remarks.—The inner whorls of the figured specimen give evidence of somewhat coarse costæ—an ornament similar to, but perhaps more pronounced

[1] Δελτωτός, delta-shaped, as the cross section is.

than that of *Deltoidoceras idoneum*. More of the inner whorls is exposed than in that species, and the inner marginal edges are much more pronounced.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, evidently upper part. This fine example of a most distinctive species is unique. It is from the collection formed by Mr. Darell Stephens, F.G.S.

Date of Existence.—*Discitæ* hemera.

2. *Nonsepticarinate.*

2. Deltotoceras triangulare, *S. Buckman*. Suppl., Fig. 84 in text.

Distinction.—From *D. discoideum* (Quenstedt), the stouter, more definitely triangular whorls. From *D. cuneatum*, the smaller umbilicus.

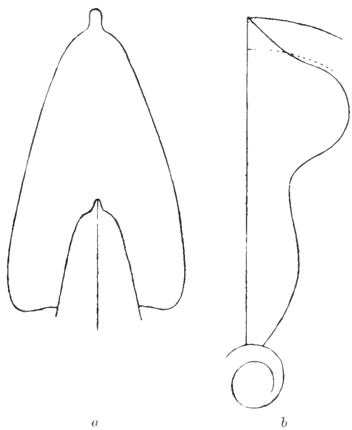


Fig. 84.—*Deltotoceras triangulare*; *a*, Section; *b*, Radial line and umbilicus.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed, evidently upper part (Collection of Mr. D. Stephens).

Date of Existence.—*Discitæ* hemera.

3. Deltotoceras aff. discoideum (*Quenstedt*).

1889. Hyperlioceras discoideum, This Monogr., pp. 98—100. Some of the remarks on p. 99 about the carina refer to this form.

Remarks.—The figures of *H. deflexum* (olim *H. discoideum*, p. 98) Plate XIX, figs. 1, 2, will indicate this form; but it is not compressed around the umbilicus. It has a much heavier carina. Quenstedt's *A. discoideus* is without test; but the cast seems to indicate a heavy keel. The inner margin of this form does not agree with Quenstedt's figure (see Fig. 85); it is more like that of *D. subsectum.*

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed (my father's Collection).

Date of Existence.—*Discitæ* hemera, presumably.

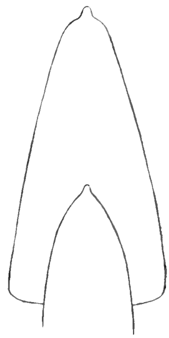


FIG. 85.—*A. discoideus*, Quenst., tracing of type.

Subcrassicarinate.

The carina not so coarse as in the preceding species.

4. DELTOTOCERAS SUBSECTUM (*S. Buckman*), Plate XIX, figs. 3, 4; Suppl., Fig. 86, p. clxv.

1889. HYPERLIOCERAS DISCOIDEUM *a*, This Monogr., Pl. xix, figs. 3, 4, only.
1902. DELTOCERAS SUBSECTUM, Emend. Amm. Nom., p. 3.

Description.—Subgradumbilicate (inner margins of whorls overhanging umbilicus); levigate; whorl-section acutely triangular; densiseptate, sublongisubangustilobate.

Note.—Suture line differs slightly from that of preceding series.

Remarks.—For distinction from the last species and from *A. discoideus*, see p. 99.

Localities and Strata.—Bradford Abbas, Fossil Bed, evidently upper part; Gloucestershire: Wistley Hill, near Cheltenham (Lower *Trigonia*-Grit; 'Quart. Journ. Geol. Soc.,' vol. li, p. 414, sect. xix, Bed 2).

L. *Genus*—HYPERLIOCERAS, *S. Buckman.*

(Type: *Hyperlioceras discites*, Waagen, sp.)

1889. HYPERLIOCERAS, This Monogr., p. 88.

Definition.—Perplatyleptogyral; angustumbilicate; subpauciseptate, brevisubangustilobate; laterally flexiradiate; peripherally acutanguliradiate, penetabulate, alticarinate. (Radial line fig. 87, p. clxv.)

Notes.—The ribs are subfalcate, with a long peripheral projection. The gradumbilicus shown by Waagen is incorrect, it is filled with matrix in the original.

Remarks.—The above definition and notes are drawn up partly from Waagen's figure, partly from several photographs and a drawing kindly sent me by Dr. Paul Gustaf Krause, to whom I beg to tender my very best thanks for the considerable trouble he took in this matter.

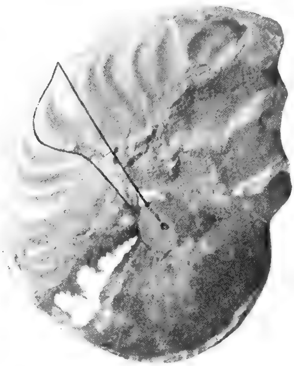


Fig. 88.—*Hyperlioceras discites* (Waagen). From a photograph of the holotype in the Berlin Museum.

I cannot identify any English specimens satisfactorily with *Am. discites.* Those which agree in costation differ in proportions; those which agree in proportions differ in costation; and most species seem to be more longilobate.

As this is an important species, and the type of the genus, a reproduction of one of Dr. Krause's photographs of the type is advisable. It is given in the accompanying fig. 88. The species more or less closely allied to *Hyperlioceras discites* are given in the following pages.

A. Subtriangularia.

1. Hyperlioceras deflexum, *S. Buckman.* Plate XIX, figs. 1, 2.

1889. Hyperlioceras discoideum, β, This Monogr., Pl. xix, figs. 1, 2 only; pp. 98—100 (pars).

Description.—To 50 mm. diameter costate; to 70 mm. diameter subcostate; then smooth; whorl-section subtriangular, becoming flattened.

Distinction.—Young like *H. discites*, but they differ in whorl-section. From *A. discoideus*, see p. 99.

Note.—Not *Deltoidoceras*, nor *Deltotoceras*, because the suture line is brevilatilobate.

Date of Existence.—*Discitæ* hemera, presumably.

2. Hyperlioceras Desori (*Moesch*). Plate XVII, figs. 6, 7; Suppl., Figs. 89, 90, p. clxv.

1889. Hyperlioceras Desori, This Monogr., Pl. xvii, figs. 6, 7; p. 97.

Remarks.—Moesch gives the dimensions of his specimen as—diameter 124 mm., width of umbilicus 14 mm. But his figure shows along the diameter-line of 124 mm. an umbilicus only 10 mm. across. Where the umbilicus is 14 mm. across the specimen, had it not been broken, would have been about 150 mm. in diameter.

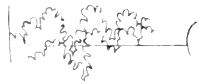


FIG. 89.—Suture line of *Hyperlioceras Desori* (from my specimen).

B. Parallela.

The whorl-section with somewhat parallel sides separates this series from the last.

1. *Pinguia.*

The whorls are somewhat stout.

3. HYPERLIOCERAS LUCYI, *S. Buckman.* Plate XXI, figs. 3, 4; Suppl., Figs. 91, 92, p. clxv.

1889. LUDWIGIA LUCYI, This Monogr., Pl. xxi, figs. 3, 4 only.

Remarks.—The costæ are coarse and distant, but not prominent. They join by twos a little distance from inner margin to form subobscure lumps. The radial line with long peripheral projection indicates the generic position.

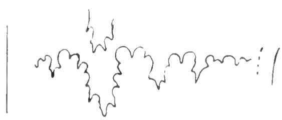


FIG. 91.—Suture line of *Hyperlioceras Lucyi.*

4. HYPERLIOCERAS SUBLEVE, *S. Buckman.* Plate XVII, fig. 5; Plate XVIII, fig. 3; Suppl., Fig. 93, p. clxv.

1889. HYPERLIOCERAS DISCITES, This Monogr., Pl. xvii, fig. 5; Pl. xviii, fig. 3 only.
1902. — SUBLEVE, Emend. Amm. Nom., p. 4.

Description.—Concavumbilicate; levigate.

Distinction.—From *Am. discites*, stouter whorls, larger umbilicus, and the absence of costæ.

2. *Compressa.*

The whorls are thinner than in the preceding series.

5. Hyperlioceras curvicostatum, *S. Buckman.* Suppl., Plate XVI, figs. 4—6.

Description.—Costate (declining); subgradumbilicate; subdensiseptate; brevi-subangustilobate.

Distinction.—From *H. discites*, the larger umbilicus.

Remarks.—The figured example is mostly without test, hence the small size of the carina, which has, however, been drawn not quite prominent enough. Still, the carina is not so developed as in similar species.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably.

6. Hyperlioceras rudidiscites, *S. Buckman.* Plate XVIII, figs. 1, 2 (Type); Plate XVII, figs. 3, 4; Suppl., Fig. 94, p. clxv.

1886. Ammonites discoideus, *Quenstedt*, Amm. Schwäb. Jura, Pl. lviii, fig. 4 only.
1889. Hyperlioceras discites, This Monogr., Pl. xviii, figs. 1, 2; Pl. xvii, figs. 3, 4, p. 94.
1902. — rudidiscites, Emend. Amm. Nom., p. 4.

Remarks.—A necessary change of name. Fully described on p. 94.

Distinction.—From *H. discites*, the larger umbilicus (see p. 95) and the less distinct costæ.

7. Hyperlioceras discitiforme, *S. Buckman.* Plate XVI, figs. 12, 13; Suppl., Plate XVIII, figs. 7—9, 23.

1889. Hyperlioceras discites, This Monogr., Pl. xvi, figs. 12, 13 only.
1902. — discitiforme, Emend. Amm. Nom., p. 4.

Description.—Subconcavumbilicate; spissi-parvicostate, declining to striate.

Distinction.—From *H. rudidiscites*, thinner, more compressed around umbilicus, which is also rather more exposed. From *H. discites*, less prominent costæ, more closely set.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, evidently upper part; Burton Bradstock, from a grey matrix (Collection of Mr. D. Stephens).

Date of Existence.—*Discitæ* hemera.

8. Hyperlioceras liodiscites, *S. Buckman.* Plate XVII, figs. 1, 2; Suppl., Figs. 95, 96, p. clxv.

1889. Hyperlioceras discites *a*, This Monogr., Pl. xvii, figs. 1, 2 only.
1902. — liodiscites, Emend. Amm. Nom., p. 4.

Description.—Subconcavumbilicate; levigate.

Remarks.—This is a thin form with narrow periphery and prominent carina. Ribs, if present, would only belong to quite the young stage. As regards the inner margin, the upper edge tends to overhang the umbilicus.

Fig. 95.—Suture-line of *Hyperlioc. liodiscites* (from type).

Distinction.—From *H. discitiforme*, smoothness, greater compression, smaller umbilicus. From *H. discites*, the smooth test. There is general likeness also to *Toxolioceras tenerum* (see below, p. cxxvii), but radial line and suture line are distinctions; also the narrower, more carinate periphery, and the deeper, more concentric umbilicus.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed, evidently upper part. Somerset: Dundry, middle of "Limestone and Marl Beds" ('Quart. Journ. Geol. Soc.,' vol. lii, p. 677, Bed 13).

Date of Existence.—*Discitæ* hemera.

In the next species the radial line lacks the long peripheral projection characteristic of the previous forms.

9. Hyperlioceras? occlusum, *S. Buckman.* Suppl., Plate XXI, figs. 34—36.

Description.—Perplatyleptogyral; concavumbilicate; spissiparvicostate to striate; periphery tabulate; alticarinate.

Distinction.—From *H. Desori*, finer style of costation; broader periphery, with less projected radial line.

Remarks.—It does not seem to be actually related to *H. Desori*, though it has somewhat the appearance of that species. There is nothing else to compare with it.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

Biarcurate, much projected peripherally.

LI. *Genus*—Toxolioceras,[1] *S. Buckman.*

(Type: *Toxolioceras Walkeri*, S. Buckman.)

1902. Toxolioceras, Emend. Amm. Nom., p. 5.

Definition.—Platyleptogyral, angustumbilicate; densiseptate, brevisublatilobate[2]; laterally anguliradiate, peripherally acutanguliradiate, tabulate, crassialticarinate. (Radial line, Fig. 97, p. clxv.)

Distinction.—From *Darellia*, radial line more projected peripherally, stronger carina, character of costate ornament. From *Hyperlioceras*, radial line more definitely biarcuate, larger umbilication, earlier smoothness.

Remarks.—The alti-carinati-tabulate periphery is shown to perfection in adult *T. Walkeri.*

1. Toxolioceras incisum, *S. Buckman.* Suppl., Plate XXI, figs. 31—33.

Description.—Subangustumbilicate, costate.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Burton Bradstock, grey matrix.

Date of Existence.—*Discitæ* hemera, presumably.

2. Toxolioceras mundum, (*S. Buckman*). Suppl., Plate XVIII, figs. 4—6.

Description.—Parvispissicostate and subangustumbilicate (gradumbilicate).

Distinction.—From *T. incisum*, smaller umbilicus, neater ornament.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

3. Toxolioceras Walkeri (*S. Buckman*). Plate XVI, figs. 1, 2; Suppl., Plate XVIII, figs. 1—3, 22.

1889. Hyperlioceras Walkeri, This Monogr., Pl. xvi, figs. 1, 2, only (not figs. 4—11).[3]

1902. Toxolioceras Walkeri, Emend. Amm. Nom., p. 5.

Distinction.—From *T. mundum*, smaller umbilicus before excentricity commences. In the adult the umbilicus reverts from angust to become subangust.

[1] Τόξον, a bow, in reference to the radial line.

[2] In adult *T. Walkeri*, affected perhaps by gerontic catagenesis.

[3] Figs. 3—6, *Darellia polita*; figs. 7, 8, 9, *Reynesella piodes*; figs. 10, 11, *Reynesia cœla.*

Remarks.—For comparison with the species of the genus and with species of *Darellia*, *Hyperlioceras*, etc., formerly confounded herewith, an immature example has been depicted in Suppl., Plate XVIII, figs. 1—3.

Locality and Stratum.—Dorset : Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

4. TOXOLIOCERAS TENERUM, *S. Buckman.* Suppl. Fig. 98 in text.

Description.—Levigate, angustumbilicate (subconcavumbilicate).

Distinction.—From *T. Walkeri*, the smaller umbilicus.

Remarks.—In *T. Walkeri* excentric coiling commences at a radius of 67 mm.; in this species it begins at a radius of 31 mm. In *T. Walkeri* this excentric

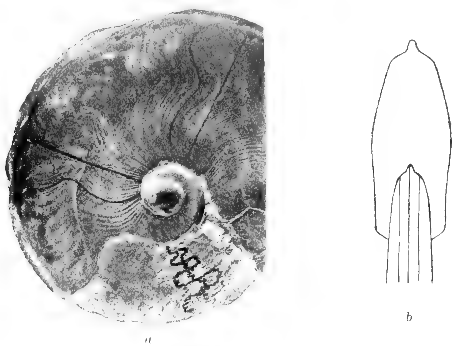


FIG. 98.—*Toxolioceras tenerum.*

coiling follows after a gradumbilicate stage, in this species after a subconcavumbilicate stage.

Locality and Stratum.—[Dorset : Bradford Abbas, Fossil Bed], certainly by matrix, though figured specimen not labelled.

Date of Existence.—*Discitæ* hemera.

Falcate, subprojected peripherally.

LII. *Genus*—STOKEIA,[1] *S. Buckman.*

(Type : *Stokeia marmorea*, sp. n.)

Definition.—Perplatyleptogyral, angustumbilicate; laterally flexiradiate; peripherally subacutanguliradiate, penetabulate, alticarinate. (Radial line, fig. 99, p. clxv.)

[1] Stoke Knap, near Broad Windsor.

Distinction—From *Darellia*, the radial line, which is falcate instead of biarcuate, the stronger carina, the smaller umbilication. From *Toxolioceras*, the radial line, the smaller umbilicus, the slightly convergent, not parallel-sided, build of whorls.

1. Stokeia marmorea, *S. Buckman*. Suppl., Plate XXII, figs.13—15; Fig. 99, p. clxv.

Description.—Subdistanti-subobscuricostate to levigate; gradumbilicate.

Remarks.—The ribs are connate, inconspicuous, and rather distant. There is a gradual decline to striæ at about 50 mm. diameter; but the ribs are very feeble before that.

Locality and Stratum.—Dorset: Stoke Knap, Building Stone.

Date of Existence.—*Discitæ* hemera, presumably.

2. Stokeia subacuta, *S. Buckman*. Suppl., Pl. XVIII, figs. 10—12.

Description.—Obsoleticostate to levigate; concavumbilicate.

Remarks.—The overlap of whorl is to the edge of preceding inner margin. There are faint indications of distant costæ; but practically the costæ have failed when the diameter of about 25 mm. is reached.

Distinction.—From *S. marmorea*, failure of costæ, the concavumbilicus, the narrower periphery.

Localities and Strata.—Dorset: Bradford Abbas neighbourhood, probably Halfway House from the "Blue Beds"; but the exact locality is not recorded. Somerset: Dundry, Limestone and Marl beds.

Date of Existence.—*Discitæ* hemera, presumably.

End of *Carinatitabulate* series.

A Lioceratoid genus.[1]

LIII. *Genus.*—Canavarella, *S. Buckman.*

(Type: *Canavarella belophora*, sp. n.)

Definition.—Platysubleptogyral, sublatumbilicate; subdensiseptate; subbrevisubangustilobate; laterally flexiradiate; peripherally acutanguliradiate, acutifastigate, parvicarinate. (Radial line, fig. 100. p. clxv.)

Distinction.—From *Lioceras*, the whorls thinner and more acute peripherally; the radial line more projected peripherally and altogether more definitely falciform.

[1] See p. xxxiii.

1. Canavarella belophora. *S. Buckman.* Suppl., Plate XXII, figs. 22—24.

Description.—Subpaucicostate, with little sign of decline.

Locality and Stratum.—Dorset: Stoke Knap, in sandy grits with *Terebratula infraoolithica*.

Date of Existence.—*Scissi* hemera.

The two following species have a radial line much less projected peripherally than in *C. belophora*. It is like that of *Lioceras;* but they are much more compressed shells than any of that genus, also they do not show any striate character.

2. Canavarella ? toma, *S. Buckman.* Suppl. Plate XXII, figs. 16—18.

Description.—Leptogyral; angustumbilicate; subspissi-parvi- and connaticostate; periphery acutifastigate.

Locality and Stratum.—Gloucestershire: Buckholt Wood (Frocester), hard bed at top of Cephalopod bed.

Date of Existence.—*Opaliniformis* hemera.

3. Canavarella ? sceleta, *S. Buckman.* Suppl., Plate XXII, figs. 19—21.

Description.—Almost perleptogyral; angustumbilicate; subpauci-subobscuri-simplicicostate, periphery acutifastigate.

Distinction.—From *C. toma*—the umbilicus is a little wider, and the margin less definite, the ribs are not connate, are somewhat distant, and are less distinct.

Locality and Stratum.—Dorset: Burton Bradstock, top of Yeovil Sands.

Date of Existence.—*Aalensis*, or *Opaliniformis* hemera.

The following species is placed here for convenience only.

4. Canavarella ? arenacea, *S. Buckman.* Plate XXVIII, figs. 20, 21; Suppl., Fig. 101, p. clxv.

1890. Grammoceras striatulum, This Monogr., Pl. xxviii, figs. 20, 21.

Description.—Platyleptogyral, sublatumbilicate; pauciseptate, brevilatilobate; subspissi-parvicostate; periphery subfastigate, parvicarinate.

Distinction.—From *Ammontes lympharum*, Dumortier,[1] the smaller carina, the much more open umbilicus.

Remarks.—This species is not a *Grammoceras*, nor does it belong to any of the Grammoceratoid genera. The radial line is remarkable with its biarcuate curves. The species may be allied to *Am. lympharum*, Dum.; but it is easily separable therefrom.

[1] 'Dep. Jurass. Rhône,' iv, Pl. xvi, figs. 5, 6.

Localities and Strata.—Gloucestershire: near Stroud, Buckholt Wood; near Dursley, Coaley Wood; nodules in the *striatulus* beds.

Date of Existence.—*Variabilis* hemera, properly—the nodules being *remanié* in the *Striatulus* beds.

CYPHOLIOCERAS PLICATUM? Plate XIV, figs. 5, 6. (See p. xlv.)

1888. LIOCERAS OPALINUM, *var.* COMPTUM, This Monogr., Pl. xiv, figs. 5, 6.

The radial line (fig. 102, p. clxv) of this specimen, however, is less curved laterally and less projected peripherally than in the type, perhaps due to youth.

HYATTINA? sp. Pl. IV, fig. 7; Suppl., Pl. XVII, fig. 29. (See p. lvii.)

1887. LIOCERAS BRADFORDENSE, This Monogr., Pl. iv, fig. 7.

Description.—The periphery is subtabulate, the carina is subdistinct, subacute. Suture-lines: Subdensiseptate, sublongi-angustilobate.

Note.—The radial line (Suppl., Pl. XVII, fig. 29) is drawn with rather too much lateral curve: the bend should not be quite so close to the guide line.

Remarks.—Nearest to *Hyattina Brasili*, agrees fairly in suture line—perhaps a trifle more longilobate—in periphery—in carina, *H. Brasili* having no test, in proportions; differs in ornament, the ribs being closer together, and not so coarse.

BRASILINA TUTCHERI? Suppl., Pl. X, figs. 35—37. (See p. lxxxiii.)

Remarks.—The specimen referred to looks like a young example of *B. Tutcheri*, but it seems to be too compressed and too carinate.

GAMMIRADIATE.

Quite a distinct series of Ammonites of the family *Hildoceratidæ* has now to be dealt with; they were formerly classed as *Grammoceras*. Their radial line in the main suggests a Greek Γ; and the suture line is simple. Other characters are well-marked ribs and latumbilication; but normal decline affects these features to produce small ribs, or none at all, and angustumbilication. Before degeneration sets in the species have much likeness to *Lillia* (p. xiii), but with this important distinction: the earliest species (see below, *Grammoceras*) have costæ with knobs on the peripheral edge; in *Lillia* the knobs are on the umbilical border. However, in an allied genus, *Chartronia* (p. xvi), there are two rows of nodi. Possibly, then, *Lillia*, *Chartronia*, *Grammoceras*, with their respective allies and descendants, have a common origin in a binodate ancestor.

The distinction of *Grammoceras* and its allies as a sub-family from *Lillia*, *Ludwigia*, etc., would seem advisable. The difficulty, however, is with definition; because the degenerates in both series, passing through similar phases of decline, simulate each other's characters so much, and lose the features once severally distinctive; therefore broad demarcation seems to be difficult.

A. Non-septicarinate.

LIV. *Genus*—GRAMMOCERAS, *Hyatt*.

(Type: *Grammoceras striatulum*, J. D. C. Sow., sp.)

1890. GRAMMOCERAS, This Monogr., p. 158 (pars).
1900. DUMORTIERIA,[1] *Hyatt*, in Text-book of Palæontology, by Zittel-Eastman, vol. i, p. 576.

Definition.—Substenoleptogyral, latumbilicate; pauciseptate; subbrevisublatilobate; laterally subflexiradiate; peripherally subacutanguliradiate, fastigate, parvinonsepticarinate. (Radial line, fig. 103, p. clxv.)

Note.—The definition applies to the genotype which is already degenerate. Such characters as the fastigate periphery and leptogyral shape mark degeneration: a subtabulate periphery, and subleptogyral, even subpachygyral, whorls are characters of less degenerate species of the genus.

Remarks.—The species figured by Wright, 'Monogr. Lias Amm.,' Plate xlix, figs. 4, 5, as *Harpoceras nitescens* has, according to a specimen kindly given to me by Dr. Vaughan, the simple suture line,[2] rib characters and general shape of *Grammoceras toarciense*, with this difference: it is knobbed on the peripheral margin.

As my specimen is certainly a *Grammoceras*, it takes the genus a step further back into the tuberculate stage, with the important distinction from *Lillia* that the tubercles occupy the outer, not the inner, edge of the whorl.

A carina between two definite furrows is also a character of my specimen, though the furrows become obsolete with age. Wright shows the furrows more persistent.

Separation of the species formerly (p. 158 *et seqq.*) placed under *Grammoceras* has become necessary.

1. GRAMMOCERAS, sp. A., Plate XXXIV, fig. 12.

1890. GRAMMOCERAS TOARCENSE, var., This Monogr., Pl. xxxiv, fig. 12; p. 169.

Remarks.—A distinct form with a wide umbilicus, a carinati-subtabulate periphery and occasional connate costæ.

[1] The Fig. 1201 labelled "*Dumortieria*, sp.," is *Grammoceras toarciense*. It has neither the ribbing nor the suture line of *Dumortieria*.

[2] The lobe line given by Wright, fig. 3, seems doubtful. At least, my specimen has quite the simple suture line of *Grammoceras*.

2. Grammoceras audax, *S. Buckman*. Plate XXVIII, figs. 4—6; Suppl., Fig. 104, p. clxv.

1890. Grammoceras toarcense, This Monogr., Pl. xxviii, figs. 4—6; p. 169.
1902. — audax, Emend. Amm. Nom., p. 3.

Description.—Crassipaucicostate, with nearly quadrate whorls, periphery subtabulate.

Distinction.—From *G. toarciense*, the stouter whorls, broader periphery, coarser costation.

3. Grammoceras toarciense (*d'Orbigny*). Plate XXVIII, figs. 7—13.

1843. Ammonites Thouarsensis, *d'Orbigny*, Ceph. Jurass., Pl. lvii.
1878. Grammoceras Thouarsense, *Bayle*, Pl. lxxviii, fig. 3 only.
1885. Ammonites radians depressus, *Quenstedt*, Amm. Schwäb Jura, Pl. lii, fig. 1.
1890. Grammoceras toarcense, This Monogr., Pl. xxviii, figs. 7—13; pp. 169—173 (pars).
1902. — — *Janensch*, Abh. Geol. Spez-Karte Elsass-Lothr., N. F., Heft v, Pl. iii, fig. 2.

Distinction.—A less robust form than *G. audax*, with smaller, more numerous, costæ, and a narrow though flattish periphery.

Remarks.—Beyond the diameter of the specimen depicted in Plate XXVIII, figs. 7, 8, the periphery becomes more and more fastigate, though the ribs tend to gain more of the distant character of those in *G. audax*.

The largest specimens which I have obtained are, from Coaley Wood, 140 mm. in diameter, from Wotton-under-Edge, 127 mm. in diameter.

4. Grammoceras penestriatulum, *S. Buckman*. Plate XXVIII, figs. 16, 17.

1890. Grammoceras striatulum, This Monogr., Pl. xxviii, figs. 16, 17; p. 173.
1902. — penestriatulum, Emend. Amm. Nom., p. 3.

Description.—Subparvicostate, periphery fastigate.

Distinction.—From *G. striatulum*, coarser, less numerous costæ.

Grammoceras striatulum, *J. D. C. Sowerby*. Plate XXVI, figs. 8—10; Plate XXVIII, figs. 18, 19.

1890. Grammoceras striatulum, This Monogr., Pl. xxvi, figs. 8—10; Pl. xxviii, figs. 18, 19; p. 173.

In Pl. A., figs. 43—45 show radial and suture lines of *Grammoceras*, though not necessarily of *G. striatulum*.

LV. *Genus*—Cotteswoldia,[1] *S. Buckman.*

(Type: *Cotteswoldia paucicostata*, sp. n.)

1902. Cotteswoldia, Emend. Amm. Nom., p. 3.

Definition.—Subplatyleptogyral, sublatumbilicate; subpauciseptate, brevilatilobate; laterally subrectiradiate; peripherally anguliradiate, fastigate, parcicarinate. (Radial line, fig. 105, p. clxv.)

Distinction.—From *Grammoceras*, a more distant style of costation, broader and more compressed whorls; and in the main less peripherally projected radii. Deficiency of carination in the costate species.

Remarks.—Besides the typical series (I) it seems advisable to place here for the present two other series. Their distinctions may be noted in the following manner:

I. Costæ simple.
II. Costæ connate.
III. Costæ connate, but umbilicus persists larger.

I. Costæ simple.

1. Cotteswoldia paucicostata, *S Buckman.* Suppl., Plate XXIII, figs. 1—3.

Description.—Distanti-subcrassicostate to obsoleticostate.

Localites and Stratum.—Gloucestershire, Buckholt Wood (Frocester); Bowcott Wood (Dursley); Upper part of Cephalopod Bed (*Moorei* Beds).

Date of Existence.—*Moorei* hemera.

2. Cotteswoldia costulata (*Zieten*). Plate XXXIII, figs. 3, 4; Suppl., Plate XXIII, figs. 4, 4 *a*.

cf. 1885. Ammonites costula, *Quenstedt*, Amm. Schwäb Jura, Pl. liv, figs. 7, 51.
1890. Grammoceras costulatum, This Monogr., Pl. xxxiii, figs. 3, 4; p. 179.
1902. Cotteswoldia costulata, Emend. Amm. Nom., p. 3.

Distinction.—From *C. paucicostata*, the ribs are not so coarse and the umbilicus is not so concentric—it is more oligogyral.

Localities and Stratum.—Gloucestershire: Coaley Peak, Frocester Hill, Haresfield Hill, Cephalopod Bed, upper part.

Date of Existence.—*Aalensis* hemera.

3. Cotteswoldia particostata, *S. Buckman.* Suppl., Plate XXIII, figs. 5—7.

Description.—Subspissicostate, passing to obsoleticostate and levigate.

Distinction.—From *C. costulata*, a larger number of more closely set costæ.

Locality and Stratum.—Gloucestershire: Buckholt Wood (Frocester), Cephalopod Bed, upper part (*Moorei* Beds).

Date of Existence.—*Moorei* hemera.

[1] Cotteswold Hills.

4. COTTESWOLDIA EGENA, *S. Buckman.* Suppl., Plate XXIII, figs. 9—11.

cf. 1885. AMMONITES COSTULA, *Quenstedt*, Amm. Schwäb. Jura, Pl. liv, fig. 14.

Description.—Subdistanti-parvicostate, passing to obsoleticostate and striate.

Distinction.—From *C. costulata*, smaller ribs while costate, and early decline to a distinct striate stage.

Locality and Stratum.—Gloucestershire: Buckholt Wood (Frocester), Cephalopod Bed, upper part (*Moorei* Beds).

Date of Existence.—*Moorei* hemera.

5. COTTESWOLDIA LIMATULA, *S. Buckman.* Plate XXX, figs. 5—7; Suppl., Fig. 106, p. clxv.

cf. 1885. AMMONITES cf. RADIANS DEPRESSUS, *Quenstedt*, Amm. Schwäb. Jura, Pl. liv, fig. 15.
1890. GRAMMOCERAS MACTRA, This Monogr., Pl. xxx, figs. 5—7; p. 176 (pars).
1902. COTTESWOLDIA LIMATULA, Emend. Amm. Nom., p. 3.

Description.—Subspissiparvicostate, declining.

Distinction.—From *C. egena*, costæ are more numerous; the umbilicus has a less definite inner margin.

Localities and Strata.—Gloucestershire: Frocester Hill, Cephalopoda Bed, upper part (*Aalense* Beds). Foreign—France: "Le Bernard (Vendée) Lias supérieur, Le Moulin Drapeau" (submitted by Mr. C. Chartron).

6. COTTESWOLDIA ATTRITA, *S. Buckman.* Suppl., Plate XXIII, figs. 12—14.

cf. 1885. AMMONITES cf. COSTULA, *Quenstedt*, Amm. Schwäb. Jura, Pl. liv, fig. 50.

Description.—Parvicostate, passing to subirregulari-subobscuricostate, and tending to decline to levigate; periphery subfastigate; carina slightly distinct.

Note.—The figure shows the costæ rather too definite and distinct.

Distinction.—Is a stouter shell with a more definite periphery than any of the preceding species.

Locality and Stratum.—Gloucestershire: Buckholt Wood (Frocester), Cephalopod Bed, upper part (*Moorei* Beds).

Date of Existence.—*Moorei* hemera.

II. Costæ Connate.

7. COTTESWOLDIA SUPERBA, *S. Buckman.* Plate XXXII, figs. 1, 2; Suppl., Fig. 107, p. clxv.

cf. 1885. AMMONITES cf. RADIANS, *Quenstedt*, Amm. Schwäb. Jura, Pl. liv, fig. 21.
1890. GRAMMOCERAS AALENSE, This Monogr., Pl. xxxii, figs. 1, 2; p. 192 (pars).
1902. COTTESWOLDIA SUPERBA, Emend. Amm. Nom., p. 3.

Description.—Costate; the costæ occasionally connate; umbilicus somewhat excentric.

Locality and Stratum.—Gloucestershire: Coaley Peak (Frocester), in top part of Cephalopod Bed.

Date of Existence.—*Aalensis* hemera.

8. Cotteswoldia subcandida, *S. Buckman.* Plate XXXII, figs. 7, 8; Suppl., Fig. 108, p. clxv.

1890. Grammoceras aalense, This Monogr., Pl. xxxii, figs. 7, 8; p. 192 (pars).
1902. Cotteswoldia subcandida, Emend. Amm. Nom., p. 3.

Description.—Subcostate, declining to obscuricostate.

Distinction.—From *C. superba*, the ornament.

Locality and Stratum.—Gloucestershire: Coaley Peak (Frocester), top of Cephalopod Bed.

Date of Existence.—*Aalensis* hemera.

9. Cotteswoldia misera, *S. Buckman.* Plate XXXI, figs. 15, 16; Suppl., Fig. 109, p. clxv.

1890. Grammoceras aalense, This Monogr., Pl. xxxi, figs. 15, 16; p. 192 (pars).
1902. Cotteswoldia misera, Emend. Amm. Nom., p. 3.

Description.—Parvicostate, with tendency to decline.

Distinction.—The smallness of the ornament.

Locality and Stratum.—Gloucestershire: Haresfield Hill, top of Cephalopod Bed.

Date of Existence.—*Aalensis* hemera.

10. Cotteswoldia, sp. Plate XXXI, figs. 13, 14; Suppl., Fig. 110, p. clxv.

1890. Grammoceras subserrodens, This Monogr., Pl. xxxi, figs. 13, 14; p. 179 (pars).

Locality and Stratum.—Gloucestershire: Haresfield Hill, Cephalopod Bed, upper part.

Date of Existence.— *Aalensis* hemera.

III. Umbilicate.

There appears to be generally more lateral curvature to the radial line in this series than in the foregoing.

11. Cotteswoldia distans (*S. Buckman*). Plate XXXIII, figs. 1, 2; Suppl., Plate XXIII, fig. 8.

1890. Grammoceras distans, This Monogr., Pl. xxxiii, figs. 1, 2; p. 196.
1902. Cotteswoldia distans, Emend. Amm. Nom., p. 3.

Remarks.—In the figured specimen the ribs are distinctly joined near the inner margin in two or three cases. The duplication of ribs towards peripheral area, shown in the figure, is a mistake of the draughtsman.

Locality and Stratum.—Gloucestershire: Haresfield Hill, Cephalopod bed, upper part.

Date of Existence.—*Aalensis* hemera.

12. Cotteswoldia bifax, *S. Buckman.* Fig. 110a in text.

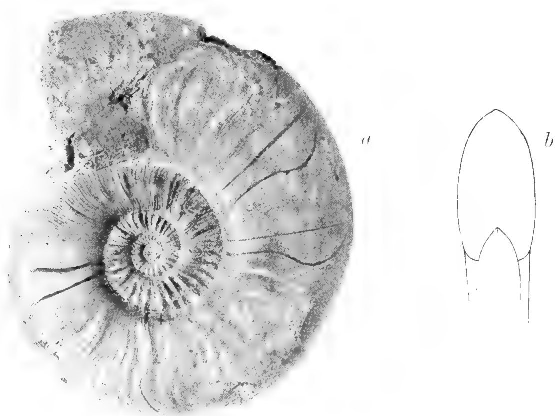


Fig. 110a. *Cotteswoldia bifax; a*, side view; *b*, section.

Description.—Connaticostate, declining to subcostate and striate; periphery fastigate, passing on to become convex; carina subdistinct, but failing where periphery tends to convexity.

Remarks.—Costæ are irregular in size, and tend to join on inner border. The species is remarkable for the two distinct phases—costate and striate—both so marked and well developed; also for the great likeness to *Dumortieria Moorei.* Therefrom, however, the laterally curved radial line with longer peripheral projection distinguishes it.

Locality and Stratum.—Gloucestershire: Buckholt Wood (Frocester), Cephalopod Bed, *Moorei* (*aalensis ?*) beds.

Date of Existence.—*Moorei* (*aalensis ?*) hemera.

13. COTTESWOLDIA CRINITA, *S. Buckman.* Plate XXXI, figs. 3, 4; Suppl., Fig. 111, p. clxv.

1890. GRAMMOCERAS MACTRA β, This Monogr., Pl. xxxi, figs. 3, 4; p. 176 (pars).
1902. COTTESWOLDIA CRINITA, Emend. Amm. Nom., p. 3.

Description.—Striate; periphery tending to be convex with no definite carina.

Distinction.—From *C. bifax*, greater compression, more of striate stage.

Remarks.—The costate stage, similar to that of *C. bifax*, but on a reduced scale, ends about a whorl earlier than in that species. Tachygenesis in this feature, and in regard to the periphery, in comparison with *C. bifax*, seems well marked.

The side view in the monograph is by no means a satisfactory representation.

Locality and Stratum.—Gloucestershire: Coaley Peak (Frocester), Cephalopod Bed, *Moorei* [*Aalensis ?*] Beds.

Date of Existence.—*Moorei* (*Aalensis ?*) hemera.

LVI. *Genus*—PLEYDELLIA,[1] *S. Buckman.*

(Type: *Pleydellia aalensis*,[2] Zieten, sp.)

1899. PLEYDELLIA, This Monogr., Expl. of Suppl., Pl. x.

Definition.—Subplatyleptogyral, sublatumbilicate; subpauciseptate; brevi-sublatilobate; laterally subflexiradiate; peripherally anguliradiate, acutifastigate, carinate. (Radial lines, figs. 112, 113, p. clxv.)

Distinction.—From *Cotteswoldia*, more compressed form of whorls, though hardly enough to be called perleptogyral, more laterally flexed radial line (from the type series), sharper periphery, distinct carina.

Note.—*Ammonites candidus*, d'Orbigny, Pal. franç.; Terr. jurass.; Pl. lxiii, figs. 1, 2, would appear to be a species of this genus.

1. PLEYDELLIA AALENSIS (ZIETEN). Plate XXXII, figs. 3—6; Suppl., Figs. 112, 113, p. clxv.

1890. GRAMMOCERAS AALENSE, This Monogr., Pl. xxxii, figs. 3—6; p. 192 (pars).
1902. PLEYDELLIA AALENSIS, Emend. Amm. Nom., p. 4.

2. PLEYDELLIA FLUENS, *S. Buckman.* Plate XXXI, figs. 1, 2; Suppl., Fig. 114, p. clxv.

1890. GRAMMOCERAS MACTRA, This Monogr., Pl. xxxi, figs. 1, 2; p. 176 (pars).
1902. PLEYDELLIA FLUENS, Emend. Amm. Nom., p. 4.

Description.—Connati-parvicostate to obscuricostate.

[1] In compliment to Mr. J. C. Mansel Pleydell, J.P., F.L.S., F.G.S., etc., for so many years President of the Dorset Field Club.

[2] The type of the genus is the species figured in this Monograph, Pl. xxxii, figs. 4—6.

Distinction.—From *P. aalensis*, finer ornament.
Date of Existence.—*Aalensis* hemera.

3. Pleydellia leura (*S. Buckman*). Plate XXXIII, figs. 8—10 (type); figs. 5—7; Suppl., Figs. 115, 116, pp. clxv, clxvii.

1890. Grammoceras leurum, This Monogr., Pl. xxxiii, figs. 5—10, p. 195.
1902. Pleydellia leura, Emend. Amm. Nom., p. 4.

Remarks.—The two specimens figured as *Grammoceras leurum* in Pl. XXXIII differ in details of suture line: the larger one is brevilatilobate, the smaller one is sublongi-subangustilobate. On the test of the smaller example, however, are certain marks, and there are also some slight irregular markings around the periphery; so perhaps this specimen is not quite normal, owing to some injury.
Date of Existence.—*Aalensis* hemera.

4. Pleydellia comata, *S. Buckman.* Suppl., Plate X, figs. 11—13.

Description.—Obscuriparvicostate to striate; angustumbilicate.
Distinction.—From *P. leura*, smaller, less distinct ornament.
Locality and Stratum.—Dorset: Burton Bradstock, high up in Yeovil Sands.
Date of Existence.—*Aalensis* hemera.

The following species belong to several series which cannot at present be more definitely separated. They are placed here for convenience.

5. Pleydellia? subcompta? (*Branco*). Plate XXX, figs. 13, 14; Suppl., Fig. 117, p. clxvii.

1890. Grammoceras subcomptum, This Monogr., Pl. xxx, figs. 13, 14; p. 198.
1902. Pleydellia subcompta, Emend. Amm. Nom., p. 4.

Remarks.—The side view is drawn too flat, and the peripheral view not stout enough. The identification with Branco's species is very doubtful.

6. Pleydellia? sp. A., Plate XXX, figs. 11, 12; Suppl., Fig. 118, p. clxvii.

1890. Grammoceras subcomptum, This Monogr., Pl. xxx, figs. 11, 12; p. 198.

Remarks.—A much compressed shell, much thinner than the last.

7. Pleydellia ? mactra ? (*Dumortier*). Plate XXX, figs. 3, 4; Suppl., Fig. 119, p. clxvii.

1890. Grammoceras mactra, This Monogr., Pl. xxx, figs. 3, 4; p. 176.
1902. Pleydellia mactra, Emend. Amm. Nom., p. 4.

Remarks.—The identification is by no means satisfactory, in spite of very considerable resemblance. My efforts to obtain local information concerning the type have been unsuccessful.

8. Pleydellia ? sp. B., Plate XXXI, figs. 7—9; Suppl., Fig. 120, p. clxvii.

1890. Grammoceras subserrodens, This Monogr., Pl. xxxi, figs. 7—9; p. 179 (pars).

Remarks.—The shape seems the same as that of Branco's species, but the ornament differs; lacks the carina of *Pleydellia.*

LVII. *Genus*—Walkeria,[1] *S. Buckman.*

(Type: *Walkeria delicata*, sp. n.)

1902. Walkeria, Emend. Amm. Nom., p. 5.

Definition.—Subplatyleptogyral, sublatumbilicate; laterally flexiradiate; peripherally subacutanguliradiate, subfastigate, parvicarinate.

Distinction.—From *Pleydellia*, radial line more curved laterally, more projected peripherally, carina less definite, whorls less compressed.

1. Walkeria arcuata, *S. Buckman.* Plate XXXII, figs. 11, 12; Suppl., Fig. 121, p. clxvii.

1890. Grammoceras, sp., This Monogr., Pl. xxxii, figs. 11, 12; p. 191.
1902. Walkeria arcuata, Emend. Amm. Nom., p. 5.

Description.—Costate, showing slight decline.

Localities and Strata.—Gloucestershire: Haresfield Hill, Cephalopod Bed, upper part; Dorset: Chideock Quarry Hill, towards top of Yeovil Sands.

Date of Existence.—*Aalensis* hemera.

2. Walkeria burtonensis, *S. Buckman.* Plate XXXII, figs. 9, 10.

1890. Grammoceras aalense, This Monogr., Pl. xxxii, figs. 9, 10.
1902. Walkeria burtonensis, Emend. Amm. Nom., p. 5.

Description.—Costate passing to spissiparvicostate, and declining.

[1] In compliment to Mr. J. F. Walker, M.A., F.G.S.

Distinction.—From *W. arcuata*, the smaller ornamentation.

Locality and Stratum.—Dorset: Burton Bradstock, high up in Yeovil Sands.

Date of Existence.—*Aalensis* hemera.

3. WALKERIA DELICATA, *S. Buckman.* Suppl., Fig. 122 in text.

Description.—Spissiparvicostate declining to striate, passing to irregulari-obscuricostate.

Distinction.—From *W. burtonensis*, the decline in the ornament and the more compressed whorls.

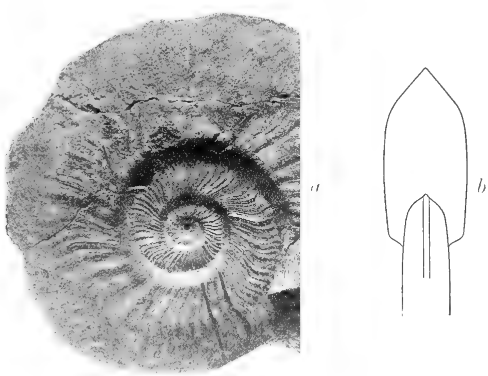


FIG. 122.—*Walkeria delicata.* *a*, side view; *b*, apertural view.

Remarks.—The type specimen I purchased from the Collection of the late Dr. T. Wright, F.R.S.

Locality and Stratum.—Dorset: Burton Bradstock, Yeovil Sands.

Date of Existence.—*Aalensis* hemera, presumably.

4. WALKERIA? LOTHARINGICA? (*Branco.*) Plate XXX, figs. 8, 9; Suppl., Fig. 123, p. clxvii.

1890. GRAMMOCERAS LOTHARINGICUM, This Monogr., Pl. xxx, figs. 8, 9; p. 199.
1902. WALKERIA LOTHARINGICA? Emend. Amm. Nom., p. 5.

Remarks.—Identification with Branco's species will not pass critical investigation.

5. WALKERIA? sp. Plate XXX, fig. 10; Suppl., Fig. 124, p. clxvii.

1890. GRAMMOCERAS LOTHARINGICUM, This Monogr., Pl. xxx, fig. 10; p. 199.

Remarks.—Like *W. delicata*, but more umbilicate.

6. Walkeria? subglabra, *S. Buckman*. Plate XIII, figs. 7, 8 (type); Figs. 9, 10?; Figs. 125, 126, p. clxvii.

1888. Lioceras opalinum, This Monogr., Pl. xiii, figs. 7—10, p. 35 (pars).
1902. Walkeria subglabra, Emend. Amm. Nom., p. 5.

Description.—Striate; gradumbilicate; periphery fastigate, subcarinate.

Remarks.—The generic position is not satisfactory. A specimen of an allied species from North Nibley, in my Collection, shows the same much projected radial line which is distinctive of this species but indicative of disagreement with *Walkeria*. It also shows in its umbilicus coarse, distant costæ, suddenly passing to striæ. The characters seem to indicate another genetic series.

LVIII. *Genus*—Canavarina,[1] *S. Buckman.*

(Type: *Canavarina digna*, sp. n.)

1902. Canavaria, Emend. Amm. Nom., p. 3.

Definition.—Subplaty-subleptogyral; subangustumbilicate; subpauciseptate; subbrevi-subangustilobate; laterally flexiradiate, peripherally anguliradiate, convexitabulate, subcrassicarinate. (Radial line, fig. 127, p. clxvii.)

Distinction.—From preceding allied genera, which it resembles in ornament, the convexitabulate periphery and somewhat stout carina. From the genus which it resembles in these characters—*Grammoceras*, *e.g. G. audax*, *toarciense*—the difference in mode of ribbing and the smaller umbilicus.

Remarks.—Since this was penned the name chosen has been used.

1. Canavarina folleata (*S. Buckman*). Plate XXX, figs. 1, 2; Suppl., Fig. 128, p. clxvii.

1890. Grammoceras fluitans, This Monogr., Pl. xxx, figs. 1, 2; p. 190.
1902. Canavaria folleata, Emend. Amm. Nom., p. 3.

Distinction.—From *A. fluitans*, Dumortier—the costæ are smaller and less distinct, particularly in the umbilicus, which is also rather less concentric. The costæ also seem to have more lateral curve than in Dumortier's species.

Remarks.—Dr. E. Haug wrote as follows (May 22nd, 1890): "Your *Gram. fluitans* is somewhat different from the specimens of La Verpillière, which I have identified as such; they are more compressed." He was referring to the figure in the part of this work then just published.

2. Canavarina digna, *S. Buckman*. Suppl., Fig. 127, p. clxvii, and Fig. 129, p. cxlii.

1874. Ammonites aalensis, *E. Dumortier*, Depôts Jurass. IV, Pl. 1, fig. 3; cf. ? figs. 1, 2.

[1] In compliment to Prof. Mario Canavari.

Description.—Spissi- and connaticostate; the central whorls smooth to about 10 mm. diameter in the figured specimen.

Distinction.—From *C. folleata*, the smaller, closer set costæ; slightly more compressed whorl.

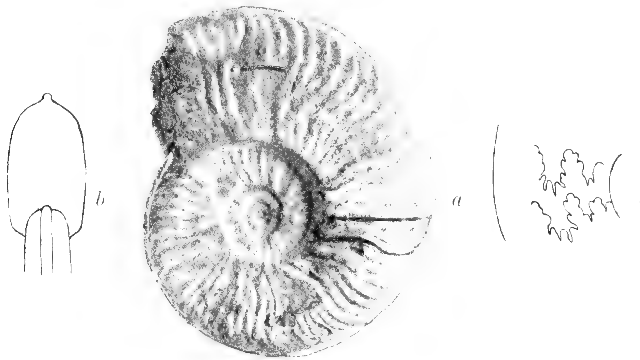


FIG. 129.—*Canavarina digna.*

Locality and Stratum.—Dorset: Burton Bradstock, Yeovil Sands, near the top.

Date of Existence.—*Aalensis* hemera.

3. CANAVARINA STEINMANNI (*Haug*). Suppl., Fig. 130 in text.

1885. HARPOCERAS STEINMANNI, *Haug*, Monogr. *Harp.*; Neues Jahrbuch für Mineral., Bl.-Bd. iii, Pl. xii, fig. 3.

Distinction.—From *C. digna*, the finer ornamentation.

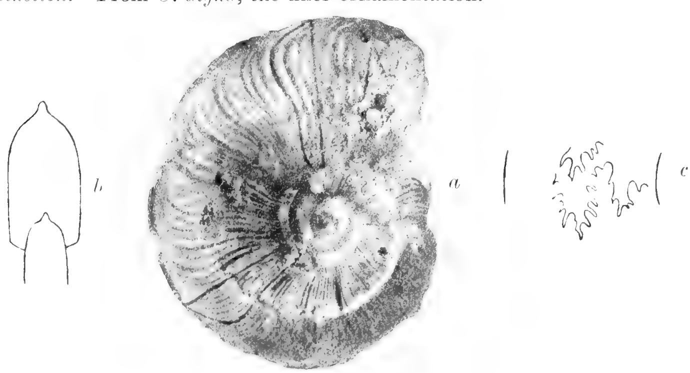


FIG. 130.—*Canavarina Steinmanni* (Haug).

Locality and Stratum.—Dorset: Burton Bradstock [Yeovil Sands, near top].

Date of Existence.—*Aalensis* hemera, presumably.

CANAVARINA VENUSTULA (*S. Buckman*). Plate XXXI, figs. 5, 6 (type); Figs. 10—12?; Suppl., Figs. 131, 132, p. clxvii.

1890. GRAMMOCERAS SUBSERRODENS, This Monogr., Pl. xxxi, figs. 5, 6; 10—12? p. 179 (pars).

1902. CANAVARIA VENUSTULA, Emend. Amm. Nom., p. 3.

Description.—Striate (coarsely); gradumbilicate; periphery fastigate, carina distinct, subacute.

Distinction.—From *C. Steinmanni*, to which it has much likeness—the smaller, finer character of the ornament, the more acute periphery, and rather less thickened carina.

Remarks.—The identification with Branco's *Amaltheus subserrodens*, though justified by the general shape, is vitiated by the coarser ornament. Branco's figure shows a smooth shell; his description speaks only of "fine growth-lines."

Date of Existence.—*Aalensis* hemera.

5. CANAVARINA?, sp. Plate XIII, figs. 4, 5; Suppl., Fig. 133, p. clxvii.

1888. LIOCERAS OPALINUM, This Monogr., Pl. xiii, figs. 4, 5; p. 35 (pars).

Remarks.—Possibly an involute development of *C. venustula*, and agrees therewith in its radial line.

The radial line is not so much curved laterally as in *Lioceras opalinum*.

Locality and Stratum.—Gloucestershire: Coaley Wood, at base of hard capping of Cephalopod Bed (not in hard bed).

Date of Existence.—*Aalensis* hemera (or ? *Opaliniformis*).

B. Septicarinate.[1]

a. Non-tuberculate.

LIX. *Genus*—PSEUDOGRAMMOCERAS, *S. Buckman*.

(Type: *Pseudogrammoceras regale*, sp. n.)

1901. PSEUDOGRAMMOCERAS, Proc. Cotteswold Club, vol. xiv, p. 266.

1902. PSEUDOGRAMMOCERAS, Emend. Amm. Nom., p. 4.

Definition.—Subplaty-subleptogyral; latumbilicate; subdensiseptate, sublongi-sublatilobate; laterally flexiradiate; peripherally acutanguliradiate, convex to convexifastigate, altisepticarinate.[2] (Radial line, fig. 134, p. clxvii.)

Distinction.—From most of the genera of the *Hildoceratidæ*—the septicarina. From genera possessing this character, from *Lillia*, *Haugia*, etc.—the developed

[1] Certain otherwise similar species are included which, on account perhaps of degeneration, do not show a definite septicarina. (See p. cliii.)

[2] Carina bordered by sulci in some species.

rostration shown in the long projection of the radial line; from *Harpoceras* (*falciferum*-group), less lateral flexure of the radial line, the simpler suture line; from *Pseudolioceras*, radial and suture lines.

Remarks.—The typical forms of the genus are flexiradiate, but two other series are placed here for convenience—one subflexiradiate, the other rectiradiate.

In many species expansion of the umbilicus by excentric coiling may be observed. It is particularly noticeable in the leptogyral species, taking place while the umbilicus is comparatively open. Thus *P. pedicum* is subangust-umbilicate in youth and becomes latumbilicate later. One leptogyral species, *P. explicatum*, is an exception; it is latumbilicate throughout, and is an example of concentric coiling.

In many genera, the concavumbilicate Ammonites for example, and forms of the *Hyperlioceras*-type, the leptogyral species do not show expansion of umbilicus until angustumbilication has first been obtained, and often, too, not until the ribs have been lost. In *Pseudogrammoceras* the expansion of the umbilicus is associated with strong ribbing.

I. Flexiradiate.

1. PSEUDOGRAMMOCERAS QUADRATUM (*Quenstedt*), (*Haug*).

1874. AMMONITES GRUNOWI, *Dumortier* (non *Hauer*), Basin du Rhone IV, Pl. xiv, figs. 6, 7 only.

1885. HILDOCERAS QUADRATUM, *Haug*, Monogr. *Harp.*; N. Jahrb. Mineral., Beil-Bd. iii, p. 638.

1887. AMMONITES QUADRATUS, *Denckmann*, Fauna von Doernten; Abh. Geol. Landesanstalt, VIII, 2, Pl. vi, fig. 3.

Remarks.—There are two series of *quadratus*-like species—one in which the ribs are distinctly flexed, the other in which they are hardly curved. Dumortier shows both forms (Pl. xiv, figs. 6, 7; Pl. xv, figs. 1, 2). Denckmann shows the flexed form, agreeing with Dumortier's Pl. xiv, figs. 6, 7, which I take as type-figure of the present species. I showed a flexed form, but it has coarser ribs (see *aff. quadratum*). Brasil[1] figured a straight-ribbed form, but it is a very massive shell, quite distinct.

Locality and Stratum.—Somerset: Shepton Beauchamp, near Ilminster, "Upper Lias."

2. PSEUDOGRAMMOCERAS *aff.* QUADRATUM. Plate XXXIV, figs. 6, 7.

1890. GRAMMOCERAS QUADRATUM, This Monogr., Pl. xxxiv, figs. 6, 7, p. 201.

Remarks.—This form has coarser ribs than the last, but my material of these two forms is scanty and ill preserved.

[1] "Ceph. Nouv.," 'Bull. Soc. Géol. de Normandie,' xvi, Pl. i, figs. 9—11.

3. PSEUDOGRAMMOCERAS SUBQUADRATUM (*S. Buckman*). Plate XXXVI, figs. 3—5; Suppl., Fig. 135, p. clxvii.

1890. GRAMMOCERAS SUBQUADRATUM, This Monogr., Pl. xxxvi, figs. 3—5.
1902. PSEUDOGRAMMOCERAS SUBQUADRATUM, Emend. Amm. Nom., p. 5.

4. PSEUDOGRAMMOCERAS THRASU, *S. Buckman*. Plate XXXVI, figs. 6—8; Suppl. Fig. 136, p. clxvii.

1890. GRAMMOCERAS SÆMANNI, This Monogr., Pl. xxxvi, figs. 6—8.
1902. PSEUDOGRAMMOCERAS THRASU, Emend. Amm. Nom., p 5.

Description.—Subplaty-subleptogyral, subcrassicostate to costate, periphery convexitabulate.

Distinction.—From *P. subquadratum*, the less coarse ornamentation, and the more oligogyral character; from *P. Sæmanni*, see p. cxlix, below.

Locality and Stratum.—Gloucestershire: Coaley Wood, Bed 8, p. 45 (by matrix).

5. PSEUDOGRAMMOCERAS BINGMANNI (*Denckmann*). Plate XXXIV, figs. 3—5; Suppl., Fig. 137, p. clxvii.

1890. GRAMMOCERAS FALLACIOSUM, *var.* BINGMANNI, This Monogr., Pl. xxxiv, figs. 3—5.
1902. PSEUDOGRAMMOCERAS BINGMANNI, Emend. Amm. Nom., p. 4.

Remarks.—Denckmann's two examples differ—one (Pl. v, fig. 4) is more umbilicate and less coarsely costate than the other (Pl. vi, fig. 5). My examples agree in proportions with the first, in costation more with the second.

Distinction.—From *P. thrasu*, thinner, and with a more fastigate periphery.

Locality and Stratum.—Gloucestershire: Coaley Wood, Bed 7, p. 45.

6. PSEUDOGRAMMOCERAS REGALE, *S. Buckman*. Suppl., Figs. 134 (p. clxvii), 138 (p. cxlvi).

Description.—Subplaty-subleptogyral, latumbilicate, subspissicostate, periphery convexifastigate.

Distinction.—From *P. Bingmanni*, thinner, more finely ribbed, and with a slightly larger umbilicus.

Remarks.—Is too thin for Denckmann's *Ammonites Bingmanni* in his Plate v, fig. 4.

Mr. G. C. Crick, F.G.S., kindly compared my figured example with Wright's *Harpoceras radians* in his Plate lxxiv, figs. 1, 2, and writes: "I believe it to be specifically distinct." See *P. Struckmanni*, p. cxlviii, below.

Localities and Strata.—Gloucestershire : Coaley Wood (Bed 7, p. 45) ; Somerset : Maes Knoll, Dundry (Bed 7, p. 687, vol. lii, 'Quart. Journ. Geol. Soc.').

Date of Existence.—*Struckmanni* hemera.

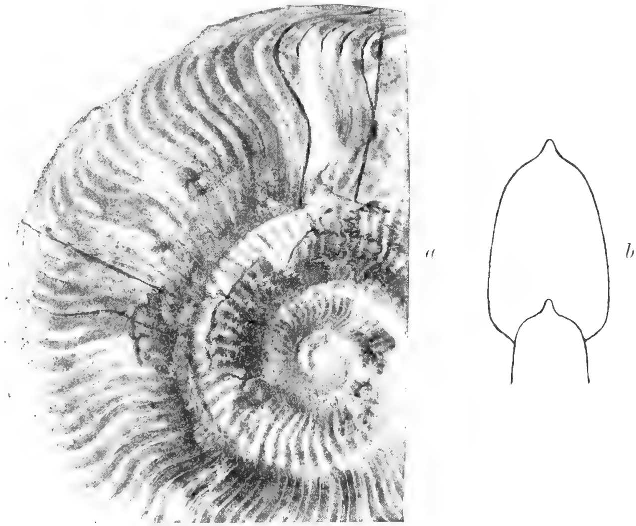


FIG. 138.—*Pseudogrammoceras regale*, 117 mm. diam.

II. Subflexiradiate.

Tenuia.

7. PSEUDOGRAMMOCERAS EXPLICATUM, *S. Buckman.* Plate XXVIII, figs. 14, 15 ; Suppl., Fig. 139, p. clxvii.

1890. GRAMMOCERAS TOARCENSE-STRIATULUM, This Monogr., Pl. xxviii, figs. 14, 15.
1902. PSEUDOGRAMMOCERAS EXPLICATUM, Emend. Amm. Nom., p. 4.

Description.—Subplatyleptogyral, latumbilicate, costate.

Remarks.—Further investigation has shown that the figured example has really a hollow carina—it is septicarinate. Therefore it must be removed from association with *Grammoceras toarciense* and brought into connection with the *Struckmanni* series. The term "*toarcense-striatulum*" was intended to be merely descriptive, not a definite specific title. The placing of "S. Buckman" after it was an editorial "correction" of a supposed omission.

Locality and Stratum.—Gloucestershire: Little Sodbury, Bed 18, p. 165. (? Batcombe, near Shepton Mallet, Upper Lias, but specimen not yet sufficiently freed from matrix).

8. PSEUDOGRAMMOCERAS PEDICUM, *S. Buckman.* Suppl., Fig. 140 in text.

1882. ? HARPOCERAS RADIANS, *Wright*, Pl. lxiv, figs. 5—7.
1885. ? AMMONITES RADIANS DEPRESSUS, *Quenstedt*, Amm. Schwäb. Jura, Pl. lii, fig. 6.
1902. HARPOCERAS FALLACIOSUM, *var.* cf. BINGMANNI, *Janensch*, Jur. Elsass; Abh. Geol. Spez. K. Elsass-Lothr., N.F., H. 5, Pl. vii, fig. 2.

Description.—Subplatyleptogyral, sublatumbilicate; subspissi-subcrassicostate; periphery convexifastigate.

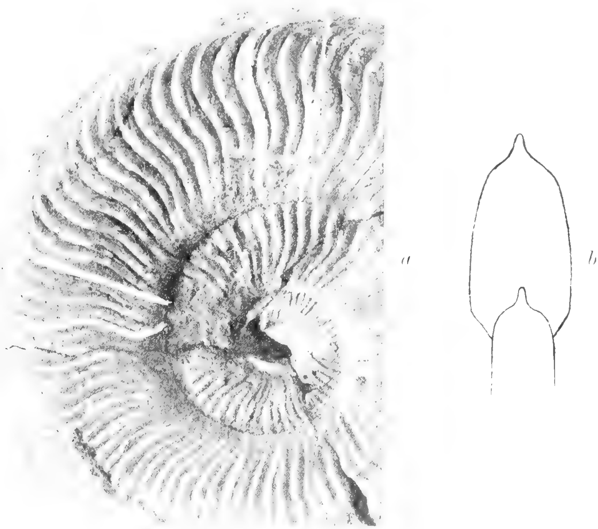


FIG. 140.—*Pseudogrammoceras pedicum*, 113 mm. diam.

Distinction.—From *Grammoceras fallaciosum*, Bayle; the costæ are larger and have a distinct lateral curvature.

Locality and Stratum.—Gloucestershire: Coaley Wood, Bed 8, p. 45.

9. PSEUDOGRAMMOCERAS SUBFALLACIOSUM, *S. Buckman.* Plate XXXIII, fig. 17, 18; Suppl., Fig. 141, p. clxvii.

1874. AMMONITES ESERI, *Dumortier*, vol. iv, Pl. xii, fig. 3.
cf. 1885. AMMONITES RADIANS, *Quenstedt*, Amm. Schwäb. Jura, Pl. liv, fig. 56.
1890. GRAMMOCERAS FALLACIOSUM, This Monogr., Pl. xxxiii, figs. 17, 18.
1902. PSEUDOGRAMMOCERAS SUBFALLACIOSUM, Emend. Amm. Nom., p. 5.

Description.—Subplatyleptogyral, sublatumbilicate, spissicostate, periphery convexifastigate.

Distinction.—From *Gram. fallaciosum*, Bayle, slight lateral flexure of costæ, less distinct costæ, more oligogyral character of the inner whorls. From *P. pedicum*, smaller, more closely set costæ, slightly thinner whorls.

Remarks.—The ribs are slightly flexed laterally. They are more distinct than shown in Plate XXXIII, fig. 17.

Localities and Strata.—Gloucestershire: Coaley Wood, Bed 8, p. 45 (by matrix); Stinchcombe and Cam Down, lower part of Cephalopod Bed. Somerset: White Lackington, Upper Lias—'Quart. Journ. Geol. Soc.,' vol. xlv, p. 450 (1889), 1 ft. 7 in. from top of Bed 4. Foreign.—France: "Milhau, Lias supérieur" (Sturtz).

10. PSEUDOGRAMMOCERAS EXPEDITUM, *S. Buckman.* Pl. XXXIV, figs. 10, 11; Pl. XXXV, fig. 7; Suppl., Fig. 142 in text (Type).

1890. GRAMMOCERAS FALLACIOSUM, *var.* COTTESWOLDIÆ, This Monogr., Pl. xxxiv, figs. 10, 11; Pl. xxxv, fig. 7.
1902. PSEUDOGRAMMOCERAS EXPEDITUM, Emend. Amm. Nom., p. 4.
1902. HARPOCERAS FALLACIOSUM, *var.* COTTESWOLDIÆ, *Janensch*, Jur. Elsass; Pl. vii, fig. 1.

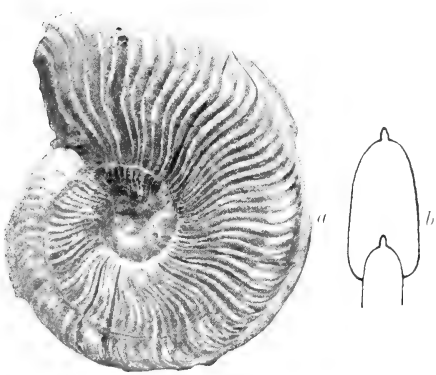


FIG. 142. *Pseudogrammoceras expeditum.* *a*, side view; *b*, sectional view.

Description.— Platyleptogyral, subangustumbilicate, spissicostate.

Remarks. — Compressed flat-sided whorls and a rapid increase in the diameter of the shell are particular features of this species.

Distinction.— From *P. pedicum* and *P. subfallaciosum*, smaller umbilicus.

Localities and Strata. — Gloucestershire, Stinchcombe, Cephalopod Bed; Coaley Wood: Bed 8, p. 45. Somerset: Maes Knoll (Dundry), Bed 7—' Quart. Journ. Geol. Soc.,' vol. 52, p. 687. Foreign: "Avec *G. striatulum*, Tilly-s.-Seulles" (Dr. L. Brasil); "Milhau, Aveyron, Lias supérieur" (Sturtz).

11. PSEUDOGRAMMOCERAS STRUCKMANNI (*Denckmann*). Suppl., Fig. 143, p. clxvii.

1883. HARPOCERAS RADIANS, *Wright* (non *Reinecke*), Monogr. Lias Ammonites, Pl. lxxiv, figs. 1, 2.
1887. AMMONITES STRUCKMANNI, *Denckmann*, Fauna von Doernten, Pl. iii, fig. 1, p. 72.

1890. GRAMMOCERAS FALLACIOSUM, *var.* STRUCKMANNI, This Monogr., pp. 206, 207 (pars).

Remarks.—Wright gives (*loc. cit.*) a figure of a grand specimen, which I identify with Denckmann's species. With Wright's example Mr. G. C. Crick very kindly compared a specimen from my cabinet. He considered it, as I expected, the same species. He notes, however, "the [varying] curvature of the ribs in Wright's figure is not correct; all the ribs are curved in the lateral area."

The radial line (fig. 143, p. clxvii) has been taken from my specimen mentioned above.

Distinction.—From *P. pedicum*, stouter whorls, broader ribs, and more concentric umbilicus.

The distinctions from *A. Bingmanni* are, according to Denckmann (*loc. cit.*, p. 79), that this species is decidedly thinner and not so high-mouthed (*hochmundig*), also it increases very slowly. The ribs have not, as in *A. Bingmanni*, quite so distinct a bend in the first third of their length.

Localities and Strata.—Gloucestershire: Coaley Wood (Bed 7, p. 45); Stinchcombe, Cephalopod Bed, lower part; Buckholt Wood, near Stroud, Cephalopod Bed, (L. Richardson, F.G.S.). Wright does not give the locality of his example.

12. PSEUDOGRAMMOCERAS COTTESWOLDIÆ (*S. Buckman*). Plate XXXV, figs. 4—6; Suppl., Fig. 144, p. clxvii.

1890. GRAMMOCERAS FALLACIOSUM, *var.* COTTESWOLDIÆ, This Monogr., Pl. xxxv, figs. 4—.6

1902. PSEUDOGRAMMOCERAS COTTESWOLDIÆ, Emend. Amm. Nom., p. 5.

1902. HARPOCERAS FALLACIOSUM, *var.* MUELLERI, *Janensch*, Jur. Elsass; Pl. vii, fig. 3.

Distinction.—From *P. expeditum*, which it resembles in general shape, decidedly stouter, and with gibbous-sided whorls.

Localities and Strata.—Gloucestershire: Buckholt Wood (Frocester), Bed 6, p. 164; Sodbury, Bed 11, p. 164. Foreign.—France: "Tilly sur Seulles, *toarcense*," from Dr. L. Brasil; "Milhau, Aveyron, Toarcien" (purchased); "Besançon, Toarcien" (purchased).

Pinguia.

13. PSEUDOGRAMMOCERAS SÆMANNI (*Dumortier*). Suppl., Fig. 145 in text.

1874. AMMONITES SÆMANNI, *Dumortier*, Depôts Jurassiques, vol. iv, Pl. xiii, figs. 4—6.

Remarks.—Dumortier only figures a fragment, but it has special characteristics —a tabulate carinati-sulcate periphery. It was not right to identify with this species examples which lacked such characteristics; hence the identifications in the body of this work are invalid.

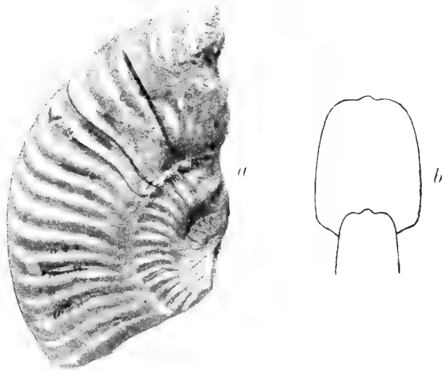


FIG. 145.—*Pseudogrammoceras Sæmanni* (Dumortier).

Locality and Stratum.—Gloucestershire: Wotton-under-Edge, Cephalopod Bed (from Mr. Charles Upton).

14. PSEUDOGRAMMOCERAS OBESUM, *S. Buckman.* Suppl., Fig. 146 in text.

Description.—Subplaty-subleptogyral, sublatumbilicate, costate, periphery convex.

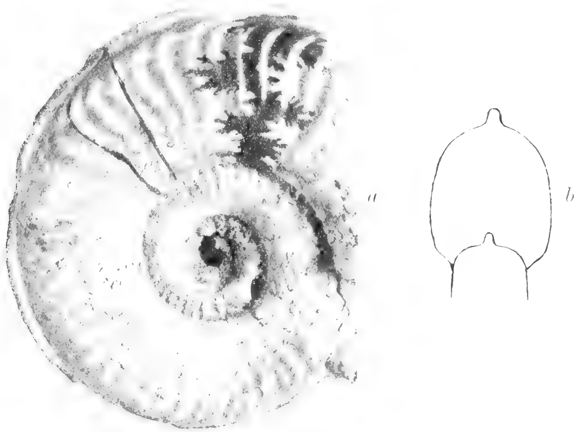


FIG. 146.—*Pseudogrammoceras obesum*, 82 mm diam.

Distinction.—Lacks the furrows and the broad tabulate periphery of *P. Sæmanni.*

Locality and Stratum.—Somerset: Shepton Beauchamp, Upper Lias. I collected the figured specimen from the north side of the cutting in the road leading from Shepton to Boxtone Hill in strata with *Hildoceras.* Its position below the beds yielding species of the *Haugia jugosa*-type attracted my attention at the time, being quite out of accord with that of other species of its genus.

Date of Existence.—*Lilli* hemera.

15. Pseudogrammoceras pachu, *S. Buckman.* Plate XXXIV, figs. 1, 2; Fig. 147, p. clxvii.

1887. ? Ammonites Sæmanni, *Denckmann,* Fauna von Doernten, Pl. iii, fig. 2.
1890. Grammoceras Sæmanni, This Monogr., Pl. xxxiv, figs. 1, 2.
1902. Pseudogrammoceras pachu, Emend. Amm. Nom., p. 4.

Description.—Subplaty-subleptogyral, sublatumbilicate, subspissicostate, periphery convex.

Distinction.—From *P. obesum,* the umbilicus is less concentric—it begins with a smaller centre; the whorls are somewhat flattened on the side, not slightly gibbous; the ribs are more flattened, more approximate, and slightly different in curve.

Locality and Stratum.—Gloucestershire: Cam Down, Dursley, Cephalopod Bed, lower part—a much ironshot matrix.

16. Pseudogrammoceras Muelleri (*Denckmann*). Plate XXXIV, figs. 8, 9; Plate XXXV, figs. 1—3; Suppl., Figs. 148, 149, p. clxvii.

1890. Grammoceras Muelleri, This Monogr., Pl. xxxiv, figs. 8, 9; Pl. xxxv, figs. 1—3.
1902. Pseudogrammoceras Muelleri, Emend. Amm. Nom., p. 4.

Remarks.—My young specimen differs from Denckmann's in having the periphery a trifle narrower and more compressed, and not showing the indications of furrows which he speaks of.

III. Rectiradiate.

17. Pseudogrammoceras fallaciosum (*Bayle*). Suppl., Fig. 150 in text.

1878. Grammoceras fallaciosum, *Bayle*, Explic. Carte géol. France, Pl. lxxviii, figs. 1, 2.
1885. Ammonites radians, *Quenstedt*, Amm. Schwäb. Jura, Pl. li, fig. 4.

Remarks.—A particular feature of Bayle's figure is the straightness of the costæ on the lateral area. The example now figured is the only one at all like

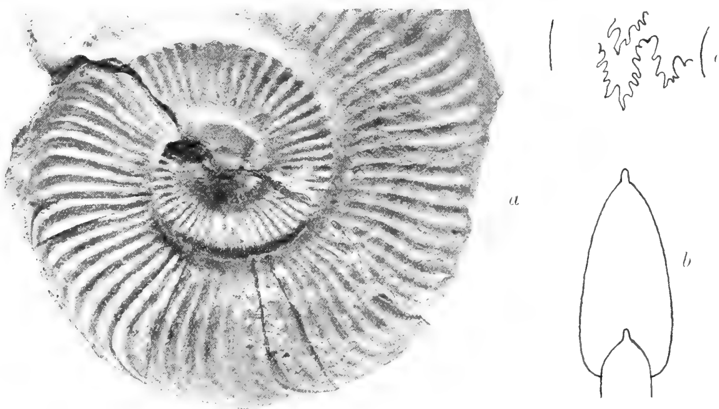


Fig. 150.—*P. fallaciosum* (Bayle). *a*, side view. *b*, section. *c*, part of suture lines.

Bayle's in other respects which also possesses this feature. Whether it is so compressed as Bayle's specimen is difficult to decide on account of that author's figure. Quenstedt figures a large example in which the recticostate character is noticeable.

Locality and Stratum.—Gloucestershire: Stinchcombe Hill, Cephalopod Bed.

18. Pseudogrammoceras, sp.

1882. Harpoceras radians, *Wright*, Lias Ammonites, Pl. lxiv, figs. 1—3.

Remarks.—Wright's figs. 1—3 (Plate lxiv) represent a noticeably coarser, more distant ribbed fossil than Bayle's *G. fallaciosum.* It is also presumably a rather thicker fossil than his; but on this point Bayle gives little opportunity for judgment.

Localities and Stratum.—Gloucestershire: Little Sodbury, in sandstone. Wright quotes his specimen from Frocester Hill.

Species not showing Septicarina.

The suture line particularly indicates that the following species are closely related to *Pseudogrammoceras;* radial line and general appearance support it. But they lack the septicarina. This may be due to degeneration, but such degeneration in the costate stage is unusual.

The radial line and the more lobate suture line separate this series from *Grammoceras.*

19. Pseudogrammoceras ? doerntense (*Denckmann*). Plate XXIX, figs. 1—5; Suppl., Fig. 151, p. clxvii.

1890. Grammoceras doerntense, This Monogr., Pl. xxix, figs. 1—5, only; pp. 182—184 (pars).
1902. Pseudogrammoceras doerntense, Emend. Amm. Nom., p. 4.

Remarks.—Denckmann's fig. 4, in his Pl. viii, may be taken as the type; his fig. 5 is distinctly coarser ribbed.

20. Pseudogrammoceras ? placidum. *S. Buckman.* Plate XXIX, figs. 8—10 (Type); Plate XXXIII, figs. 11, 12; Suppl., Fig. 152, p. clxvii.

1890. Grammoceras doerntense, *var.*, This Monogr., Pl. xxix, figs. 8—10; Pl. xxxiii, figs. 11, 12.
1902. Pseudogrammoceras placidum, Emend. Amm. Nom., p. 5.

Description.—Substeno-subleptogyral, perlatumbilicate; parvicostate to striate. Immature example (Pl. XXXIII, figs. 11, 12)—Subplaty-subleptogyral; latumbilicate.

Distinction.—From *G. doerntense*, the smaller, regular ribs, and the more acute periphery.

21. PSEUDOGRAMMOCERAS? sp. Plate XXIX, figs. 6, 7; Suppl., Fig. 153, p. clxvii.

GRAMMOCERAS DOERNTENSE, This Monogr., Pl. xxix, figs. 6, 7; pp. 182—184 (pars).

Remarks.—More compressed and less costate than *P. doerntense*, and it has a less projected radial line. Its generic position is quite uncertain.

DATES OF EXISTENCE OF *Pseudogrammocerata*.

Since the species were first described attempts have been made towards more exact chronology; for instance, the term "*Dispansum* beds" was found to be too wide. The following table summarises the dates, by hemeræ, so far as present information allows.

DISPANSI.—(Genus, *Phlyseogrammoceras*, see below).

STRUCKMANNI.—*Pseudogrammoceras quadratum ? aff. quadratum, subquadratum, Bingmanni, regale, Struckmanni, Muelleri, doerntense, placidum.*

STRIATULI.—Late:[1] *P. thrasu ? pedicum, subfallaciosum, expeditum, Cotteswoldiæ, Sæmanni ? pachu ? fallaciosum ?* Early: *P. explicatum.*

VARIABILIS.

LILLI.—*P. obesum;* (*Hildoceras semipolitum*).

BIFRONTIS.—(*Hildoceras bifrons*).

b. Tuberculate.

LX. *Genus*—PHLYSEOGRAMMOCERAS,[2] *S. Buckman.*

(Type: *Phlyseogrammoceras mettalarium*,[3] Dumortier, sp.)

1901. PHYLSEOGRAMMOCERAS, Proc. Cotteswold Club, vol. xiii, p. 266 (misprint).
1902. PHLYSEOGRAMMOCERAS, Emend. Amm. Nom., p. 4.

Definition.—Platyleptogyral, subangustumbilicate;[4] laterally parvibullate, flexiradiate; peripherally acutanguliradiate, septicarinate. (Radial line, fig. 154, p. clxvii.)

[1] Date of Ammonites of the *Haugia Eseri*-type; and see Ammonite sequence given in "Dundry Hill," 'Quart. Journ. Geol. Soc.,' vol. lii, p. 688, footnote 2.

[2] Φλύσις, a breaking out.

[3] The species figured in Pl. XXXVI, figs. 1, 2, is the type of the genus.

[4] Becoming latumbilicate by excentric coiling in catagenetic species.

Distinction.—From *Pseudogrammoceras*—the tuberculate ornament; from *Phymatoceras*—the longer projection of the radial line on the periphery. From genera of similar appearance which possess the tuberculate ornament—the septicarina.

1. PHLYSEOGRAMMOCERAS METALLARIUM (*Dumortier*). Plate XXXVI, figs. 1, 2.

1890. GRAMMOCERAS METALLARIUM, This Monogr., Pl. xxxvi, figs. 1, 2.
1902. PHLYSEOGRAMMOCERAS METALLARIUM, Emend. Amm. Nom., p. 4.

Date of Existence.—*Dispansi* hemera.

2. PHLYSEOGRAMMOCERAS DISPANSUM (*Lycett*). Plate A, figs. 41, 42.

1890. GRAMMOCERAS DISPANSUM, This Monogr., Pl. A, figs. 41, 42; p. 211.

3. PHLYSEOGRAMMOCERAS ORBIGNYI (*S. Buckman*). Plate XXVII, figs. 3—6 (figs. 3, 4, Type); Suppl., Fig. 155, p. clxvii.

1890. GRAMMOCERAS ORBIGNYI, This Monogr., Pl. xxvii, figs. 3—6; p. 184.
1902. PHLYSEOGRAMMOCERAS ORBIGNYI, Emend. Amm. Nom., p. 4.

Correction, p. 184.—The small carina is not exactly solid; it is really a degenerate form of a hollow carina. There are traces of the septum in certain cases, though the hollow character is obliterated.

Remarks.—The interpretation of this species seems to be that it is a latumbilicate descendant of *P. metallarium*, but that it does not come through *P. dispansum*. The latumbilication arises from excentric coiling (outcoiling) beginning before any great degree of angustumbilication has been attained. In many cases among Hildoceratidæ the incoiling which produced angustumbilication is carried much farther, even to concavumbilication, before outcoiling commences. In *P. dispansum* angustumbilication (incoiling) is carried farther than in this species.

The following work contains figures of species belonging to the *Gammiradiate* series:—

1898. *Benecke*, Beitr. Kennt. Jura Deutsch-Lothr.; Abh. Spez.-Karte Elsass-Lothr.; N. F., Heft I.

End of *Gammiradiate* series.

FALCIRADIATE.

Nonsepticarinate.

LXI. *Genus*—HILDOCERAS, *Hyatt.*

1889. HILDOCERAS, This Monogr., p. 111. For radial line see Pl. A, fig. 30.

1. HILDOCERAS SEMIPOLITUM, *S. Buckman.* Plate XXII, figs. 30, 31; Plate A, fig. 28.

1889. HILDOCERAS BIFRONS, This Monogr., Pl. xxii, figs. 30, 31; Pl. A, fig. 28.
1902. HILDOCERAS SEMIPOLITUM, Emend. Amm. Nom., p. 4.

Remarks.—The characters of the species are the inclusion up to the lateral sulcation, giving thereby a smooth central area; the numerous small costæ, the compression of the whorl.

Common low down in Cotteswold Sands (*vide* Bed 17, Section p. 45, as *H. bifrons*, and footnote) of many localities of the Cotteswolds. In Upper Lias clay = argillaceous condition of Cotteswold Sands at Overbury (Worcestershire). Not yet found in that Upper Lias which lies below Cotteswold Sands, as at Stinchcombe.

Date of Existence.—*Lilli* hemera.

Septicarinate.

LXII. *Genus*—VACEKIA,[1], *S. Buckman.*

(Type: *Vacekia Stephensi*, sp. n.)

1899. VACEKIA, This Monogr., Expl. of Suppl., Pl. X.

Definition.—Subplaty-subleptogyral, sublatumbilicate; subdensiseptate, sublongi-sublatilobate; laterally anguliradiate; peripherally peracutanguliradiate, tabulate, subalti-septicarinate. (Radial line, fig. 156, p. clxvii.)

Distinction.—The radial curve, with its extreme length of peripheral projection. The only comparable genus from this point of view is *Harpoceras*, but that has neither so long a peripheral projection nor so much lateral curvature of the radial line.

Remarks.—In his work, "Ueber die Fauna der Oolithe von Cap S. Vigilio" ('Abh. der K. K. Geol. Reichsanstalt,' Bd. xii, No. 3, 1886), Vacek figures (pl. viii, figs. 3, 9) certain specimens which appear to show a radial curve comparable with that of the present genus. It is possible, therefore, that *Vacekia* would be their correct genus, but they are not the same species as the one now under consideration.

[1] In compliment to Dr. M. Vacek.

No other figured species with which I am acquainted seems to have any resemblance when proportions and the radial curve are considered, so that the species to be described appears to belong to a particularly scarce series.

1. Vacekia Stephensi, *S. Buckman.* Suppl., Plate X, figs. 17—19; Suppl., Fig. 156, p. clxvii; Fig. 162 in text.

Description.—Given under the generic definition. The ornament consists of very obscure but somewhat distant costæ, which later become definite and more numerous.

Remarks.—Since this species was first figured another example has been found in a parcel of specimens collected some years ago. As this example is larger and gives important additional features, a figure is inserted in the text. The development of the costæ is noteworthy in this example.

Fig. 162.—*Vacekia Stephensi,* Building Stone, Stoke Knap, Dorset.

This species has a certain resemblance in general features to *Asthenoceras nannodes* (see p. xlix); and this is remarkable considering that the date of existence is about the same. But, apart from the great difference in the radial curve, this species is much less umbilicate, and has a distinctly tabulate periphery.

Locality and Stratum.—Dorset: Bradford Abbas, and, judging by the matrix, from the Paving Bed; Stoke Knap, from the Building Stone.

Date of Existence.—*Bradfordensis* hemera. The find at Stoke Knap fixes the date as not earlier than that; the Paving Bed of Bradford Abbas is not later.

Subfalciradiate.

Nonsepticarinate.

LXIII. *Genus*—Polyplectus, *S. Buckman.*

1890. Polyplectus, This Monogr., p. 214.

Remarks.—A genus closely connected with *Harpoceras*, and the absence of a septicarina perhaps due to degeneration. The much less falcate radial line (Fig. 158, p. clxvii.) is a good distinction from that genus.

1. Polyplectus discoides (*Zieten*). Plate XXXVII, figs. 1—5; Suppl., Fig. 157, p. clxvii.

1890. Polyplectus discoides, This Monogr., p. 215.

Septicarinate.

LXIV. *Genus*—Pseudolioceras, *S. Buckman.*

1889. Pseudolioceras, This Monogr., p. 81.

Distinction.—From Lioceratoid genera, the septicarina; from *Harpoceras* or *Vacekia*, the radial line (Fig. 158, p. clxvii).

Remarks.—As the type of the genus I take the species figured by Blake (Yorkshire Lias, Plate viii, fig. 6) as *Harpoceras compactile*, and consider this example to be the type of the species, since this is the first delineation.

Correction.—The idea of this genus being the ancestor of *Hyperlioceras* must be rejected. The two genera are really morphic equivalents, easily distinguishable, however, by their radial lines, as well as by the greater persistence of costation in *Pseudolioceras.*

1. Pseudolioceras gradatum, *S. Buckman.* Plate XX, figs. 3, 4; Suppl., Fig. 159, p. clxvii.

1889. Pseudolioceras compactile, This Monogr., Pl. xx, figs. 3, 4; p. 85.

Description.—Gradumbilicate, costate; and see p. 85.

Remarks.—Must be separated from *P. compactile* on account of its gradumbilicus and its rectangular inner margin. See p. 86.

Locality and Strata.—Gloucestershire: Coaley Wood, Bed 17, Section vi, p. 45. North Nibley, Bed 28 or 30, Section vii, p. 46.

Date of Existence.—*Lilli* hemera.

2. Pseudolioceras Dumortieri, *S. Buckman.*

1874. Ammonites Lythensis, *Dumortier* (non *Young & Bird*), Bassin du Rhône, IV, Pl. xi, figs. 9, 10.
1889. Pseudolioceras compactile, This Monogr., p. 85 (pars).

Description.—Perangustumbilicate, but gradumbilicate, inner margin rectangular; costate; periphery narrow, subtabulate.

Distinction.—From *P. gradatum*, the smaller umbilicus, narrower periphery, slightly more compressed whorls.

Remarks.—The largest specimen of this species is the size of the *P. gradatum*, Plate XX, fig. 3. To obtain an idea of this species give to that view of *P. gradatum* the umbilicus of Fig. 5.

Dumortier's figure represents the species well, except that the last three ribs are too coarse.

Locality and Stratum.—Gloucestershire: North Nibley, Bed 28 or 30, Section vii, p. 46. This is commoner than the other species.

Date of Existence.—*Lilli* hemera.

3. Pseudolioceras pumilum, *S. Buckman.* Pl. xx, figs. 5, 6.

1889. Pseudolioceras compactile, This Monogr., Pl. xx, figs. 5, 6.
1902. — pumilum, Emend. Amm. Nom., p. 5.

Description.—Perangustumbilicate, with tendency to widen; gradumbilicate, inner margin rectangular; costate; periphery somewhat narrow, with tendency to broaden, penetabulate.

Distinction.—From *P. gradatum*, a smaller umbilicus, a broader periphery, with more distinct areas each side of a less prominent carina. From *P. Dumortieri*, broader and more tabulate periphery.

Remarks.—This species shows signs of hypostrophy—in the tendency to excentrumbilication, broadening of periphery, and tendency to increase thickness of whorl. It is, perhaps, a gerontic form of *P. Dumortieri.*

Locality and Stratum.—Gloucestershire: North Nibley, Bed 28, Section vii, p. 46.

Date of Existence.—*Lilli* hemera.

4. Pseudolioceras compactile (*Simpson*).

1889. Pseudolioceras compactile, This Monogr., p. 85 (pars).
1902. Harpoceras (Pseudolioceras) compactile, *Janensch*, Jur. Elsass; Abh. Geol. Spez.-Karte-Elsass-Lothr., N.F., H. 5, Pl. v, fig. 5.

Distinction.—From *P. gradatum*, the concavumbilicus.

Notes.—Remove from the synonomy, p. 85, *Amm. lythensis, falcodiscus,* and *compactile* (*Haug*). Remove the references to plates of this Monograph. Transfer description to *P. gradatum.*

Remarks.—A sloping inner margin and a regular concavumbilicus characterise this species according to Blake's figure and description. See p. 86 of this Monograph.

Apparently Denckmann's *A. Wurttenbergeri* cannot be separated from this species; at least, it has the same concavumbilicus as Blake's figure.

Distinction.—From *P. gradatum,* the concavumbilicus.

Localities and Strata.—Gloucestershire: Coaley Wood, Bed 7 of Section vi, p. 45, a specimen 113 mm. in diameter; North Nibley, Cephalopod Bed.

Date of Existence.—*Struckmanni* hemera.

5. Pseudolioceras falcidiscus (*Quenstedt*).

1885. Ammonites falcodiscus, *Quenstedt,* Amm. Schwäb. Jura, Pl. liv, fig. 24 only.
1889. Pseudolioceras compactile, This Monogr., p. 85 (pars).

Distinction.—From *P. gradatum,* the concavumbilicus, and the carina less definitely separated from the periphery. From *P. compactile,* the larger umbilicus, and the more distinct costæ.

Locality and Stratum.—Gloucestershire: Stinchcombe Hill, towards base of Cephalopod Bed.

Date of Existence.—*Striatuli,* or *Struckmanni* hemera.

6. Pseudolioceras Beyrichi (*Schloenbach*). Plate XX, figs. 7, 8; Plate A, fig. 22; Suppl., Fig. 160, p. clxvii.

1889. Pseudolioceras Beyrichi, This Monogr., Pl. xx, figs. 7, 8; Pl. A, fig. 22; p. 87 (pars).

Locality and Stratum.—Gloucestershire: Coaley Wood, upper part of Cephalopod Bed.

Date of Existence.—*Aalensis* hemera, probably.

7. Pseudolioceras replicatum, *S. Buckman.* Pl. XX, figs. 9, 10. Suppl., Fig. 161, p. clxvii.

1889. Pseudolioceras Beyrichi, This Monogr., Pl. xx, figs. 9, 10; p. 87 (pars).
1902. — replicatum, Emend. Amm. Nom., p. 5.

Description.—Gradumbilicate, costatumbilicate, subcostate; and see p. 87.

Distinction.—From *P. Beyrichi,* the larger and costate umbilicus; the less definite costation; the whorl section.

Locality and Horizon.—Gloucestershire: North Nibley, Bed 6, Section vii, p. 46.

Date of Existence.—*Aalensis* hemera.

The two following species remain for record :

7. Denckmannia bredonensis, *S. Buckman.*

1903. Denckmannia bredonensis, Quart. Journ. Geol. Soc , vol. lix, Pl. xxvii, figs. 1—4, p. 459.

Locality and Stratum.—Worcestershire : Overbury, in a gravel pit, with derived Toarcian and other materials. Collection of Surgeon-Major Isaac Newton.

Date of Existence.—Hemera *Variabilis* (presumably). For allied species see pp. xvii—xxii.

2. Chartronia costigera, *S. Buckman.*

1903. Chartronia costigera, Quart. Journ. Geol. Soc., vol. lix, Pl. xxviii, figs. 1—4, p. 459.

Locality and Stratum.—Gloucestershire : Buckholt Wood, near Stroud, Cephalopod Bed (*Dispansum* bed). Collection of Mr. Charles Upton.

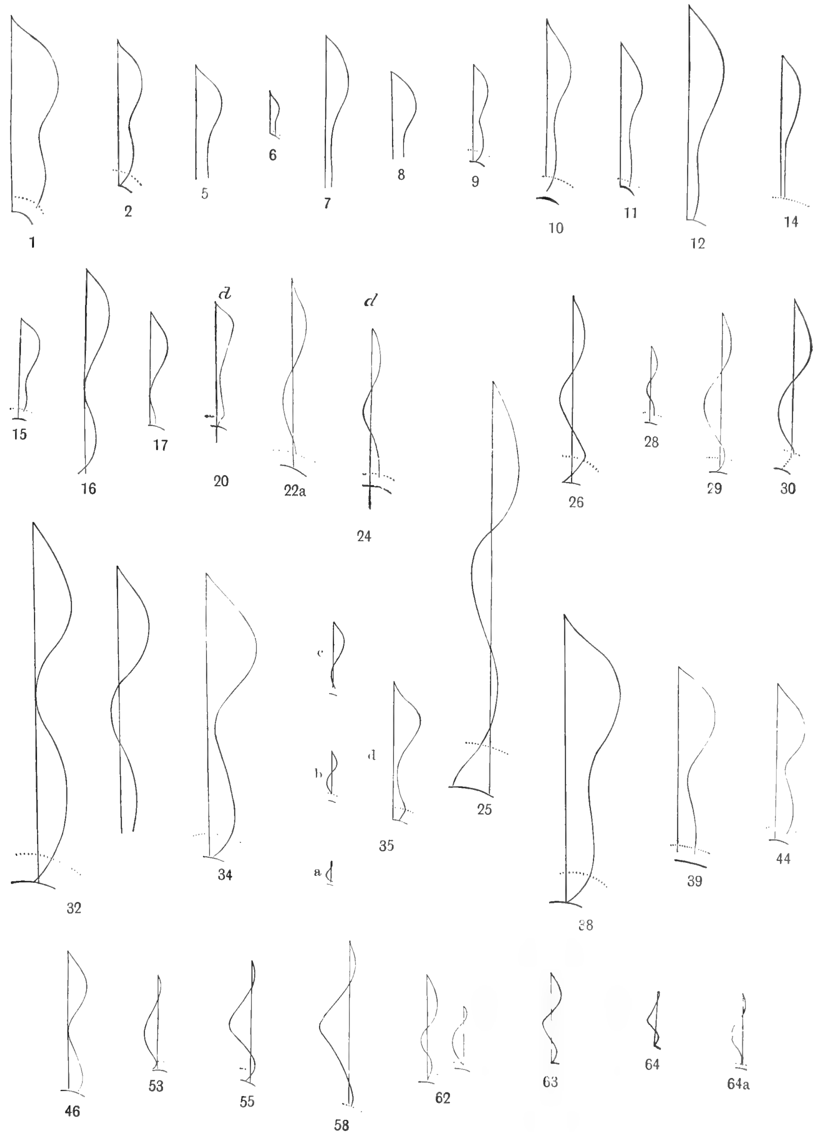
Date of Existence.—Hemera *Dispansi.* For allied species see p. xvi.

SUPPLEMENT, TABLE I.

Fig. 1.—*Cypholioceras opaliniforme*, pp. xliii, xlv.
Fig. 2.—*Lioceras opalinum*, pp. xxxv, xli.
Fig. 5.—*Ancolioceras substriatum*, pp. xlvii, xlviii.
Fig. 6.—*Asthenoceras nannodes*, p. xlix.
Fig. 7.—*Cylioceras undatum*, pp. xlix, l.
Fig. 8.—*Geyeria fasciata*, p. l.
Fig. 9.—*Geyeria ? evertens*, p. l.
Fig. 10.—*Welschia obtusiformis*, p. li.
Fig. 11.—*Cosmogyria obtusa*, p. lii.
Fig. 12.—*Hyattia pustulifera*, p. lv.
Fig. 14.—*Hyattina Brasili*, p. lvii.
Fig. 15.—*Manselia subfalcata*, p. lviii.
Fig. 16.—*Apedogyria patellaria*, p. lix.
Fig. 17.—*Ludwigina patula*, p. lxi.
Fig. 20 *d.*—*Strophogyria cosmia*, p. lxiii.
Fig. 22 *a.*—*Kiliania laciniosa*, pp. lxiv, lxv.
Fig. 24 *d.*—*Paquieria angulata*, p. lxvii.
Fig. 25.—*Wiltshireia gigantea*, p. lxviii.
Fig. 26.—*Ludwigia Murchisonæ*, p. lxix.
Fig. 28.—*Rhæboceras tortum*, p. lxxii.
Fig. 29.—*Crickia reflua*, p. lxxiii.
Fig. 30.—*Lucya caduceifera*, pp. lxxiv, lxxv.
Fig. 32.—*Lucya magna*, p. lxxvi. (Two radial lines.)
Fig. 34.—*Depaoceras fallax*, pp. lxxvii, lxxviii.
Fig. 35 *a*—*d.*—*Depaoceras fallax*, p. lxxviii. (Four radial lines showing development.)
Fig. 38.—*Depaoceras formosum*, p. lxxix.
Fig. 39.—*Brasilia bradfordensis*, p. lxxx.
Fig. 44.—*Brasilina Tutcheri*, p. lxxxiii.
Fig. 46.—*Ludwigella arcitenens*, pp. lxxxiv, lxxxv.
Fig. 53.—*Pseudographoceras literatum*, p. xci.
Fig. 55.—*Platygraphoceras apertum*, p. xciii.
Fig. 58.—*Graphoceras v-scriptum*, pp. xcv, xcvi.
Fig. 62.—*Braunsina contorta*, p. xcix. (Two radial lines showing development.)
Fig. 63.—*Braunsina ? angulifera*, p. ci.
Fig. 64.—*Braunsina ? futilis*, p. ci.
Fig. 64 *a.*—*Braunsella semilenis*, p. cii.

SUPPLEMENT, TABLE I.

Radial lines.—Hildoceratidæ.



SUPPLEMENT, TABLE II.

Fig. 65.—*Reynesia intermedia*, p. ciii. (Two radial lines showing development of rostration during ontogeny.)

Fig. 66.—*Darellina planaris*, p. cvi. (Two radial lines showing rapid development of rostration.)

Fig. 68.—*Darellella recticostata*, p. cvii.

Fig. 69.—*Œdania falcigera*, pp. cvii, cviii. (Two radial lines showing change from falcate to biarcuate.)

Fig. 70.—*Reynesella juncta*, p. cix.

Fig. 71.—*Hugia curva*, p. cxi.

Fig. 72.—*Lopadoceras arcuatum*, pp. cxi, cxii.

Fig. 73.—*Darellia semicostata*, p. cxiii.

Fig. 74.—*Darellia lævis*, p. cxiii.

Fig. 76.—*Dissoroceras tabulatum*, p. cxv. (Two radial lines.)

Fig. 79.—*Deltoidoceras astrictum*, pp. cxvii, cxviii.

Fig. 82.—*Deltoidoceras subdiscoideum*, p. cxviii. (From specimen figured Pl. XIX, figs. 5, 6.)

Fig. 83.—*Deltotoceras cuneatum*, p. cxix.

Fig. 86.—*Deltotoceras subsectum*, p. cxxi.

Fig. 87.—*Hyperlioceras discites*, pp. cxxi, cxxii.

Fig. 89.—*Hyperlioceras Desori*, p. cxxii.

Fig. 91.—*Hyperlioceras Lucyi*, p. cxxiii. (Radial lines at two stages in the same specimen.)

Fig. 93.—*Hyperlioceras sublere*, p. cxxiii.

Fig. 94.—*Hyperlioceras rudidiscites*, p. cxxiv.

Fig. 95.—*Hyperlioceras liodiscites*, p. cxxv. (Two radial lines.)

Fig. 97.—*Toxolioceras Walkeri*, p. cxxvi.

Fig. 99.—*Stokeia marmorea*, pp. cxxvii, cxxviii.

Fig. 100.—*Canavarella belophora*, pp. cxxviii, cxxix.

Fig. 101.—*Canavarella ? arenacea*, p. cxxix.

Fig. 102.—*Cypholioceras plicatum ?* p. cxxx. (From specimen figured Pl. XIV, figs. 5, 6.)

Fig. 103.—*Grammoceras striatulum*, pp. cxxxi, cxxxiii.

Fig. 104.—*Grammoceras audax*, p. cxxxii.

Fig. 105.—*Cotteswoldia paucicostata*, p. cxxxiii.

Fig. 106.—*Cotteswoldia limatula*, p. cxxxiv.

Fig. 107.—*Cotteswoldia superba*, p. cxxxiv.

Fig. 108.—*Cotteswoldia subcandida*, p. cxxxv. (Two radial lines.)

Fig. 109.—*Cotteswoldia misera*, p. cxxxv.

Fig. 110.—*Cotteswoldia*, sp., p. cxxxv.

Fig. 111.—*Cotteswoldia crinita*, p. cxxxvii.

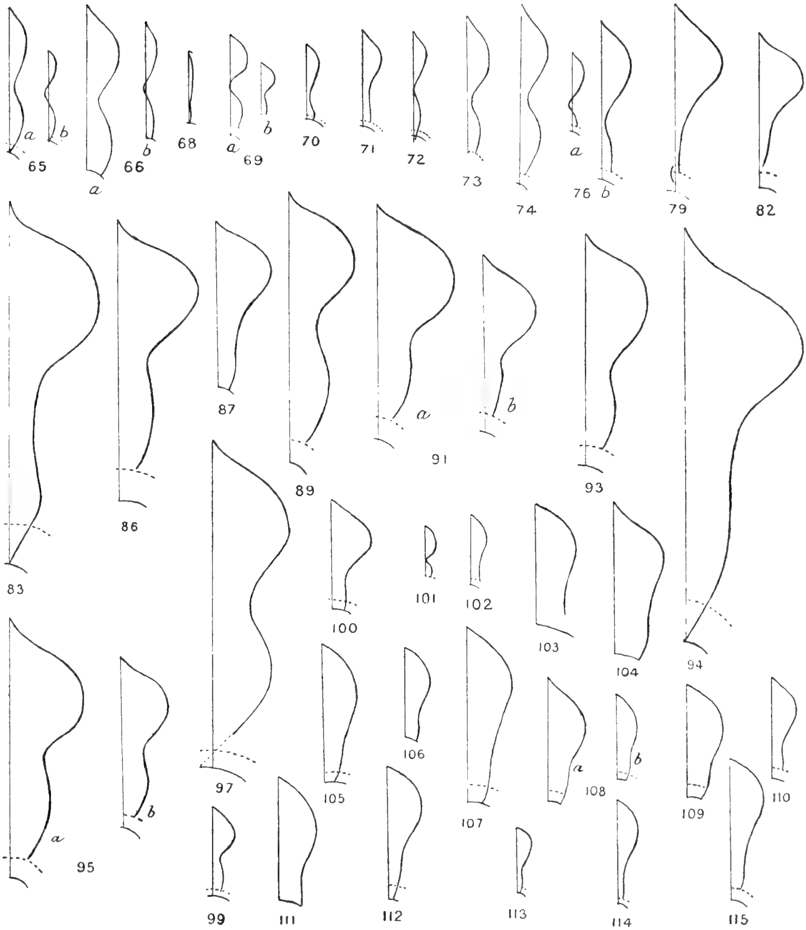
Figs. 112, 113.—*Pleydellia aalensis*, p. cxxxvii. (Fig. 112 from specimen figured Pl. XXXII, figs. 4—6; Fig. 113 from specimen figured Pl. XXXII, fig. 3.)

Fig. 114.—*Pleydellia fluens*, p. cxxxvii.

Fig. 115.—*Pleydellia leura*, p. cxxxviii. (From specimen figured Pl. XXXIII, figs. 8—10.)

SUPPLEMENT, TABLE II.

Radial lines.—HILDOCERATIDÆ.



SUPPLEMENT, TABLE III.

Fig. 116.—*Pleydellia leura*, p. cxxxviii. (From specimen figured Pl. XXXIII, figs. 5—7.)

Fig. 117.—*Pleydellia? subcompta?* p. cxxxviii.

Fig. 118.—*Pleydellia*, sp. A., p. cxxxviii.

Fig. 119.—*Pleydellia? mactra?* p. cxxxix.

Fig. 120.—*Pleydellia*, sp. B., p. cxxxix.

Fig. 121.—*Walkeria arcuata*, p. cxxxix.

Fig. 123.—*Walkeria? lotharingica?* p. cxl.

Fig. 124.—*Walkeria?* sp., p. cxl.

Figs. 125, 126.—*Walkeria? subglabra*, p. cxli. (Fig. 125 from specimen figured Pl. XIII, figs. 7, 8; Fig. 126 from specimen figured Pl. XIII, figs. 9, 10.)

Fig. 127.—*Canavarina digna*, p. cxli.

Fig. 128.—*Canavarina folleata*, p. cxli.

Figs. 131, 132.—*Canavarina venustula*, p. cxliii. (Fig. 131 from specimen figured Pl. XXXI, figs. 10, 11; Fig. 132 from specimen figured Pl. XXX, figs. 5, 6.)

Fig. 133.—*Canavarina?* sp., p. cxliii.

Fig. 134.—*Pseudogrammoceras regale*, pp. cxliii, cxlv.

Fig. 135.—**Pseudogrammoceras subquadratum*, p. cxlv.

Fig. 136.—**Pseudogrammoceras thrasu*, p. cxlv.

Fig. 137.—**Pseudogrammoceras Bingmanni*, p. cxlv.

Fig. 139.—**Pseudogrammoceras explicatum*, p. cxlvi.

Fig. 141.—**Pseudogrammoceras subfallaciosum*, p. cxlvii.

Fig. 143.—**Pseudogrammoceras Struckmanni*, p. cxlviii.

Fig. 144.—**Pseudogrammoceras Cotteswoldiæ*, p. cxlix.

Fig, 147.—**Pseudogrammoceras pachu*, p. cli.

Figs. 148, 149.—**Pseudogrammoceras Muelleri*, p. cli. (Fig. 148 from specimen figured Pl. XXXIV, figs. 8, 9; Fig. 149 from specimen figured Pl. XXXV, figs. 1—3.)

Fig. 151.—*Pseudogrammoceras? doerntense*, p. cliii. (*a* from specimen figured Pl. XXIX, figs. 4, 5; *b* from Pl. XXIX, figs. 1, 2.)

Fig. 152.—*Pseudogrammoceras? placidum*, p. cliii.

Fig. 153.—*Pseudogrammoceras?* sp., p. cliv.

Fig. 154.—*Phlyseogrammoceras mettalarium*, pp. cliv, clv.

Fig. 155.—*Phlyseogrammoceras Orbignyi*, p. clv. (From specimen figured Pl. XXVII, figs. 5, 6.)

Fig. 156.—*Vacekia Stephensi*, pp. clvi, clvii.

Fig. 157.—*Polyplectus discoides*, p. clvii. (From a specimen in my collection.)

Fig. 158.—**Pseudolioceras lythense*, Young and Bird. (From a specimen in my collection, from Whitby.[1])

Fig. 159.—*Pseudolioceras gradatum*, p. clviii.

Fig. 160.—*Pseudolioceras Beyrichi*, p. clx.

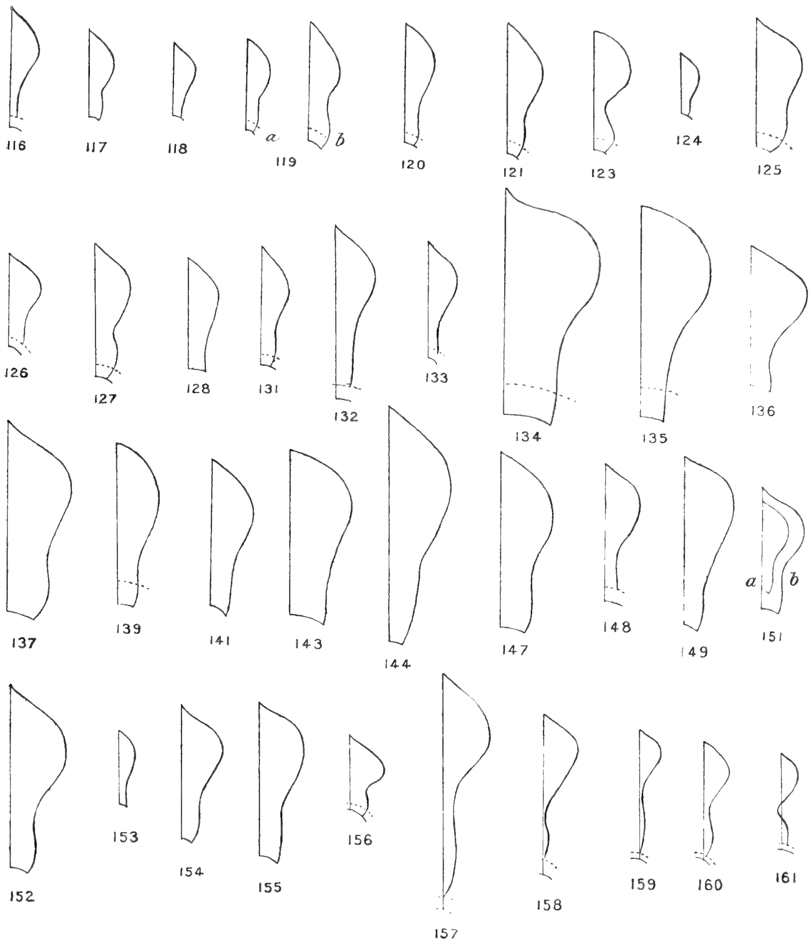
Fig. 161.—*Pseudolioceras replicatum*, p. clx.

* Without carina, therefore the peripheral projection appears slightly less.

[1] By an oversight on my part the radial line has been taken from *P. lythense* instead of from the genotype *P. compactile*.

SUPPLEMENT, TABLE III.

Radial lines.—HILDOCERATIDÆ.



SUPPLEMENT, PLATE XV.

Murchisonæ hemera.

Figs. 1—3.—KILIANIA ? TUBERATA, *S. Buckman.*

Fig. 1.—Side view of a specimen without test. From the Pea Grit series of the Andoversford neighbourhood, probably from Brockhampton, Gloucestershire. (Page lxvi.)
Fig. 2.—Front view.
Fig. 3.—Suture-lines. 3 *a*. Radial-line.

Figs. 4—6.—KILIANIA LACINIOSA, *S. Buckman.*

Fig. 4.—Side view of a specimen with test. "Wild Bed," Chideock Quarry Hill, Dorset. (Page lxv.)
Fig. 5.—Front view.
Fig. 6.—Suture-lines. 6 *a*, *b*. Radial-lines.

Bradfordensis hemera.

Figs. 7, 8.—WILTSHIREIA GIGANTEA, *S. Buckman.*

Fig 7.—Side view of an immature specimen. From the "Building Stone," Stoke Knap, near Broad Windsor, Dorset. (Page lxviii.)
Fig. 8.—Suture-line. 8 *a*. Radial-line.
(See Suppl. Pl. XI, fig. 31; also Pl. XI, fig. 1, 1888.)

Concavi hemera.

Figs. 9—11.—GRAPHOCERAS ROBUSTUM, *S. Buckman.*

Fig. 9.—Side view. "Fossil Bed," Bradford Abbas, Dorset. (Page xcv.)
Fig. 10.—Front view.
Fig. 11.—Radial-line.

Figs. 12—14.—GRAPHOCERAS MIRABILE, *S. Buckman.*

Fig. 12.—Side view. "Fossil Bed," Bradford Abbas, Dorset. Collected by Mr. Darell Stephens, F.G.S. (Page xcvii.)
Fig. 13.—Whorl-section.
Fig. 14.—Radial-lines.

Discitæ hemera.

Figs. 15—17.—GRAPHOCERAS ? INCLUSUM, *S. Buckman.*

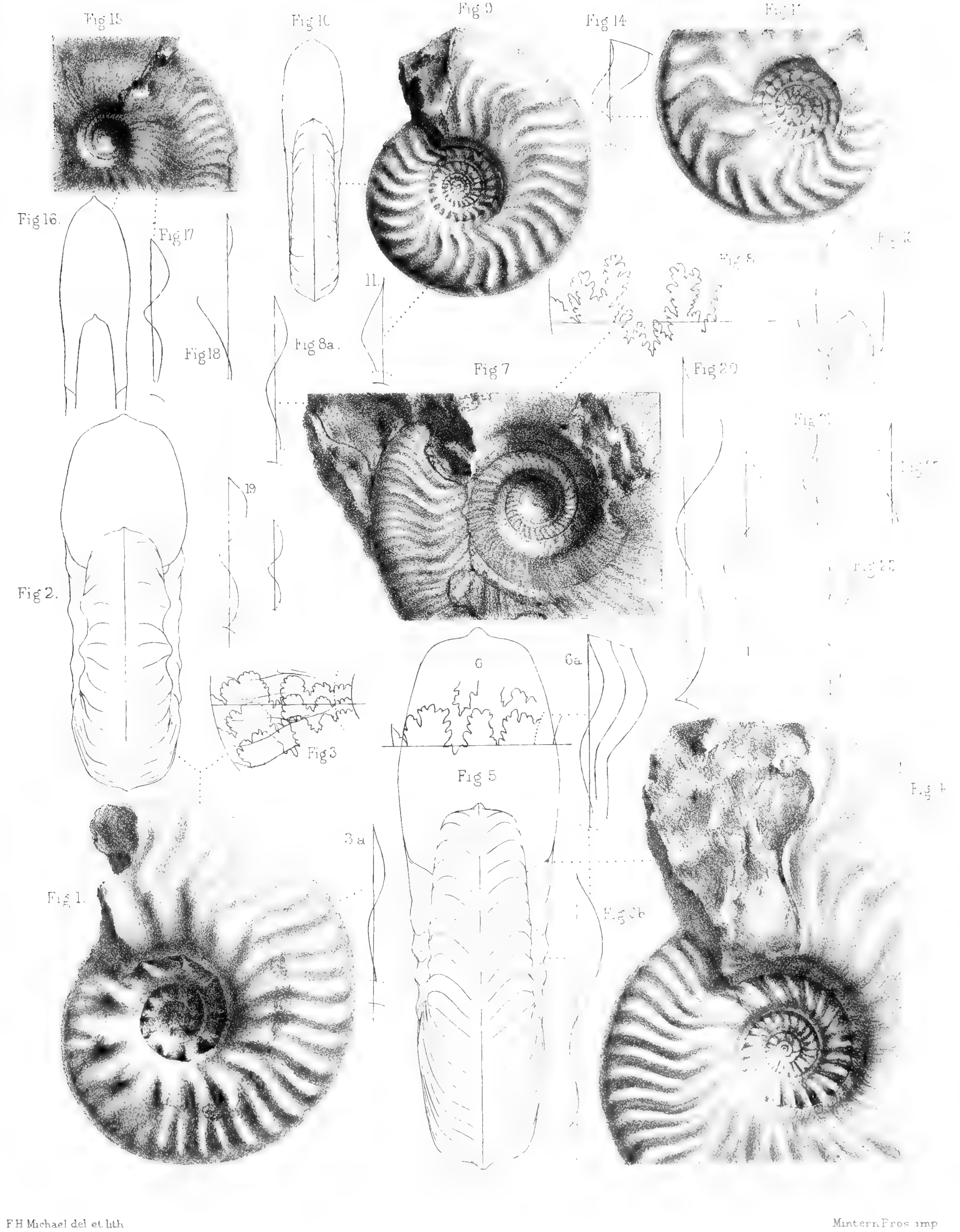
Fig. 15.—Side view. "Fossil Bed," Bradford Abbas. (Page xcviii.)
Fig. 16.—Whorl-section.
Fig. 17.—Radial-line.

Figs. 18—23.—Radial-lines.

Fig. 18.—*Graphoceras v-scriptum*, Pl. X, figs. 5, 6. (Page xcvi.)
Fig. 19.—*Graphoceras ? decorum*, Pl. VIII, figs. 3, 4. (At two periods.) (Page xcviii.)
Fig. 20.—*Lucya ? cavata*, Pl. IX, figs. 1, 2. (At two periods.) (Page lxxvi.)
Fig. 21.—*Pseudographoceras ? compressum*, Pl. XV, figs. 5, 6. (Page xciii.)
Fig. 22.—*Graphoceras limitatum*, Pl. X, figs. 7, 8. (Page xcvi.)
Fig. 23.—*Platygraphoceras apertum*, Pl. X, figs. 10, 11. (Page xciv.)

The references denote the specimens from which the radial-lines have been taken.

All the specimens are in my Collection.



F H Michael del et lith

Mintern Bros imp

SUPPLEMENT, PLATE XVI.

Discitæ hemera.

Figs. 1—3.—Depaoceras fallax, *S. Buckman.*

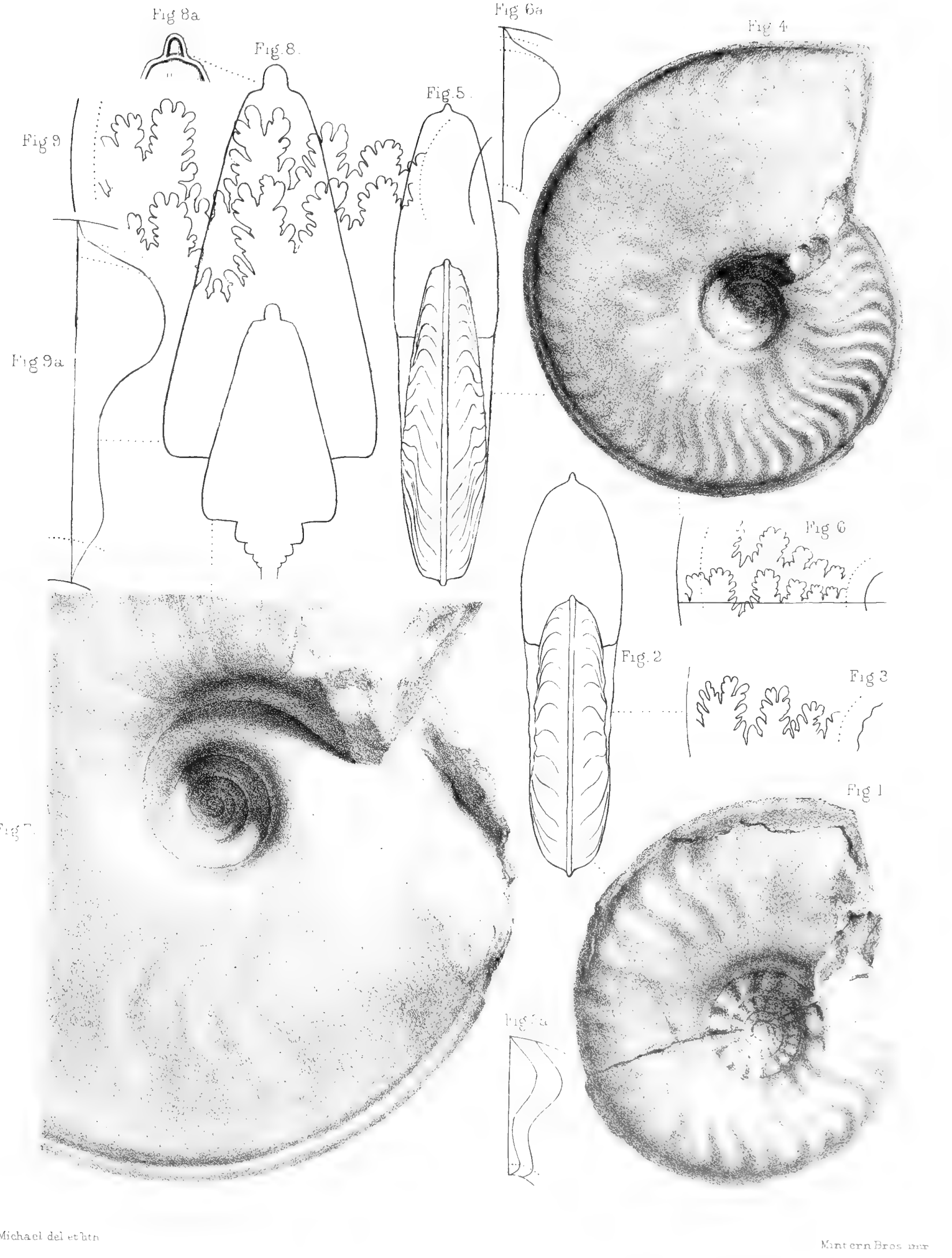
Fig. 1.—Side view. "Fossil Bed," Bradford Abbas, Dorset. (Page lxxviii.)
Fig. 2.—Front view.
Fig. 3.—Suture-line. 3 *a*. Radial-line.
(See Pl. XIV, figs. 10, 11, "*Lioceras fallax*.")

Figs. 4—6.—Hyperlioceras curvicostatum, *S. Buckman.*

Fig. 4.—Side view of a wholly septate specimen almost without test. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens, F.G.S. (Page cxxiv.)
Fig. 5.—Front view. The carina is not drawn conspicuous enough.
Fig. 6.—Suture-lines. 6 *a*. Radial-line.

Figs. 7—9.—Deltotoceras cuneatum, *S. Buckman.*

Fig. 7.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens. (Page cxix.)
Fig. 8.—Whorl-sections. 8 *a*. Section of the septicarina.
Fig. 9.—Suture-lines. 9 *a*. Radial-line.



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Mintern Bros imp.

SUPPLEMENT, PLATE XVII.

Discitæ hemera.

Figs. 1—3.—REYNESELLA ? RODBURGENSIS, *S. Buckman.*

Fig. 1.—Side view. Rodborough Hill, near Stroud; Lower *Trigonia*-grit. (Page cx.)
Fig. 2.—Front view.
Fig. 3.—Radial curve. 3 *a*. Outline of the lateral mouth-border.

Figs. 4—6.—REYNESELLA JUNCTA, *S. Buckman.*

Fig. 4.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens. (Page cix.)
Fig. 5.—Front view.
Fig. 6.—Radial curve.

Figs. 7—9.—BRAUNSELLA ? ROTABILIS, *S. Buckman.*

Fig. 7.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens. (Page cii.)
Fig. 8.—Front view.
Fig. 9.—Radial curve.

Figs. 10—12.—DARELLELLA RECTICOSTATA, *S. Buckman.*

Fig. 10.—Side view. Bradford Abbas, "Fossil Bed." From my father's Collection. (Page cvii.)
Fig. 11.—Front view.
Fig. 12.—Radial curve. 12 *a*. Outline of lateral mouth-border. 12 *b*. Suture-line from another example.

Figs. 13—15.—BRAUNSINA ASPERA, *S. Buckman.*

Fig. 13.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens. (Page xcix.)
Fig. 14.—Front view.
Fig. 15.—Radial curves. 15 *a*. Outline of lateral part of aperture.

Figs. 16—18.—BRAUNSINA CONTORTA, *S. Buckman.*

Fig. 16.—Side view. Bradford Abbas, "Fossil Bed." (Page xcix.)
Fig. 17.—Front view.
Figs. 18, 18 *a*.—Radial curves.

Figs. 19—21.—BRAUNSELLA SEMILENIS, *S. Buckman.*

Fig. 19.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens. (Page cii.)
Fig. 20.—Front view.
Fig. 21.—Radial curve.

Figs. 22—24.—DARELLINA PLANARIS, *S. Buckman.*

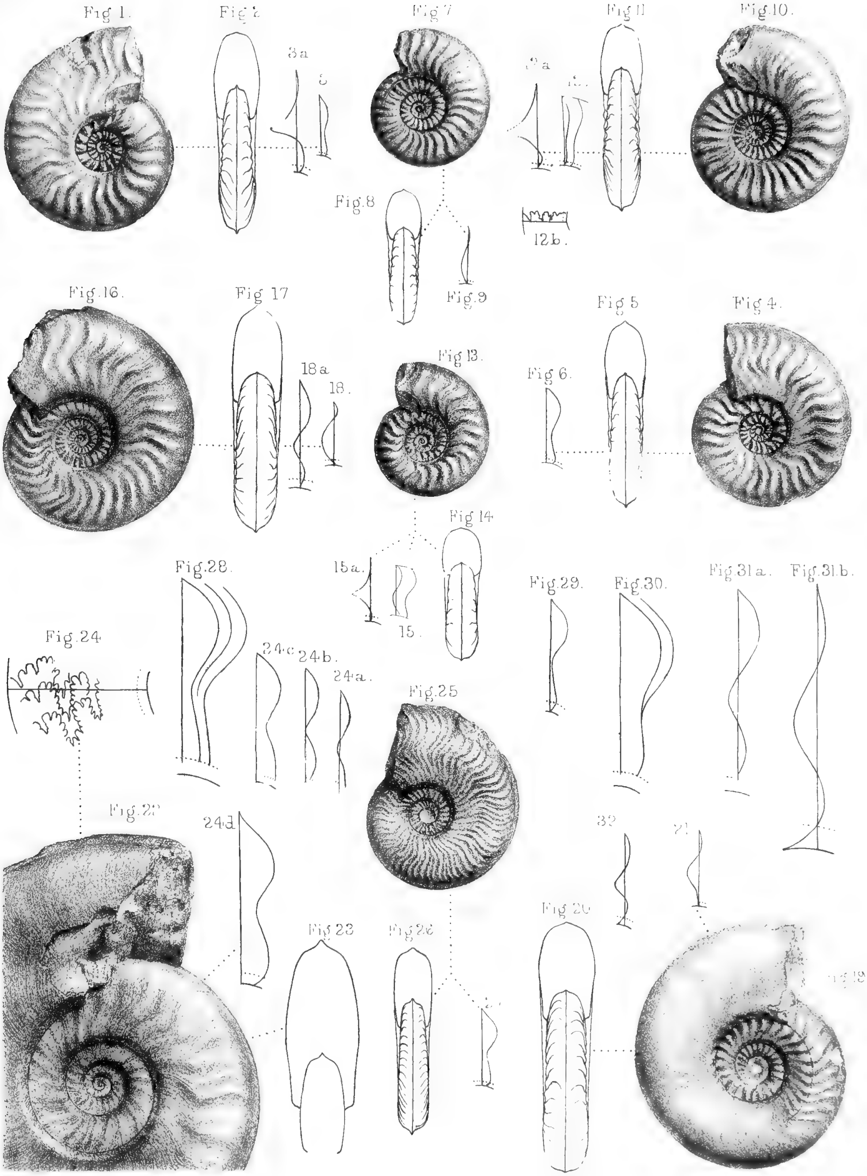
Fig. 22.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens. (Page cvi.) Type; and see Suppl., Pl XXII, figs. 7—9.
Fig. 23.—Whorl-section.
Fig. 24.—Suture-lines. 24 *a*—*d*. Radial lines at different periods.

Figs. 25—27.—REYNESELLA ? LINEATA, *S. Buckman.*

Fig. 25.—Side view. Bradford Abbas, "Fossil Bed." (Page cx.)
Fig. 26.—Front view.
Fig. 27.—Radial curve.

Figs. 28—32.—RADIAL CURVES.

Fig. 28.—*Brasilia bradfordensis*, Pl. IV, fig. 5. (Page lxxv.)
Fig. 29.—*Hyattina* sp., Pl. IV, fig. 7. (Page cxxx.)
Fig. 30.—*Ancolioceras? costatum*, Pl. VII, fig. 7. (Page xlviii.)
Fig. 31.—*Ludwigia ambigua*, Pl. VII, figs. 1, 2. (Page lxxii.)
Fig. 32.—*Braunsella lenis*, Pl. VII, figs. 5, 6. (Page cii.)



F.H.Michael del.et. lith.

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SUPPLEMENT, PLATE XVIII.

Discitæ hemera.

Figs. 1—3.—Toxolioceras Walkeri, *S. Buckman.*

Fig. 1.—Side view. Bradford Abbas, "Fossil Bed." (Page cxxvi.)

(See Fig. 22, and also Pl. XVI, figs. 1, 2, "*Hyperlioceras Walkeri.*")

Fig. 2.—Whorl-section.

Fig. 3.—Radial curve.

Figs. 4—6.—Toxolioceras mundum, *S. Buckman.*

Fig. 4.—Side view. Bradford Abbas, "Fossil Bed." My father's Collection. (Page cxxvi.)

Fig. 5.—Front view.

Fig. 6.—Radial curve.

Figs. 7—9.—Hyperlioceras discitiforme, *S. Buckman.*

Fig. 7.—Side view. Bradford Abbas, "Fossil Bed." Collection of Mr. Darell Stephens, F.G.S. (Page cxxiv.)

Fig. 8.—Whorl-section.

Fig. 9.—Radial curve.

Figs. 10—12.—Stokeia subacuta, *S. Buckman.*

Fig. 10.—Side view (portion). Locality not recorded. Matrix like Halfway House (near Sherborne, Dorset) "Blue Beds." My father's Collection. (Page cxxviii.)

Fig. 11.—Whorl-section.

Fig. 12.—Radial curve.

Figs. 13—15.—Darellia toxeres, *S. Buckman.*

Fig. 13.—Side view. Stoke Knap (Dorset), "Building Stone." (Page cxiii.)

Fig. 14.—Front view (outline).

Fig. 15.—Radial curve.

Figs. 16—18.—Darellia concinna, *S. Buckman.*

Fig. 16.—Side view (portion). Locality not recorded, presumably Bradford Abbas, "Fossil Bed." My father's collection. (Page cxiv.)

Fig. 17.—Whorl-section.

Fig. 18.—Radial curve.

Figs. 19—21.—Hugia curva, *S. Buckman.*

Fig. 19.—Side view. Bradford Abbas, "Fossil Bed." (Page cxi.)

Fig. 20.—Front view (outline).

Fig. 21.—Suture-line. 21 *a.* Radial curves.

Figs. 22—31.—Radial Curves.

Fig. 22.—*Toxolioceras Walkeri*, Pl. XVI, figs. 1, 2. (Page cxxvi.)

Fig. 23.—*Hyperlioceras discitiforme*, Pl. XVI, figs. 12, 13. (Page cxxiv.)

Fig. 24.—*Reynesella piodes*, Pl. XVI, figs. 7, 8. (Page cix.)

Fig. 25.—*Reynesella piodes*, Pl. XVI, fig. 9. (Page cix.)

Fig. 26.—*Reynesia cœla*, Pl. XVI, figs. 10, 11. (Page civ.)

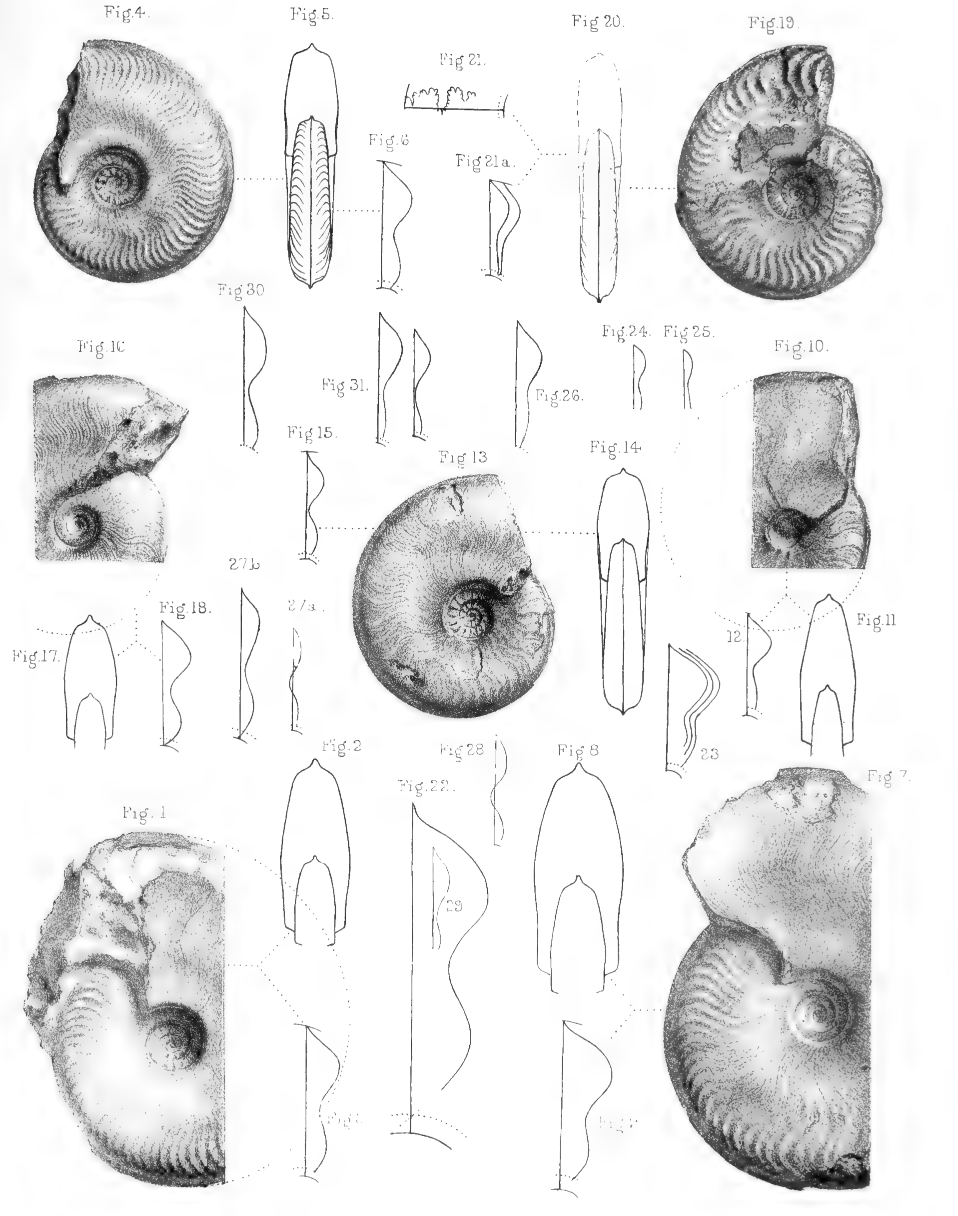
Fig. 27.—*Reynesia intermedia*, Pl. XI, figs. 2, 3. (Page ciii.)

Fig. 28.—*Reynesia laxa*, Pl. XI, figs. 6, 7. Drawn with curves rather too pronounced. (Page ciii.)

Fig. 29.—*Reynesia lepida*, Pl. XI, figs. 4, 5. (Page civ.)

Fig. 30.—*Darellia semicostata*, Pl. XII, figs. 10, 11. (Page cxiii.)

Fig. 31.—*Darellia? polita*, Pl. XVI, figs. 3, 4. (Page cxiv.)



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SUPPLEMENT, PLATE XIX.

Discitæ hemera.

Figs. 1—3.—Braunsina elegantula, *S. Buckman.*

Bradford Abbas (Dorset), "Fossil Bed." (Page c.)

Figs. 4—6.—Ludwigella subobsoleta, *S. Buckman.*

Bradford Abbas, "Fossil Bed." (Page lxxxviii.)

Concavi hemera.

Figs. 7—9.—Ludwigella micra, *S. Buckman.*

Louse Hill, near Halfway House (Dorset). (Page lxxxix.)

Figs. 10—12.—Ludwigella attenuata, *S. Buckman.*

Bradford Abbas, "Fossil Bed." (Page lxxxvii.)

Figs. 13—15.—Ludwigella vibrata, *S. Buckman.*

Bradford Abbas, "Fossil Bed." (Page lxxxviii.)

Figs. 16—18.—Ludwigella callosa, *S. Buckman.*

Sandford Lane, Sherborne. (Page lxxxviii.)

Date uncertain.

Figs. 19—21.—Ludwigella opaca, *S. Buckman.*

Locality uncertain. From my father's Collection. (Page xc.)

Bradfordensis hemera.

Figs. 22—24.—Ludwigella blanda, *S. Buckman.*

Stoke Knap, "Building Stone." (Page lxxxvii.)

Figs. 25—27.—Ludwigella impolita, *S. Buckman.*

Stoke Knap, "Building Stone." (Page lxxxv.)

Figs. 28—30.—Ludwigella flexilis, *S. Buckman.*

Stoke Knap, "Building Stone." (Page lxxxviii.)

Figs. 31—33.—Ludwigella attracta, *S. Buckman.*

Louse Hill, near Halfway House (Dorset). (Page lxxxvii.)

Figs. 34—36.—Ludwigella nodata, *S. Buckman.*

Stoke Knap, "Building Stone." (Page xc.)

Discitæ hemera.

Figs. 37—39.—Ludwigella modica, *S. Buckman.*

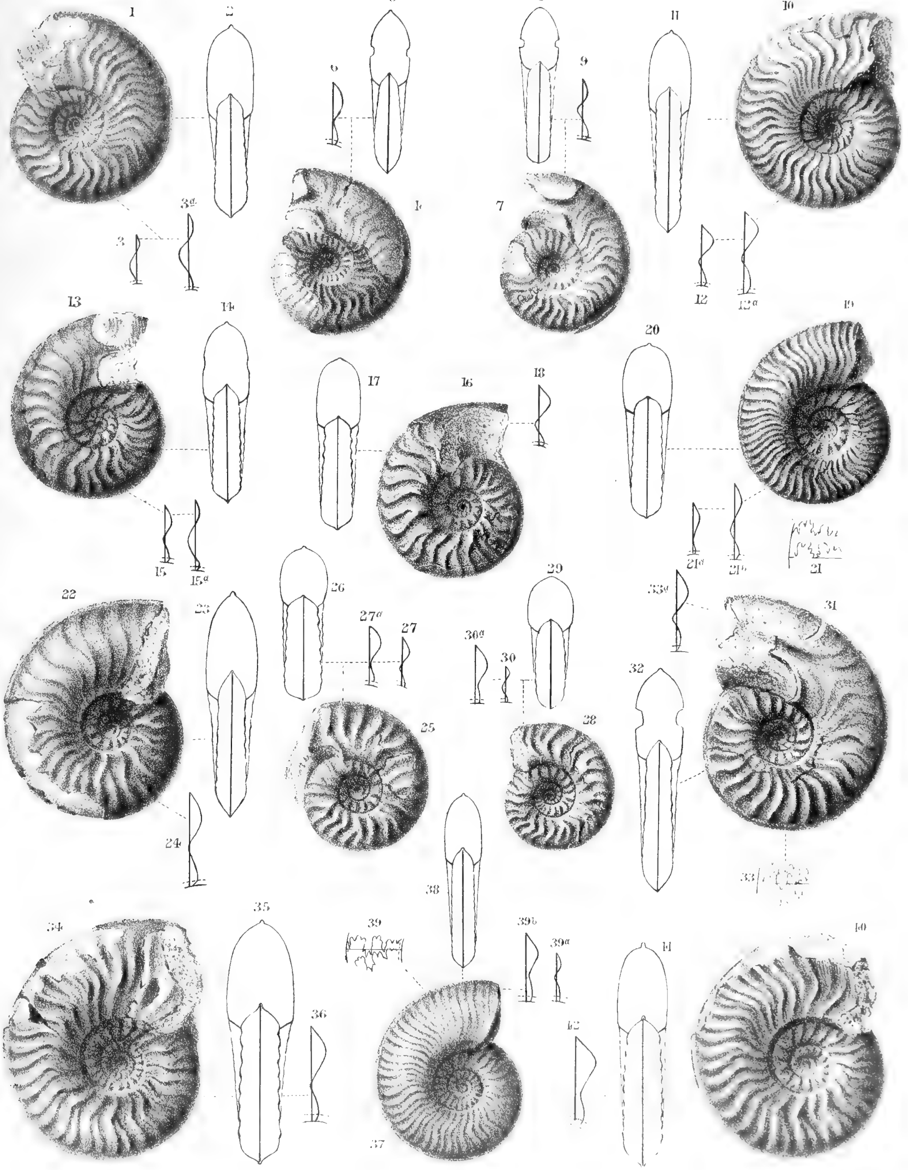
Locality unrecorded, but evidently Bradford Abbas, "Fossil Bed." From my father's Collection. (Page xci.)

Bradfordensis hemera.

Figs. 40—42.—Ludwigella carinata, *S. Buckman.*

Stoke Knap, "Building Stone." (Page xc.)

PLATE XIX.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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1904.

LONDON:

MDCCCCIV.

THE

LOWER PALÆOZOIC TRILOBITES

OF THE

GIRVAN DISTRICT, AYRSHIRE.

BY

F. R. COWPER REED, M.A., F.G.S

TRINITY COLLEGE, CAMBRIDGE.

PART II.

Pages 49—96; Plates VII—XIII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1904.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

There are some good hypostomes from Dow Hill, showing the typical characters of *Isotelus*, which probably belong to this species. The hypostomes have a straight truncated front, very short anterior wings, behind which the lateral margins are slightly excavated, and they end in a pair of large triangular pointed lobes nearly as long as the rest of the hypostome, and separated by a deep rounded notch. There is no distinct body marked off by furrows, but in front of the notch is a depressed elliptical area, and near the shoulders of the lateral margins is a pair of maculæ. In a specimen from Balclatchie the posterior lobes and border are striated. These hypostomes closely resemble the one figured by Schmidt[1] as belonging to *Isot. remigium*, Eichw., and the hypostome of *A. gigas* figured by Clarke, *op. cit.*, p. 706, fig. 8.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology (f. M.); Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Dow Hill; Ardmillan. (?) Balclatchie Conglomerate.

3. **Asaphus,** sp. ind. Plate VII, fig. 9.

Remarks.—In Mrs. Gray's collection there is an imperfect head-shield from Minuntion which apparently belongs to the group of *Asaphus* typified by *A. expansus*, Dalm. The glabella is of an indistinctly pear-shaped form with a decided independent convexity, being slightly more elevated towards the base, where there is a median tubercle. The eyes are prominent and situated nearly opposite the middle of the glabella, and their distance apart is approximately equal to the length of the glabella. The free cheek is produced slightly backwards, but the genal angle is not preserved.

Affinities.—The species which seem most nearly allied to it are *A. tyrannus*, Murch., *A. peltastes*, Salt., and *A. raniceps*, Dalm.,[2] but it is too fragmentary and badly preserved to determine its precise specific relations.

Dimensions.—

Length of head	22·0 mm.
Width „ (about) . . .	42·0 „
Width between eyes (about) . . .	21·0 „

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Minuntion.

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' Abth. v, pt. ii (1900), pl. x, fig. 17. Brögger, 'Hypost. Asaph.,' p. 31 (Bih. t. k. Vet. Akad. Handl., vol. ii, No. 3, 1886).

[2] Dalman, 'Palæad.,' pl. iii, fig. 4 (1827); and Schmidt, *op. cit.*, p. 32, pl. i, figs. 8—11; pl. ii, figs. 1—3.

Genus **STYGINA,** Salter.

1. **Stygina latifrons** (Portlock), 1843. Plate VII, fig. 10.

1843. *Asaphus latifrons,* Portlock, Geol. Rep. Londond., p. 292, pl. vii, figs. 5, 6.
— *Asaphus marginatus,* Portlock, ibid., p. 293, fig. 7.
1853. *Stygina latifrons,* Salter, Rep. Brit. Assoc., Trans. Sect., p. 59 (read 1852).
1854. *Stygina latifrons,* Morris, Cat. Brit. Foss., 2nd ed., p. 115.
1859. *Stygina latifrons,* Salter, in Murchison's Siluria, 2nd ed., p. 184, Foss. 26, fig. 2.
1864. *Stygina latifrons,* Salter, Mem. Geol. Surv., dec. xi, pl. ii.
1866. *Stygina latifrons,* Salter, Mon. Brit. Trilob., p. 172, pl. xviii, figs. 7—10.
1869. *Stygina latifrons,* Linnarsson, Vestergotl. Camb. Silur. Aflagr., p. 77, pl. ii, figs. 41, 42 (Kongl. Svensk. Vet. Akad. Handl., vol. viii, No. 2).
1877. *Stygina latifrons,* Woodward, Cat. Brit. Foss. Crust., p. 59.
? 1899. *Stygina latifrons,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 513, 674, 689.
1900. *Stygina latifrons,* Wiman, Bull. Geol. Instit. Upsala, vol. v, pt. 2, No. 10, p. 171, pl. v, figs. 16—18, ? 19; pl. vii, fig. 17.

Specific Characters.—General form depressed, elliptical.

Head-shield as long as the pygidium, more than one third the whole length, nearly a true semi-oval, evenly convex (except on the posterior median portion, which is somewhat abruptly raised), sloping on all sides to a concave border. Glabella pyriform, scarcely defined in front, much contracted posteriorly but expanding suddenly upon neck border; greatest width not more than one fifth that of the head. Eyes small, convex, much curved, situated at less than their own length from the hinder margin opposite the contracted part of the glabella, and rather further apart than the width of the thoracic axis. Facial sutures bend outwards behind the eyes to meet the posterior margin at a very acute angle; the anterior branches describe a large arc, diverging from the eyes at an angle of 70° and cutting the anterior margin far out in a line with the fulcral points of the thorax. Free cheeks triangular; genal angles produced into short points. Occipital segment obscurely marked.

Thorax of nine rings, not so long as the head. Axis convex, cylindrical, about two thirds the width of the pleuræ. Pleuræ flat as far out as the fulcrum, not grooved. Fulcrum situated at about two thirds the length of the pleuræ. Extra-fulcral portion of pleuræ bent down and slightly backwards and facetted for rolling up.

Pygidium semi-oval, blunt, not convex. Axis conical, with rounded obtuse end, about half as wide as the lateral lobes and quite two thirds as long as the pygidium, with about eight faint rings, very indistinct posteriorly. Lateral lobes with inner portion gently convex, outer portion broadly concave with somewhat sharply defined margin. Anterior border of pygidium shows a strong fulcrum about halfway out, with a more or less obsolete furrow behind it.

Remarks.—The foregoing description is a revised summary of that given by Salter (*op. cit.* 1864). In the Girvan area only pygidia of this species have so far been recognised, and these are from Shalloch Mill and typical in all respects; the Balclatchie specimens which have been assigned to it belong to *Bronteopsis ardmillanensis*, as do those from Ardmillan in the Museum of Practical Geology.

Wiman has recently (1900) described this species from the Borkholm Beds in the Silurian area on the Baltic, and he mentions in his specimens a small ridge proceeding from the extremity of the pygidial axis to the margin which is absent from the British examples. Judging from his figures, it seems likely that the pygidia possessing this feature (Wiman, *op. cit.*, p. 171, pl. v, figs. 17 and 19) should be referred to a form akin to *Bronteopsis ardmillanensis*.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill.

Genus **CYCLOPYGE**, Corda.

1. **Cyclopyge armata** (Barrande), 1872. Plate VII, figs. 11—14; plate VIII, fig. 1.

1872. *Æglina armata*, Barrande, Syst. Silur. Bohême, vol. i, suppl., p. 59, pl. iii, figs. 1—14; pl. xv, figs. 16—19.

1880. *Cyclopyge armata*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. iii, p. 286, pl. xix, figs. 5—8.

1884. *Æglina armata*, Novák, Zur Kennt. böhm. Trilob. (Beitr. zur Palæont. Oesterr.), p. 35, pl. xii, fig. 12.

1899. *Cyclopyge armata*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 517, 672, 688.

Specific Characters.—Glabella suboval, gently convex, produced anteriorly into a short rounded tapering frontal spine, but posteriorly truncated. Surface of glabella marked by two pairs of well-marked transverse furrows, short, horizontal or slightly arched, and isolated from axial furrows; anterior pair of furrows rather behind middle of glabella; second pair halfway between anterior pair and posterior margin of glabella. Surface of glabella ornamented with fine undulating raised lines transverse at base but concentric to lateral margins and extending on to basal portion of frontal spine. Eyes (not well preserved in the Girvan specimens) large, completely embracing sides of glabella and uniting in front below spine with convex surfaces. Palpebral lobe narrow, band-like, separated by a deep furrow from the glabella.

Thorax imperfectly known. Axis more than one quarter the width of thorax; pleuræ short with strong groove along whole length.

Pygidium semicircular, with flattened border marked off by marginal furrow. Axis conical, gently tapering to rounded extremity, about one fourth the width and three fourths the length of the pygidium; consists of three well-marked segments, of which the posterior is the largest (in the Girvan specimen a faint transverse furrow divides the posterior segment into two). Axial furrows strong, deep. Lateral lobes bear a few (2—3) feeble radiating furrows, of which only the first is distinct.

Remarks.—This species has been described and figured by Nicholson and Etheridge (*op. cit.*) from Whitehouse Bay, but only the glabella was known to them. A pygidium has since then been found, and some further details regarding the head-shield may be added. In one of our specimens a portion of the eye and free cheek is preserved; the eye consists of very numerous closely placed hexagonal lenses arranged in diagonal rows. A deep furrow separates the eye from the very narrow rounded band-like free cheek, which decreases to a mere rim anteriorly and is ornamented with transverse arched coarse lines. The epistome is preserved in another specimen and is seen to lie immediately below and behind the eyes; it has a transverse crescentic shape with its anterior margin strongly arched forward and its posterior margin concave to a less extent; and its surface is marked from side to side by a few coarse striæ.

The typical Bohemian forms seem to have the glabella of a more regular oval shape and slightly contracted at the base. In the Girvan specimens the glabella is decidedly broadest at the base and narrows anteriorly; but this appears to be the only difference, and is perhaps more or less due to the state of preservation. No well-preserved thorax has been found.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

2. **Cyclopyge rediviva** (Barrande), 1846. Plate VIII, figs. 2, 3.

1846. *Ægle rediviva*, Barrande, Notice Prelim., p. 34.
1847. *Cyclopyge megacephala*, Corda, Prodr. Mon. Böhm. Trilob., p. 64, pl. iv, fig. 32.
1852. *Æglina rediviva*, Barrande, Syst. Silur. Bohême, vol. i, p. 665, pl. xxxiv, figs. 3—13.
1880. *Cyclopyge rediviva*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. iii, p. 284, pl. xix, fig. 4.
1899. *Cyclopyge rediviva*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 517, 672, 688.

Specific Characters.—Body subrectangular, rounded at both extremities; trilobation faint, except on thorax.

Head-shield elongate oval, truncate posteriorly, nearly half the entire length of the body, convex, not trilobed, nor subdivided into glabella and cheeks. A pair of short deep oblique furrows, directed outwards, situated not far from posterior margin and more than one third the width of the head apart. Eye large, vertical, embracing side of head for three fourths its length. Palpebral lobe very narrow, band-like. At base of eyes is small triangular area marked off by a furrow which cuts basal angle of glabella and may represent occipital furrow.

Thorax shorter than head, but about equal in length to pygidium, of six segments (the Girvan example is not adult and only possesses four); axis slightly convex, broader than pleuræ, tapering a little to pygidium. Axial furrows distinct. Pleuræ narrower than axis, somewhat bent down, furrowed, and successively increasing in length towards pygidium.

Pygidium semicircular, gently convex; axis convex, conical, of three segments, less than half the length of pygidium (in adults the axis is reduced to a very short unsegmented rudiment). Lateral lobes with two pairs of faintly marked radiating grooves on anterior portion, but rest of surface smooth. No border present.

Remarks.—No adult example of the thorax is known from Girvan, and the eyes are not preserved. But in all parts available for comparison there is complete agreement with the Bohemian examples of the species.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

Genus **BOHEMILLA**, Barrande.

1. **Bohemilla** (? = *Cyclopyge*), sp. Plate VIII, fig. 4.

Specific Characters.—Elongated oval in shape, truncated posteriorly; composed of five segments (of which the first is the largest and the second, third and fifth are subequal in width) and of one narrow neck [?] ring. Whole surface dotted with small tubercles.

The anterior or first segment is as wide as all the next three together, and has a double row of small tubercles with a faint groove between them down the centre. It is marked off posteriorly by a pair of almost straight furrows meeting in the centre, where they are slightly bent back. The second segment is marked off from the third by a single straight furrow extending right across. Down the centre runs a deep median groove bordered on each side by a large low tubercle of the same width as the ring. The third segment has a similar median groove and lateral tubercles on it, but is marked off posteriorly by a pair of furrows arched forwards and not meeting in the middle but with their inner ends curved round and connected by a short shallow horizontal furrow. The fourth segment is rather wider; its two posterior limiting furrows arch backwards and then forwards in the middle where they meet. The median groove and tubercles are less distinct than in the preceding segment. The fifth segment is marked off by a pair of straight furrows not meeting in the centre. There is on this segment a median ridge widening slightly behind, the surface of the segment being depressed as an oval area on each side of the ridge. The neck segment is very narrow and linear, with a straight posterior margin.

Dimensions.—Length, 6 mm.; width, 4 mm.

Remarks.—This genus has been recorded by Mrs. Gray[1] from the beds of Whitehouse Bay, and the above description is based on her specimens.

The genus has not apparently been recorded hitherto from Britain. The Bohemian forms[2] come from the horizon Etage E, associated with some of the same species as here.

Beecher[3] doubts if this genus can stand, for he believes it to represent the glabella of an *Æglina* (= *Cyclopyge*) deprived of its eyes and free cheeks. No further light is thrown on this point by these specimens.

From Jemtland, Linnarsson[4] records a species termed *Boh.? denticulata*, and Holm,[5] following Beecher, assigns it to *Æglina*.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

Genus **ILLÆNUS,** Dalman.

1. **Illænus æmulus,** Salter, 1867. Plate VIII, fig. 5.

1867. *Illænus (Dysplanus) æmulus*, Salter, Mon. Brit. Trilob., p. 187, pl. xxviii, fig. 5.
1877. *Illænus æmulus*, Woodward, Cat. Brit. Foss. Crust., p. 40.
1882. *Illænus æmulus*, Holm, Svensk. Artern. Illænus (Bih. k. Vet. Ak. Handl., vol. vii, No. 3), p. 50.

Remarks.—There is one perfect pygidium (together with the impression of it) from Penkill in Mrs. Gray's collection, which agrees exactly with Salter's type of the species. It shows the faint ribs and furrows on the lateral lobes which are such a remarkable feature, though the arched broken fine lines on the surface are not preserved. The submarginal fascia is well seen; it is about half the width of

[1] 'Mem. Geol. Surv.,' "Silur. Rocks Britain," vol. i, Scotland, 1899, pp. 517, 688.
[2] Barrande, 'Syst. Silur. Bohême,' vol. i, suppl., pl. xiv, figs. 30—32 (1872.)
[3] Beecher, 'Amer. Geol.,' vol. xvii, 1896, p. 360.
[4] Linnarsson, 'Geol. Foren. Förh,' vol. ii, p. 495, pl. xxii, figs. 4, 5?
[5] Holm, ibid., vol. xix, pt. 3, No. 6; and 'Sv. Geol. Undersökn.,' ser. C, No. 176, 1898, p. 11.

the truncated lateral angles, and consists of two sets of rather remote striæ meeting at an obtuse angle in the middle line.

This species differs from the common Girvan variety of the species (see below) (1) in having an axis more clearly defined and with a more marked independent convexity, (2) in the presence of the faint ribs on the lateral lobes, and (3) in the greater relative width of the pygidium.

Dimensions.—Length of pygidium, 20·0 mm.; width of pygidium, 37·0 mm.

Collection.—Mrs. Gray.

Horizon and Locality.—Penkill Group (Tarannon): Penkill.

1*a*. **Illænus æmulus,** Salter, var. Plate VIII, figs. 6—11.

1879. *Illænus æmulus?*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 157, pl. xi, fig. 10.

1879. *Illænus nexilis?*, Nicholson and Etheridge (*e. p.*), ibid., p. 158, pl. xi, fig. 13.

1899. *Illænus æmulus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 536, 673.

Remarks.—The common Llandovery form attributed to *Illænus æmulus?* by Nicholson and Etheridge differs somewhat from Salter's type of the species, which was founded on a pygidium. The pygidium of this variety is of a more oval and less transverse shape, the axis is less prominent, and there are no pleural indications on the lateral lobes, but the ornamentation of fine arched or angulated lines is similar. Nicholson and Etheridge figured (*op. cit.*) an example of such a pygidium, but apparently knew of no specimens attached to the thorax and head-shield. There is, however, an entire individual amongst Mrs. Gray's new material, with several isolated head-shields. The head has the general shape and appearance of *I. bowmani*, but its whole surface is ornamented with numerous transverse fine thread-like lines, slightly irregular and wavy, but for the most part concentric with the anterior margin. The thorax consists of nine segments, and has an axis as wide as the pleuræ, but tapering slightly for the last four or five rings to the pygidium. The pleuræ seem to have their inner portion wider than in *I. bowmani*, the fulcrum being further out; the fulcrum is also rather less marked and less angular, and the extra-fulcral portion less bent down. But these parts are in a more or less imperfect state of preservation, though fragments are fairly numerous.

The epistome from Penkill figured by Nicholson and Etheridge as probably belonging to *I. nexilis* may belong to this variety of *I. æmulus*. It has the anterior border nearly straight and the posterior border strongly arched backwards, but the width from side to side is nearly three times the length from back to front, and thus it is utterly different from Salter's type of *I. nexilis*. The lateral angles are truncated at about 60° to the front edge, and there are 6—7 strong striæ crossing the surface from side to side.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; ? Hunterian Museum.

Horizon and Localities.—Saugh Hill Group (M. Llandovery): Woodland Point. Camregan Group (U. Llandovery): Bargany Pond Burn. Penkill Group (Tarannon): Penkill; Penwhapple Glen.

2. **Illænus balclatchiensis,** sp. nov. Plate VIII, figs. 12—16.

Specific Characters.—Pygidium broadly oval, nearly half as wide again as long, very slightly arched from side to side, but steeply inclined near posterior margin. Lateral angles truncated at 45°— 60°, but gently arched outwards, not straight. Fulcrum distant from axis about two thirds its width, with very faint shallow groove behind it. Axis about one third as wide and about half as long as pygidium; subcylindrical, with slight independent convexity, raised above lateral lobes and projecting on front margin. Axial furrows broad, shallow, straight, subparallel, dying out posteriorly before end of axis (in casts they are seen to be united behind axis, which has a rounded extremity as in *I. latus*). Low narrow ridge in some specimens runs back on surface of shell from end of axis to posterior margin. In casts a groove is seen behind axis running straight back towards margin. Caudal fascia wide, about one third to one half the length of pygidium; of few rather widely spaced striæ. Surface of shell ornamented with minute punctæ, with scattered larger pits.

Dimensions.—

	I.	II.
Length of pygidium . . .	12·0 mm.	13·0 mm.
Width ,, ,, across broadest part .	17·5 ,,	19·0 ,,
,, of axis	7·0 ,,	8·0 ,,

Remarks.—The species *I. bowmani*, Salter, to which the specimens here described as a new species have been previously assigned, has been frequently used as a kind of refuge for all sorts of forms which owing to their imperfect condition or bad state of preservation were difficult of discrimination. This has had the unfortunate result of obscuring the definiteness of the English species, and rendering the comparison of it with foreign forms a matter of difficulty. Holm[1] has been led accordingly to stigmatise the British species as badly characterised. It is therefore better to separate off examples with differences of a marked character, though these

[1] Holm, 'Rev. Ostbalt. Silur. Trilob.,' pt. 3 (1886), p. 153.

have been hitherto regarded as only of a varietal importance or due to age, than to associate them with a species already sufficiently overburdened in this respect. Such is the case with these Balclatchie specimens, which seem allied to, though not identical with, the typical *I. bowmani*. It is on the strength of the well-preserved pygidia, not of the imperfect head-shields, which in their poor state are practically indistinguishable from *I. bowmani*, that this species is separated.

In Mrs. Gray's collection from Balclatchie, however, there is one small specimen of this species showing the whole individual, but slightly crushed and broken; and another specimen with five thoracic segments attached to a typical pygidium. We are thus enabled to describe to some extent the characters of the head and thorax. The thorax in this example only possesses eight segments, whereas *I. bowmani* has nine, but the smaller number may be due to immaturity. The axis is wide, subcylindrical, tapering very gently to the pygidium, and is not so wide as the pleuræ. The pleuræ consist of a flattened inner horizontal straight portion and an outer extra-fulcral portion of about equal length, bent strongly downwards and less strongly backwards. The fulcrum is situated at about half the length of the pleuræ and at a distance from the axial furrow equal to two thirds (or rather more) the width of the axis.

The head is not very well preserved in the entire individual from Balclatchie, but another from Balclatchie and a still more perfect example from Ardmillan enable me to give a nearly complete description. The head-shield is semi-oval, about twice as broad as long, convex, and more or less strongly bent down in front. The glabella is about half the length of the head-shield and less than one third its width, gently convex, and defined by well-marked axial furrows, nearly straight and parallel and deepening posteriorly. The fixed cheeks are gently convex and nearly as wide as the glabella. The eye-lobes are small, prominent, projecting laterally, and situated at about one third the length of the head from the posterior margin. A narrow occipital segment is visible at the base of the glabella and on the fixed cheeks in the Ardmillan cast. The facial sutures have their anterior branches from the eyes to the front margin nearly parallel, curving convergently inwards near the front margin. Behind the eyes the posterior branches bend outwards sharply, to cut the posterior margin at about 60°. The free cheeks are well preserved in the Ardmillan specimen, and are long, narrow, and pointed anteriorly at about 20°—30°; their length is more than twice their breadth, and they are about two thirds the width of the fixed cheeks. The genal angles are very widely rounded off, and the posterior and lateral margins form one continuous gentle curve. The surface of the head-shield is seen (in the Balclatchie specimen) to be punctate like the pygidium.

Affinities.—This species has been confused with *I. bowmani*, which, indeed, it resembles in general characters, particularly in the shape of the pygidium, but it differs from typical examples in the pygidium in the degree of definition of the axis and its independent convexity, as well as in the ornamentation of the surface. In the head-shield the course of the facial sutures is different, the eyes are further from the posterior margin, the axial furrows are nearly straight and parallel, the free cheeks are of a distinct shape, and the surface is punctate. The head-shield also is relatively shorter and broader than in the typical *I. bowmani*.

With *I. latus* the pygidium agrees in the characters of the axis, but differs in the position of the fulcrum, in the amount of truncation of the lateral angles and their convexity, and in the ornamentation. The longitudinal median groove behind the axis recalls *I. portlocki*.

The shape and convexity of the pygidium, truncation of the lateral angles, caudal fascia and ornamentation appear to be similar to *I. linnarssoni*, Holm,[1] but the resemblance may only be superficial.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Ardmillan.

3. **Illænus barriensis** (Murchison), *pars*, 1839. Plate IX, figs. 1, 2.

? 1828. *Nileus glomerinus*, Dalman, Arsberätt. Zool. Arbet., p. 134.
1829. "A New Species of Trilobite," Jukes, Ann. Mag. Nat. Hist., vol. ii, p. 41, figs. 8—10.
— "Probably *Isotelus*," J. D. C. Sowerby, ibid., p. 45.
? 1833. "Trilobite," Silliman, Amer. Journ. Sci., vol. xxiii, i, p. 203.
? 1837. *Nileus glomerinus*, Hisinger, Leth. Suec., p. 16.
1839. *Bumastus barriensis*, Murchison (*e. p.*), Silur. Syst., p. 656, pl. vi *bis* (*non* pl. vii *bis*, fig. 3, *nec* pl. xiv, fig. 7).
1840. *Nileus? (Bumastus) barriensis*, M. Edwards, Crust., vol. iii, p. 295.
1842. *Illænus (Bumastus) barriensis*, Burmeister, Organ. Trilob., p. 120 (Ray Soc. Edit., 1846, p. 104).
1843. *Bumastus barriensis*, Hall, Geol. Rep. New York, p. 102, No. 10, fig. 4; No. 19, fig. 3.
1846. *Illænus (Bumastus) barriensis*, Keyserling, Reise in Petschoraland, p. 289, pl. ii, fig. 17.
1849. *Illænus barriensis*, Salter (*e. p.*), Mem. Geol. Surv., dec. ii, pl. iii (excl. fig. 2); pl. iv (excl. figs. 9—11).
1852. *Bumastus barriensis*, Hall, Pal. New York., vol. ii, p. 302, pl. lxvi, figs. 1—15.
1854. *Bumastus lindstromi*, Angelin, Pal. Scand., pl. xxiv, figs. 1, 1 *a*.
? — *Bumastus? glomerinus*, Angelin, ibid., p. 63, pl. xxxiii, figs. 17, 17 *a*.
1857. *Illænus barriensis*, Nieszkowski, Mon. Trilob. Ostseeprov., p. 585.
1859. *Illænus barriensis*, Murchison, Siluria, 2nd edit., p. 123, Foss. 16, fig. 2.
1863. *Bumastus barriensis*, Volborth, Russ. Trilob., p. 40, pl. iv, figs. 10—15.
1865. *Illænus barriensis*, Kjerulf, Veiviser, pp. 30, 32, figs. 45 *a*, *b*.
1867. *Illænus (Bumastus) barriensis*, Salter, Mon. Brit. Trilob., p. 203, pl. xxvii, figs. 1—5.
1875. *Illænus barriensis*, Baily, Char. Brit. Foss., p. 68, pl. xxiii, figs. 4 *a*, *b*.

[1] Holm, 'Rev. Ostbalt. Silur. Trilob.,' pt. 3, 1886, p. 146, pl. x, figs. 10—23.

1876. *Illænus barriensis*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.

1877. *Illænus (Bumastus) barriensis*, Woodward, Cat. Brit. Foss. Crust., p. 40.

1883. *Illænus (Bumastus) barriensis*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 124.

1885. *Illænus (Bumastus) barriensis*, Lindström, Forteckn. Gotl. Silur. Crust. (Ofv. K. vet. Akad. Förhandl., No. 6), p. 82.

1886. *Illænus (Bumastus) barriensis*, Holm, Rev. Ostbalt. Silur. Trilob., pt. 3, p. 164, pl. xi, figs. 12—16.

1899. *Illænus (Bumastus) barriensis*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 538, 673, 689.

Remarks.—This well-marked species occurs in the Llandovery beds of the Girvan area with moderate frequency, and is represented in most collections. The specimens call for no special mention.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum.

Horizons and Localities.—Saugh Hill Group (M. Llandovery): Woodland Point. Camregan Group (U. Llandovery): Bargany; Pond Burn; Penwhapple Glen. Penkill Group (Tarannon): Penkill.

4. **Illænus bowmani,** Salter, 1848.

1843. *Illænus centrotus*, Portlock (*non* Dalman), Geol. Rep. Londond., p. 300, pl. x, figs. 3—6 (*non* fig. 9).

1846. *Illænus centrotus*, M'Coy, Synops. Silur. Foss. Ireland, p. 54.

1848. *Illænus bowmanni*, Salter, Mem. Geol. Surv., vol. ii, pt. 1, p. 339, pl. viii, figs. 1—3.

1849. *Illænus bowmanni*, Salter, Mem. Geol. Surv., dec. ii, art. 2, p. 3.

1852. *Dysplanus centrotus ?*, M'Coy, Synops. Palæoz. Foss. Woodw. Mus., p. 173.

— *Illænus bowmanni*, M'Coy, ibid., appendix, p. iv, pl. 1 E, fig. 19.

1854. *Illænus bowmanni*, Morris (*e. p.*), Cat. Brit. Foss., 2nd ed., p. 110.

1866. *Illænus bowmanni*, Salter, Mem. Geol. Surv., vol. iii, p. 317, pl. xviii, fig. 8.

1867. *Illænus (Dysplanus) bowmanni*, Salter (*e. p.*), Mon. Brit. Trilob., p. 185, pl. xxviii, figs. 7—10, 12, 13 (*non* figs. 6, 11; *nec* pl. xxx, fig. 6).

1873. *Illænus bowmanni*, Salter (*e. p.*), Cat. Camb. Silur. Foss. Woodw. Mus., p. 54.

1875. *Illænus bowmanni*, Baily, Char. Brit. Foss., p. 39, pl. 13, figs. 5 *a*—*c*.

? 1876. *Illænus bowmanni*, Armstrong and Young, Cat. West Scot. Foss., p. 16.

1877. *Illænus bowmanni*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 40.

1879. *Illænus bowmanni*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. ii, p. 155 (*non* pl. xi, figs. 6—8).

1882. *Illænus bowmanni*, Holm, Svensk. Art. Illæn. (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 48.

1899. *Illænus bowmanni (e. p.)*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, *passim*.

Remarks.—Of the multitude of specimens from various localities and horizons which have been referred to this species by different authors, it is certain that only a small proportion will ultimately be allowed to remain in it, for there has been too much breadth of interpretation and frequent erroneous determination of specimens. Amongst the Girvan specimens it is doubtful if any are truly referable to the typical *I. bowmani*, and at any rate the very large majority must be distributed amongst other species. Some specimens from Drummuck, however, are perhaps referable to *I. bowmani*. The difficulties of identification are increased by the generally poor state of preservation of the fossils. Nicholson and Etheridge figure some specimens from Balclatchie as *I. bowmani* (*op. cit.*), but they belong to the new species *I. balclatchiensis*.

Holm[1] has suggested that perhaps *I. linnarssoni*, Holm, ought to be united with *I. bowmani;* but this seems doubtful.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum.

Horizon and Locality.—Drummuck Group (U. Bala): Drummuck.

4 *a*. **Illænus bowmani,** var. **longicapitatus,** Reed.

There is a fine specimen in Mrs. Gray's collection of a head-shield with a few thoracic rings attached, which is referable to this variety,[2] which has been described from the Keisley Limestone by the present author.

Collection.—Mrs. Gray.

Horizon and Locality.—Drummuck Group (U. Bala): Starfish Bed.

5. **Illænus davisi,** Salter, 1849.

1848. *Illænus crassicauda*, Sharpe (*non* Dalman), Quart. Journ. Geol. Soc., vol. iv, p. 149.
1849. *Illænus davisii*, Salter, Quart. Journ. Geol. Soc., vol. v, p. 15.
— *Illænus davisii*, Salter, Mem. Geol. Surv., dec. ii, pl. ii.
1852. *Illænus davisii*, M'Coy, Synops. Palæoz. Foss. Woodw. Mus., p. 171, pl. 1 G, fig. 36.
1854. *Illænus davisii*, Morris, Cat. Brit. Foss., 2nd ed., p. 110.
— *Illænus davisii*, Murchison, Siluria, 1st ed., woodcut 29, fig. 2.
1859. *Illænus davisii*, Murchison, ibid., 2nd ed., p. 223, Foss. 44, fig. 2.
1865. *Illænus davisii*, Salter, Mem. Geol. Surv., vol. iii, p. 317, pl. xviii, fig. 9.
1867. *Illænus davisii*, Salter, Mon. Brit. Trilob, p. 194, pl. xxix, figs. 10—16.
1876. *Illænus davisii*, Armstrong and Young, Cat. West Scot. Foss, p. 16.
1877. *Illænus davisii*, Woodward, Cat. Brit. Foss. Crust., p. 41.
1879. *Illænus davisii*, Etheridge and Nicholson, Mon. Silur. Foss. Girvan, fasc. ii, p. 159.
1882. *Illænus davisii*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 45.

[1] Holm, 'Rev. Ostbalt. Silur. Trilob.,' pt. 3 (1886), p. 153.
[2] Reed, 'Quart. Journ. Geol. Soc.,' vol. lii (1896), p. 412, pl. xx, fig. 5.

Remarks.—This species appears to be represented at Craighead, but two imperfect head-shields in Mrs. Gray's collection are the only evidence of it. The forward position of the eyes and their relative size, the length of the axial furrows and the course of the facial sutures appear to be identical with Salter's species; but the poorness of the material makes the identification somewhat uncertain. Salter recorded this species from Craighead in 1848, and Armstrong and Young from the same horizon at Aldons in 1876.

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

6. **Illænus extensus**, sp. nov. Plate IX, figs. 3—5.

Specific Characters.—Head-shield broad, transversely semicircular, weakly convex; posterior margin nearly straight. Glabella slightly raised, narrow and short, being in width less than one sixth that of the head-shield, and in length between one third and one half that of the head-shield. Axial furrows well marked, slightly concave outwards. At the base of the glabella a transverse furrow, strong at the sides but weak in the centre, cuts off a rounded neck-ring, unusually wide for *Illænus*, and bearing a low median tubercle. Fixed cheeks slightly swollen and rising up on each side of glabella to prominent eye-lobes situated at a distance from the axial furrows rather less than the width of the glabella, and elevated somewhat above it. Posterior wing of fixed cheeks small, narrow, steeply sloping to posterior margin of head-shield. Facial sutures bend sharply outwards behind eyes to cut posterior margin of head at very acute angle (15°—20°), nearly halfway out to genal angle. Anterior branch of facial sutures curves strongly outwards from eye to anterior lateral margin with a general inclination of about 60° to posterior margin of head-shield. Free cheek broad, almost an equilateral triangle in general outline, the lateral and posterior margins meeting at about 60° at the genal angle, which is produced into a short spine. Eye of moderate size, about one sixth length of head, situated far back, not more than its own length from the posterior margin of head.

Thorax of nine segments. Axis subcylindrical, tapering very slightly to pygidium, narrow (only about one fifth width of thorax), moderately convex. Pleuræ flat, horizontally extended and straight as far out as fulcrum, which is weak and remote, being situated at more than half the length of pleuræ. Beyond fulcrum pleuræ slightly bent backwards and more strongly downwards. Small pit at base of each pleura in axial furrow.

Pygidium large, semicircular, weakly convex, longer than thorax; anterior edge straight and horizontal as far out as fulcrum, beyond which it is obliquely truncated at about 45°. Shallow groove behind the fulcrum. Axis well marked, short, triangular, about one third the length and less than one fourth the width of the pygidium. Axial furrows distinct, straight, converging at angle of about 60° to meet at tip of axis. Fascia round posterior margin strong, concave, about one third the length of the pygidium, marked with closely set concentric striæ. Ornamentation unknown.

Dimensions.—

Width of head-shield (about) . . .	36·0 mm.
Length of ,, ,, . . .	?14·0 ,,
Width of glabella between eyes . . .	5·0 ,,
Length of thorax	8·0 ,,
,, of pygidium	13·5 ,,
Width of ,, ...	26·0 ,,
,, of axis of pygidium . . .	6·5 ,,

Remarks.—An almost complete individual and an external impression of the same are the material on which this new species is founded. Both were obtained from the Starfish Bed (U. Bala), and are in Mrs. Gray's collection.

A small epistome of an *Illænus* from the Starfish bed is also probably referable to this species. Its description is as follows:—Shape transversely fusiform, anterior margin gently arched forward; lateral angles obliquely truncated at about 60° to front margin; posterior margin obtusely angulated in centre, forming slightly swollen median projection; ornamented with 8—10 strong striæ from side to side. *Dimensions.*—Width between lateral angles, 11 mm.; length from back to front across middle, 5 mm.

Affinities.—The elevation of the eye-lobes and of the median portion of the fixed cheeks recalls *I. tauricornis*, Kutorga;[1] the pointed genal angles, the triangular axis and straight front margin to the pygidium resemble *I. schmidti*, Nieszk.,[2] but the peculiar neck-ring, smaller eyes, narrower glabella, narrower axis and wider pleuræ distinguish this Girvan form from both these species.

The species which appears to bear the closest resemblance is *I. wahlenbergianus*, Barrande,[3] which possesses a glabella of similar shape, spinose genal angles, pleuræ and axis of similar proportions and characters, pits at the base of the pleuræ in the axial furrows, pygidium of much the same shape and an axis of the same relative width and length. But there is no neck-ring, the eyes are larger, the cheeks less elevated and the pygidial axis less defined.

Collection.—Mrs. Gray.

Horizon and Locality.—Drummuck Group (U. Bala): Starfish Bed, Thraive Glen.

[1] Kutorga, 'Einige balt. silur. Trilob.' (1848), p. 42, pl. viii, figs. 1 *a*—*c*, 2 *a*.

[2] Nieszkowski, 'Archiv Naturk. Livl. Ehst. Kurl.,' ser. i, vol. i (1857), p. 580, pl. i, figs. 10—12.

[3] Barrande, 'Syst. Silur. Bohême,' i, p. 684, pl. xxxiv, figs. 19—25.

7. **Illænus latus,** M'Coy, 1849. Plate IX, figs. 6, 7.

1849. *Illænus latus*, M'Coy, Ann. Mag. Nat. Hist. [2], vol. iv, p. 404.
1854. *Illænus latus*, M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., p. 172, pl. 1 E, figs. 17, 17*a*.
— *Illænus latus*, M'Coy, Contrib. Brit. Palæont., p. 143.
1867. *Illænus bowmanni ?*, Salter, Mon. Brit. Trilob., p. 215, fig. 55.
— *Illænus crassicauda ?*, Salter, ibid., p. 215, fig. 56.
1873. *Illænus crassicauda ?*, Salter, Cat. Camb. Sil. Foss. Woodw. Mus., p. 34.
1876. *Illænus crassicauda ?*, Armstrong and Young, Cat. West Scot. Foss., p. 16.
1879. *Illænus bowmani*, Nicholson and Etheridge (*e. p.*), Mon. Sil. Foss. Girvan, fasc. ii, p. 155.
— *Illænus crassicauda*, Nicholson and Etheridge, ibid. p. 160.

Remarks.—There are several specimens of pygidia from Minuntion in Mrs. Gray's collection which resemble the one figured by Salter (*op. cit.*) as *Illænus crassicauda*, Wahl. (?) from the Llandeilo Limestone of Knockdolian, and also agree with those from the same locality in the Woodwardian Museum similarly named by Salter. One of the latter was mentioned by M'Coy (*op. cit.*) as probably belonging to a young individual of his species *I. latus*, which was founded on an imperfect head-shield from Wrae Quarry, Tweed. Salter, however, was of the opinion that this specimen should be attributed to *I. bowmani*, and that accordingly M'Coy's species *I. latus* could not stand and that the name must be dropped. The specimens from Bugon, Knockdolian, in the Woodwardian Museum, which Nicholson and Etheridge refer to (*op. cit.*, p. 160) as the sole evidence of the occurrence of *I. crassicauda* in the Girvan area, are these very specimens which Salter and M'Coy mentioned, and they include the above mentioned small pygidium of *I. latus ?*, a few thoracic segments and a much crushed head-shield.

In Mrs. Gray's collection from Minuntion there is one imperfect and poorly preserved head-shield which closely resembles M'Coy's *I. latus*, and it is associated with pygidia from the same locality, like Salter's *I. crassicauda*. This head-shield is about twice as wide as long, is flattened posteriorly, but strongly bent down and convex anteriorly, with a short broad glabella about half the width of the head-shield and with very broad fixed cheeks; there is a distinct occipital furrow as in *I. bowmani*, and the eyes appear to occupy a similar position.

The pygidia vary from one and a half times to twice as broad as long, and are flattened or feebly convex, bent down at the sides and posteriorly; the lateral angles are truncated almost at right angles to the front margin, and the sides of the pygidium are thus straight and abrupt. The fulcrum is situated at about two thirds or three fourths the width of the axis from the axial furrow. The axis is conical with rounded end, independently convex, rising above the general surface of the pygidium, and circumscribed by broad shallow axial furrows, especially well seen in casts; its width is about one third that of the pygidium, and its length rather less than half that of the pygidium. A straight median groove is seen in some casts behind the axis. The fascia is also seen in casts to extend from the posterior margin to the tip of the axis, thus being about half the length of the pygidium. The lateral lobes are flattened, lower than the axis, with the edges steeply bent down, and there is no furrow behind the fulcrum.

Dimensions.—

	I.	II.	III.
Length of pygidium . .	17·0 mm.	11·0 mm.	10·0 mm.
Width of ,, . .	23·0 ,,	19·0 ,,	15·0 ,,
Length of axis . .	8·5 ,,	6·0 ,,	5·0 ,,
Width of ,, . .	10·0 ,,	7·5 ,,	6·0 ,,

Affinities.—The proportions of the head-shield are different from those of *I. bowmani*, and M'Coy (*op. cit.*) has pointed out its distinctive features. The pygidium differs by the possession of the prominent well-marked axis, more strongly truncated lateral angles and absence of post-fulcral furrow.

From *I. portlocki*, Salter, it differs by the narrower more prominent axis, and rather more remote fulcrum; but in the smaller specimens of *I. portlocki* figured by Salter[1] this last point of difference is not so apparent. The groove behind the axis and the truncation of the lateral angles are points of agreement.

In Salter's figure of the pygidium ascribed to *I. crassicauda*, from Bugon, the axis does not appear so well defined, but this is mainly due to the state of preservation of the specimen; and in other respects (width of axis, position of fulcrum, truncation of angles, caudal fascia) this specimen is identical with the Minuntion form.

Of American forms, *I. americanus*, Billings,[2] appears to be very closely allied to *I. latus;* the head-shield, however, seems rather more convex, and the lateral angles of the pygidium less abruptly truncated. In the strongly marked and convex axis, and the degree of truncation of the lateral angles of the pygidium, *I. latus* resembles *I.* (*Thaleops*) *ovatus*, Conrad,[3] from the Trenton Limestone.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizons and Localities.—Stinchar Limestone Group (Llandeilo): Minuntion, ? Balclatchie Group (Llandeilo); Ardmillan. Balclatchie Conglomerate.

[1] Salter, 'Mon. Brit. Trilob.,' pl. xxvi., fig. 4.

[2] Billings, 'Canad. Nat. and Geol.,' vol. iv, 1859, p. 371; Clarke, 'Lower Silur. Trilob. Minnesota,' 1894, p. 714, figs. 20—23.

[3] Conrad, 'Proc. Acad. Nat. Sci. Philad.,' vol. i, 1843, p. 332; Clarke, *op. cit.*, p. 716, figs. 25—27.

8. **Illænus macallumi,** Salter, 1867. Plate IX, figs. 8, 9.

1867. *Illænus* (*Bumastus*) *maccallumi*, Salter, Mon. Brit. Trilob., p. 210, pl. xxviii, fig. 1; pl. xxx, figs. 2, 3.
1877. *Illænus* (*Bumastus*) *maccallumi*, Woodward, Cat. Brit. Foss. Crust., p. 41.
1879. *Illænus macallumi*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 162, pl. xii, fig. 2.
1882. *Illænus macallumi*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 54.
1899. *Illænus maccallumi*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 529, 673.

Remarks.—This curious species has only so far been found at Mulloch Hill, from which locality Salter's types were obtained. Nicholson and Etheridge (*op. cit.*) also figure an example from this place. A specimen of a head-shield in Mrs. Gray's collection shows, in addition to the characters mentioned by Salter, that the fixed cheeks are very narrow, that the eyes are situated about halfway up the sides of the glabella, and the distance between them is slightly less than the length of the head-shield. A faint keel runs along the middle of the glabella, which is about half the length of the head-shield.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology.

Horizon and Locality.—Mulloch Hill Group (L. Llandovery): Mulloch Hill.

9. **Illænus murchisoni,** Salter, 1852. Plate IX, figs. 10—12.

1848. *Illænus rosenbergii*, Salter (*non* Eichwald), Mem. Geol. Surv., vol. ii, pt. 1, pl. v, figs. 6—8.
1849. *Illænus murchisoni*, Salter, Mem. Geol. Surv., dec. ii, art. ii, p. 4.
1852. *Illænus murchisoni*, Salter, in M'Coy's Synops. Pal. Foss. Woodw. Mus., fasc. i, appendix, p. iv (description only).
1854. *Illænus murchisoni*, Morris, Cat. Brit. Foss., 2nd ed., p. 110.
1866. *Illænus murchisoni*, Salter, Mon. Brit. Trilob., p. 201, pl. xxvi, fig. 1; pl. xxx, fig. 7.
1877. *Illænus murchisoni*, Woodward, Cat. Brit. Foss. Crust., p. 41.
1882. *Illænus murchisoni*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 46.

Remarks.—Certain pygidia from Craighead in Mrs. Gray's collection may probably be referred to Salter's species *I. murchisoni*. These pygidia are semi-oval, nearly as long as broad, rather flat and not bent down posteriorly. The axis is broad, projects slightly on the front edge and is scarcely defined at all by furrows or even by indentations on the front edge. The fulcrum is approximate, being only distant from the axis about half its width. The lateral angles are only slightly truncated, being cut off obliquely at only about 30° to the front edge. There is no groove behind the fulcrum. In *I. murchisoni*, as figured by Salter, the pygidium is more convex, and there is a groove behind the fulcrum.

There is also a free cheek from the same locality which may be referred to the same species. It is of trapezoid form with the eye large and far forward; the anterior and posterior branches of the facial suture meet at about 110°, the anterior branch curving forwards and outwards nearly at right angles to the lateral margin; the genal angle is about 60° but rounded, and the surface near it is concentrically wrinkled.

There is likewise an epistome from Craighead which may belong to the same species. It is of transverse shape, about twice as wide as long, with the anterior edge flattened but the posterior edge arched regularly, and the surface crossed by about fifteen transverse striæ. It is not angulated behind, nor does it bulge out suddenly in the middle as in *I. davisi* and some other species; it is longer and tapers more rapidly to the lateral angles than *I. thomsoni*, and the transverse striæ are finer and more numerous.

The pygidium from Penkill attributed by Nicholson and Etheridge to *I. murchisoni* (M., fasc. ii, 1879, p. 161, pl. xii, fig. 1) is probably referable to *I. thomsoni*.

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

10. **Illænus nexilis,** Salter, 1867. Plate IX, fig. 13.

1867. *Illænus nexilis*, Salter, Mon. Brit. Trilob., p. 190, pl. xxx, figs. 4, 5 (described as a sub-species of *I. bowmani*).

1877. *Illænus nexilis*, Woodward, Cat. Brit. Foss. Crust., p. 158.

1879. *Illænus nexilis*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 158, pl. xi, fig. 11? (*non* figs. 12, 13).

1882. *Illænus nexilis*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 48.

1899. *Illænus nexilis*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 536, 673, 689.

Remarks.—This species was only recorded from Mulloch by Salter (*op. cit.*), who gave it its name and considered it to rank merely as a sub-species intermediate between *I. bowmani* and *I. thomsoni*. The epistomes attributed to it are certainly distinct from those of either species, but the head, thorax and pygidium are scarcely distinguishable from *I. thomsoni*, particularly when imperfect or in a poor state of preservation.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Rough Neuk;

Craigens. Saugh Hill Group (M. Llandovery): Woodland Point. ? Penkill Group (Tarannon): Penkill.

11. **Illænus portlocki,** Salter, 1849. Plate IX, figs. 14—16; plate X, figs. 1, 1*a*.

1843. *Illænus crassicauda*, Portlock (*non* Dalman), Geol. Rep. Londond., p. 301, pl. x, figs. 7, 8.
1849. *Illænus portlockii*, Salter, Mem. Geol. Surv., dec. ii, art. ii, p. 3.
1854. *Illænus portlockii*, Morris, Cat. Brit. Foss, 2nd ed., p. 110.
1867. *Illænus portlockii*, Salter, Mon. Brit. Trilob., p. 197, pl. xxvi, figs. 3, 4.
1877. *Illænus portlockii*, Woodward, Cat. Brit. Foss. Crust., p. 42.
1882. *Illænus portlockii*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 47.

Specific Characters.—The thorax of this species has a broad axis, more than half as wide again as the pleuræ, gently convex and tapering very slowly to the pygidium. The pleuræ have the inner portion horizontally extended to the fulcrum, which is situated about halfway out; the extra-fulcral portion of the pleuræ bends down almost at right angles and at the same time backwards at about 45° to the inner portion in the front portion of the thorax, increasing to 60° posteriorly.

The pygidium is broad and short, from one and a half to twice as wide as long, gently convex, bent down steeply behind and less so at the sides. The axis is broad, half the width or rather more than half the width of the pygidium, with very slight independent convexity in front, and very short, shallow, faintly impressed axial furrows. The fulcrum is approximate, being distant from the axis about half or rather less than half its width; the lateral angles are abruptly truncated at about 60° or more to the front edge. The caudal fascia is wide, marked by a few widely spaced undulating striæ meeting in the middle line at an obtuse angle. The surface of shell is smooth.

Dimensions.—

	I.	II.	III.
Length of pygidium . . .	12·0 mm.	11·0 mm.	6·5 mm.
Width of ,, (across broadest part) .	20·0 ,,	18·0 ,,	11·0 ,,
,, of axis . . .	9·0 ,,	8·0 ,,	5·0 ,,

Remarks.—There is a series of pygidia from Craighead, some with thoracic rings attached, in Mrs. Gray's collection and the Museum of Practical Geology, which are attributable to *I. portlocki*, Salter. I have had the opportunity of examining Salter's types, through the kindness of Mr. E. T. Newton, F.R.S., and I do not therefore feel any doubt about the accuracy of the determination. There are also some poorly preserved head-shields from Craighead which perhaps belong to the same species, but the type is so distorted and imperfect that I hesitate to identify them, as Salter's description alone is insufficient.

Affinities.—The broad shape of the pygidium, strong truncation of the lateral angles, absence of post-fulcral furrow, approximate fulcrum, and wide axis mark it off from *I. bowmani.*

From *I. latus* it differs in the broader less defined axis, more approximate fulcrum and less strongly truncate lateral angles; but they seem rather closely allied.

I. americanus, Billings,[1] from the Trenton Limestone, appears to belong to the same group and seems more closely allied to I. *portlocki* than to I. *latus.*

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

12. **Illænus shallochensis,** sp. nov. Plate X, figs. 2—5.

Specific Characters.—Head-shield semi-elliptical, rounded, appearing from above to be nearly as long as wide owing to the sides being bent down nearly at right angles. Anterior portion in front of glabella strongly bent down with convex surface. Posterior margin of head-shield with slightly concave outline. Glabella with gentle independent convexity, occupying nearly the middle third of head-shield and extending less than half its length. Narrow depressed occipital band seen in cast. Axial furrows well marked and parallel, but curving outwards slightly at anterior end. Fixed cheeks with base a little over half as wide as the glabella; palpebral lobe slightly elevated, of moderate size, about its own length from posterior margin, and situated a little behind the middle of the glabella. Shallow broad groove extending across base of fixed cheek and on to free cheek around eye. Facial sutures with posterior branch straight and vertical to posterior margin of head-shield; anterior branches nearly parallel but curving inwards near front margin to meet it at about 45°. Free cheeks narrow, nearly twice as long as wide, but wider than fixed cheek, pointed in front; genal angle well rounded, not quadrate. Eyes of moderate size, with broad shallow groove round base continued behind across base of fixed cheek. Surface of head-shield ornamented with coarse circular pits scattered irregularly amongst numerous fine punctæ. Free cheek continued forwards beneath the sharp lateral margin of the head-shield as a flattened inferior marginal band ornamented with longitudinal parallel rugæ continuous with those on epistome. Epistome bounded and truncated by the epistomial sutures meeting the front edge of the head-shield at about 75°. Anterior and posterior margins of epistome with almost similar curvature in opposite directions. Epistome measures from back to front about half as much as from side to side on front edge; and 8—12 coarse rugæ traverse it from side to side.

[1] Billings, 'Canad. Natur. and Geol.,' vol. iv (1859), p. 371; J. Clarke, "Lower Silur. Trilob. Minn."; 'Final Rep. Geol. Nat. Hist. Surv. Minn.,' vol. iii, pt. 2 (1894), p. 714, figs. 20—23.

Thorax of nine rings, about two thirds the length of head-shield. Axis wide, gently convex, nearly cylindrical, scarcely decreasing at all in width posteriorly. Pleuræ with an inner straight horizontal portion, and an outer (extra fulcral) portion bent downwards nearly at right angles, and also bent backwards at about 45° to the inner portion. Inner portion increases in length from head-shield to about middle of thorax, where it is nearly half the total length of pleura, but behind this point it again decreases slightly to pygidium. (In the Shalloch Mill specimens the shell surface of the axis and pleuræ shows a few fine irregular transverse wrinklings or raised lines.) Pygidium broadly oval, wider than long, very gently convex, but rather steeply and suddenly bent down near the posterior margin. Axis wide, about one third the width of whole pygidium, slightly projecting on front margin, without independent convexity or axial furrows, and only indicated by pair of short shallow marginal depressions. Fulcrum weak, distant from the axis less than half the width of latter. Lateral angles truncated at about 50° to front edge; faint shallow groove behind fulcrum. Narrow median groove behind axis running back across the fascia to the margin. Doublure or fascia consists of narrow marginal convex portion (concave in casts) and broad concave portion (convex in casts), and both portions are marked by a few rather irregular concentric striæ.

Surface of shell of pygidium punctate as head-shield. (The better preserved Shalloch Mill specimens also show some transverse irregular broken lines.)

Dimensions.—

	Specimen from Thraive Glen.	From Shalloch Mill. I.	From Shalloch Mill. II.
Length of head	25·0 mm.	—	—
Width of ,,	28·0 ,,	—	—
,, of glabella	13·0 ,,	—	—
Length of ,,	11·0 ,,	—	—
Width of fixed cheek	6·0 ,,	—	—
,, of free cheek	9·0 ,,	—	—
,, of thoracic axis	14·0 ,,	—	—
Length of thorax	14·5 ,,	—	—
,, of pygidium	+ 22·0 ,,	23·0	21·5
Width of ,,	28·0 ,,	28·0	26·5

Remarks.—This new British species of *Illænus* is represented by a considerable number of fragments (head-shields, epistomes, free cheeks, and thoracic rings) and by a few detached but nearly perfect pygidia from Shalloch Mill in Mrs. Gray's collection. The thick black shell is preserved for the most part in all these specimens. A remarkably fine and complete individual from Thraive Glen showing the same characters but in a different state of preservation has been lent me by Mr. A. Macconochie. From the latter the above complete description has been prepared. The Shalloch Mill specimens, in addition to being fragmentary, are frequently crushed and more or less distorted; but point for point they agree with the fine Thraive Glen specimen, and I have no doubt they are identical.

Affinities.—This species very closely resembles *I. bowmani*, sens. str., but it differs in the strongly marked punctation of the surface, the groove round the eye continued across the base of the fixed cheek, and the character of the caudal fascia. With *I. linnarssoni*[1] the resemblance appears still closer, particularly in the characters of the pygidium and the ornamentation of the surface of the shell; but the thoracic axis in the foreign form is narrower, the free cheeks broader and shorter, and the caudal fascia different. The characters altogether seem sufficiently distinctive to justify placing it to a new species.

Collections.—Mrs. Gray; Museum of Practical Geology; Mr. Macconochie's collection.

Horizons and Localities.—Whitehouse Group (M. Bala): Shalloch Mill. Drummuck Group (U. Bala): Thraive Glen.

13. **Illænus thomsoni,** Salter, 1866. Plate X, figs. 6—8.

1851. *Illænus*, sp. ind., Salter, Quart. Journ. Geol. Soc., vol. vii, p. 171, pl. ix, fig. 3.
1866. *Illænopsis thomsoni*, Salter, Mem. Geol. Surv., vol. iii, p. 231 (*non* p. 316, pl. ix, figs. 1, 2).
— *Illænus thomsoni*, Salter, ibid., p. 360.
1867. *Illænus* (*Dysplanus*) *thomsoni*, Salter, Mon. Brit. Trilob., p. 188, pl. xxviii, figs. 2—4 (? pl. xxx, figs. 8—10).
1873. *Illænus thomsoni*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 86.
1876. *Illænus thomsoni*, Armstrong and Young, Cat. West Scot. Foss., p. 16.
1877. *Illænus* (*Dysplanus*) *thomsoni*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 42.
1879. *Illænus thomsoni*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 157, pl. xi, fig. 9.
— *Illænus nexilis ?*, Nicholson and Etheridge, ibid., p. 158, pl. xi, fig. 12.
— *Illænus murchisoni ?*, Nicholson and Etheridge, ibid., p. 161, pl. xii, fig. 1.
1882. *Illænus thomsoni*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 49.
1899. *Illænus thomsoni*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, p. 689.

Remarks.—This species occurs in considerable abundance at Woodland Point and Penkill. The pygidia from both these localities agree with the broad form figured by Salter (Mon. Brit. Trilob., pl. xxviii, figs. 2, 3), and not with the narrower form with more truncate angles (figured *op. cit.*, pl. xxx, figs. 8, 10). The latter occurs at Mulloch Hill; but apart from the pygidia there is not sufficient evidence to separate the two forms. The species is also found at Rough Neuk and Bargany Burn, and probably at Camregan Wood.

[1] Holm, 'Svensk. Art. Illænus,' p. 103, pl. iv, figs. 13—27; pl. v, figs. 1—8; pl. vi, fig. 15; id. 'Rev. Ostbalt. Silur. Trilob.,' pt. 3, p. 146, pl. x, figs. 10—23.

The large associated epistomes from Woodland Point and Rough Neuk which probably belong to *I. thomsoni* measure relatively more from side to side than those of *I. nexilis* as figured by Salter (*op. cit.*, pl. xxx, fig. 5), the proportions from side to side and back to front being 1 : 2 instead of 2 : 3. The sides in these epistomes also make a smaller angle with the front edge than in *I. nexilis*. The front border is gently arched forwards, and the posterior border protrudes somewhat in the centre; the surface is crossed from side to side by 9—10 strong ridges. In a free cheek from Rough Neuk the anterior submarginal continuation of the cheek to the epistome is similarly ridged. This free cheek is of an elongated shape, rather more than twice as long as wide, and pointed anteriorly at about 30°. The anterior and posterior branches of the facial suture meet at the eye at about 135°. The genal angle is widely rounded.

The epistome from Penkill figured by Nicholson and Etheridge as *I. nexilis?* (*op. cit.*, p. 158, pl. xi, fig. 12), and the head ascribed to *I. murchisoni?* from the same locality (*op. cit.*, p. 161, pl. xii, fig. 1), probably belong to this species.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill; Rough Neuk. Saugh Hill Group (M. Llandovery): Woodland Point. Camregan Group (U. Llandovery): Camregan; Bargany Pond Burn. Penkill Group (Tarannon): Penkill.

14. **Illænus** cf. **oculosus,** Holm, 1886. Plate X, figs. 9—11.

Description.—Head-shield convex, rounded, short, about one third wider than long, strongly bent down in front and less so at the sides. Glabella wide, short, with low median tubercle at base. Axial furrows curving inwards and converging anteriorly, but bending a little outwards near their front extremity, extending slightly in front of the eyes. Fixed cheeks about two thirds the width of the glabella. Eye-lobes large, about one third the length of the head-shield, placed close to the posterior margin, prominent, rounded. Facial sutures curving inwards strongly from anterior margin to eyes, and behind them bending a little out to cut posterior margin at about 45° just below eyes. Free cheeks broad, short, subquadrate, as wide as long; genal angle well rounded; posterior margin nearly straight; lateral margin strongly arched outwards. Eyes large, nearly half as long as free cheeks and one third the length of the head-shield, semi-annular, elevated with prominent convex surface, less than half their length distant from posterior margin; base of eyes surrounded by wide shallow groove. Wide convex doublure below free cheek (concave in cast). Narrow neck-ring present?

Dimensions.—

Length of head (about) . . .	15·0 mm.
Width of head between eyes . . .	23·0 „
„ of glabella	10·5 „
Length of eye	5·0 „

Remarks.—These head-shields from Ardmillan are characterised by the possession of unusually large eyes close to the posterior margin, and a low median tubercle at the base of the glabella. In one specimen the free cheeks are attached but not well preserved. One detached free cheek, however, is fairly perfect. The thorax and pygidium belonging to this form are unfortunately unknown.

The species which bears the closest resemblance to this form appears to be *I. oculosus*, Holm,[1] from Stage C of the Ordovician of the Baltic provinces. But there is no median tubercle at the base of the glabella described in this Russian form. The relative size and position of the eyes, course of the axial furrows and shape of the head-shield appear to be identical. Salter's typical *I. ocularis*[2] from the much higher horizon of the Chair of Kildare Limestone has the axial furrows pursuing a similar course, but the eyes are too far forward and the genal angles are produced. There is one free cheek, however, doubtfully assigned to *I. ocularis* by Salter,[3] which in the genal angle and in the character of the doublure resembles more closely our Ardmillan specimens.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizon and Locality.—Balclatchie Group (Llandeilo): Ardmillan.

15. **Illænus** cf. **perovalis,** Murchison, 1839. Plate X, fig. 12.

1839. *Illænus perovalis*, Murchison, Silur. Syst., p. 661, pl. xxiii, fig. 7.
1854. *Illænus perovalis*, Murchison, Siluria, 1st ed., pl. iv, figs. 13, 14.
- *Illænus perovalis*, Morris, Cat. Brit. Foss., 2nd ed., p. 110.
1866. *Illænus perovalis*, Salter, Mem. Geol. Surv., vol. iii, p. 256.
1867. *Illænus* (*Ectillænus*) *perovalis*, Salter, Mon. Brit. Trilob., p. 211, pl. xxvi, figs. 5, 6 (? figs. 7, 8).
1877. *Illænus* (*Ectillænus*) *perovalis*, Woodward, Cat. Brit. Foss. Crust., p. 41.
1882. *Illænus perovalis*, Holm, Svensk. Art. Illænus (Bih. K. vet. Akad. Handl., vol. vii, No. 3), p. 47.

Description.—One solitary pygidium in Mrs. Gray's collection from Minuntion exhibits the following characters:—Shape subparabolic rather than semicircular, not twice as broad as long, very slightly convex in middle and somewhat flattened

[1] Holm, 'Rev. Ostbalt. Silur. Trilob.,' pt. 3 (1886), p. 98, pl. xii, figs. 6—9.
[2] Salter, 'Mon. Brit. Trilob.,' p. 198, pl. xxix, figs. 7, 8.
[3] Ibid., pl. xxix, fig. 9.

towards margins; anterior outline regularly but slightly arched forward on each side of axis, which itself projects to a similar extent; no distinct fulcrum. Axis narrow, short, about one fourth the width of the pygidium and less than half its length, conical, with slight independent convexity but indistinctly defined by axial furrows. Axial furrows very faint, shallow, converging posteriorly. Lateral lobes without any furrows or ribs; margin flattened. Whole surface of pygidium covered by more or less continuous undulating striæ, arched back and concentric to margin posteriorly, but becoming straighter and more transverse towards anterior margin of pygidium.

Dimensions.—

Length of pygidium	6·5 mm.
Width of ,, ...	11·5 ,,
,, of axis at front end . . .	3·0 ,,

Remarks.—The general shape of the pygidium, anterior outline, absence of fulcrum, and size of axis appear to be similar to *I. perovalis*, Murchison, but the conical shape of the axis (distinctly seen in our specimen, though the upper part is chipped off) and particularly the striation over the whole surface, as in *I.? puer*, Barrande,[1] seem to differentiate it from that species.

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Minuntion.

16. **Illænus,** sp. ind. Plate X, fig. 13.

Description.—Two head-shields from Craighead in Mrs. Gray's collection show certain peculiar features in the fixed cheeks not observed in any other Girvan or, indeed, British specimens which I have seen. The head-shields are about half as wide again as long and strongly convex from back to front, with a short broad glabella faintly defined by almost obsolete axial furrows. The palpebral lobes form prominent rounded subcylindrical lateral projections to the fixed cheeks, such as are found in *I.* (*Thaleops*) *ovatus*, Conrad,[2] from the Trenton Limestone, and in *I. arcturus*, Hall,[3] from the Chazy Limestone. Though the state of preservation is not good in our specimens, they do not appear to have suffered distortion.

[1] Barrande, 'Syst. Silur. Bohême,' vol. i, Suppl., p. 73, pl. xiv, figs. 39—42; Novák, 'Zur Kennt. böhm. Trilob.,' p. 36, pl. ix, figs. 1—3.

[2] Conrad, 'Proc. Acad. Nat. Sci. Philad.,' 1843, vol. i, p. 332; J. Clarke, "Lower Silur. Trilob. Minn., Final Rep."; 'Geol. Nat. Hist. Surv. Minn.,' vol. iii, pt. 2 (1894), p. 716.

[3] Hall, 'Palæont. N. Y.,' vol. i (1847), p. 23, pl. iv *bis*, fig. 12.

Dimensions.—

		I.	II.
Length of head-shield	. .	30·0 mm.	20·0 mm.
Width of ,,	. .	45·0 ,,	30·0 ,,

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

Family PROETIDÆ.

Genus **PROETUS,** Steininger.

1. **Proetus girvanensis,** Nicholson and Etheridge, 1879. Plate XI, figs. 1—3.

1879. *Proetus girvanensis*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 169, pl. xii, figs. 7—10.

1899. *Proetus girvanensis*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 524, 673, 689.

Specific Characters.—General shape oblong oval, tapering slightly posteriorly.

Head-shield subparabolic in appearance rather than semicircular, owing to the sides being bent down; convex from side to side and from back to front; about twice as broad as long. Border surrounding head narrow, band-like, marked off by fairly strong furrow. Glabella short, wide, nearly as broad as long, narrowing a little anteriorly and slightly contracted in front of basal lobes; anterior end bluntly rounded, nearly reaching anterior border. Lateral furrows distinct[1] and consisting of three pairs; the two anterior pairs short, fine, weak, nearly horizontal and parallel, the front pair very far forward, being nearly at the anterior lateral angles of the glabella, and the second pair opposite the anterior end of the eyes; the third or basal pair of furrows opposite the middle of the eyes and running obliquely back to the occipital furrow, thus marking off a pair of triangular basal lobes on the glabella, each rather less than one third its basal width. Axial furrows deep, well marked, converging a little anteriorly, and uniting in front of glabella. Occipital furrow deep, arched forward in centre and bent up at sides. Occipital segment wide, flattened, with central tubercle and almost obsolete, small, indistinct occipital lobes. Fixed cheeks very narrow, uniting in front of glabella as strongly convex narrow band. Palpebral lobes rounded, of moderate size, gently upturned, situated opposite middle of glabella and extending more than one third its length. Facial sutures cutting front margin of head outside anterior lateral angles of glabella, running back thence straight to eyes, and behind it running straight back till opposite occipital furrow, where they suddenly bend outwards

[1] According to Nicholson and Etheridge they are indistinct, and no description of them was given by these authors; but even in the type specimens they are clearly seen, though the shell is not preserved.

to cut posterior margin of head at about 30° halfway between glabella and genal angles. Free cheeks triangular, gently convex, bent down strongly; genal angles produced into short tapering pointed spines, reaching back to about fourth thoracic segment. Eyes large, prominent, subreniform, more than one third the length of glabella and situated very close to it; elevated on distinct base with narrow rim and strong furrow below.

Thorax of ten segments, longer than head. Axis convex, tapering gradually to pygidium, broader than pleuræ; axial rings with minute median tubercle and well-developed lateral nodules on each (particularly well shown in casts). Pleuræ strongly bent down beyond fulcrum, but very slightly curved back; strong diagonal pleural groove; extremities slightly recurved, pointed, with broad articulating surface on anterior margin for rolling up. Fulcrum weak, situated at about half the length of pleuræ.

Pygidium broadly semicircular. Axis convex, prominent, occupying middle third and extending about three fourths its length, conical, with rounded extremity connected with posterior margin by low indistinct ridge; axis segmented by 5—6 rings, followed by a longer terminal piece. Lateral lobes depressed, feebly convex, bent down slightly, with 4—5 indistinct low pleuræ separated by faint furrows; first pleura the most distinct.

Dimensions.—

Length of head	8·0 mm.
Width of ,, (over curved surface) . .	17·0 ,,
Length of glabella	5·5 ,,
Width of ,, at base . . .	5·0 ,,
Length of thorax	10·0 ,,
Width of axis	5·0 ,,
Length of pygidium	4·5 ,,
Width of ,, ...	9·0 ,,

Remarks.—This species was compared by its authors (*op. cit.*) with a large number of foreign forms, but it seems unnecessary to mention species from any widely different stratigraphical horizon. *Proetus ramisulcatus*, Nieszk.,[1] has somewhat similar cranidial characters, and perhaps *P. kertelensis*, Schmidt,[2] is allied. Both of these species occur in the highest Ordovician beds of the East Baltic provinces.

Collections.—Mrs. Gray (f. M., pl. xii, figs. 9, 9 *a*, 10); Museum of Practical Geology (f. M., pl. xii, fig. 7); Edinburgh Museum (f. M., pl. xii, fig. 8).

Horizon and Localities.—Drummuck Group (U. Bala): Thraive Glen, Drummuck Burn; Drummuck.

[1] Nieszkowski, "Mon. Trilob. Ostseeprov.," in 'Archiv Naturk. Liv., Est., Kurl.,' ser. 1, vol. i, p. 560, pl. iii, figs. 1, 2.

[2] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. 4, p. 56, pl. iv, fig. 37.

2. **Proetus latifrons** (M'Coy), 1843. Plate XI, figs. 4, 4 *a*.

1846. *Forbesia latifrons*, M'Coy, Synops. Silur. Foss. Ireland, p. 49, pl. iv, fig. 11.

Remarks.—The true *P. latifrons* of M'Coy occurs in the Lower and Middle Llandovery of the Girvan area. The broad rounded triangular glabella nearly reaching the anterior border, with a very narrow pre-glabellar band interposed, is a characteristic feature. Unfortunately our specimens are not very well preserved, and only consist of more or less imperfect head-shields. There are obscure traces of lateral furrows on the glabella, and the occipital lobes are well marked. The course of the facial sutures seems to agree with that of M'Coy's type.

M'Coy (*op. cit.*) described the species as follows:—" Longitudinally oval, width two thirds the length; side-lobes about one third wider than the axial lobe; glabella subtrigonal, prominent, but flattened above, length and width of the base equal; front rounded, narrower than the base; sides with two (? three) short, very obscurely marked cephalothoracic [lateral] furrows on each side; neck furrow very strongly marked, terminating at each end in a large flattened oblique tubercle; cheeks very prominent, triangular, nearly twice as long as wide; eyes large, reniform, close to the glabella; eye-line [facial suture] descending perpendicularly to the lower margin of the cheeks, and then turns abruptly outward at its extremity; margin rather broad; abdomen [thorax] of eleven [ten] segments, those of the axial lobe [axis] terminating in prominent tubercles; side segments [pleuræ] compound; pygidium semi-oval; axial segments ten, simple; lateral segments [pleuræ of lateral lobes] divided by a groove, extending rather more than halfway from the margin; margin entire, even." Subsequently in 1854 M'Coy [1] described what he considered to be the same species from the Upper Ludlow of Underbarrow, Kendal; but the description does not quite agree with that of the type, and the specimens (which are in the Woodwardian Museum) are certainly different to it, though their poor state of preservation renders their characters difficult to distinguish.

The differentiation of the various Silurian and Ordovician species of *Proetus* requires attention to minute details, and a revision of the British species is to be desired. It is much to be regretted that in the majority of cases the material is too poor to permit satisfactory comparison, particularly with foreign species.

Collection.—Mrs. Gray.

Horizon and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill. Saugh Hill Group (M. Llandovery): Woodland Point.

[1] M'Coy, 'Synops. Brit. Pal. Foss. Woodw. Mus.' (1854), p. 174.

3. **Proetus procerus,** Nicholson and Etheridge, 1879. Plate XI, figs. 5, 6, 6 *a*.

1879. *Proetus procerus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan., fasc. ii, p. 174, pl. xii, fig. 11.

1899. *Proetus procerus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 524, 673, 689.

Specific Characters.—General shape elongate oval, twice as long as wide.

Head-shield parabolic, length rather more than two thirds the width, gently convex, bent down at sides, surrounded by narrow rounded border separated off by well-marked marginal furrow. Glabella convex, oblong, narrowing a little anteriorly, rounded in front, rather longer than wide, very slightly contracted between eyes. Lateral furrows indistinguishable, except a faint trace of a pair of oblique basal furrows starting at sides opposite middle of eyes and marking off triangular basal lobes. Glabella separated from anterior border by narrow raised pre-glabellar band uniting fixed cheeks. Axial furrows narrow, deep, uniting in front of glabella, and converging slightly anteriorly. Occipital furrow strong, deep, arched forwards at sides and in middle; occipital ring rather broad; occipital lobes obsolete. Fixed cheeks very narrow, but widening in front of eyes. Palpebral lobes of moderate size, situated by their own length from posterior margin of head-shield, and extending along middle of glabella for about one third of its length. Facial sutures curving strongly outwards in front of eyes to cut anterior margin; posterior branches bending outwards to cut posterior edge at about 45° below eyes. Free cheeks triangular, with strong neck furrow cutting off neck segment, and genal angles furnished with short spines extending to third thoracic segment, and longitudinally striated beneath. Eyes close to glabella, opposite its middle and extending about one third of its length; crescentic, elevated, with convex surface, and wide shallow groove surrounding their base.

Thorax of ten segments. Axis convex, cylindrical, gently tapering, wider than pleuræ. Axial furrows strong. Pleuræ with their distal half curved sharply downwards; wide strong diagonal pleural groove on surface; extremities rounded.

Pygidium semicircular. Axis conical, rounded, convex, strongly elevated, of 5—6 segments, about one third the width of pygidium and nearly reaching posterior margin, with which it is connected by short low pointed terminal appendage. Lateral lobes gently convex and bent down, with 3—4 faint pleuræ visible. (A narrow border surrounds the pygidium in the type specimen, which is a cast.)

Dimensions.—

Length of body	14·0 mm.
,, of head	5·5 ,,
Width of ,, ...	7·5 ,,

Length of glabella	. . . .	3·5 mm.
,, of thorax	. . . .	5·5 ,,
,, of pygidium	. . . .	3·0 ,,
Width of ,,	. . . .	5·5 ,,
,, of axis	. . . .	2·0 ,,

Remarks.—The description given by Nicholson and Etheridge (*op. cit.*, p. 174) of this species has been slightly amplified above, several minor features having failed to attract their attention. The preceding description is drawn up after a minute examination of the original type specimen.

In one complete specimen in Mrs. Gray's collection, but not very well preserved, the hypostome is present in its normal position. It is about two thirds the length of the glabella, and possesses a long narrow convex subcylindrical body, more than twice as long as wide, marked by a few strongly arched lines near the front end. Towards its posterior extremity at about two thirds its length its sides are indented by short oblique notches, and its rounded extremity has a flattened band pressed against it. Near the front end the border is extended as a pair of flattened rounded (?) wings; and a narrow raised rim lies at the front end of the body.

Affinities.—This species is closely allied to *P. girvanensis*, but it differs not only, as Nicholson and Etheridge have pointed out, in its more elongate shape and narrower glabella, but in the course of the facial suture and the more forward position of the eyes, which also are relatively smaller.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum.

Horizon and Localities.—Drummuck Group (U. Bala): Thraive Glen; Drummuck.

4. **Proetus pseudolatifrons,** sp. nov. Plate XI, figs. 7—9.

1848. *Proetus latifrons*, Salter, Mem. Geol. Surv., vol. ii, pt. 1, p. 337, pl. vi, figs. 1, 1*a*.
1854. *Forbesia latifrons*, M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., p. 174.
— *Proetus latifrons*, Morris (*e. p.*), Cat. Brit. Foss., 2nd ed., p. 114.
1872. *Proetus latifrons*, Murchison, Siluria, 5th ed., p. 235, Foss. 65, fig. 7.
? 1873. *Proetus latifrons*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., pp. 134, 165.
1877. *Proetus latifrons*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 56.
1879. *Proetus latifrons*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 171.
1899. *Proetus latifrons* (*e. p.*), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 524, 673.

Specific Characters.—"Oval; width three fifths the length; gently convex; head and body equally long; axis prominent, rather narrow; glabella smooth, widest and most convex behind, as wide as the cheeks, not reaching to the tumid margin; eyes close to it, large, not prominent; facial suture vertical from the eye till close to the neck margin, then turning abruptly outwards to the first third; spines thick, vertical, reaching the fourth or fifth segment; axis of body narrow and prominent; fulcrum at half in front, one third behind; caudal axis six- or seven-ribbed, prominent, long conical, only four fifths the length of the semicircular shield, and narrower than the sides, which have about five furrows not reaching the border, with faint ones between them" (*Salter*).

Remarks.—It does not appear that the specimens described and figured by Salter (*op. cit.*) as "*Proetus latifrons* (M'Coy)" from the Upper Ludlow of Usk are really identical with M'Coy's *Forbesia* [*Proetus*] *latifrons* from the Silurian of Eggool, co. Mayo. I have compared the type with Salter's figure, and find several important points of difference. In the first place the glabella of Salter's species is more cylindrical, narrower, less triangular, and narrows more gradually and to a less extent towards the front end. Secondly, the pre-glabellar portion is much wider, being nearly one third the length of the glabella, whereas in the Irish type it is very narrow, since the glabella nearly touches the border. Thirdly, the pygidium is longer, more oval, and less transverse, with a narrower, more slowly tapering axis. The fulcrum on the anterior edge also appears to be stronger.

As previously stated, M'Coy (1854), subsequent to his naming of the Irish specimen *Forbesia* [*Proetus*] *latifrons*, identified with it the Upper Ludlow specimens of *Proetus* from Underbarrow, Kendal, but they resemble much more closely Salter's form, so far as their poor state of preservation permits one to see.

Specimens of the head and pygidium agreeing with Salter's species occur in the Upper Llandovery of the Girvan area. The characters are so distinct from those of M'Coy's *P. latifrons* that it seems absolutely necessary to separate them specifically, and the name *P. pseudolatifrons* is suggested.

Collection.—Mrs. Gray.

Horizon and Localities.—Camregan Group (U. Llandovery): Camregan Wood; Cuddystone Glen; Bargany Pond Burn.

5. **Proetus stokesi** (Murchison), 1839. Plate XI, figs. 10, 11.

1839. ***Asaphus stokesii***, Murchison, Silur. Syst., p. 656, pl. xiv, fig. 6.
1845. ***Proetus stokesi***, Lovén, Ofv. K. vet. Akad. Förhandl., p. 50, pl. i, fig. 3.
1854. ***Proetus stokesii***, Murchison, Siluria, 1st ed., pl. xvii, fig. 7.
— ***Forbesia stokesii***, M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., p. 174.
— ***Proetus stokesii***, Morris, Cat. Brit. Foss., 2nd ed., p. 114.
1855. ***Phaetonides stokesi***, Angelin, Pal. Scand., p. 22, pl. xvii, fig. 4.
1873. ***Proetus stokesii***, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 134.
1877. ***Proetus stokesii***, Woodward, Cat. Brit. Foss. Crust., p. 56.
? 1879. ***Proetus?*** or ***Acidaspis***, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 206, pl. xiv, fig. 15.

1885. *Phaetonides stokesi*, Lindström, Forteckn. Gotl. Silur. Crust. (Ofv. K. vet. Akad. Förhandl., No. 6), p. 75.

1899. *Proetus stokesii*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 550, 673.

Specific Characters.—General shape longitudinally oval.

Head-shield semi-elliptical to parabolic, with genal angles produced backwards as broad flattened pointed spines, closely pressed to sides of thorax and reaching as far as pygidium; broad rounded tumid border surrounding head-shield and extending to tip of spines. Glabella semi-oval, subconical, convex, about three fourths the length of the head and one third its width, slightly expanded posteriorly at sides, broadest at base, truncate behind, rounded in front, narrowing anteriorly, and not reaching marginal furrow in front. Pair of large subtriangular basal lobes present, about half the length of the glabella and less than one third its basal width, projecting somewhat laterally, and marked off by strong slightly curved oblique furrows, inclined at about 60° to occipital furrow, and arising a little behind front end of eyes. (The anterior portion of these furrows is in some specimens weak or almost obsolete.) No other lateral furrows present. Occipital furrow strong. Occipital ring broad, of uniform width, with pair of well-defined oval occipital lobes. Fixed cheeks very small and narrow, but expanding in front of eyes and uniting as pre-glabellar band in front of glabella. Facial sutures curving inwards strongly from anterior margin to eyes, and behind them running vertically back about half-way towards posterior margin and then bending out sharply to cut it at an acute angle below or a little outside eyes. Free cheeks large, long, bent down on each side, produced posteriorly into broad flattened genal spines, overlapping at base the extremities of the first and second thoracic pleuræ and reaching back to pygidium. Eyes reniform, large, convex, prominent, closely pressed against glabella and extending about half its length, situated at about two thirds their own length from hinder margin of head-shield. Neck furrow strong. Neck segment rounded, narrower than occipital ring, but equal in width to cephalic border and continued to tip of genal spine.

Thorax of ten segments; axis convex, subcylindrical, tapering gently to pygidium; at front end equal in width to pleuræ, but considerably less wide posteriorly. Axial rings without lateral nodules or only with very faint traces of them. Pleuræ gently curved down, with median, scarcely diagonal furrow; extremities pointed, recurved, and slightly falcate. Fulcrum strong, situated at about one third the length of pleuræ.

Pygidium semi-elliptical to semicircular, with broad tumid border. Axis conical, convex, prominent, tapering slightly posteriorly to rounded tip reaching border; less than one third the width of pygidium at front end; annulated with 8—10 rings. Lateral lobes arched down slightly, and marked with about six radiating flattened pleuræ, each with fine median furrow. Margin simple, entire.

Remarks.—The descriptions previously given of this species have been meagre and incomplete. It is represented in most collections of Llandovery fossils from the Girvan area, and shows the typical characters. The poor specimen which Nicholson and Etheridge (*op. cit.*) figured from Bargany Pond Burn as "*Proetus ?* or *Acidaspis ?*" is perhaps referable to this species.

Lindström (*op. cit.*) placed this species in the genus *Phaetonides*, but it lacks the characteristic spines on the margin of the pygidium, and it appears doubtful if *Phaetonides* can in any case be regarded as more than a sub-genus of *Proetus*.[1]

Collections.—Mrs. Gray (f. M.): Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill. Saugh Hill Group (M. Llandovery): Newlands; Woodland Point. Camregan Group (U. Llandovery): Camregan Wood; Bargany Pond Burn. Penkill Group (Tarannon): Penkill.

6. **Proetus** cf. **obconicus,** Lindström. Plate XI, fig. 12.

Remarks.—There is a head-shield from Woodland Point which much resembles *P. obconicus*, Lindström,[2] in the shape of the glabella, position and size of the eyes, distinct occipital lobes and median tubercle on the neck-ring. From *P. procerus* it differs in the broader, more oval glabella; in the eyes being relatively larger and situated considerably behind the middle of the glabella and therefore much further back; in the possession of well-marked occipital lobes, which are always indistinctly defined in *P. procerus;* and in the median tubercle of the neck-ring.

Collection.—Mrs. Gray.

Horizon and Locality.—Saugh Hill Group (M. Llandovery): Woodland Point. ? Mulloch Hill Group (L. Llandovery): Mulloch Hill.

7. **Proetus,** sp. ind. Plate XI, fig. 13.

An incomplete head-shield and its impression from the Lower Llandovery of Craigens seem to indicate a new species of *Proetus*, but the material is hardly sufficient to attach to it a new specific name.

Description.—Head-shield with broad, thick, raised and rounded border. Glabella about two thirds the length of head-shield, oval, truncated behind, pointed acutely in front, gently convex, with traces of two pairs of short oblique lateral furrows; front end of glabella separated from border of head-shield by wide flattened horizontal pre-glabellar area. Occipital lobes distinct at sides of neck-

1 Oehlert, 'Bull. Soc. Ét. Scient. d'Angers,' 1885, pp. 5, 8.

2 Lindström, 'Ofv. K. vet. Akad. Förhandl.,' 1885, No. 6, p. 78, pl. xv, figs. 22—24.

ring, encroaching slightly on glabella. Occipital furrow strong, bending forwards slightly in middle and at sides in front of occipital lobes. Axial furrows narrow, distinct. Fixed cheeks very narrow at base, but widening out in front of eye-lobes and confluent in front of glabella by pre-glabellar area. Eye-lobes large, long, extending more than one third the length of glabella from base, very approximate to glabella. Facial sutures bending sharply outward in front of eyes to cut anterior margin of head-shield nearly at right angles.

Dimensions.—

Length of head-shield	. . .	14·0 mm.
Length of glabella	. . . .	9·0 ,,
Width of ,, at base	. . .	8·0 ,,

Affinities.—This form resembles *P. latifrons* in most points, but differs in the pointed apex of the glabella. *P. obconicus*, Lindström,[1] is somewhat similar, but the glabella in it is narrower and not pointed in front, and the pre-glabella portion is smaller. *P. acutus*, Lindström,[2] appears to have a similarly pointed glabella, but the type is a mere fragment.

Collection.—Mrs. Gray.

Horizon and Localities.—Mulloch Hill Group (L. Llandovery): Craigens; ? Mulloch Hill.

Genus **CYPHASPIS,** Burmeister.

1. **Cyphaspis megalops** (M'Coy), 1846.

1846. *Harpes? megalops*, M'Coy, Synops. Silur. Foss. Ireland, p. 54, pl. iv, fig. 5.
1849. *Harpidella megalops*, M'Coy, Ann. Mag. Nat. Hist. [2], vol. iv, p. 412.
1852. *Harpidella megalops*, M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., pp. 143, 368.
1853. *Cyphaspis megalops*, Salter, Mem. Geol. Surv., dec. vii, pl. v, figs. 1—7 (*non* fig. 8).
1867. *Cyphaspis megalops*, Murchison, Siluria, 4th ed., p. 235, Foss. 65, fig. 2.
1873. *Cyphaspis megalops*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., pp. 77, 133.
1877. *Cyphaspis megalops*, Woodward, Cat. Brit. Foss. Crust., p. 34.
1879. *Cyphaspis megalops*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 140.

Specific Characters.—"General form convex, truly ovate; extremities obtuse. Head-shield very convex, strongly granulose, nearly semicircular, but contracted at posterior angles just in front of genal spine. Genal spine strong, curved, about equal in length to head, reaching back to seventh thoracic segment. Glabella very convex, parallel-sided or parabolic, rounded; about one third the width of the head and about two thirds its length; with one pair of lateral lobes at base of

[1] Lindström, *op. cit.*, p. 78, pl. xv, figs. 22—24.
[2] Lindström, *op. cit.*, p. 79, pl. xv, fig. 25.

glabella, convex, longitudinally ovate [pointed in front], about one fifth the width of the glabella, completely circumscribed by uniformly deep furrow. [Fixed cheeks moderate, swollen, separated from glabella by deep axial furrows, and united in front of it by tumid pre-glabellar portion about one fifth or sixth the length of the glabella.] Facial suture curves inward from anterior margin to eye, behind which it bends outward [with a slightly sigmoidal course] to cut the posterior margin far out a little within the base of the spine. Free cheeks elongated, high-conical, with long curved genal spines; eyes large, prominent, crescentic, smooth, situated about halfway up the head and near the glabella. Occipital segment moderately broad, prominent; occipital furrow strong. Border to head-shield thick, rounded, tumid, as wide as neck-segment; marginal furrow strong, but does not quite reach neck furrow at base of genal spine.

"Thorax much less convex than head, and a little longer than it; of eleven segments; axis moderately convex, tapering quickly backward, rather wider than pleuræ; sixth ring much swollen and produced backward into straight horizontal spine, lying upon surface of posterior rings and nearly reaching end of pygidium. Pleuræ short, flattish, divided nearly to tip by strong straight central groove; extremities thickened, truncate, and very faintly bilobed. Fulcrum situated about halfway along pleuræ of middle segments, but nearer axis posteriorly. Extra-fulcral portion of pleuræ sharpened and facetted anteriorly for rolling up.

"Pygidium small, short, transverse, slightly convex, more than twice as wide as long. Axis short, broad, conical, rounded, one third the width of pygidium, with one distinct ring, a second less distinct, and a terminal joint. Lateral lobes with fulcrum on anterior border about one third of the way out, and one distinct upper furrow, not reaching the margin. All the prominent parts of the surface of the body, especially head-shield, ornamented with small tubercles of fairly regular size" (*Salter*).

Remarks.—The only specimen of this species from the Girvan area is the one in the Woodwardian Museum mentioned by M'Coy and Salter, and it is in such a miserable state of preservation that its identification is doubtful, as Nicholson and Etheridge remarked.

Collection.—Woodwardian [Sedgwick] Museum.

Horizon and Locality.—Mulloch Hill Group (L. Llandovery): Mulloch Quarry.

Genus **ARETHUSINA**, Barrande.

1. **Arethusina konincki,** Barrande, 1846. ? Plate XI, figs. 14, 15.

1846. *Arethusa konincki*, Barrande, Not. prélim., p. 48.
1847. *Aulacopleura konincki*, Corda, Prodrom. Boh. Trilob., p. 84, pl. v, fig. 48.
— *Aulacopleura angusticeps*, Corda, ibid., p. 85.

1852. *Arethusina konincki*, Barrande, Syst. Silur. Bohême, vol. i, p. 495, pl. xviii, figs. 1—21.
1868. *Arethusina konincki*, Barrande, Réapp. d. g. Arethusina, figs. 4—6.
1884. *Arethusina konincki*, Törnquist, Undersokn. Siljans. Trilobitf., p. 51, pl. ii, figs. 10, 11.

Specific Characters.—Barrande's description of this species may be summarised as follows:—

General shape oval; head-shield occupying about one fourth and pygidium about one twelfth of the whole length.

Head-shield broadly semicircular, with narrow border separated off by marginal furrow and prolonged into genal spines parallel to axis and reaching back to sixth pleuræ. Posterior margin of head nearly straight. Occipital ring prominent, with median tubercle. Neck segment behind cheeks widening laterally. Axial furrows deep, almost parallel, uniting nearly at right angles in front of glabella. Glabella short, subcylindrical or slightly conical, strongly convex; varying somewhat in width in relation to cheeks. Three pairs of lateral furrows present on glabella, but only posterior ones usually visible, marking off small ovoid basal lobes. Fixed cheeks uniting in front of glabella in broad area. Free cheeks rather large, subtriangular, with genal spines. Eyes prominent, rounded, situated opposite first lateral furrows of glabella, and connected with it at this level by transverse eye-lines. Fixed and free cheeks ornamented with minute pits irregularly distributed.

Thorax of twenty-two segments; axis convex, about half the width of lateral lobes. Lateral lobes horizontal, bending down slightly in outer fourth. Pleuræ rectilinear, with strong diagonal furrow and rounded extremity.

Pygidium transverse, forming segment of circle, three times as wide as long, surrounded by narrow border. Axis prominent, about one fifth the whole width of the pygidium, and showing six segments. Lateral lobes almost horizontal, with 4—5 pleuræ, each with diagonal furrow.

Remarks.—A single minute head-shield in a fair state of preservation and several pygidia in Mrs. Gray's collection from Balclatchie afford the only evidence for the occurrence of this Bohemian and Swedish species in the Girvan area. But it seems impossible to do otherwise than refer these specimens without much doubt to Barrande's species, *Arethusina konincki*, after a careful comparison with a large number of Bohemian examples.

In the Girvan specimen of the head-shield all the typical features are seen. The course of the facial sutures and the eye-lines are distinct, but the latter are rather oblique instead of horizontal, though this may be due to the distortion which the specimen has evidently suffered through crushing. The punctation of the cheeks, the narrow border, the genal spines and the short glabella are well seen; the basal lobes are indistinct owing to the surface of the glabella being injured. The pygidium appears to offer no points of difference.

The genus *Arethusina* has been recorded by Walcott[1] from the Prospect Mountain

[1] Walcott, "Palæont. Eureka district," 'Mon. U.S. Geol. Surv.,' vol. viii (1884), p. 62, pl. 9, fig. 27.

Group (Cambrian) of the Eureka district, but it seems doubtful whether this American form is really attributable to Barrande's genus.

Dimensions.—Length of head-shield, 3·0 mm.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

Genus **PHILLIPSINELLA**, Novák.

1. **Phillipsinella parabola** (Barrande), 1846. Plate XII, figs. 1, 1*a*, 2.

1846. *Phacops parabola*, Barrande, Nouv. Trilob., p. 6.
1852. *Phillipsia parabola*, Barrande, Syst. Silur. Bohême, vol. i, p. 477, pl. xviii, figs. 24—29.
1869. *Phillipsia parabola*, Linnarsson, Om Vestergotl. Camb. Silur. Aflagr., p. 72, pl. ii, figs. 30—32.
1872. *Phillipsia parabola*, Barrande, op. cit., Suppl., p. 18, pl. i.
1884. *Phillipsia parabola*, Novák, Z. Kennt. böhm. Trilob., p. 27 (Beitr. z. Palæont. Osterreich).
1885. *Phillipsinella parabola*, Novák, Stud. Hypost. III (Sitz. K. böhm. Gesell. Wiss., Jahrg. 1885), p. 581, pl. iii, figs. 1—3.
1885. *Phillipsinella parabola*, Marr and Roberts, Quart. Journ. Geol. Soc., vol. xli, p. 476.
— *Phillipsella parabola*, Oehlert, Bull. Soc. Ét. Scient. Angers, pp. 11, 21, pl. ii, fig. 38.
1896. *Phillipsinella parabola*, Reed, Quart. Journ. Geol. Soc., vol. lii, p. 435.

Specific Characters.—Barrande's description of this species may be summarised as follows:—Head parabolic, much elongated, with a flattened border prolonged at the genal angles into spines almost as long as the glabella. Glabella, not prominent, subclaviform; front lobe inflated, occupying half the total length of the glabella and twice as wide as the narrow somewhat depressed neck. Occipital ring broad, elevated, and projecting a little posteriorly. Axial furrows well marked. Facial sutures with the anterior branch cutting the front margin a little outside the eye, and the posterior branch cutting the middle of the posterior margin of the head. Eyes of moderate size, opposite and as long as the neck of the glabella, and situated a short distance from the axial furrows. Palpebral lobes rounded. Surface of glabella ornamented with irregular concentric striæ.

Thorax of six segments; axis prominent, and about a fourth the width of the thorax. Pleuræ bent back at 60° in the middle of their length [with a strong median furrow on the inner half]; extremities rounded.

Pygidium strongly arched from side to side [semi-elliptical in shape, about two thirds as long as wide]; axis [prominent, tapering, not quite reaching posterior margin] with 5—6 articulations. Lateral lobes with 2—4 faintly indicated pleuræ on each side. Border smooth, a little flattened, simple, slightly excavated posteriorly.

Remarks.—In addition to several detached head-shields and pygidia from Thraive Glen in Mrs. Gray's collection, there is one perfect individual showing the elongated genal spines longitudinally striated and of somewhat unusual length, as they extend back past the thorax (against which they are closely pressed) to the middle of the pygidium. Another specimen shows complete enrolment.

This species has been previously recorded in the British Isles from the *Staurocephalus* Limestone of Swindale, the Sholeshook Limestone of Sholeshook, and the Keisley Limestone of Keisley.

Collection.—Mrs. Gray.

Horizon and Locality.—Drummuck Group (U. Bala): Thraive Glen.

Genus **MENOCEPHALUS,** Owen.

1. **Menocephalus? (Törnquistia)** cf. **nicholsoni,** Reed. Plate XII, figs. 3—7.

Remarks.—There are several specimens from Balclatchie in Mrs. Gray's collection which bear a very close resemblance to the Keisley trilobite described by the author[1] as *Cyphaspis (Törnquistia) nicholsoni.* The only point of difference in the head-shield is that the median pre-glabellar furrow is obsolete or only represented by a faint notch. In one specimen also there are slight traces of oblique basal furrows on the glabella, obscurely marking off triangular basal lobes more than one third the length of the glabella. The course of the facial suture is well shown, the two branches making nearly a right angle at the eye, where the fine thread-like ridge accompanying the suture is slightly thickened.

In one specimen the thorax and pygidium are attached to the head-shield, and though not quite perfect, and forced by crushing partly under the head-shield, show certain distinctive features. Six or seven thoracic segments are present; the axis is cylindrical, strongly convex, and as wide as the pleuræ. The pleuræ are straight and horizontally extended as far out as the fulcrum, which is situated at rather more than half their length, and here they are bent downwards and slightly backwards. Each pleura is traversed by a submedian furrow, dividing it into an anterior elevated portion which is ornamented with a row of 3—5 tubercles; and a posterior portion which is narrower, lower, and less conspicuously tuberculated. The pygidium is short, transverse, broad, and twice as wide as long; the axis is strongly convex and cylindrical, reaching the posterior border, and furnished with three prominent rounded rings separated by deep transverse grooves; the lateral lobes are wider than the axis, flattened, triangular, crossed by three rounded subparallel ridges corresponding to the axial rings and finely tuberculated. The border of pygidium is sharply marked off, wide, smooth, depressed and excavated.

In addition to this complete individual there are several isolated head-shields and pygidia from Balclatchie in Mrs. Gray's collection showing identical features.

Affinities.—The close resemblance to Törnquist's *Trilobites triradiatus* in the case

[1] Reed, 'Quart. Journ. Geol. Soc.,' vol. lii (1896), p. 433, pl. xxi, fig. 3.

of the Keisley examples of this species was pointed out by the present writer in 1896 (*op. cit.*). But only the head-shield was known at that time. The curious group of furrows in front of the glabella recalls those in *Agraulos ? globosus*, Walcott, from the Cambrian of the Eureka district, Nevada.[1] In the shape and characters of the glabella and cheeks there is also a resemblance to *Bathyurus tuberculatus*, Walcott,[2] from the same horizon and region. But on the whole the head-shield with its short swollen glabella, and the thorax, so far as they are known, seem to link this form more with species of *Menocephalus* (e. g. *M. minutus*, Nieszk.[3]) than with any representatives of *Cyphaspis* or any other genus, and therefore the sub-genus *Törnquistia* may preferably be placed under the genus *Menocephalus*.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

Family BRONTEIDÆ.

Genus **BRONTEUS,** Goldfuss.

1. **Bronteus andersoni,** Nicholson and Etheridge, 1879. Plate XII, figs. 8—11.

? 1876. *Bronteus brongniarti*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.

1879. *Bronteus andersoni*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 162, pl. xii, figs. 3—5.

1899. *Bronteus andersoni*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 536, 542, 672, 688.

Specific Characters.—Head transverse, semicircular (?), flattened. Glabella weakly convex, broadly club-shaped, consisting of an almost parallel-sided neck about half the entire length of the glabella, and of an expanded anterior portion nearly twice the width of the neck and projecting laterally so as to overhang the cheeks. Frontal lobe with anterior lateral angles measuring about 45°, and anterior end gently arched; width of frontal lobe equal to about one and a half times the whole length of the glabella. Three pairs of lateral glabellar furrows present; anterior pair situated near base of expanded anterior portion of glabella, rather long, obliquely directed backwards, widening and deepening outwards but not reaching axial furrows. Second pair situated at front end of neck, and consisting of two isolated elongated deep pits or short grooves, connected by faint longitudinal furrows with the inner ends of the first pair of furrows. Third pair of furrows similar in character to second pair, and situated halfway down the neck. Axial furrows distinct, strongly curved outwards in front of neck, nearly parallel along its sides. Occipital furrow strong, arched forward in middle. Occipital ring rounded, widest in middle, and furnished with

[1] Walcott, "Palæont. Eureka District," 'Mon. U.S. Geol. Surv.,' vol. viii (1884), p. 61, pl. ix, fig. 23.

[2] Walcott, ibid., p. 93, pl. xii, fig. 9.

[3] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. 4, p. 60, pl. iv, figs. 46, 49.

median tubercle. Narrow marginal border present round front of head-shield. Fixed cheeks flattened, wider at their base than the neck of the glabella. A strongly-curved furrow on each side marks off a small subcircular area near inner basal angles of cheeks. Neck-segment marked off by strong furrow. Eyes situated at level of second pair of glabellar furrows, and distant from axial furrows a little more than half the width of neck of glabella. Facial sutures with anterior branch cutting front margin of head-shield just outside lateral angle of frontal lobe, running thence straight back to eye, behind which the posterior branch curves sharply outwards and then runs back to cut posterior margin of head-shield. Free cheeks unknown. Surface of head ornamented by fine curved lines (indistinctly preserved).

Thorax of ten or eleven segments; axis cylindrical, convex, not as wide as pleuræ. Pleuræ simple, horizontal, flattened, with extra-fulcral portion deflected, wrinkled transversely. Fulcrum moderate, situated at about half the length of pleuræ.

Pygidium of two shapes (probably of only sexual value), (1) transversely oval, (2) elongated parabolic; in both cases wider than long; gently convex in middle, but flattened and slightly concave towards margins. Anterior edge nearly straight, with very weak fulcrum about halfway out. Axis short, conical, convex, about a quarter the length of the pygidium or a little more, with sides slightly arched and converging at about 45°; faintly trilobed with broader median conical piece separated from narrow lateral pieces by faint longitudinal furrows. Whole axis crossed by 7—8 parallel continuous transverse wrinkles. One strong ring on front end of axis, marked off by a deep furrow. Axial furrows distinct. Lateral lobes marked by seven pairs of nearly straight radiating raised and slightly angulated ribs broadening and decreasing in height towards the margin, and separated by strong interpleural furrows, which become weaker towards their outer extremities. Seventh pair of pleuræ separated by a slightly elevated and angulated narrow post-axial piece, widening posteriorly, and nearly double the width of any of the ribs. Surface of lateral lobes crossed by coarse concentric striæ, closely set and strongly undulating incrossing the ribs, especially near the margin.

Dimensions.—

Length of head-shield . . .	8·0 mm. (about).
,, of glabella . . .	7·0 ,, ,,
Width of neck of glabella . .	6·0 ,,
,, of frontal lobe of glabella . .	10·0 ,,
,, of fixed cheek at base . .	5·0 ,,

	Broad form.	Long form.
Length of pygidium . .	13·0 mm.	16·5 mm.
Width of ,, . .	17·5 ,,	18·5 ,,
Length of axis . .	4·0 ,,	4·0 ,,
Width of ,, . .	3·5 ,,	5·0 ,,

Remarks.—Nicholson and Etheridge described the transverse wrinkles on the axis of the pygidium as axial rings, but there is only one true ring on the front of the axis, the wrinkles or imbricating striæ being of the same nature as the concentric striæ on the lateral lobes. The affinities of this form have been discussed by the same authors, but it seems to me that the pygidium is allied to that of *B. partschi*, Barr.,[1] from Ét. E in Bohemia. The characters of the head-shield and glabella (which occur at Penkill in the closest association with the pygidia), also bear some resemblance to those of the same species so far as they are known. Toll[2] has described *Bronteus andersoni* from the Silurian beds of Kotelny, one of the New Siberian Islands; but, judging from the figure and description, it appears to me somewhat doubtful whether his specimens really belong to the Girvan species.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Hunterian Museum, Glasgow.

Horizons and Localities.—Saugh Hill Group (M. Llandovery): Woodland Point. Camregan Group (U. Llandovery): Bargany Pond Burn; Penwhapple Glen. Penkill Group (Tarannon): Penkill.

2. **Bronteus craigensis,** sp. nov. Plate XII, figs. 12, 13.

1899. *Bronteus hibernicus,* Mem. Geol. Surv., Silur. Rocks Brit., Scotland, vol. i, pp. 671, 674.

Specific Characters.—Pygidium sub-semicircular, very slightly convex. Axis short, conical, feebly convex, broader than long, about one third the length of the pygidium and less than one fourth its width; consisting of one or two faintly-marked rings at the front end and of a triangular piece behind. Axial furrows very faint, converging at about 80°, but obsolete at posterior end of axis. Lateral lobes composed of six pairs of simple radiating, slightly raised pleuræ, curved gently backwards, and separated by distinct but shallow interpleural furrows, dying out near margin. Sixth pair of pleuræ very indistinctly defined. Broad post-axial piece, apparently composed of the completely fused seventh pair of pleuræ, but without any trace of an interpleural furrow.

Dimensions.—

Length of pygidium	18·0 mm.
Width of ,, ...	29·0 ,,
Length of axis	6·5 ,,
Width of ,, ...	7·0 ,,

Remarks.—There are several pygidia of this form from Craighead in Mrs.

[1] Barrande, 'Syst. Sil. Bohême,' vol. i, p. 870, pl. xlvi, figs. 19—31.

[2] Toll, 'Mem. Acad. Imper. Sci., St. Petersburg, vol. xxxvii (1890), No. 3, p. 39, pl. iii, fig. 5.

Gray's collection. Unfortunately the specimens are not in a completely satisfactory state of preservation, but they indicate definitely a new species which may be known by the name *craigensis*. Probably it was this form which Nicholson and Etheridge referred to as *Bronteus*, sp. ind. (*b*) (M., fasc. ii, 1879, p. 166).

Affinities.—This pygidium bears some resemblance to that of *B. hibernicus*, Portl.,[1] the number of pleuræ being the same and the post-axial piece likewise simple, but the shape of the pygidium is different. *B. laticauda*, Wahl.,[2] also appears to be an allied form, but in it the axial furrows are continued posteriorly. *B. lunatus*, Billings,[3] from the Trenton Limestone, bears apparently a closer resemblance.

Collections.—Mrs. Gray; Museum of Practical Geology?

Horizons and Localities.—Stinchar Limestone Group (Llandeilo): Craighead. ? Balclatchie Group (Llandeilo): Ardmillan (Mus. Pract. Geol.).

3. **Bronteus grayi,** sp. nov. Plate XII, fig. 14.

1879. *Bronteus*, sp. ind. *a*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 165, pl. xii, fig. 6.

Specific Characters.—Pygidium parabolic, very slightly convex. Axis cylindrical, convex, broad and short, being about one third the width of the pygidium and extending for about half its length; extremity rounded. Two well-marked broad rings on anterior end of axis, the second ring defined behind by a furrow, which is apparently obsolete in the middle. Axial furrows strong in front but weak posteriorly and faintly encircling extremity of axis. Lateral lobes composed of seven pairs of flattened pleuræ; the first six well defined and separated by strong interpleural furrows; the seventh pair fused in middle line behind axis, the interpleural furrow extending for only a short distance behind it. Sixth pair of interpleural furrows directly continuous with axial furrows, slightly divergent towards posterior margin. All the interpleural furrows die out some distance from the margin of the pygidium.

First pleura imperfectly preserved. Second pleura of nearly uniform and constant width, bending back rather suddenly at about half its length. Third pleura very narrow at base, but expanding steadily towards extremity. Fourth pleura of greater and uniform width, curving regularly backward, starting at an angle of about 30° to axial line. Fifth pleura of same width at base as fourth, but expanding towards extremity. Sixth pleura of about same dimensions as the

[1] Portlock, 'Geol. Rep. Londond.,' p. 270, pl. v, figs. 8*a*, 8*b*.

[2] Wahlenberg, 'Nov. Act. Soc. Upsala,' vol. viii, p. 28, pl. ii, fig. 8 (*non* fig. 7).

[3] Ruedemann, 'Bull. N.Y. State Mus.,' No. 49 (1901), p. 65.

fifth, but running nearly straight backwards. Doublure of pygidium broad and concentrically striated.

Dimensions.—

Length of pygidium	. . .	50·0 mm. (approx.).
Width of „	. . .	55·0 „
Length of axis	. . .	24·0 „
Width of „	. . .	22·0 „

Remarks.—As Nicholson and Etheridge observed (*loc. cit.*), this form resembles *B. hibernicus*, Portlock, but the axis of the latter was unknown to Portlock, and is at any rate considerably narrower than in this Craighead species. It may appropriately be distinguished by the specific designation *grayi*.

Collection.—Mrs. Gray (f. M.).

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

4. **Bronteus,** sp. ind. (*a*). Plate XII, fig. 15.

An epistome, probably belonging to one of the foregoing species of *Bronteus*, is in Mrs. Gray's collection from Craighead.

Description.—Shape transversely subfusiform, narrowing laterally. Anterior border gently arched forwards. Lateral angles truncated obliquely at angles of about 60° to front edge. Posterior border nearly straight, but bulging out suddenly in middle to form blunt projection. Surface ornamented by 8—9 strong transverse imbricating striæ, the anterior 3—4 parallel to front edge, the posterior 3—4 following outline of posterior margin, and the median ones straight.

Dimensions.—

Width between lateral angles on front margin	.	12·0 mm.
Length from back to front across middle .	.	4·0 „

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

5. **Bronteus,** sp. ind. (*b*). Plate XII, fig. 16.

There is a small imperfect head-shield of a species of *Bronteus* from Craighead in Mrs. Gray's collection which is worthy of a separate description, though its specific relations cannot be determined.

Description.—Glabella very gently convex, clavate, expanding in front to twice (?) basal width, without furrows or pits, but ornamented with slightly undulating striæ arched forwards and concentric to a median point near the base of the glabella. Occipital furrow distinct, marking off neck-ring of moderate width ornamented with striæ arched forward. Axial furrows narrow, concave outwards, diverging anteriorly. Fixed cheeks gently convex, at least half as wide as glabella, and ornamented with similar arched striæ.

Dimensions.—

Length of glabella	. . . .	+ 5 mm.
Width ,, at base	. . .	3 ,,

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo) : Craighead.

Genus **BRONTEOPSIS,** Wyville Thomson.

1. **Bronteopsis ardmillanensis,** sp. nov. Plate XIII, figs. 1—4.

Specific Characters.—Head-shield short, transverse, broadly semicircular, nearly three times as wide as long; gently convex. Glabella strongly pyriform, with long narrow convex neck, expanding rather suddenly into frontal lobe to twice its basal width; anterior end truncated. Pair of ill-defined small nodular lobes situated at base of neck. Axial-furrows strong, deep, curving outwards anteriorly, and then sharply inwards to meet in front of glabella. Small pit situated in axial furrow on each side of broad anterior portion of glabella. Neck-furrow strong; neck ring rounded, with prominent median tubercle and a smaller lateral tubercle on each side. Fixed cheeks convex on each side of neck of glabella, but flattened in front; half as wide again as neck. Eye-lobes placed far back, opposite basal lobes of glabella; subcircular and projecting laterally; extending about one fourth the length of the head-shield. Facial sutures with short oblique posterior branch, running outwards behind eye so as to meet posterior margin of head at acute angle; anterior branch curving at first inwards and then strongly outwards, following closely the outline of glabella, bending inwards in front to cut anterior margin of head. Free cheeks wide, triangular; posterior and lateral edges meeting at about 45° at genal angle. Inner portion of free cheek gently convex; outer marginal portion broad, flattened or slightly concave. Eyes of moderate size, about one fourth the length of head, and placed very far back. Genal angles furnished with short spine. Ornamentation of glabella composed of fine wavy lines parallel to its length and forming loop at base of neck.

Thorax of + 7 segments (seven segments are attached to one head-shield), with narrow convex cylindrical axis, half as wide as the pleuræ. Pleuræ narrow, arched downwards and slightly backwards, ending in free blunt points. Surface of pleuræ not well preserved, but apparently furnished with a broad median groove ending at fulcrum which is weak, and situated about halfway out or rather more.

Dimensions.—

Length of head . . .	8·5 mm.
Width of „ . . .	23·0 „

Affinities.—The general characters of the head-shield of this species ally it closely to *B. scotica*, Salter (*q.v.*), but it differs in the absence of paired pits on the glabella, the presence of basal lobes to the glabella and of the tubercles on the neck-ring, the narrower neck of the glabella and the course of the facial sutures. With *Ogygia? concentrica*, Linnarsson,[1] it agrees in the position of the eyes, course of the facial suture, tubercle on neck-ring and surface-contour of the cheeks, but there are no pits on the glabella, and the genal angles are less produced. Except for the want of glabellar pits and the presence of the tubercles on the neck-ring, the head-shield of *Br. ardmillanensis* closely resembles that of *Bronteus lunatus*, Billings,[2] from the Trenton Limestone.

Remarks.—There are two head-shields belonging to this species of *Bronteopsis* in Mrs. Gray's collection from Ardmillan, and another from Balclatchie, one of which is nearly perfect and has its external cast also preserved. There are some poorly preserved pygidia associated by Mrs. Gray with this form, and from the same locality (Ardmillan), but they have not so far been found directly attached to the thorax or connected with the head-shield. In the Museum of Practical Geology there are three with the same characters, also from Ardmillan, labelled *Stygina latifrons*.[3] It is probable that all these pygidia are referable to *Bronteopsis ardmillanensis*, as they are of the proper relative size and are in many respects similar to those of the allied species *B. scotica*. Their shape is semicircular to semielliptical, generally twice as broad as long, with a distinct raised fulcrum situated about halfway out on the anterior margin with a groove behind it. Round the margin of the pygidium is a broad shallow excavation. The axis is narrow and subcylindrical, being in width about one fifth to one fourth that of the pygidium, and extending from two thirds to three fourths its length; it bears 8—9 rings, generally faint, and has a narrow terminal pointed appendix or ridge running back to the margin. On the lateral lobes are faint curved pleuræ. It is deserving of notice that some of the pygidia attributed by Wiman[4] to *Stygina latifrons*

[1] Linnarsson, 'Vestergotl. Camb. Silur. Aflagr.' (1869), p. 75, pl. ii, figs. 37—40.

[2] Billings, 'Geol. Surv. Canada, Rep. Progr.,' 1853–56, p. 338; Clarke, 'Geol. Surv. Minn.,' vol. iii, pt. 2 (1894), p. 725, fig. 43; Ruedemann, 'Bull. New York State Mus.,' No. 49 (1901), p. 65, pl. iv, figs. 10, 11.

[3] Armstrong and Young also record *Stygina latifrons* from this locality, 'Cat. West. Scot. Foss.,' p. 16.

[4] Wiman, 'Bull. Geol. Instit. Upsala,' No. 10, vol. v, pt. 2 (1900), p. 171, pl. v, figs. 17, 19 (*non* fig. 16).

have this post-axial ridge, and suggest in other respects also that they are referable to *Bronteopsis*.

Collection.—Mrs. Gray; Museum of Practical Geology.

Horizon and Localities.—Balclatchie Group (Llandeilo): Ardmillan; Balclatchie.

2. **Bronteopsis scotica**, Salter. Plate XIII, figs. 5—13.

Bronteopsis scotica, Salter, MS. in Coll. Museum of Practical Geology.

1879. *Bronteopsis scotica*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 167, pl. x, figs. 21, 22; pl. xi, figs. 1—4 (? fig. 5).

1899. *Bronteopsis scotica*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 514, 672, 688.

Specific Characters.—Head broadly semicircular, with flattened curvature in front; weakly convex. Glabella clavate, broad in front, and reaching margin of head shield, posteriorly narrowing regularly to base, which measures about two thirds the anterior width; moderately convex, most elevated towards middle; feebly marked off from cheeks along anterior half, but strongly defined from them behind. Surface of glabella marked with three pairs of lateral pits, the first two pairs subcircular, generally shallow, faint and nearly obsolete, the posterior or basal pair larger, deeper, and triangular in shape. Axial furrows strong behind middle of glabella, but almost or quite obsolete in front. Occipital furrow wide and fairly deep. Occipital ring narrow, rounded, and furnished with median tubercle. Fixed cheeks with inner portion strongly convex, becoming flatter towards front margin; wider at base than glabella. Facial sutures cutting front margin of head-shield at about 100°—120°, at a distance from the anterior lateral angle of the glabella equal to about half its anterior width; from this point, curving slightly outwards, then bending gently inwards and encircling the small semicircular projecting eye-lobe which is situated at about the level of the basal pair of glabellar pits. Behind the eye-lobes the facial sutures bend outwards to cut the posterior margin of the head-shield at a distance from the axial furrows rather greater than the basal width of the glabella. Free cheeks triangular, with convex inner portion, sinking down to broad concave concentrically striated border. Genal angles produced backwards and broadly pointed. Surface of cheeks and glabella covered with fine wavy, more or less concentric striæ and raised lines.

Thorax composed of seven or eight segments. Axis convex, cylindrical, about two thirds the width of pleural portions. Pleuræ narrow, horizontal, and straight as far out as fulcrum which is situated at rather more than half their length; beyond fulcrum they are slightly recurved and bent down, and taper to a point. A slightly oblique angulated ridge runs down each pleura, and on the anterior edge is a narrow, rounded band. The extremities are transversely striated.

Pygidium large, semicircular, with slightly arched anterior margin. Axis narrow, convex, cylindrical, and short, being only half the length of the pygidium or even less, composed of 5—7 narrow weak rings and a terminal pointed piece about one third the total length of the axis. Width of axis equal to about one seventh that of the pygidium. Lateral lobes weakly convex, with concave, depressed border, not sharply defined. Lateral lobes composed of six pairs of narrow rounded indistinct pleuræ radiating from the sides of the axis, and of a wide posterior smooth portion traversed down its centre by a single median narrow rib extending straight back from the extremity of the axis. All the ribs die out gradually towards the margin, and do not cross the concave border.

Remarks.—This species was first described by Nicholson and Etheridge (*op. cit.*), but the acquisition of further and better material has enabled me to give a fuller and amended diagnosis. This species may be considered as a near ally of *Ogygia ? concentrica*, Linnarsson,[1] from the Beyrichia Limestone of Sweden. The relations of the genus have been discussed by Nicholson and Etheridge (*op. cit.*), and I am in agreement with their conclusions, which need not be here repeated.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Ardmillan. ? Stinchar Limestone Group (Llandeilo): Aldons.

Family LICHADIDÆ.

Genus **LICHAS,** Dalman.

1. **Lichas (Corydocephalus) anglicus** (Beyrich), 1846.

? 1840. *Peltura bucklandi*, Milne Edwards, Hist. Foss. Crust., vol. iii, p. 345, pl. xxxiv, fig. 12.
1846. *Arges anglicus*, Beyrich, Untersuch. üb. Trilob., pt. ii, p. 6, pl. i, fig. 3.
1850. *Lichas bucklandi*, Fletcher (*e.p.*), Quart. Journ. Geol. Soc., vol. vi, p. 235, pl. xxvii, figs. 2, 3, 4, ? 5, 5*a* (*non* figs. 1, 1*a*); pl. xxvii *bis*, figs. 1, 1*a*, 1*b*.
1854. *Acanthopyge anglica*, M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., p. 151.
— *Lichas anglicus*, Morris, Cat. Brit. Foss., 2nd ed., p. 110.
1859. *Lichas anglicus*, Murchison, Siluria, 2nd ed., Foss. 63, fig. 1.
1867. *Lichas anglicus*, Murchison, ibid., 4th ed., p. 234, Foss. 64, fig. 1.
1873. *Lichas anglicus*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 130.
1877. *Lichas anglicus*, Woodward, Cat. Brit. Foss. Crust., p. 42.
1902. *Lichas (Corydocephalus) anglicus*, Reed, Quart. Journ. Geol. Soc., vol. lviii, p. 71.
1903. *Lichas (Corydocephalus) anglicus*, Reed, Geol. Mag. [4], vol. x, p. 3, pl. i, figs. 1, 2 (varieties).

[1] Linnarsson, 'Vestergotl. Camb. Silur. Aflagr.' (1869), p. 75, pl. ii, figs. 37—40.

A single but well preserved head-shield of this well-known species, which has not been hitherto recorded from the Girvan district, occurs on a slab of rock containing *Encrinurus punctatus* from the Wenlock Series of Knockgardner, Straiton.

Collection.—Edinburgh Museum.

Horizon and Locality.—Wenlock Series: Knockgardner; Straiton.

2. **Lichas (Corydocephalus) geikiei,** Nicholson and Etheridge, 1879. Plate XIII, figs. 14, 14*a*; plate XIV, fig. 1.

1879. *Lichas geikiei,* Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 137, pl. x, fig. 1.
1899. *Lichas geikiei,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 524, 673, 689.
1902. *Lichas geikiei,* Reed, Quart. Journ. Geol. Soc., vol. lviii, p. 76.

Specific Characters.—Head-shield strongly convex and much bent down at the sides, but less so in front; semicircular in shape. The glabella is tumid, and the median lobe is swollen and projects considerably in front of the bicomposite lobes, expanding regularly in width anteriorly from their base and slightly embracing them in front. The bicomposite lobes are short, being not more than half the length of the glabella; their reniform shape is distinct and there is a narrow transverse furrow across them starting from the internal notch in the course of the first lateral furrows; their posterior outer lateral angles are feebly marked out by nearly obsolete furrows. The first lateral furrows converge posteriorly at about 30° and bend outwards sharply at the base of the bicomposite lobes to end suddenly in deep pits; a shallow groove runs backward from each pit to the inner angle of the occipital lobe. The fourth lateral lobe[1] is imperfectly defined on its outer, anterior, and posterior sides owing to the weakness or disappearance of the furrows. The occipital lobes are sub-triangular rather than oval, and are incompletely defined at the anterior outer angle. The fourth lateral furrows defining them thus incompletely in front are situated at the level of the middle portion of the neck-ring, and appear to arise in a line with the neck-furrow. The axial furrows vary in strength along their course, being well marked as far back as near the posterior end of the bicomposite lobes (where they diverge outwards), but become practically obsolete outside the indistinct fourth lateral lobes; they then again increase in strength and run back to the base of the occipital lobes curving strongly inwards. The median portion of the glabella behind the base of the bicomposite lobes is slightly swollen as a post-median lobe and bears a large median tubercle. The fixed cheeks are strongly convex and slope down steeply at the sides and in front. The eye is of moderate size, prominent, and placed opposite the middle of the bicomposite lobes, not far from the axial furrows. The free cheeks are triangular with an

[1] Reed, 'Quart. Journ. Geol. Soc.,' vol. lviii (1902), p. 64.

PLATE VII.

Fig. | | Page.

Asaphus (Isotelus) gigas, De Kay. 45.

1. Head-shield. × 2. Ardmillan. Mrs. Gray's Collection.

Asaphus (Isotelus) instabilis, sp. nov. 46.

2. Pygidium. × $1\frac{1}{2}$. Dow Hill. Mrs. Gray's Collection.
3. Imperfect head-shield. × $1\frac{1}{2}$. Balclatchie. Same Collection.
4. Ditto. × 2. Dow Hill. Same Collection.
5. Pygidium. × 2. Dow Hill. Sedgwick Museum.
6. Head-shield and portion of thorax of young individual. × 2. Dow Hill. Mrs. Gray's Collection.
7. Pygidium and portion of thorax. × 2. Same locality and Collection.
8. Hypostome. × $2\frac{1}{2}$. Same locality and Collection.

Asaphus, sp. 49.

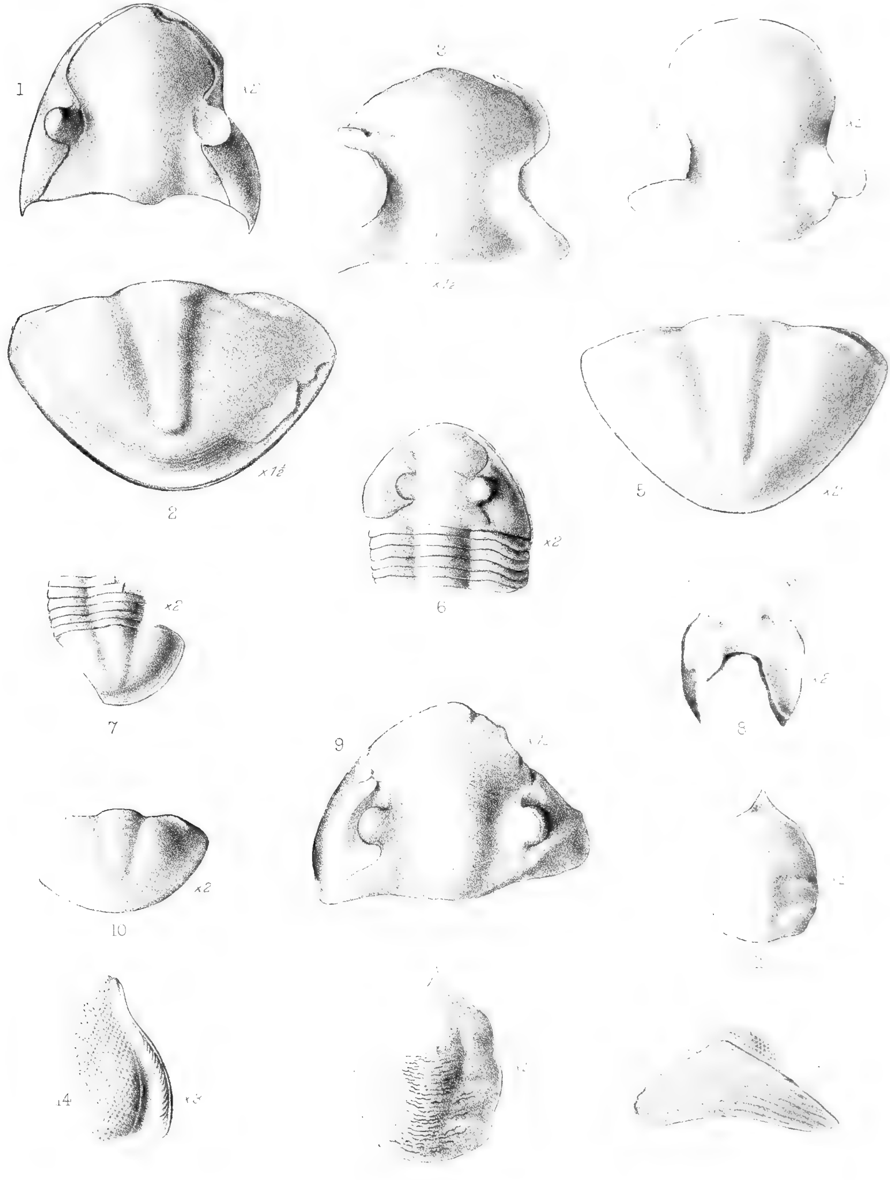
9. Head-shield. × $1\frac{1}{2}$. Minuntion. Mrs. Gray's Collection.

Stygina latifrons (Portlock). 50.

10. Pygidium. × 2. Shalloch Mill. Mrs. Gray's Collection.

Cyclopyge armata (Barrande). 51.

11. Glabella, showing ornamentation and furrows. × 2. Whitehouse Bay. Mrs. Gray's Collection.
12. Glabella, showing furrows. × 2. Same locality and Collection.
13. Epistome and portion of eyes. × 3. Same locality and Collection.
14. Eye and free cheek. × 3. Same locality and Collection.



G.M Woodward del et lith. West, Newman imp.

ASAPHUS, STYGINA, CYCLOPYGE

PLATE VIII.

Fig. | Page.

Cyclopyge armata (Barrande). 51.

1. Pygidium. × 2. Whitehouse Bay. Mrs. Gray's Collection.

Cyclopyge rediviva (Barrande). 52.

2. Complete individual. × 5. Whitehouse Bay. Mrs. Gray's Collection.
3. Head-shield. × 4. Same locality and Col'ection.

Bohemilla, sp. 53.

4. Glabella ?. × 5. Whitehouse Bay. Mrs. Gray's Collection.

Illænus æmulus, Salter. 54.

5. Pygidium, showing traces of pleuræ. Natural size. Penkill. Mrs. Gray's Collection.

Illænus æmulus, Salter, var. 55.

6. Pygidium. × 2. Woodland Point. Mrs. Gray's Collection.
7. Nearly complete individual. × $1\frac{1}{2}$. Same locality and Collection.
8. Head-shield. Nat. size. Same locality and Collection.
9. Free cheek. × 2. Same locality and Collection.
10. Pygidium. × $1\frac{1}{2}$. Penkill. Same Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. xi, fig. 10.)
11. Epistome, probably belonging to this variety. × $1\frac{1}{2}$. Same locality and Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. xi, fig. 13.)

Illænus balclatchiensis, sp. nov. 56.

12. Pygidium. × 2. Balclatchie. Sedgwick Museum.

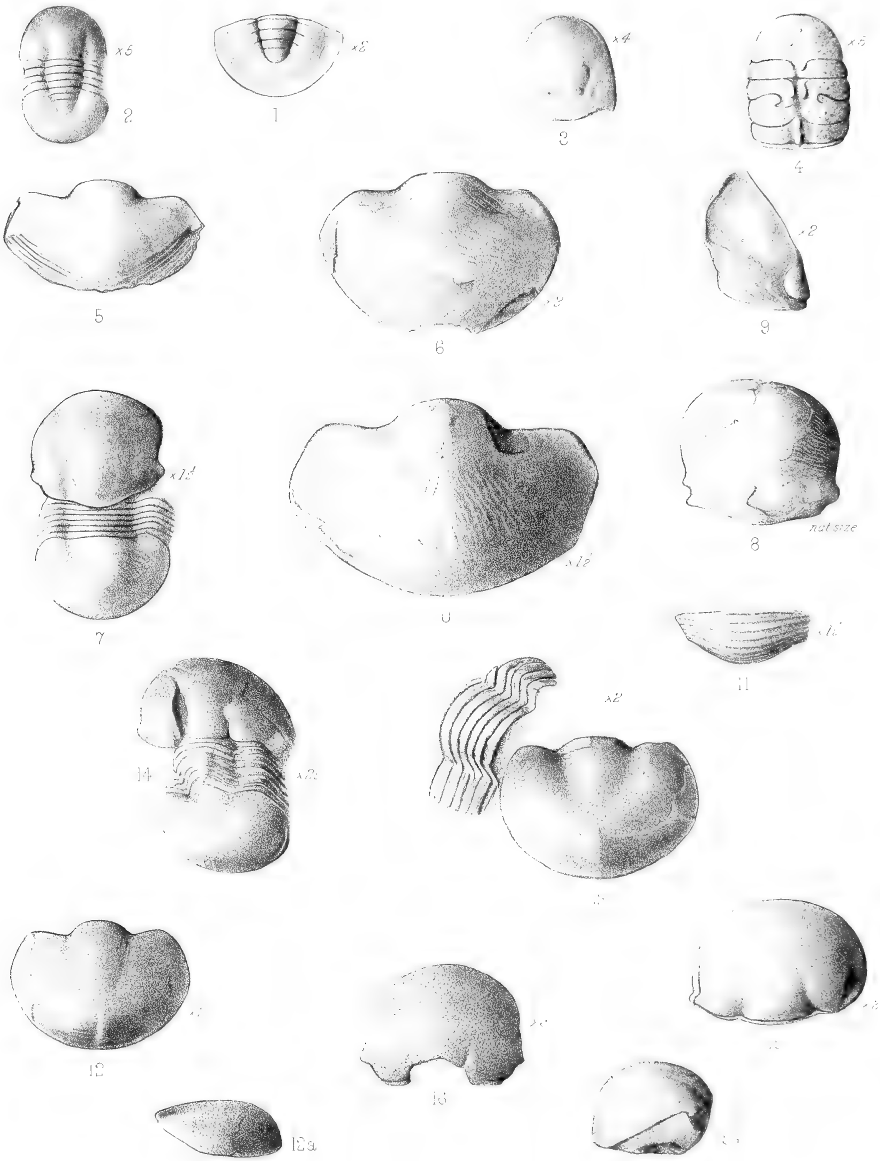
12*a*. Same specimen, viewed from side.

13. Pygidium and portion of thorax. × 2. Balclatchie. Mrs. Gray's Collection.
14. Complete individual. × $2\frac{1}{2}$. Same locality and Collection.
15. Head-shield. × 2. Ardmillan. Same Collection.

15*a*. Same specimen, viewed from side.

16. Head-shield. × 3. Balclatchie. Same Collection.

Reed, Girvan Trilobites. PLATE VIII.



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CYCLOPYGE, BOHEMILLA, ILLÆNUS.

PLATE IX.

FIG. PAGE.

Illænus barriensis (Murchison.) 58.

1. Head-shield without free cheeks. × $1\frac{1}{2}$. Bargany Pond Burn. Mrs. Gray's Collection.
2. Pygidium. × $1\frac{1}{2}$. Same locality and Collection.

Illænus extensus, sp. nov. 61.

3. Complete individual. × 2. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.
4. Hollow cast of same specimen. × 2. Same locality and Collection.
5. Epistome. × $2\frac{1}{2}$. Same locality and Collection.

Illænus latus, M'Coy. 63.

6. Pygidium. × 2. Minuntion. Mrs. Gray's Collection.
7. Ditto, showing post-axial groove. × 2. Same locality and Collection.

Illænus macallumi, Salter. 65.

8. Head-shield. × 2. Mulloch Hill. Mrs. Gray's Collection.
9. Pygidium. × 2. Same locality and Collection.

Illænus murchisoni, Salter? 65.

10. Pygidium. Nat. size. Craighead. Mrs. Gray's Collection.
11. Free cheek. × $1\frac{1}{2}$. Same locality and Collection.
12. Epistome, probably belonging to this species. × $1\frac{1}{2}$. Same locality and Collection.

Illænus nexilis, Salter. 66.

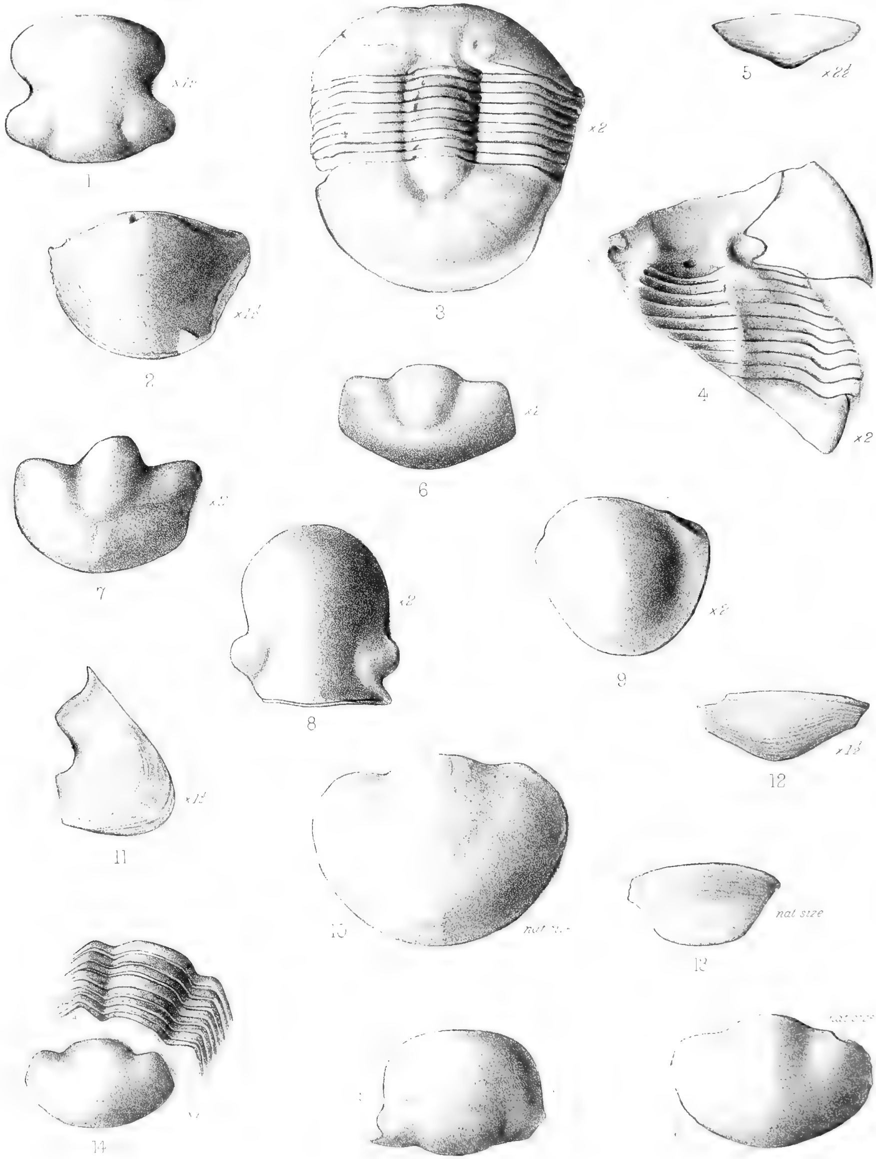
13. Epistome. Nat. size. Craigens. Mrs. Gray's Collection.

Illænus portlocki, Salter. 67.

14. Pygidium with thorax attached. × $1\frac{1}{2}$. Craighead. Mrs. Gray's Collection.
15. Head-shield, perhaps referable to this species. Nat. size. Same locality and Collection.
16. Pygidium, showing broad axis. Nat. size. Same locality and Collection.

Reed. Girvan Trilobites

PLATE IX.



G. M. Woodward del. et lith.

ILLÆNUS

PLATE X.

FIG. PAGE.

Illænus portlocki, Salter ? 67.

1. Head-shield, perhaps referable to this species. × $1\frac{1}{2}$. Craighead. Mrs. Gray's Collection.
1*a*. Side view of same specimen. × $1\frac{1}{2}$.

Illænus shallochensis, sp. nov. 68.

2. Complete individual, viewed from above. × $1\frac{1}{2}$. Thraive Glen. Mr. Macconochie's Collection. (The pygidium is foreshortened as the specimen is partially enrolled.)
2*a*. Side view of same specimen. × $1\frac{1}{2}$.
2*b*. Pygidium of same specimen. × $1\frac{1}{2}$.
2*c*. Inferior surface of head-shield of same specimen showing epistome, etc. × $1\frac{1}{2}$.
3. Pygidium, showing ornamentation of shell. × $1\frac{1}{2}$. Shalloch Mill. · Mrs. Gray's Collection.
4. Pygidium of young individual. ? × 3. Same locality and Collection.
5. Epistome. × $1\frac{1}{2}$. Same locality and Collection.

Illænus thomsoni, Salter. 70.

6. Free cheek, viewed from below, showing doublure. Nat. size. Rough Neuk, Mulloch Hill. Mrs. Gray's Collection.
7. Free cheek, viewed from above. Nat. size. Same locality and Collection.
8. Epistome. Nat. size. Penkill. Same Collection.

Illænus. Cf. **oculosus,** Holm. 71.

9. Head-shield, showing right eye. × $2\frac{1}{2}$. Ardmillan. Mrs. Gray's Collection.
10. Free cheek. × $1\frac{1}{2}$. Same locality and Collection.
11. Head-shield. × $1\frac{1}{2}$. Same locality and Collection.

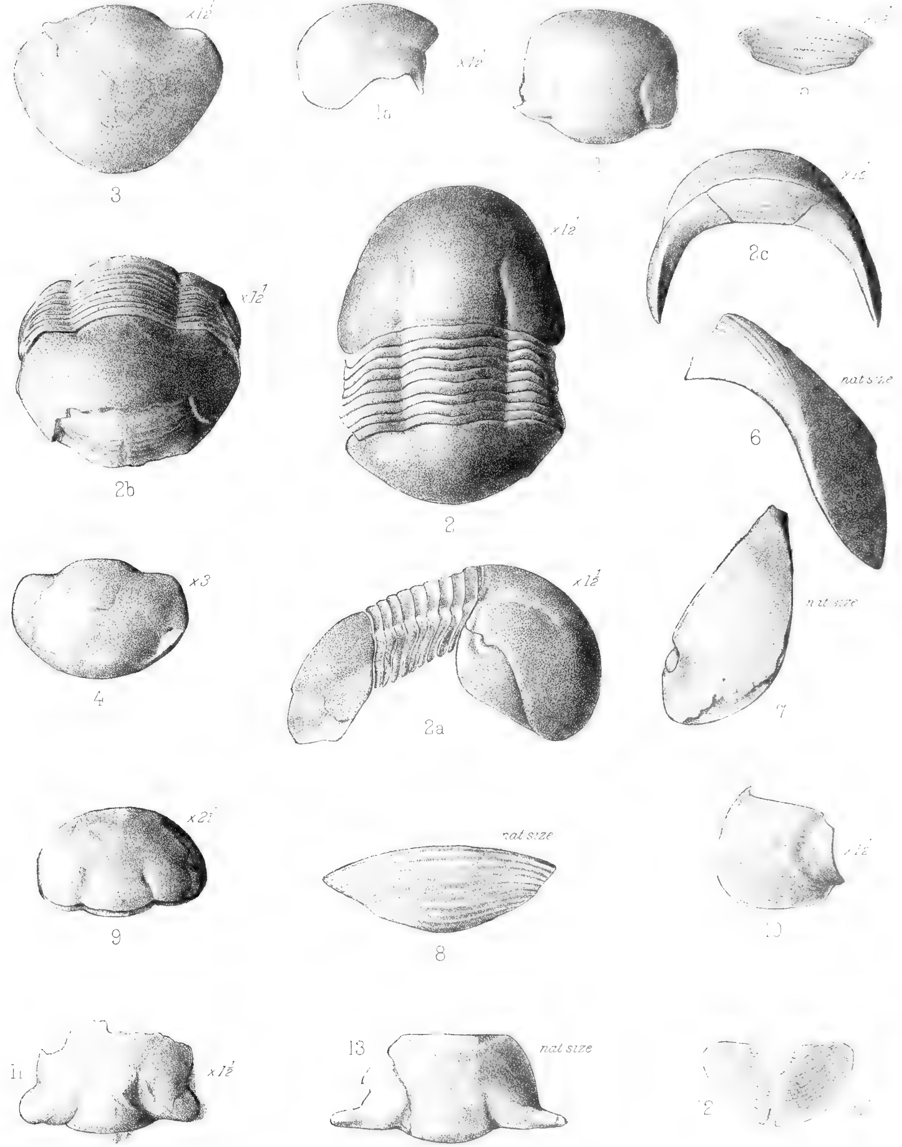
Illænus. Cf. **perovalis,** Murchison. 72.

12. Pygidium (axis abraded). × $2\frac{1}{2}$. Minuntion. Mrs. Gray's Collection.

Illænus, sp. ind. 73.

13. Head-shield. Nat. size. Craighead. Mrs. Gray's Collection.

Reed, Girvan Trilobites. PLATE X.



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ILLÆNUS

PLATE XI.

FIG.		PAGE.

Proetus girvanensis, Nicholson and Etheridge. 74.

1. Complete individual. × 2½. Thraive Glen. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. xii, fig. 10.)
2. Head and part of thorax of partially enrolled individual. × 2½. Same locality and Collection.

2*a*. Side view of same specimen. × 2½.

3. Complete individual (glabellar furrows not preserved). × 2½. Same locality and Collection.

Proetus latifrons, M'Coy. 76.

4. Imperfect head-shield, showing characters of glabella. × 3. Woodland Point. Mrs. Gray's Collection.

Proetus procerus, Nicholson and Etheridge. 77.

5. Complete individual. × 3. Thraive Glen. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. xii, fig. 11.)
6. Nearly complete individual, with impression of hypostome seen in position. × 3. Same locality and Collection.

6*a*. Hypostome of same specimen. × 6.

Proetus pseudolatifrons, sp. nov. 78.

7. Imperfect head-shield, showing characters of glabella and broad border. × 2. Camregan Wood. Mrs. Gray's Collection.
8. Pygidium, showing long conical axis. × 2. Same locality and Collection.
9. Pygidium. × 2. Mulloch Hill. Mrs. Gray's Collection.

Proetus stokesi (Murchison). 79.

10. Head-shield and part of thorax. × 4. Mulloch Hill. Mrs. Gray's Collection.
11. Nearly perfect individual. × 3. Newlands. Mrs. Gray's Collection.

Proetus. Cf. **obconicus,** Lindström. 81.

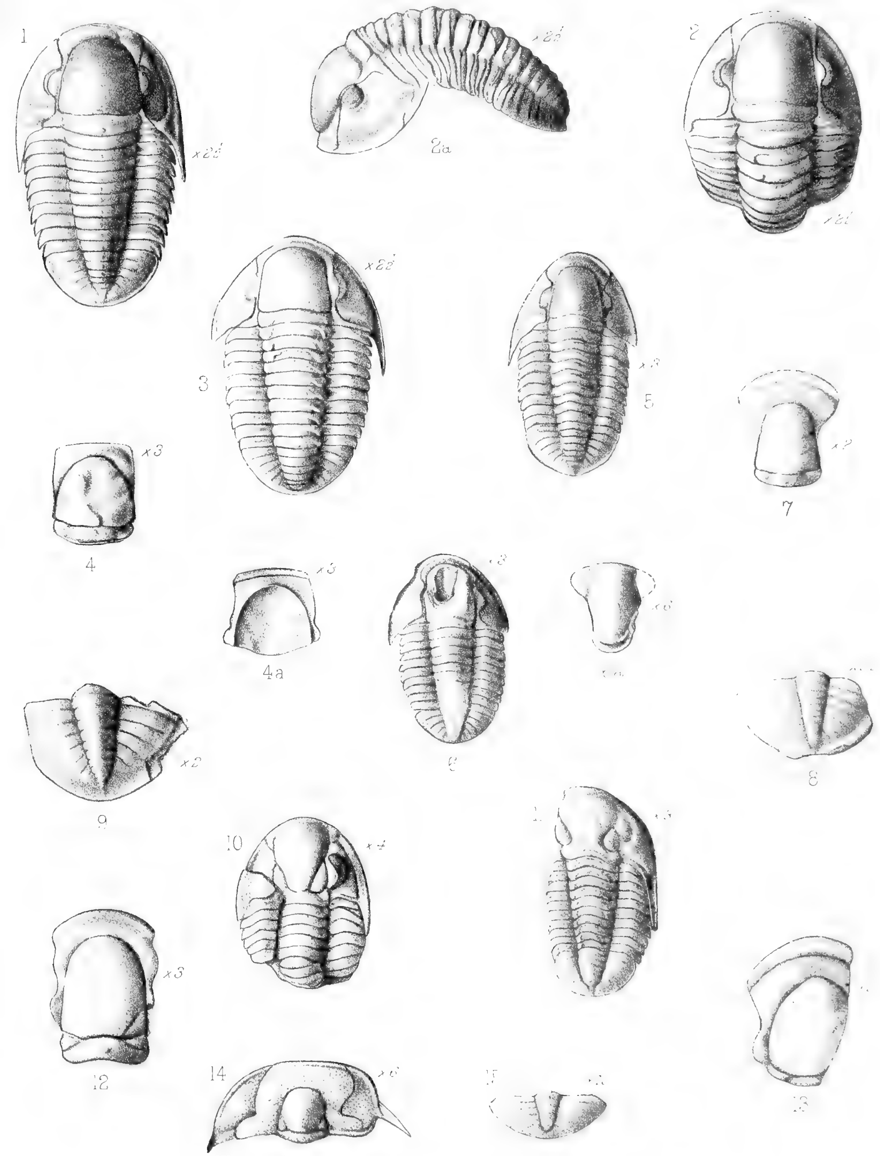
12. Middle portion of head-shield. × 3. Woodland Point. Mrs. Gray's Collection.

Proetus, sp. ind. 81.

13. Imperfect head-shield. × 2. Craigens. Mrs. Gray's Collection.

Arethusina konincki, Barrande? 83.

14. Head-shield. × 6. Balclatchie. Mrs. Gray's Collection.
15. Pygidium. × 10.



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PROETUS, ARETHUSINA.

PLATE XII.

Fig. | Page.

Phillipsinella parabola (Barrande). 85.

1. Head-shield and anterior portion of thorax of enrolled individual. × 3. Thraive Glen. Mrs. Gray's Collection.

1*a*. Pygidium and posterior portion of thorax of same specimen. × 3.

2. Imperfect specimen, showing genal spines and pygidium. × 4. Same locality and Collection.

Menocephalus? (Törnquistia) cf. **nicholsoni,** Reed. 86.

3. Head-shield, without free cheeks. × 5. Balclatchie. Mrs. Gray's Collection.
4. Ditto, showing faint basal lobes to glabella. × 5. Same locality and Collection.
5. Ditto, showing course of right facial suture. × 10. Same locality and Collection.
6. Nearly complete individual, showing thorax and pygidium. × 7. Same locality and Collection.
7. Pygidium. × 7. Same locality and Collection.

Bronteus andersoni, Nicholson and Etheridge. 87.

8. Pygidium (oval form). × 2. Penkill. Mrs. Gray's Collection.
9. Pygidium (parabolic form). × 2. Same locality and Collection.
10. Nearly complete head-shield. × $2\frac{1}{2}$. Same locality and Collection.
11. Imperfect glabella and cheek, showing anterior margin and facial suture. × $2\frac{1}{2}$. Same locality and Collection.

Bronteus craigensis, sp. nov. 89.

12. Pygidium, showing short triangular axis. × $1\frac{1}{2}$. Craighead. Mrs. Gray's Collection.
13. Ditto. × $1\frac{1}{2}$. Same locality and Collection.

Bronteus grayi, sp. nov. 90.

14. Imperfect pygidium (hollow cast). Nat. size. Craighead. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. xii, fig. 6, as *Bronteus* sp. ind. *a*.)

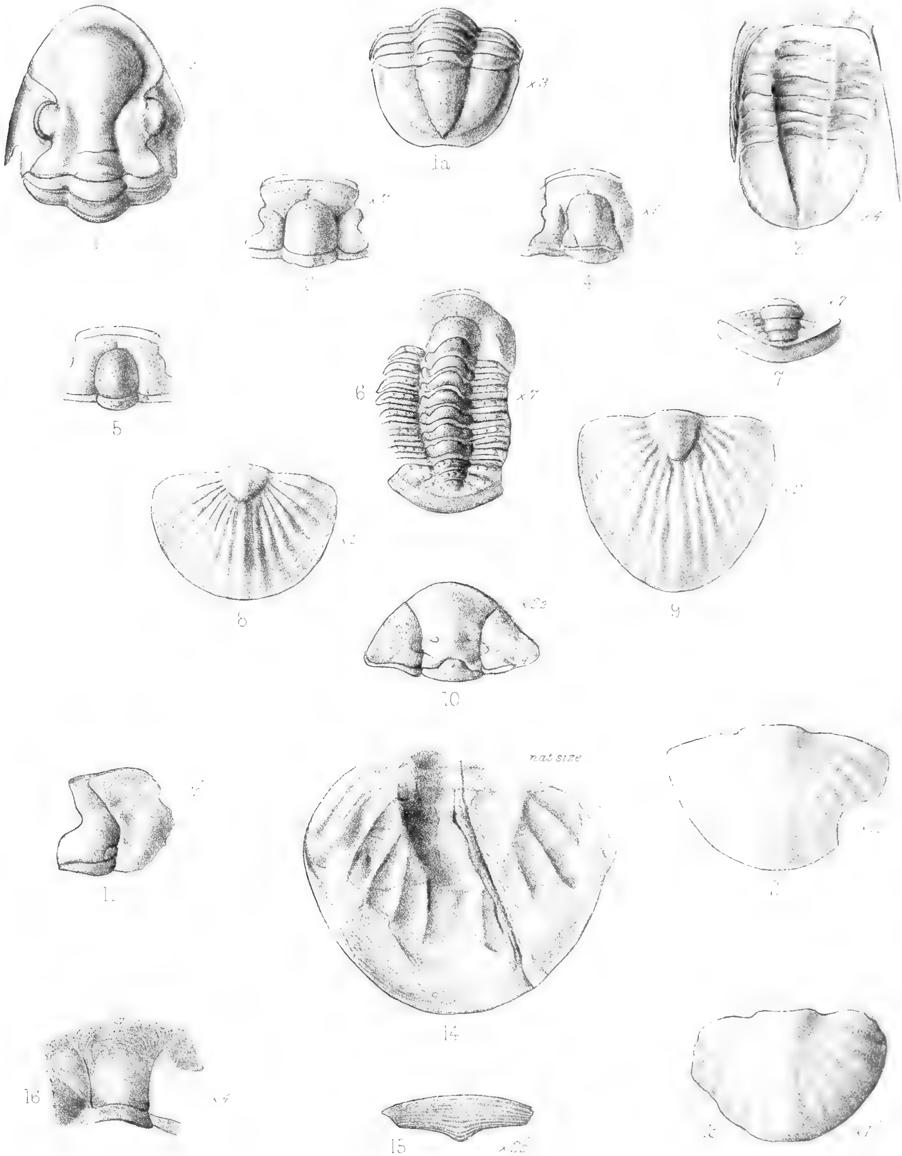
Bronteus, sp. ind. (*a*). 91.

15. Epistome. × $2\frac{1}{2}$. Craighead. Mrs. Gray's Collection.

Bronteus, sp. ind. (*b*). 91.

16. Portion of head-shield. × 2. Craighead. Mrs. Gray's Collection.

Reed, Girvan Trilobites.



G.M Woodward del.et lith

PHILLIPSINELLA, MENOCEPHALUS, BRONTEUS.

PLATE XIII.

FIG. PAGE.

Bronteopsis ardmillanensis, sp. nov. 92.

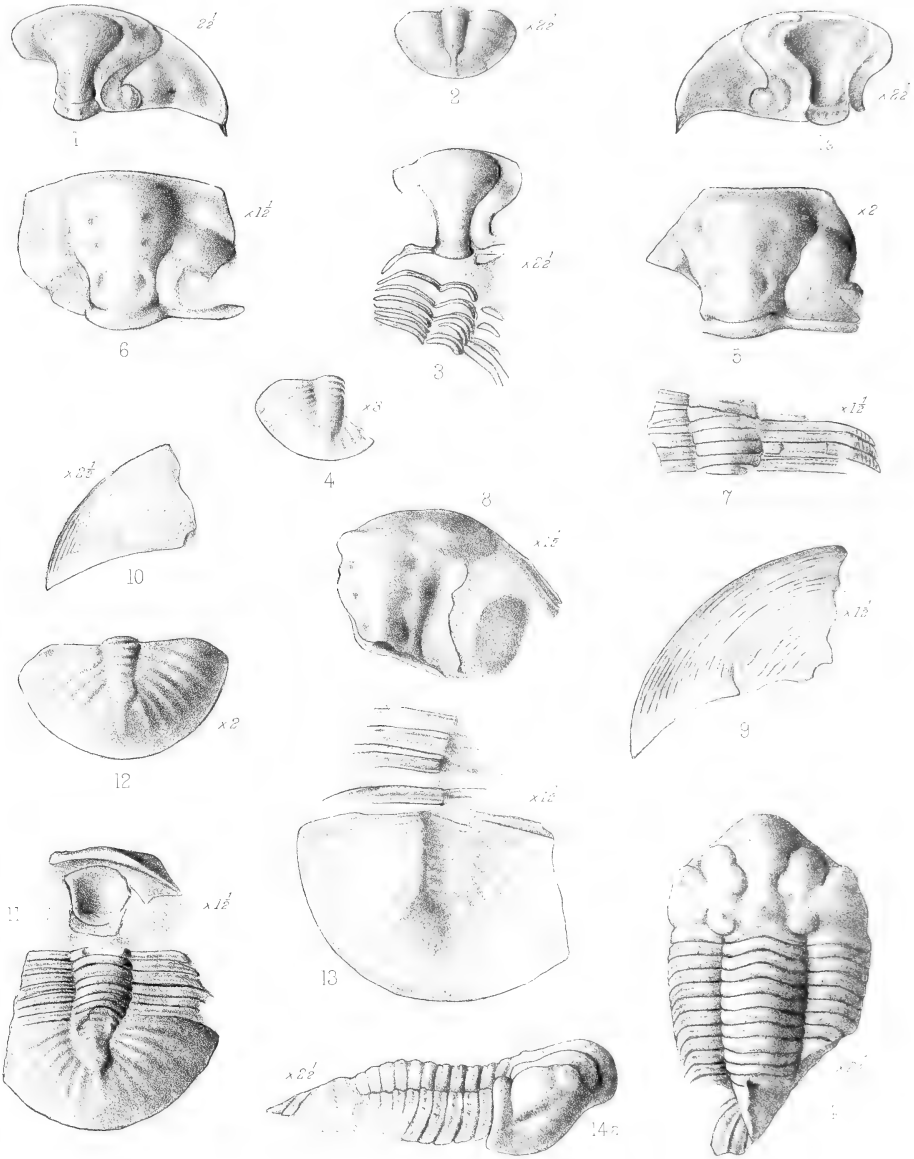
1. Head-shield with one free cheek attached. × $2\frac{1}{2}$. Ardmillan. Mrs. Gray's Collection.
1*a*. Natural cast of same specimen. × $2\frac{1}{2}$.
2. Pygidium. × $2\frac{1}{2}$. Same locality and Collection.
3. Head-shield and part of thorax. × $2\frac{1}{2}$. Same locality and Collection.
4. Pygidium, showing axial rings and pleuræ. × 3. Same locality and Collection.

Bronteopsis scotica, Salter. 94.

5. Imperfect head-shield, showing characters of glabella, fixed cheek, and facial suture. × 2. Balclatchie. Mrs. Gray's Collection.
6. Ditto, showing anterior margin. × $1\frac{1}{2}$. Same locality and Collection.
7. Thoracic pleuræ. × $1\frac{1}{2}$. Same locality and Collection.
8. Portion of head-shield. × $1\frac{1}{2}$. Same locality and Collection.
9. Free cheek. × $1\frac{1}{2}$. Same locality and Collection.
10. Ditto. × $2\frac{1}{2}$. Same locality and Collection.
11. Nearly complete individual. × $1\frac{1}{2}$. Same locality and Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. x, fig. 21.)
12. Pygidium. × 2. Same locality and Collection.
13. Pygidium with several thoracic rings attached. × $1\frac{1}{2}$. Same locality and Collection.

Lichas (Corydocephalus) geikiei, Nicholson and Etheridge. 96.

14. Nearly complete individual, showing head-shield, thorax, and imperfect pygidium. × $2\frac{1}{2}$. Thraive Glen. Mrs. Gray's Collection.
14*a*. Side view of same specimen. × $2\frac{1}{2}$.



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BRONTEOPSIS, LICHAS.

THE

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A MONOGRAPH

OF

BRITISH GRAPTOLITES.

BY

GERTRUDE L. ELLES,

LATE GEOFFREY FELLOW, NEWNHAM COLLEGE, CAMBRIDGE;

AND

ETHEL M. R. WOOD, M.Sc.,

OF NEWNHAM COLLEGE, CAMBRIDGE; AND THE UNIVERSITY OF BIRMINGHAM.

EDITED BY

CHARLES LAPWORTH, LL.D., F.R.S.,

PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF BIRMINGHAM.

PART IV.

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there are four slender common canals, which "may or may not communicate with one another."

Calycles or Cellules.—The structure and form of the various kinds of cellules are discussed by Hall in considerable detail, and excellent figures are given illustrating the longitudinal and transverse sections of various species, especially of those of *Climacograptus.* Hall agrees with Barrande that the cell walls are double. He considers that the cellule is limited by the cell walls, and he states that he has not discovered "evidence of such cell diaphragms" as were described by M'Coy; but he observes that there is "sometimes a swelling of the test of the common body below the cellule, indicating an enlargement of the parts at the bases of the buds," with occasionally an "undulation of the axis corresponding to this enlargement." The structure of the cellules of *Climacograptus* is minutely discussed, and Hall concludes that the cell partitions originate from the solid axis, and "appear to consist of triangular plates, so that there is an apparent double communication with the common body, giving not only the usual bilateral arrangement of the parts generally, but a bilateral arrangement of the parts in the individual alveoles."

The various kinds of cell-apertures are described, and the different ornaments of the test—such as spines, striæ, and pustules—in the several species, but few additions are made by him to the observations of Barrande on the same subject.

Mode of Reproduction.—One of the most important parts of Hall's work is the section devoted to the Reproduction of the Graptolites. In it he brings to light many novel facts, and by several valuable suggestions directs attention to the need for further research in this direction. In 1858 he had described certain "elongated sacs with swollen extremities," which he supposed contained the ovules or germs. These sacs "have scarcely any apparent substance," but are supported by numerous fibres, and in one case at any rate there is "conclusive evidence that they are connected with the solid axis of the parent stipe." The various figures given by Hall in illustration, both in the former and in the present work, show well the shape and arrangement of these "sacs." In his fig. 9 they are attached to what appears to be an example of *D. Whitfieldii.* In other cases there is apparently no ordinary cell structure on the stipes bearing the so-called reproductive sacs. These forms have since been separated under the provisional title of *Hallograptus* by Carruthers.

Several so-called germs or "young Graptolites of extremely minute proportions" are also described and figured by Hall in this work. Although they have never been actually found inside any of the "sacs," he has no doubt that they were derived from them. Hall's figures of these "germs" will best illustrate his views on their structure. In some of his typical instances, his so-called little "sac" containing the germ of the zoophyte is practically synonymous with the body afterwards distinguished by Lapworth as the sicula, though Hall considers the "radicle and lateral spines to be distinct from the sac." This sac "extends itself as the common body in its canal along the axis, and gives origin to the budding which develops the successive cellules." He calls attention to the long axis and to an "extension of the common body along the axis above the incipient cells."

Although these "germs" were observed by Hall only in Diplograptid forms, he considers that they probably differed but little in other species; in the branching forms the only difference would be that the common body would divide into 2, 4, 8, etc., divisions, each one bearing its axis and common canal. As respects the development of the cellules in general, Hall calls attention to their invariable "lesser development towards the base of the stipe," although the same is often the case at the distal end as well.

Affinities.—He points out that the method of reproduction in the Graptolites thus observed "shows much analogy with the Hydroidea, and would indicate the Sertularians as their nearest analogues."

Mode of Existence.—In the case of all those Graptolite species having a single row of cellules, and also in the cases of the two- and four-rowed forms, such as *Retiolites*, *Retiograptus*, and *Phyllograptus*, Hall believes that they were "free floating bodies in the Silurian seas."

With respect to the Dendroid or tree-like forms, however, he holds that there is some evidence indicative of a different mode of existence, and he infers that these were fixed to the sea bottom by a root or bulb-like expansion at their base.

Distribution of the Graptolites.—The short section dealing with the geological and geographical distribution of the Graptolites must also be briefly referred to in this place. Hall considers that Graptolites came into existence at the time of the deposition of the Potsdam Sandstone, and attained their greatest development at the epoch of the Quebec group. "Several genera are known in the Trenton formation, and a greater development occurs at the period of the Hudson River formation." "In the Clinton group there is one species of *Graptolithus* and a *Retiolites*, while *Dictyonema* and *Inocaulis* occur in the Niagara beds. *Dictyonema* also ranges up into the Upper Helderberg and Hamilton formations." The wide geographical distribution of Graptolites in America is pointed out by Hall, but no attempt is made by him to fix the geological range of the individual species.

CHAPTER III.

1866 to 1880.

Previous to the year 1866 most of the work among the Graptolites had been done by geologists living on the Continent of Europe or in America; but at this date what might be called the British period of investigation began, and for the next twenty years the great majority of papers that appeared emanated from British investigators—Salter, Carruthers, Nicholson, Hopkinson, and Lapworth.

1866.
Nicholson,
"Ovarian Vesicles or 'Grapto-gonophores,'"
'Geol. Mag.,' vol. iii.

Nicholson's first paper was devoted to the description of certain bodies occurring with Graptolites at Garple Linn, near Moffat, which he suggested might be "gonophores" or "ovarian vesicles," and for which he proposed the name "Grapto-gonophores." These bodies he describes as being "corneous and bell-shaped," "provided at one extremity with a prominent spine or mucro, the other terminating in a gentle curved or nearly straight margin." Generally they are found free; but in the case of *Gr. Sedgwickii* they occur in such close juxtaposition as to "justify the belief that the connection was organic, and not simply accidental." They appear to spring from the common canal or cœnosarc with the mucro at the free end.

Nicholson points out that, if this interpretation be correct, the Graptolites must be "finally referred to the Hydrozoa, and would find their nearest analogues in the Sertularidæ," "from which, however, they would always be separated by sufficiently distinctive and definite characters."

1866.
Salter,
Memoir Geol. Survey,
vol. iii.

In H.M. Geological Survey Memoir on North Wales (published in 1866) Salter described and figured several forms of Graptolites.

Of new species, he figures two—(1) *Diplog.* **barbatulus** (which it is at present impossible to identify), and (2) *Dendrog.* **furcatula.** Of species already named by previous observers, he refigures (3) *Gr. sagittarius* (which he considers to be identical with *Gr. virgulatus* and *Gr. Barrandei* of Scharenberg, and which is probably a fragment of a Dichograptid); (4) *Diplog. teretiusculus;* (5) *D. mucronatus;* (6) *D. ramosus;* (7) *D. bicornis* (his two figures do not show the characteristic features of that species); (8) *Didymog. geminus;* (9) *D. hirundo;* and (10) *Dictyonema sociale.* The question of the structure and the affinities of this last mentioned form (which had first been figured by Salter in 'Siluria,' Edit. 2, 1854) is entered into in much detail. Salter somewhat reluctantly accepts Hall's view of the identity of Eichwald's *Gorgonia* (*flabelliformis*), Angelin's *Phyllograpsus*, and his own *Graptopora*, with Hall's genus *Dictyonema.* While he considers the genus to have a "true relation with the Graptolite group," he regards it as a link connecting Graptolites with the Fenestellidæ among the Bryozoa, under which class, indeed, following Huxley, he groups the Graptolites in general.

Salter combats Hall's view that all the single-stiped forms of Graptolites are broken fragments of branched species, holding that the "evidence against it lies both in the mode of occurrence of these bodies and even more in the very complete series of forms which can be furnished by our cabinets." "It is, moreover, certain that the Graptolites, occurring in great shoals in muddy deposits, probably of a deep sea, often unaccompanied by other fossils, and tranquilly laid down on the soft carbonaceous floor, would be less likely to be broken up than most fossils." He also asserts that *Diplograpsus* "could never have consisted of two single Graptolites, the line of junction being quite soldered up," and he refers to such forms as *D. ramosus* in support of his opinion. He points out that in the genus *Didymograpsus* the "radix" is sometimes "lengthened out into a long acute point, and the branches reflexed," from which it appears that he did not accept Hall's assertion that *D. caduceus* (Salter) was really a *Tetragraptus*.

1866. *Geinitz*, "Bemerkungen über Hall's 'Graptolites of the Quebec Group,'" 'Neues Jahrb. f. Min.'

In a review of Hall's Memoir on the "Graptolites of the Quebec Group," Geinitz criticises Hall's generic list, and points out that there must be four distinct genera included in Hall's single genus *Graptolithus*, viz. *Monograptus*, *Didymograptus*, *Tetragraptus* and *Dichograptus*. He considers his own *Cladograpsus* to be identical with Hall's *Dicranograptus*, but he accepts Hall's genera *Phyllograptus* and *Retiograptus*. He again emphasises the close relationship of the genera *Monograptus* and *Rastrites*, and suggests a name, **Birastrites**, for those *Rastrites*-like forms having apparently two rows of thecæ, to which genus he thinks *Thamnograptus* and *Buthograptus* might also possibly belong. He considers that *Oldhamia* is an alga, but on the other hand he argues strongly in favour of *Nereograptus* being a true Graptolite. He proposes the new generic name of **Stephanograptus** for Hall's species *Gr. gracilis*, which, however, Hall himself had already acknowledged as probably identical with Emmon's *Nemagraptus* (*elegans*).

1867. *Carruthers*, "Graptolites: their Structure and Systematic Position," 'Intell. Observer,' xi (4) and xi (5) Nos. 64 and 65.

A general paper on Graptolites was published by Carruthers in 1867 in the pages of a scientific magazine known as the 'Intellectual Observer.' In this he discusses their structure, systematic position, and classification. He divides them into four sections—

Section I.—"Species with a single series of cells," including—1. *Rastrites*, 2. *Graptolithus*, 3. *Cyrtograpsus*, 4. *Didymograpsus* (including *Tetragrapsus* and *Dicellograpsus*), 5. *Dichograpsus*, 6. *Cladograpsus*, 7. *Dendrograptus*.

Section II.—"Species with two series of cells." 8. *Diplograpsus*, 9. *Climacograptus*, 10. *Retiolites*.

Section III.—"Species with single and double series of cells on different parts of the same polypary." 11. *Dicranograptus*.

Section IV.—"Species with four series of cells." 12. *Phyllograptus*.

He figures a large number of previously named species, viz.: (1) *Gr. priodon*, (2) *Gr. convolutus*, (3) *Gr. Roemeri*, (4) *Gr. Sedgwickii*, (5) *Gr. Halli*; (6) *Rastrites Linnæi*, (7) *R. capillaris*; (8) *Diplog. pristis*, (9) *D. tricornis*, (10) *D. cometa*,

(11) *D. folium*; (12) *Climacog. scalaris*; (13) *Retiolites Geinitzianus*; (14) *Didymog. Murchisoni*, (15) *D. crucialis*; (16) *Dichog. aranea*; (17) *Phyllog. ilicifolius*; (18) *Cladog. linearis*; and three new forms, viz.: (19) *Gr.* **Hisingeri** (a name which he suggests for Hisinger's *Prionotus sagittarius* to "prevent further confusion"), (20) *Gr.* **Clingani,** and (21) *Didymog.* (*Dicellog.*) **elegans.** These, however, are not described.

In the diagnoses of the various forms of Graptolites, Carruthers employs for the first time in scientific literature the same nomenclature as that already proposed by Huxley and Allman for the Hydrozoa in general, using such terms as "polypary," "cœnosarc," "hydrotheca," etc., in his descriptions. This plan has since been followed by the majority of palæontologists.

He agrees generally with Barrande's account of the structure of a typical Graptolite, such as *Monog. Roemeri* and *M. priodon*, but he notices "what seems to be a septum at the base of each hydrotheca," in *Gr. sagittarius* and *Gr. latus*. He calls attention to certain specimens of *Diplog. pristis* which he found on one slab, in which the "naked axes met." This circumstance suggested to him the "possibility of the supposed perfect specimens of *Diplograpsus* being only fragments of more complex forms" (as in *Retiograptus*). He thus, like Emmons (p. xxxviii), anticipated in theory Ruedemann's subsequent discoveries. Carruthers, however, finally rejects this idea as being "anomalous and improbable."

He also discusses what is known or surmised about the development of the Graptolites, and figures certain young forms with their "radicle," and also a specimen of a form closely resembling those examples of *Diplograpsus* bearing "reproductive sacs" figured by Hall, but in this case only the interlacing fibres are seen, not the sacs themselves.

As regards the affinities of the Graptolites, he considers that they are more closely allied to the Hydrozoa than to the Polyzoa or any other group of animals, the polyps rising directly from the cœnosarc.

1867.
Carruthers,
Murchison's 'Siluria,'
4th edit.

In an appendix to the fourth edition of Murchison's 'Siluria,' which is dated 1867, Carruthers gave a second and briefer account of the Graptolites in general, and also a classification. This classification is essentially the same as that given by him in his paper in the 'Intellectual Observer' already cited; the only difference is that he subdivides his Section I into those with their—(*a*) polyparies simple and (*b*) polyparies compound; his Section II into those—(*a*) with a slender solid axis and (*b*) without an axis (*Retiolites*).

He figures (1) *Retiolites Geinitzianus*, (2) *Dichog. Sedgwickii*, (3) *Dicranog. ramosus*, (4) *Phyllog. angustifolius*, (5) *Cladog. linearis*; and also three new species—(6) *Cyrtog.* **Murchisoni,** (7) *Rastrites* **maximus,** (8) *Dendrog.* **lentus.** (The last form in reality belongs to the genus *Clonograptus*.) He again in this article argues in support of the Hydrozoal affinities of the Graptolites.

1867.
Carruthers,
"Note on the Systematic Position, etc., of Graptolites," 'Geol. Mag.,' vol. iv.

In 1867 Carruthers criticised Nicholson's views respecting the so-called "Grapto-gonophores." He denies their ovarian character, believing them to be Brachiopods, *i.e. Siphonotreta micula*, etc. He thinks that the supposed attachment is only a case of accidental juxtaposition, as it would be more natural for them to be attached by the mucro end, and he draws attention to the fact that no living Hydrozoon has "corneous" gonophores that become free swimming zooids. Moreover, no scars of attachment have been observed. Nor, he points out, do they bear any resemblance to the young Graptolite forms figured by Hall, the various stages of growth of which Carruthers himself had traced in the development of his own *Diplog. tricornis*.

As regards the affinities of the Graptolites themselves, Carruthers now inclines to the opinion that "although they resemble the Hydrozoa in general aspect, they are nevertheless more closely allied to the Polyzoa in the following characters:

1. There is no distinct common canal. Sometimes the polyps rise from a common substance which extends along the whole of the celluliferous portion of the organism, but there is no constriction or septum at the base of the cells. In other species the walls of the cells are continued to the solid axis.

2. The mouths of the cells are furnished with spines.

Graptolites, however, differ from all living zoophytes in possessing—(1) a solid axis, (2) free polypidoms.

In this paper Carruthers places his species *Cladograptus linearis* in the genus *Dendrograptus*.

1867.
Nicholson,
"On some Fossils from the Lower Silurian Rocks of the South of Scotland," 'Geol. Mag.,' vol. iv.

The same year Nicholson described some Graptolites from the Lower Silurian beds of the South of Scotland, including three which were new to science, viz. (1) *Diplog.* **tubulariformis,** (2) *D.* **acuminatus,** (3) *Didymog.* **anceps;** and three species named by earlier observers—(4) *Didymog. flaccidus*, (5) *Diplog. quadrimucronatus*, (6) *D. Whitfieldi.* He also describes a new genus, **Corynoides,** typified by the species (7) *C.* **calicularis.** As regards this genus, the name of which was suggested by Harkness, Nicholson defines it as a "simple hollow tube, probably corneous, provided with a single or double radicle or mucro, and developed distally into a cup-like hydrotheca." The single polypite is "closely analogous to some of the Corynidæ or Tubularidæ," especially resembling *Corymorpha.* He holds that it was "undoubtedly a free floating and independent organism."

In the same paper Nicholson also describes and figures three types of Hall's "germs" of Graptolites, belonging apparently to "*Diplog. pristis.*" He figures three stages of growth in this form, also the early stage of a uniserial species. In this last example it will be seen that the true sicula is well represented as forming a constituent part of the "germ," but the solid axis, instead of being shown as a continuation of the apex of the sicula, is figured as continued into, and is confused with, the apertural spine of the sicula.

1867.
Nicholson,
'Geol. Mag.,' vol. iv.

In a letter written during this year Nicholson replies to Carruthers' criticism of his "Grapto-gonophores," and he suggests that possibly the pustuliform elevations at the bases of the cells in *Didymog. nitidus* and *D. anceps* "may be the cicatrices of ovarian capsules."

1867.
Carruthers,
'Geol. Mag.,' vol. iv.

A subsequent letter from Carruthers called forth a reply from Nicholson, but no new facts were given by either writer.

1867.
Nicholson,
"On a New Genus of Graptolites, with Notes on Reproductive Bodies," 'Geol. Mag.,' vol. iv.

A month later Nicholson published another paper, in which he suggested the generic name **Pleurograptus** for the form typified by the *Cladograptus linearis* of Carruthers. Nicholson re-describes the species, showing how it differs from *Dendrograptus*, and from all known genera, in having no 'funicle,' the "primitive parent stem being itself celluliferous." He considers that *Gr. gracilis*, with its marked 'funicle,' is unique in its character, and "should form the type of a new genus."

Nicholson also figures in this paper a stipe "studded with small rounded tubercles," "apparently springing from the common canal on either side," and he suggests that this may be an "instance of ovarian vesicles in their young condition," which may either remain permanently attached, or may possibly become free at a later stage.

He also figures several more "gonophores" of *G. Sedgwickii*, and states that he believes that he has "made out with certainty that these capsules are reproductive in function," while their resemblance to orbicular Brachiopods when compressed is "purely mimetic and illusory." Associated with examples of *Gr. sagittarius* the capsules occur in the greatest confusion, but he "failed to detect any organic connection between them and the cells." This, he suggests, may be due to the fact that they were thrown off when extremely minute, attaining their full development subsequently; or they "were attached to the sides of the polypites, or to 'gonoblastidea,' as in many living Hydrozoa."

He points out the fact that no ovarian sacs are found among the Graptolites at Hartfell—where there are no forms of *Graptolithus* (*Monograptus*); but he explains this by suggesting that the sacs belonging to the genera there represented had possibly no corneous envelope, and that therefore they have not been preserved. Some additional young forms or germs are figured by him, differing but little from those previously described, except as respects their greater size.

Nicholson strongly upholds in this paper the Hydrozoal affinities of the Graptolites, on the following grounds:

(1) The true Graptolites (except *Dictyonema* and possibly *Dendrograptus* and *Callograptus*) are all free-swimming forms, whilst the Bryozoa are invariably fixed.

(2) The undoubted presence of a common canal "in many, if not all."

(3) The mode of growth and the nature of the embryonic forms.

(4) The existence of forms like *Corynoides*.

He points out that the Graptolites differ from the whole sub-class of the Hydroida in the fact that the polypidom was free, and not fixed by a hydro-rhiza, and he is disposed to place them in a "new sub-class, intermediate between the fixed and oceanic Hydrozoa."

1867.
Carruthers,
"Note on Systematic Position, etc., of Graptolites," 'Geol. Mag.,' vol. iv.

The same year Carruthers replied to these statements and opinions of Nicholson in much detail, but his paper contained no new facts or theories.

1867.
Törnquist.
"Om Lagerföljden i Dalarnes Under-Siluriska Bildningar."

In the same year also a short stratigraphical paper was published by Törnquist dealing with the appearance of Graptolites in Central Sweden. He considers that *Prionotus sagittarius* (His.) and *Didymog. virgulatus* are identical with *D. ludensis;* while *Petalog. folium* (His.) is really a *Retiolites. Pr. scalaris* is founded partly upon *Diplog. pristis* and partly upon *D. teretiusculus.* The species discussed, together with *Rastrites? convolutus*, are recorded by him from the Lower Silurian beds of Dalarne.

1868.
Nicholson,
"The Graptolites of the Skiddaw Series," 'Quart. Journ. Geol. Soc.,' vol. xxiv.

In the following year (1868) no less than six papers on Graptolites were written by Nicholson. The first of these, "On the Graptolites of the Skiddaw Slates," is mainly descriptive in character, but the works of previous observers are carefully reviewed, and several new forms of Graptolites are named and figured. The following genera and species are recorded by him from these rocks :

Didymograpsus. Salter's *Didymog. caduceus* (which he considers to be non-existent as a distinct species—at any rate in the Skiddaw Slates—and to be probably identical with *Tetrag. bryonoides* (Hall)), *D. v-fractus, D. sextans* (which he regards as "somewhat peculiar among the *Didymograpsi*"), *D. patulus* (=*D. hirundo*, Salter), *D. nitidus, D. bifidus,* and *D. serratulus* are described, and (1) *D. geminus* is figured.

Phyllograpsus. Phyllog. angustifolius, and (2) *P. typus.*

Tetragrapsus (Nicholson defends this genus against Hall). *T. Headi, T. quadribrachiatus, T. bryonoides, T. crucifer.*

Dichograpsus. Nicholson proposes the retention of Salter's name for this genus, to include such forms as possess a "variable number (always more than four) of simple stipes, united centrally at the base by a non-celluliferous stem or funicle." He distinguishes two groups within the limits of the genus: (*a*) Those typified by *D. Logani* and *D. octobrachiatus*, in which the celluliferous stipes are never divided at all; (*b*) Those like *D. flexilis*, *D. rigidus* and *D. multiplex*, in which the celluliferous stipes themselves branch and rebranch repeatedly. Like Hall, he does not regard the disc in the Graptolite as of generic value, and is inclined to believe that its "homologue is to be found in the 'float' or 'pneumatophore' of the Physophoridæ." The disc seen in *Climacog. bicornis* and others is probably of the same character, and it "may have been developed only at certain stages of growth, in certain individuals of the species, and probably for certain definite purposes." The species of *Dichograpsus* described are *D. Logani*, (3) *D. octobrachiatus* and two new forms, (4) *D.* **multiplex** (*Temnograptus*) and (5) *D.* **reticulatus** (*Schizograptus*).

In discussing the genus *Diplograpsus*, it is noteworthy that Nicholson lays great stress on the importance of observing the character of the base for determining the various species, "forming as it does the most valuable aid to a correct diagnosis." The suggestion thus made has subsequently proved to be of especial value in the discrimination of both genera and species. He divides the Skiddaw Slate species of *Diplograpsus* by their basal characters into three classes, viz. those having (*a*) a median radicle, flanked by two lateral processes, which spring from primary cellules on each side (*D. bicornis*, etc.); (*b*) two primary cellules, greatly elongated, forming with the solid axis a broad tapering "radicle" (*D. cometa*, etc.); (*c*) the base formed by a basal extension of the solid axis beyond the proximal extremity of the frond (*D. pristiniformis*, etc.). He re-describes *Diplog. mucronatus* and *D. antennarius*, and re-figures (6) *D. teretiusculus* and (7) *D. pristiniformis*. For *D. antennarius* and *D. teretiusculus* he considers that it would be advisable in future to accept Hall's title of *Climacograpsus*.

As regards the genus "*Graptolites*" or "*Graptolithus*," as then understood (the *Monograptus* of later authors) Nicholson states that he is "inclined to think that the genus is not represented" in the Skiddaw Slates, and that the forms ascribed to it, such as *Gr. sagittarius*, *Gr. tenuis*, and *Gr. Nilssoni* are in reality fragments only of compound species. This view has been fully justified by subsequent research. A fragmentary branching form is referred by him to (8) *Dendrograptus Hallianus*, which species he considers is probably identical with *D. furcatula*, Salter.

A new form (9) *Pleurograpsus* (?) **vagans** is also described and figured. This is not a *Pleurograptus*, but belongs to the Dichograptidæ; owing, however, to its fragmentary condition it is impossible to refer it with certainty to any known genus of that family.

1868.
Nicholson,
"On the Graptolites of the Coniston Flags; with Notes on the British Species of the Genus *Graptolites*," 'Quart. Journ. Geol. Soc.,' vol. xxiv.

Nicholson's second paper was entitled "On the Graptolites of the Coniston Flags." This also is almost entirely descriptive, twenty-four species of Graptolites being described, of which five are new.

The following are the genera and species noticed in this paper: (1) *Diplograpsus folium*, (2) *D. palmeus*, (3) *D. angustifolius*, (4) *D. putillus*, *D. vesiculosus*, *D. pristis*, and two new *Diplograpti* (5) *D.* **tamariscus** and (6) *D.* **confertus**; (7) *Climacograpsus teretiusculus*; (8) *Retiolites Geinitzianus*, and a new form (9) *R.* **perlatus**; (10) *Rastrites peregrinus*, and (11) *R. Linnæi*; (12) *Graptolithus lobiferus*, (13) var. *Nicoli* and (14) var. **exiguus,** (15) *Gr. Sedgwickii*, (16) var. *triangulatus* and (17) var. **spinigerus,** (18) *Gr.* **fimbriatus,** (19) *Gr. Nilssoni*, (20) var. **major** and (21) var. **minor,** (22) *Gr. tenuis*, (23) *Gr. bohemicus*, (24) *Gr. priodon*, (25) *Gr. colonus*, (26) *Gr. sagittarius*, (27) *Gr. turriculatus*, and a new form, (28) *Gr.* **discretus,** of which Nicholson remarks that "the long sub-mucronate extremities of the cellules are often furnished with little ovoid, or triangular, vesicular bodies depending from their apices."

It is impossible to discuss the identification of each species in detail, but in the light of our present-day knowledge we are aware that several of the forms assigned by him to species already named must be regarded as incorrectly referred. The paper added very greatly to the number of British Graptolites and to our knowledge of the Graptolite species occurring in the higher beds of the Lake District.

As regards the age of the Coniston Flags, Nicholson considers them to be Lower Silurian, and the term as applied by him included all the beds between the summit of the Coniston Limestone proper and the base of the Coniston Grits.

1868.
Nicholson,
"On the Nature and Zoological Position of the Graptolitidæ," 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. i.

The four remaining papers by Nicholson were published in 1868 in the 'Annals and Magazine of Natural History.' The third, entitled "On the Nature and Zoological Position of the Graptolitidæ," gives a clear account of the general state of knowledge at that time with respect to the morphology, zoological affinities, etc., of the Group.

Treating of the morphology of the Graptolites, Nicholson discusses in turn the "three factors, structurally and developmentally distinct," of which each single linear stipe is composed—*i.e.* (1) the solid axis, (2) the common canal, and (3) the cellules.

Solid axis.—In Monoprions this is a solid cylindrical rod, but in Diprions it is "certainly a corneous plate dividing the frond into two vertical compartments, apparently composed of two laminæ, with a median cylindrical rod and perhaps *including a central canal.*" The proximal extension of the axis is probably present in all true Graptolites, and constitutes the "radicle" or "initial point" of

Hall; the "funicle" is regarded as being composed of the proximal extensions of the axis, together with, probably, the common canal. The distal extension of the axis is only seen in *Diplograpsus.* It may consist of the solid axis only, or of a "bladder-like body, more or less elliptical in form, with a distinct filiform margin, and of uncertain function." "This dilatation," as seen in the new species *D. vesiculosus*, "seems always to be a direct expansion of the axis, which would thus appear to be tubular."

The non-solid character of the axis, at any rate in some forms, though hinted at by previous authors (Suess, etc.), was thus definitely stated by Nicholson for the first time. As regards the homologies of this axis, Nicholson thinks it is "probably related (but by analogy only) to the horny or calcareous 'sclerobasis' of the Gorgonidæ and Pennatulidæ." Its chief function was to give support, and its radicle was not used for purposes of attachment; therefore there is no close parallel between it and the foot stalk of the Sertularidæ.

The common canal.—He considers that the common canal is an individual structure, "giving origin to the cellules" and conveying a "soft connecting substance uniting the various polypites into an organic whole." He considers it to be homologous with the cœnosarcal canal of zoophytes generally.

Cellules.—Nothing new is added by Nicholson in this paper concerning the structure of the cellules. He points out their resemblance to the hydrothecæ of the Sertularidæ, but is opposed to the view that they were cut off from the common canal by a diaphragm.

As regards the development of the Graptolites, Nicholson inclines to the opinion that the "germs" at present discovered are not the earliest forms of the embryo; these probably had no corneous test. He agrees by implication with Barrande's view that the youngest cells are at the proximal end of the polypary, and in consonance with this he expresses the opinion that the secondary cellules appear to be intercalated between the radicle and the primordial cellules, so that the youngest cellules are proximal, the oldest distal in position. This mode of development "corresponds with that observed in the Calycophoridæ and Physophoridæ."

Nicholson's previously published views on the reproductive organs of the Graptolites are summarised in this paper. He thinks that when the capsules dropped off, probably minute, ciliated, free-swimming organisms (? planulæ) were liberated, which, at a later stage, developed a corneous covering. He suggests that the vesicle of *D.* **vesiculosus** (which was here figured for the first time) was in some way connected with the process of reproduction.

As to the mode of existence of the Graptolites, Nicholson says "there can be no question that by far the greater number were free-swimming or free-floating organisms." Some had floats; others were very probably provided with "necto-calyces," or swimming-bells, but these would not be preserved. The Dendroid forms, which most closely resemble the Sertularidæ, may have been fixed.

He regards the Graptolites generally as the "primitive stock" from which the various existing sections of the living Hydrozoa originally diverged.

1868. *Nicholson*, "On the Occurrence of the Genus *Ptilograpsus* in Britain, with Notes on the Ludlow Graptolites," 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. i.

In his fourth paper Nicholson recorded the occurrence of *Ptilograpsus* in rocks of Ludlow age in Britain, and described a new species (*P.* **anglicus**.) Nicholson agrees with Hall that the genus *Ptilograpsus* is closely related to *Plumularia*, and that it was probably an attached form. He here modifies his previous view as to the invariable presence of the axis in all Graptolites, and admits that "the axis is not so constantly present as has generally been thought," that it "is certainly absent" in all the Dendroidea, and "probably in other families."

In addition to *P. anglicus*, Nicholson records several other forms of Graptolites from the Ludlow rocks, viz. *Gr. priodon*, *Gr. colonus*, and *Gr. Nilssoni.*

1868. *Nicholson*, "On *Helicograpsus*," 'Ann. and Mag. of Nat. Hist.,' ser. iv, vol. ii.

This paper was followed in June by a fifth, in which Nicholson proposed the new generic name of **Helicograpsus** for the species *Gr. gracilis* of Hall. The essential difference, according to him, between this and his own genus *Pleurograpsus* (Carruther's *Cladograpsus*) consists in the presence of a distinct "funicle" and regular branching in the former; whereas in the latter there is no funicle, and the branching is quite irregular.

1868. *Nicholson*, "On the Geological Distribution of Graptolites," 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. ii.

The sixth paper by Nicholson published in 1868 dealt with the "Distribution in time of the British Species and Genera of Graptolites." It may be here briefly summarised as giving an excellent idea of the general state of opinion on this subject at that date.

(1) The Graptolites as a whole are characteristically Silurian, and fourteen out of seventeen genera are exclusively confined to the Lower Silurian, the Upper Silurian only possessing two peculiar species.

(2) In the Tremadoc Slates (= Upper Cambrian) *Dictyonema* occurs.

(3) To the Lower Llandeilo (Skiddaw Slates) the genera *Dichograpsus*, *Tetragrapsus*, and *Phyllograptus*, etc., are strictly confined. They occur in association with species of *Didymograpsus* and *Diplograpsus.*

(4) The Upper Llandeilo Rocks (which include all the graptolitic beds of Scotland) contain the genera *Diplograpsus*, *Climacograpsus*, *Graptolites*, *Rastrites*, and *Dicranograpsus.*

(5) The Caradoc beds do not as a rule yield Graptolites, but in Ireland they afford *Diplog. pristis*, *Didymog. sextans*, *Helicog. gracilis*, *Gr. Nilssoni*, *Gr. Sedgwickii*, *Callog. elegans*, etc.

(6) In the Lower Llandovery one Graptolite only has been found—*Climacog. teretiusculus.*

(7) In the Wenlock *Gr. Flemingii* is characteristic; *Retiolites Geinitzianus* occurs here, but also in the Lower Silurian and the Ludlow; *Gr. priodon* and *Gr. colonus* occur in the Wenlock and in the Lower and Upper Ludlow; *Ptilograpsus* is peculiar to the Lower Ludlow.

In spite of the apparently wide range in time of nearly all the species and genera cited, Nicholson remarks that they afford "very reliable and valuable data whereby formations in different parts of the world may be correlated with one another, or the exact position held by any group of beds in the stratified series may be more or less exactly ascertained," an assertion which, however slightly founded at that time, has been shown by subsequent research to be practically correct.

1868.
Carruthers,
"Revision of the British Graptolites, with Description of New Species and Notes on their Affinities," 'Geol. Mag.,' vol. v.

During the same year, 1868, and previous to the publication of some of Nicholson's papers mentioned above, Carruthers brought out his 'Revision of the British Graptolites,' with descriptions of several new species and notes on their affinities.

In the classificatory part of this paper a large number of species are described, and the new ones (some of them previously mentioned by him in his appendix to Murchison's 'Siluria,' Edit. 4) are figured and described.

The genus *Rastrites*, as acknowledged by him, includes four species: *R. peregrinus*, (1) *R. Linnæi*, (2) *R. maximus*, and a new form (3) *R.* **capillaris.** He holds that *R. triangulatus* (Hark) was founded on the proximal part of *Gr. convolutus* (Monograptus), and he gives a figure showing that this species of Graptolite "really terminates proximally in a polypary which cannot be distinguished from that of *Rastrites*," thus throwing doubt on the stability of the genus *Rastrites* itself. He points out that *R. Barrandei* (Hark) was founded on fragments of *Cladograpsus* (*Cœnograptus*) *gracilis*.

The genus *Graptolithus* he restricts in the same manner as other palæontologists of the time to forms now classed as *Monograptus*. He considers that this generic term ought properly to be applied to double forms like *Gr. scalaris* (Linn), for which it was first employed by its founder, but that it would create too much confusion to make the correction now. *Graptolithus* is represented by twelve species in his list: *Gr. Nilssoni*, *Gr. Flemingii*, *Gr. tenuis*, *Gr. Salteri*, *Gr. Hisingeri*, (4) *Gr. convolutus*, *Gr. Sedgwickii*, *Gr. priodon*, *Gr. Halli*, *Gr. Becki*, (5) *Gr. Clingani* and a new species, (6) *Gr.* **intermedius.** His own new genus, *Cyrtograpsus* (previously named in 'Siluria'), is described, and his species (7) *C. Murchisoni* is re-figured. He shows that *C. hamatus* (Baily) also belongs to this genus.

He does not regard the number of branches in allied forms of Graptolites as a generic distinction, and therefore includes under *Didymograpsus* species of *Tetragrapsus*, as well as forms of *Dicellograpsus*. He considers that "the possession of an obvious branching hydrocaulus stipe" might be a good reliable generic character, but points out that unfortunately there are no materials in Britain to enable one to determine this.

Many species of the genus *Didymograpsus* as thus enlarged are referred to, viz. *D. hirundo*, *D. Murchisoni*, *D. v-fractus*, *D. sextans*, *D. Forchammeri*, (8) *D. elegans*, *D. moffatensis*, *D. caduceus*, *D. bryonoides*, *D. quadribrachiatus*.

The forms of *Dichograpsus* noticed by him are: *D. octobrachiatus* and *D. Sedgwickii*.

He reinstates the genus *Cladograpsus* for his own *C. linearis*, refusing to accept Nicholson's generic name of *Pleurograpsus*, and includes in the genus *C. linearis*, (9) *C.* **capillaris,** and *C. gracilis*.

The forms of *Diplograpsus* noted and figured are: (10) *D. pristis* (= *D. vesiculosus* and *D. physophora*), (11) *D.* **minimus,** *D. angustifolius*, (12) *D. Whitfieldi* (including *D. quadrimucronatus*, Nich.), (13) *D. tricornis*, (14) *D. cometa* (including *D. tubulariformis*, Nich.). This last named form he thinks "should perhaps be made the type of a new genus." As regards (15) *D. mucronatus*, Carruthers suggests that those forms with "several branching and apparently anastomosing processes from the cell mouth," which Hall considered to be the marginal fibres of the reproductive sacs, may really prove to be a distinct species, for which he proposes the name *D.* **Bailyi.** *Diplog. persculptus* is referred to, but not described or figured.

Two forms of *Dendrograptus* are noticed: *D. furcatulus* and (16) *D. lentus*, Carr.

Under *Climacograptus* Carruthers gives figures of (17) *C. scalaris* and a new species (18) *C.* **minutus.**

Under the genus *Dicranograptus* he includes *D. ramosus* and a new species (19) *D.* **Clingani,** thus for the first time restricting this genus to those forms with a biserial proximal portion and uniserial distal stipes.

The genus *Retiolites*, according to Carruthers, possesses no axis or septum. The forms recognised are: *R. Geinitzianus* and *R. venosus*.

Only one form of *Phyllograptus* is noticed from Britain, viz. the *P. angustifolius* of Hall.

Carruthers' paper is prefaced by a general description of the structure of a typical Graptolite, but this contains nothing new. He, however (as in his paper in the 'Intellectual Observer'), strongly recommends the adoption of the nomenclature already in use for the Hydrozoa, and he consistently employs it throughout this memoir.

The affinities of the Graptolites are discussed by Carruthers at great length. He considers that the general form of the polypary, its free or attached nature, its chitinous character, are of no systematic value, whereas the presence or absence of a common canal is of very great importance. The affinities of the Graptolites to the Polyzoa are fully considered, but the absence of a common canal in the Cheilostomata, and the fact that the cells are in communication only through a perforated septum in the Ctenostomata, "distinguish them at once." The various characters of the six groups of living Hydrozoa are given, but the only two which he acknowledges have any affinities with the Graptolites are the Corynidæ and the Sertularidæ, and as there are no cells in the former, Carruthers considers that the nearest allies of the Graptolites are the latter, although they have no axis.

As respects the mode of life of the Graptolites, Carruthers is inclined to the opinion that they were attached, and points to the long proximal extension of the radicle in *C. scalaris* as an example. He rejects Nicholson's idea of "floats" and "swimming bells," and also his reproductive sacs and gonophores.

1868. *Hall.* "Introduction to the Study of the Graptolitidæ," 'Twentieth Annual Report of the State Cabinet.'

The 20th Annual Report of the State Cabinet of New York, published in the same year, contains a paper by Hall, entitled "An Introduction to the Study of the Graptolitidæ." This is in the main a reprint of selections from his previous memoir on the "Graptolites of the Quebec Group," but he gives some "Supplementary Notes" on the genera *Didymograptus*, *Cladograptus*, *Dicranograptus*, and *Cœnograptus*. He points out that both M'Coy and Geinitz included under each of the first two generic names two distinct types, and he suggests the employment of *Didymograptus* (M'Coy) for such forms as *D. Murchisoni*, and *Cladograpsus* (Geinitz) for forms of the type of *D. ramosus*, etc., thus relinquishing for the time his own genus *Dicranograptus* in favour of the older title suggested by Geinitz. As regards the *Cladograpsus* of Carruthers, Hall points out that there is little doubt that it is similar to his own *Cœnograptus*, which may, again, be identical with Emmon's *Nemagraptus*.

Hall still asserts that it is generally impossible to distinguish between *Didymograptus*, *Tetragraptus*, and *Dichograptus*; but if the last of these names is to be used, he suggests that it be restricted to such forms as *Gr. Sedgwickii* and *Gr. aranea*; and he proposes the name **Loganograptus** for "those forms with central corneous discs, while those which are repeatedly dichotomous, like *Gr. flexilis*, will constitute a third genus."

Hall also makes some additional remarks on *Phyllograptus*, and on the presence of a common body in this genus.

1869. *Heidenhain.* "Ueber Graptolithen-führende Diluvial Geschiebe der Norddeutschen Ebene," 'Zeit. d. Deutsch. Geol. Gesell.,' Bd. xxi.

In 1869 Heidenhain gave descriptions and some good figures of a few species from the Graptolite-bearing boulders of the Drift of Northern Germany. Descriptions only are given of *M. priodon*, *M. sagittarius*, *M. colonus*, and *M. testis*, while there are figures of a new species—(1) *M.* **distans** (Heidenhain's species is identical with the subsequently described *M. scanicus*, Tullb.), (2) *M. Nilssoni*, (3) *M. Salteri* ?, (4) *M. Bohemicus*, (5) *M. Roemeri* (which, according to Heidenhain, occurs without associates in a harder dark limestone), and (6) *M. sp.* (This last was afterwards named by Jaekel *M. micropoma.*) The age of the beds from which these erratics must have been derived is from this record of Graptolites now known to be Lower Ludlow.

He records from rocks somewhat different in character, and therefore probably from another geological horizon, *D. palmeus*, var. *tenuis* and *D. pristis* ?, and gives descriptions of them.

1869. *Nicholson*, "On Some New Species of Graptolites," 'Ann. Mag. of Nat. Hist.,' ser. 4, vol. iv.

During the same year Nicholson described and figured several new species, and one new genus of Graptolites from the Lake District. The new genus, which he names **Trigonograptus** (1) (*T. ensiformis* type), he regards as intermediate between *Retiolites* and *Diplograptus*. A form which he here denominates (2) *Dichograpsus* **fragilis** was afterwards made by himself the type of a new genus *Trichograptus*. Other new species described and figured by him in this paper are (3) *Dichograptus* ? **annulatus,** (4) *Diplog.* **Hopkinsoni** (= *Cryptograptus*), (5) *D.* **armatus** (? *Glossograptus*), (6) *D.* **Hughesi,** (7) *D.* **sinuatus,** (8) *D.* **bimucronatus,** (9) *D.* **insectiformis,** (10) *Climacog.* **innotatus,** (11) *C.* **tuberculatus,** (12) *Gr.* **argenteus,** (13) *Didymog.* **affinis,** and (14) *D.* **fasciculatus.** He also re-figures (15) *D. vesiculosus.*

1869. *Linnarsson*, "Om Vestergötlands Cambriska och Siluriska Aflagringer."

The same year Linnarsson recognised two distinct graptolite horizons in Sweden: (1) the Lower Graptolite Shales, with *Phyllograptus*, *Didymograpsus*, etc. (the equivalents of the Skiddaw Slates), and (2) the Upper Graptolite Shales, with *Graptolithus*, *Diplograpsus*, *Rastrites*, and *Retiolites*, containing fossils similar to those in South Scotland. As the latter occur above the Brachiopod Shales (Caradoc) he thinks that the Llandeilo age of the Scotch beds (Murchison) is probably incorrect.

1869. *Hopkinson*, "On British Graptolites," 'Journ. Quekett Microscopical Club,' vol. i.

In a paper read before the Quekett Microscopical Club Hopkinson gave a generalised account of the British Graptolites. The history of research among the Graptolites is briefly dealt with, and their structure is described in some detail. He adopts throughout the Hydrozoal nomenclature first employed by Carruthers, each term being carefully defined.

He accepts Carruthers' classification for the most part, but he places all true Graptolites in the single order of the Graptolitidæ, and regards Carruthers' four classificatory sections as "sub-orders" or "families," which he names respectively Monoprionidæ, Diprionidæ, Monodiprionidæ, and Tetraprionidæ.

In the family Diprionidæ, Hopkinson suggests a new genus, **Cephalograptus,** to include the single species *D. cometa*, Gein. He figures (1) *Rastrites peregrinus*, (2) *Gr. priodon*, (3) *Gr. Hisingeri*, (4) *Gr. Sedgwickii*, (5) *Cyrtog. Murchisoni*, (6) *Didymog. Murchisoni*, (7) *Tetrag. bryonoides*, (8) *Dichog. octobrachiatus.* He describes and figures a new species of *Diplograpsus*—(9) *D.* **penna.** The genus *Retiolites* he does not consider to be a true Graptolite. He regards *Dendrograptus* as forming a connecting-link between his true Graptolites (the Rhabdophora of the later works of Allman and others) and the genera *Callograptus*, *Dictyonema*, etc.

He also treats in brief of the reproduction and development of Graptolites, and he concludes that in their mode of reproduction "Graptolites are nearly allied to Sertularian Hydrozoa."

1870. *Nicholson*, "On the British Species of *Didymograpsus*," 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. v.

A revision of the genus *Didymograpsus* and its British species was made by Nicholson in 1870. He groups the species which he assigns to this genus into three sections, according to the "angle of divergence"; and he carefully distinguishes, therefore, between what he terms the angle of divergence and the "radicular angle" of the stipes, and the position of the cells with reference to the "radicle."

The distinguishing characters of his three groups are as follows:—

(*a*) Radicle on the inferior aspect, and cells on the superior aspect, angle of divergence not greater than 180°—*D. Murchisoni*, *D. affinis*, *D. patulus*. (*b*) Radicle as in group (*a*), but the angle of divergence more than 180°—*D. flaccidus* and *D. anceps*. (*c*) Situation of cells reversed, on the inferior aspect, on the same side as radicle—*D. sextans* and *D. divaricatus*.

It will be seen from this classification that Nicholson had not yet recognised, even to the extent to which Hall had done previously, the systematic difference between the true genus *Didymograptus* and *Dicellograptus* (*Dicranograptus*—pars of Hall), nor yet the distinction between the sicula proper and its apertural spine. The species described and figured by him are (1) *D. patulus*; (2) *D. v-fractus*; (3) *D. extensus*; (4) *D. nitidus*; (5) *D. affinis*; (6) *D. serratulus* (= *D. Nicholsoni*); (7) *D. fasciculatus*; (8) *D. geminus*; (9) *D. bifidus*; (10) *D. divaricatus* (= *Dicello. elegans*, in part); (11) *D. anceps* (*Dicellograptus*); (12) *D. flaccidus* (*Leptograptus*); and (13) *D. sextans* (*Dicellograptus*).

1870. *Nicholson*, "Revision of the Genus *Climacograpsus*, with Notes on the British Species of the Genus," 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. vi.

Nicholson followed up this paper by a corresponding "Revision of the genus *Climacograpsus*," of which genus he took *C. teretiusculus* (= *C. scalaris* or *rectangularis*) as his type. His diagnosis is as follows: "Composed of two simple unicellular stipes placed back to back, their internal walls coalescing to form a single vertical septum, along the centre of which runs a delicate solid axis in the form of a fibrous, filiform rod." This rod is always prolonged distally, and generally proximally. Nicholson doubts Hall's statement that in *Cl. typicalis* "there seems to be no septum, but the solid axis runs up the centre of a tube common to both series of cellules." He agrees with Hall, however, that the cell partitions are attached to the solid axis, and that the only way in which communication could take place was by assuming that the cell partitions are triangular plates, their apices attached to the axis, having "an unequally arched or convex upper surface, and a concave lower surface." Nicholson states that in those examples of *Climacograpsus* studied by himself there exists a distinct common canal, and the figures of the various "aspects" given by him illustrate well his views of the structure of the genus. The term "suture," which was in this connection here first suggested by Nicholson for the median groove or line formed at the surface by the septum, has subsequently been generally adopted.

He discusses the true character of Linnæus' *Gr. scalaris*, and gives a brief historical sketch of the species. He is inclined to think that it is not a Graptolite at all, "at any rate it is impossible to say whether it is the scalariform impression of a mono-prionidian or di-prionidian form."

He describes four species in addition to (1) *C. teretiusculus*, viz. (2) *C. innotatus*, (3) *C. tuberculatus*, (4) *C. antennarius*, and (5) *C. bicornis*. His figures of this last named species include both the *peltifer* and *tridentatus* varieties of later authors. He states that he has "little or no hesitation in comparing the basal disc or cup in *C. bicornis* with the disc of *Dichograpsus*," &c.

1870. *Hopkinson*, "On the Structure and Affinities of the Genus *Dicranograptus*," 'Geol. Mag.,' vol. vii.

In 1870 Hopkinson published a paper on the genus *Dicranograptus*, Hall. He regards *Dicranograptus* as a distinct genus (not a sub-genus as Hall believed), and agrees with Carruthers in restricting it to those Graptolite forms in which the proximal portion is di-prionidian and the distal mono-prionidian. He differs, however, from Carruthers in believing it to be more nearly allied to *Climacograptus* than to *Diplograptus*. Although he describes the proximal extremity of the polypary as "composed of two series of thecæ, each having its own common canal," he somewhat modifies this assertion by saying in a footnote that "I am by no means certain that the two series are thus isolated." "*Climacograptus* and *Dicranograptus* alike differ from *Diplograptus* in the fact that the separation of the hydrothecæ is only occasionally seen, and very seldom extends to the common periderm, and their apertures are in a hollow which appears to be excavated out of the polypary. *Dicranograptus* only differs from *Climacograptus* in that its thecæ are usually, but by no means always, more or less prolonged distally."

Hopkinson describes and figures the following species in this paper: (1) *D. ramosus*, (2) *D. Clingani*, (3) *Dicranog. sextans* (doubtfully referred to this genus), (4) *D.* **Nicholsoni** (the web which seems to unite the branches for a short distance after bifurcation, he suggests, may be possibly analagous to the central disc of *Dichograptus*), and (5) *D.* **formosus.**

1871.
Hopkinson,
"On *Dicellograptus*, a New Genus of Graptolites," 'Geol. Mag.,' vol. viii.

In 1871 Hopkinson published a paper on **Dicellograptus,** a new genus which he proposed for those simple bifurcating forms which had been previously included along with others by Hall in his genus *Dicranograptus*, but had been retained by Carruthers, Nicholson, and others in the genus of *Didymograptus*. In the forms assigned to this new genus the solid axis bifurcates in the "axil" of the branches; in one species the polypary is slightly enlarged at the axil, in others we get a spine of variable length, while in another the branches are connected by a membrane very like the corneous disc of *Dichograpsus*. The thecæ are the same as in *Climacograptus*, "undistinguishable from each other for the greater portion of their length."

Hopkinson discusses the nature of the so-called "axillary spine," which is especially conspicuous in this genus, and which had been regarded by Nicholson as the true "radicle," and also by Carruthers as the true "initial process," while Hopkinson claims that the "proximal spine" (which is usually flanked by two lateral spines) is the true "radicle," and that the "axillary spine" is, so far as we know at present, "an organ without its analogue in any other genus." This was the first recognition of the distinction between what is now known to be the "apertural spine" of the sicula and the apex of the sicula itself, a distinction which has proved to be of first-class systematic importance in this diagnosis.

Hopkinson also points out the unavoidable confusion in measuring the angle of divergence of the branches resulting from this failure to distinguish between the "initial spine" and the "axillary spine;" and he shows that it is not always possible to measure the angle of divergence along the polypiferous margin, as suggested by Nicholson.

He believes that in *Dicellograpsus*, *Dicranograptus*, and *Climacograptus* the branches are organically connected where in juxtaposition, "there being no septum observable."

The following species are included by him in his genus *Dicellograpsus*: (1) *D. Forchammeri*, (2) *D. elegans*, (3) *D. moffatensis*, (4) *D. anceps*, and a new species,(5) *D.* **Morrisi.**

He gives the range of *Dicellograpsus* as "exclusively Lower Silurian," and he states that it is eminently characteristic of the Llandeilo formation.

1871.
Hopkinson,
"On a Specimen of *Diplograpsus pristis* with Reproductive Capsules," 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. vii.

Hopkinson's second paper contained a description of an interesting specimen of *Diplog. pristis* collected by the Geological Survey of Scotland from Leadhills, bearing "reproductive capsules." These reproductive organs, which he considers "represent the gonothecæ of the recent Sertularian Zoophytes," appear to have budded from the periderm at right angles to the thecæ. They are pear-shaped and "bounded by a single marginal fibre slightly thickened at its edges." These fibres, he suggests, may have been slender tubes. One specimen appears to indicate that the capsule may have been composed of two "membranes joined together at their edges through which the fibre has run."

He also figures two young forms of *Diplograpsus*, apparently lying within one of the capsules, but points out that they are large enough to have "entered on an independent existence."

He remarks on the agreement of this specimen with the capsules figured by Hall, but not with those figured by Nicholson, of the existence of which he seems to doubt. Their possible bearing on the affinities of the Graptolites is discussed, and Hopkinson considers that they confirm the near alliance of the Graptolites to the Sertularina, "though all the characters of their reproductive organs are not found in any one genus of the Hydroida."

1871.
Lapworth,
"On the Graptolites of the Gala Group,"
'Brit. Ass. Report.'

To the Meeting of the British Association of 1871 Lapworth communicated a list of the characteristic Gala Graptolites of South Scotland, and described but did not figure two new species: (1) *Retiolites* **obesus** and (2) *Graptolithus* **socialis** (afterwards identified with *M. exiguus*, Nich.).

1871.
Baily, W. H.,
'Memoir of the Geological Survey of Ireland.'

In 1871 W. H. Baily contributed some palæontological notes on the Silurian rocks of the country round Downpatrick and the shores of Dundrum Bay and Strangford Lough. In dark-grey slates near Downpatrick and Portaferry he recognises three Graptolite species, one *Gr. priodon* and two new forms which he named (1) *Gr.* **plumosus** and (2) *Gr.* **gradatus.** *Gr. plumosus* is certainly the *M. exiguus* of Nicholson, while *Gr. gradatus* is allied to *M.communis* (Lapw.). Both species are described and figured.

1871.
Richter,
"Aus dem Thüringschen Schiefergebirge,"
'Zeit. d. Deutsch. Geol. Gesell.,' Bd. xxiii, Heft 1.

In the same year Richter published a paper giving the results he had arrived at in the continuation of his work on the Thüringian Graptolites. He gives a general revision of his views on their structure, development, affinities, etc., and the new points brought out by him may here be briefly summarised.

He founds a new genus which he names **Triplograptus,** with a single species (1) *T.* **Nereitarum.** (This, however, is now known not to be a Graptolite and need not, therefore, be discussed.) He also describes and figures Thüringian examples of older species, viz. (1) *Diplog. pristis*, (2) *D. teretiusculus*, (3) *Monog. cf. sagittarius*, (4) *M. priodon*, (5) *M. gemmatus*, (6) *M. peregrinus*, (7) *Phyllograptus*, and in addition three new forms: (8) *Diplog.* **pennatulus,** (9) *Monog.* **crenatus,** and (10) *M.* **chorda.** Most of the species are readily recognisable from his illustrations.

The greater part of Richter's paper deals with the structure of the Graptolites. He states for the first time in the history of graptolitic research, that the skeleton, *Specific Characters of Forms belonging to the Genus* Nemagraptus (Cœnograptus).

	Group I.				Group II.	
	N. gracilis.	var. *remotus.*	var. *surcularis.*	var. *nitidulus.*	*N. explanatus.*	var. *pertenuis.*
Character of stipes	Conspicuous sigmoid curvature; numerous branches at regular intervals	Irregular sigmoid curvature; few branches, distant from sicula	Curvature upward so that stipes cross; branches as in *N. gracilis*	Irregular sigmoid curvature; one branch only, near sicula	Stipes horizontal, straight or slightly flexed; one or two branches	Stipes straight or slightly flexed; no branches (?).
Maximum width of stipes . .	·4—·9 mm.	·3 mm.	·5 mm.	·3 mm.	·6—·8 mm.	·5—·6 mm.
Length of sicula	1 mm.	1 mm.	1 mm.	1·3 mm.	1 mm.	1·2 mm.
No. of thecæ in 10 mm. . .	7—9	10	7 -9	7	8	6—7.
Inclination	10°—15°	10°	10°	10°	10°	10°.
Overlap	$\frac{1}{3}$—$\frac{1}{4}$	Small fraction	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{3}$—$\frac{1}{4}$	$\frac{1}{4}$.

Family **DICRANOGRAPTIDÆ,** *Lapworth.*

1873. *Dicranograptidæ*, Lapworth, Notes on the British Graptolites and their Allies, Geol. Mag., vol. x, table i, p. 555.

Uniserial and uni-biserial Graptoloidea with straight or flexed stipes, the angle of divergence always exceeding 180°.

Thecæ tubular, with conspicuous sigmoid ventral curvature, apertural portion more or less isolated; apertures horizontal or inclined, situated within well-defined depressions (excavations), and frequently introverted and introtorted. Thecal spines (when present) ventral, mesial.

Fig. 83.—*Dicellograptus, sp.*

Specimen in full relief, showing proximal end (obverse view) and form of thecæ characteristic of the Family Dicranograptidæ. Benan Burn, Glenkiln Shales. Coll. Lapworth.

The characteristic feature of the Dicranograptidæ is afforded mainly by the peculiarities of the thecæ, as contrasted with those of the families already described. In the Dichograptidæ the thecæ are simple straight tubes, and their apertures are neither inclined nor introverted, nor are they situated within "excavations." In the Leptograptidæ the ventral walls of the thecæ show slight sigmoid curvature, the apertures are gently inclined and introverted, and open within shallow excavations. In the Dicranograptidæ, however, the sigmoid curvature of the ventral wall is typically far more pronounced, and the thecal apertures are always situated within conspicuous and deep excavations; and, as a general rule, not only does the apertural portion of each theca show a marked introversion, but it is also introtorted.

While all the members of the family possess these general characteristics, they nevertheless exhibit great variation among themselves. Some have but a gentle sigmoid curvature of their thecal walls, and a slight introversion of their apertures, thus approximating in form to the Leptograptidæ. Others show pronounced sigmoid curvature, and possess horizontal apertures of the type more especially characteristic of *Climacograptus*, thus suggesting relationship with the Diplograptidæ.

There are only two recognised British genera belonging to this family of the Dicranograptidæ, namely *Dicellograptus* and *Dicranograptus*.

In the genus *Dicellograptus* the polypary is uniserial throughout, like that in the Leptograptidæ. In the genus *Dicranograptus*, however, the polypary is uniserial only in its distal portions; proximally it is biserial, as in the Diplograptidæ.

The mode and direction of growth of the earlier thecæ in the proximal portion of the polypary in the species belonging to the genus *Dicellograptus* are similar to those in *Leptograptus*. In some forms, however, belonging to the genus, and in all forms of *Dicranograptus*, the mode of growth agrees with that in *Diplograptus*.

Thus the Dicranograptidæ may conveniently be regarded as constituting a family intermediate between the Leptograptidæ on the one hand, and the Diplograptidæ on the other.

Genus **DICELLOGRAPTUS**, *Hopkinson.*

1871. *Dicellograptus*, Hopkinson, Geol. Mag., vol. viii, p. 20.

Polypary bilaterally symmetrical, consisting of two uniserial stipes diverging from the sicula at angles exceeding 180°.

Thecæ of the characteristic Dicranograptid type (*ante*, p. 135).

The polypary in *Dicellograptus* is generally narrow, but never so slender as that in *Leptograptus*. The two stipes may be straight, gently flexed, or with such a strong convex curvature as to cross each other; but the polypary is always more or less stiff and rigid in its general aspect, and rarely takes on the limp and flexuous appearance of that of *Leptograptus*.

The normal angle of divergence (ventral angle) varies greatly in the different species, ranging from 220° (*D. Forchammeri*), to 340° (*D. anceps*). The dorsal angle, which is naturally the complement of the ventral angle, becomes of especial diagnostic importance in this genus. It is here referred to under Hopkinson's designation of the *axillary angle*, and the space (axillary space) included between the dorsal walls of the stipes is denominated the *axil*. The form of the axil, which depends upon the direction and amount of growth of the proximal thecæ, may be rounded (*D. Morrisi*), square (*D. complanatus*), or angular (*D. sextans*).

The sicula is of the same type as that of *Leptograptus*. Its apex (*axillary spine* of some authors) is generally visible, occupying the centre of the axil. It can occasionally be seen passing into the thread-like nema; more frequently, however, the apex is broken off, and then the sicula appears as a blunt node. The apertural spine (*virgella*) of the sicula is usually conspicuous, occupying the central (initial) position on the ventral margin, and is sometimes referred to as the "initial spine" (the so-called *radicle* or *radicular spine* of earlier authors).

The development of the proximal end of the polypary is essentially similar to that in *Leptograptus* as regards (1) the presence of two crossing canals, and (2) the alternate development of thecæ 1^1, 1^2, 2^1 and 2^2. In all the *Leptograpti* these four earlier thecæ all grow in a horizontal direction. In the widely divergent species of *Dicellograptus*, such as *D. Forchammeri*, a similar mode of growth obtains; but in the narrowly divergent (or more or less convergent) forms, such as *D. anceps*, the distal portions of thecæ 2^1 and 2^2 assume an upward direction of growth, so that the form of the proximal end corresponds with that of *Dicranograptus*.

Throughout the entire genus thecæ 1^1 and 1^2 are generally small; they each make a sharp upward bend at a certain distance below their apertures, and at the point of bending a single spine is given off. The two spines belonging to these two earliest thecæ are always conspicuous on the proximal end of the polypary, and owing to their position with regard to the central or initial spine (virgella), were termed "*lateral*" spines by the earlier authors (this title may be conveniently retained in diagnoses). In certain states of preservation these lateral spines appear as if they were true apertural spines, such as are found in *Leptograptus*, but in better preserved specimens it appears tolerably certain that this appearance is deceptive, and that they are ventral and mesial in position. These "lateral" spines are occasionally so strongly developed (*D.*, var. *ornatus*) as to give ground for suspicion that the two primal thecæ, in their later stages, at all events, became functionless.

In many species only a few of the more proximally situated thecæ exhibit mesial spines similar to the lateral spines of thecæ 1^1 and 1^2, but their apparent absence on the more distal thecæ may be merely a result of their small size or imperfect state of preservation. In one species—*D. anceps*—all, or nearly all, the thecæ are spinose, but this is only evident in exceptionally well preserved specimens. These thecal spines are never apertural in origin, but, like the lateral spines of thecæ 1^1 and 1^2, develop from a point in the ventral wall of the theca. In some species (*D. Forchammeri*) this point is immediately below the aperture; in others (*D. anceps*) the spine is situated about midway between the aperture and the "excavation."

All the thecæ in *Dicellograptus* are of the general type characteristic of the family. They present, however, many differences of detail in the several species, varying in (1) the amount of curvature of the ventral walls, (2) the amount of introversion and introtorsion of the free apertural portion, (3) the inclination of the aperture, and (4) the amount and shape of the ventral excavation.

In the various genera of the Dichograptidæ the form of the theca remains practically constant, while the form of the polypary exhibits great variation, and the recognised minor groups in that family are consequently founded upon the latter characteristics. In the genera of the Dicranograptidæ, on the contrary, the form of the polypary remains more or less invariable, while the thecæ show many distinctions in matters of detail, and we consequently utilise these for our minor grouping.

I.—*Dicellograpti* in which the thecæ have straight ventral walls and horizontal apertures.

Type *Dicellog. complanatus.*
- *D. complanatus.*
  - var. *ornatus.*
- *D. anceps.*

II.—*Dicellograpti* in which the thecæ have approximately straight ventral walls, but slightly introverted apertural portions.

Type *Dicellog. divaricatus.*
- *D. divaricatus.*
  - var. *rigidus.*
  - var. *salopiensis.*
- *D. intortus.*

III.—*Dicellograpti* in which the thecæ narrow aperturally, have gently curved ventral walls, and slightly introverted apertural portions.

Type *Dicellog. patulosus.*
- *D. patulosus.*
- *D. pumilus.*
- *D. angulatus.*

IV.—*Dicellograpti* in which the thecæ have markedly curved ventral walls and strongly introverted and introtorted apertural portions.

Type *Dicellog. Morrisi.*
- *D. sextans.*
  - var. *exilis.*
- *D. Forchammeri.*
  - var. *flexuosus.*
- *D. Morrisi.*
- *D. moffatensis.*
- *D. elegans.*
  - var. *rigens.*
- *D. caduceus.*

Group I.—Type *Dicellog. complanatus.*

Dicellograpti in which the thecæ have straight ventral walls and horizontal apertures.

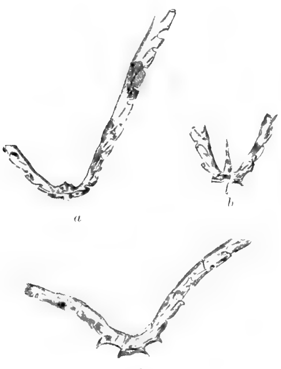
Dicellograptus complanatus, Lapworth. Plate XX, figs. 1 *a—d*.

1880. *Dicellograptus complanatus*, Lapworth, Ann. Mag. Nat. Hist. [5], vol. v, p. 160, pl. v, figs. 17 *a—e*.

Stipes 8 cm. or more in length, generally straight, diverging at angles of 270°—240° from a conspicuous sicula. Virgella and lateral spines short and stout. Thecæ ten to eight in 10 mm., free outer wall straight, overlapping one third to one half their length. Apertures horizontal and slightly introtorted, opening within a shallow but well-marked excavation, which occupies about one third the width of the stipe and one fifth of the ventral wall.

Description.—The stipes are usually straight, but occasionally they curve slightly outward throughout the whole of their extent in such a way as to increase the axillary angle. They are only ·5 to ·6 mm. wide at their origin, but the breadth increases somewhat rapidly up to 1 mm., and this width is maintained for the remainder of their length.

Figs. 84 *a, b,* and *c.*—*Dicellograptus complanatus*, Lapw.



a. Reverse view, showing prominent virgella. Dobb's Linn, Hartfell Shales. Coll. Lapworth.
b. Young form, showing complete sicula. Dobb's Linn, Hartfell Shales. Coll. Wood.
c. Reverse view, low relief. Ibid.

The sicula has a length of about 1·5 mm. when perfect, and is long and tapering, but it is so rarely preserved complete that it has been described as short and blunt. In the reverse aspect of the polypary the sicula is almost entirely concealed by the growth of the earliest thecæ, and its presence and position are only indicated by its apertural spine. Few specimens are sufficiently well preserved to show details regarding the structure and relations of the thecæ of the proximal end. Th. 1^1 and th. 1^2 are small and grow almost entirely in a horizontal direction, giving off a mesial ventral spine not far below the apertures. Th. 1^2 develops from th. 1^1 in the normal manner. Th. 2^1 is abnormally long for a theca in the proximal region; it arises from the basal part of th. 1^2 and grows horizontally for a considerable distance, crossing completely over the sicula.

Th. 2^2 is apparently developed from the under side of th. 2^1. Each of the remaining thecæ is developed from the one immediately below it.

The thecæ throughout the whole length of the stipes approximate in form to those of a typical *Climacograptus*, their free ventral walls being parallel to the dorsal margin of the polypary and their apertures perpendicular to it. The mature thecæ have an average length of 2 mm. The variable appearance of the apertures when compressed suggests introtorsion of the apertural region of the thecæ.

Figs. 84 *d* and *e*.—*Dicellograptus complanatus*, Lapw.

d. Proximal thecæ, profile view. Dobb's Linn, Hartfell Shales. Coll. Lapworth.
e. Distal thecæ, scalariform view. Same stab as Fig. 84 *d*.

Affinities.—*D. complanatus* resembles *D. Forchammeri* most nearly in general form, but it differs from it markedly in the characters of the proximal extremity and also in those of the thecæ.

Horizon and Localities.—Upper Hartfell Shales. In the Moffat area *D. complanatus* occurs at a single horizon in the Upper Hartfell Shales, being restricted, so far as known, to a thin band of black shale near the base of the so-called "Barren Mudstones." It occurs also in a corresponding zone in the Whitehouse Beds (Bala) of Girvan.

S. Scotland, Moffat area: Dobb's Linn; Moory Sike. Portpatrick. *Girvan area:* Myoch Bay. *Ireland:* Co. Down, Coalpit Bay.

Associates, etc.—*D. complanatus* occurs in S. Scotland associated with some small *Diplograpti*—*Diplog. socialis*, etc. The best specimens known are in the collections of Lapworth and the Authors.

Var. **ornatus**, var. nov. Plate XX, figs. 2 *a*—*c*.

In addition to the typical form of *Dicellog. complanatus*, there occurs in S. Scotland a slender variety which is characterised by an extraordinary development of the lateral spines. Its close alliance to *Dicellog. complanatus* is, however, evident in the general shape of the polypary and the characters of the thecæ.

Description.—The stipes widen from about ·3—·4 mm. at their origin to about ·7 mm. distally; they are usually rigid, but occasionally show slight curvature. The axil is characteristically wide open and square at the base.

The sicula probably exceeds 1 mm. in length, but complete specimens have not been obtained. Th. 1^1 and th. 1^2 appear to be always somewhat abnormal; they show no curvature of their ventral walls, and grow straight out in a horizontal direction, giving off a long spine below the aperture, which seems to open in a direction parallel with the general direction of growth of the rest of the stipe. In some specimens these two primary thecæ appear to have been entirely modified to stout spines which have a length of 4—4·5 mm. Th. 2^1 and th. 2^2 are of unusual length, measuring commonly 1·7—2 mm. long. They grow right back to the sicula, but we have been unable to determine exactly how they arise. No theca subsequently developed measures more than 1·4 mm.

FIGS. 85 *a* and *b*.—*Dicellograptus complanatus*, var. *ornatus*, nov.

a. Proximal end, showing large "lateral" spines. Enlargement of part of Pl. XX, fig. 2 *b*.
b. Complete specimen showing characters of thecæ. Dobb's Linn, Hartfell Shales. Coll. Wood.

Affinities.—Var. *ornatus* may be readily distinguished from all other *Dicellograpti* by the abnormal size of its lateral spines.

Horizon and Localities.—Upper Hartfell Shales. (Zone of *Dicellog. anceps*).

S. Scotland.—Dobb's Linn.

Associates, etc.—Var. *ornatus* occurs on a somewhat higher horizon than *Dicellog. complanatus* itself, being found in some abundance in the zone of *Dicellog. anceps*, where it is associated with the zone fossil and numerous *Diplograpti*.

The best specimens at present known are in the Authors' collections and in that of the Sedgwick Museum, those in the latter having been collected and presented by Mr. William Swanston of Belfast.

Dicellograptus anceps, Nicholson. Plate XX, figs. 3 *a*—*e*.

1867. *Didymograpsus anceps*, Nicholson, Geol. Mag., vol. iv, 1867, p. 110, pl. vii, figs. 18—20.
1870. *Didymograpsus anceps*, Nicholson, Ann. Mag. Nat. Hist. [4], vol. v, p. 351, pl. vii, fig. 5.
1871. *Dicellograpsus anceps*, Hopkinson, Geol. Mag., vol. viii, p. 335, pl. i, fig. 5.
1876. *Dicellograptus anceps*, Lapworth, Cat. West Scott. Foss., pl. iv, fig. 82.
1877. *Dicellograptus anceps*, Lapworth, Grapt. of Co. Down, pl. vii, fig. 5.
1890. *Dicellograptus anceps*, Törnquist, Undersök. öfver Siljansområdets Grapt. i, p. 21, pl. ii, figs. 16—19.

Stipes 2—6 cm. in length, somewhat rigid proximally but slightly curved distally, and having an average uniform width of 1 mm., diverging at an angle of 340° from an inconspicuous sicula. Virgella short, lateral spines often conspicuous. Thecæ ten to eight in 10 mm., free outer wall approximately straight, overlapping one half to one third their length. Apertures horizontal, situated in semicircular excavations occupying nearly half the width of the stipe.

Description.—Isolated fragments of stipes frequently attain a length of 5—6 cm., but the more complete specimens rarely exceed 3 cm. in length, and still smaller forms are of more frequent occurrence. As a general rule the stipes are straight and rigid proximally, but some of the longer specimens take on a slight concave or convex curvature towards their distal extremities. Occasionally the proximal parts of the stipes run almost parallel to each other. At their origin the stipes measure ·7 mm. in breadth, but they widen quickly up to 1—1·2 mm., a width which is subsequently maintained.

The sicula is somewhat broad; it commonly only appears as a slight node between the dorsal walls of the stipes, but when perfect has a length of about 1·3 mm; its apertural spine is clearly visible on the ventral margin. Theca 1^1 originates basally and grows out at first horizontally, but bends abruptly upward in the region of the aperture which thus opens almost at right angles to the original direction of growth. Th. 1^2 develops from th. 1^1 in a similar manner, but is slightly longer, and hence the sicula often appears to be situated unsymmetrically with regard to the two stipes. Where the upward growth of th. 1^1 and th. 1^2 commences a small spine is given off, but this is only visible in very well preserved specimens. The whole structure of the proximal end perhaps approaches more nearly than that of any other species of *Dicellograptus* to the type perfected in the Diplograptidæ.

Figs. 86 *a* and *b*.—*Dicellograptus anceps*, Nich.

a. Complete specimen in low relief. Dobb's Linn, Hartfell Shales. Coll. Wood.
b. Proximal end (obverse view), showing sicula, etc. Enlargement of part of Pl. XX, fig. 3 *e*.

All the thecæ which are developed after th. 2^1 and th. 2^2 arise from the theca immediately underlying. In their general form they closely resemble those of a typical *Climacograptus*, having an approximately straight ventral wall. A small mesial spine is given off from about the middle of this wall on the more proximal thecæ, and where this spine is conspicuous its base gives a marked curvature to the ventral margins of the theca. Where, however, the spines are wanting or invisible the thecal wall is seen to be normally straight. Spines have been detected up to the fifteenth theca from the proximal extremity in British specimens, and Törnquist records their existence on all the distal thecæ, but they are certainly more conspicuous proximally. Each theca is 1·5 mm. long and overlaps for one third to one half of that length. The apertural excavation is large and occupies half the width of the stipe, and about one third of the length of the free outer wall of the theca.

Affinities.—*D. anceps* may be separated at sight from all other *Dicellograpti* (1) by its narrow axil; (2) by its inconspicuous sicula, more or less concealed by the four proximal thecæ; (3) and by the straight free outer walls of its thecæ, those nearest the proximal end bearing small projecting spines.

Horizon and Localities.—Upper Hartfell Shales (*Dicellog. anceps* zone).

S. Scotland.—Dobb's Linn; Ettrick Bridge End; Riskinhope Burn; Black Grain, etc., etc.

Associates, etc.—This species occurs in fair abundance in the highest zone of the Hartfell Shales in S. Scotland associated with a number of small *Diplograptidæ*, including *Diplog. socialis.*

There are good specimens in the collections of the Geological Survey of Scotland, the Natural History Museum, South Kensington, the Sedgwick Museum, and the private collections of Lapworth and the Authors.

Group II.—Type *Dicellog. divaricatus.*

Dicellograpti in which the thecæ have approximately straight ventral walls, but slightly introverted apertural portions.

Dicellograptus divaricatus, Hall, Plate XX, figs. 5 *a*, 5 *b*.

1859. *Graptolithus divaricatus*, Hall, Pal. New York, vol. iii, Suppl., pp. 513, 514, figs. 3, 4.
1865. *Graptolithus divaricatus*, Hall, Grapt. Quebec Group, p. 14, fig. 19 (pars).
1870. *Didymograpsus divaricatus*, Nicholson, Ann. Mag. Nat. Hist. [4], vol. v, p. 351, pls. 7, figs. 4, 4 *a*.
1875. *Dicellograptus Moffatensis*, Hopkinson and Lapworth, Quart. Journ. Geol Soc., xxxi, pl. 35, fig. 5 *b*.

Stipes 4 cm. or more in length, straight or slightly curved, widening rapidly from their origin up to 1 mm., diverging from an inconspicuous sicula at angles varying from 270°—250°. Thecæ twelve to ten in 10 mm., overlapping one third to one half their length, free outer walls approximately straight. Apertures slightly introverted, opening within a deep and wide excavation, occupying nearly half the width of the stipe, and more than one third of the free ventral wall of theca.

Description.—The stipes vary somewhat in form, being sometimes quite straight and rigid, and at other times having a distinct concave curvature at the proximal end, which gradually changes distally to a convex curvature. Their width at the proximal end is about ·5 mm., but it increases rapidly within the first 5 mm. to nearly 1 mm., and this width undergoes but little increase. The axillary angle is characteristically 90°, but may be as small as 60°.

Fig. 87 *a*.—*Dicellograptus* cfr. *divaricatus*, Hall.

a

a. Proximal end. Enlargement of part of Pl. XX, fig. 5 *a*.

The apex of the sicula is rarely visible in the axil, but its apertural spine is conspicuous. The lateral spines of th. 1^1 and th. 1^2 are long; a few of the other proximal thecæ also exhibit mesial spines.

The distal thecæ are 1·5 mm. in length and are essentially of the same type as those of *D. intortus*.

Remarks.—*D. divaricatus* was originally described by Hall from the Norman's Kill beds of America (Glenkiln); and it is a very characteristic species in these beds, being readily recognised by its form, the rapid increase in width of the stipes, and the character of the thecæ. The typical species is not common in Britain, and such specimens as are referable to it are for the most part poorly preserved. Consequently the above description has been wholly drawn up from those from the typical American beds. It is also represented in the Glenkiln beds of Scotland by a well-marked variety to which Lapworth gave the name of var. *rigidus*.

FIGS. 87 *b* and *c*.—*Dicellograptus divaricatus* (Hall).

a. Specimen, natural size, from Hall's typical district, Normanskill Beds, Coll. Lapworth.
b. Enlargement of distal thecæ.

Affinities.—*D. divaricatus* resembles *Dicellog. intortus* in the character of its thecæ, but differs markedly in the general form of the polypary. From all other species of *Dicellograptus* it can be distinguished by the shape of the thecæ.

Horizon and Localities.—Glenkiln Shales (Llandeilo).

S. Scotland: Wanlock Head; Craigmichan Scaurs, etc. *Wales:* Tiddyndicwm; Abereiddy Bay. *Shropshire:* Spy Burn (?).

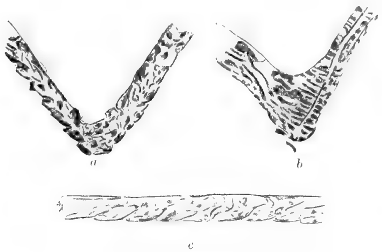
Associates, etc.—*D. divaricatus* is confined to beds of Glenkiln age, and occurs in association with all the other fossils characteristic of those beds. Specimens are in the collections of the Sedgwick Museum and of Lapworth.

Var. **rigidus,** Lapworth. Plate XX, figs. 6 *a—e*.

1876. *Dicellograptus divaricatus,* Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 86.
1877. *Dicellograptus Moffatensis,* var. *divaricatus,* Lapworth, Grapt. Co. Down, pl. vii, fig. 10.
1880. *Dicellograptus divaricatus,* var. *rigidus,* Lapworth, Ann. Mag. Nat. Hist. [5], vol. v, p. 163, pl. v, fig. 20.

In addition to the typical *D. divaricatus,* there occurs at the same horizon a much stouter form, to which Lapworth has given the varietal name of var. *rigidus.* It is readily distinguished by the greater breadth of the stipes at the proximal end, where it has a width of 1 mm. and this is maintained throughout their whole length. The dorsal margins of the stipes are frequently connected at the axil by a chitinous film which extends at least as far as a point opposite the

FIGS. 88 *a*, *b*, and *c*.—*Dicellograptus divaricatus*, var. *rigidus*, Lapw.



a. Proximal end without "web." Enlargement of part of Pl. XX, fig. 6 *e*.
b. Proximal end with "web." Enlargement of counterpart of Pl. XX, fig. 6 *b*.
c. Distal thecæ. Enlargement of part of Pl. XX, fig. 6 *a*.

aperture of the third theca. This film gives a very thickened appearance to the axillary portion.

Specimens in which this chitinous web is preserved rarely show the form of the thecæ; but from other examples it is clear that they are essentially similar to those of the typical species, though they are somewhat more distant (eight in 10 mm.).

Affinities.—Var. *rigidus* is easily distinguished from all other *Dicellograpti* belonging to this group by the uniform width, stoutness, and rigidity of its stipes.

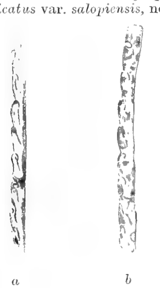
Horizon and Localities.—Glenkiln and (?) Lower Hartfell (zone of *Climacog. Wilsoni*).

S. Scotland: Birnock Water; Wanlock Head; Dobb's Linn, etc. *Ireland:* Ballygrot.

Associates.—Var. *rigidus* occurs in the Glenkiln Shales associated with *Didymog. superstes*, *Dicellog. sextans*, *Cryptog. tricornis*, etc. It has also been quoted from the zone of *Climacog. Wilsoni*. The best specimens are in the collections of Lapworth and the Sedgwick Museum.

Var. **salopiensis**, var. nov. Plate XX, figs. 7 *a*—*e*.

FIGS. 89 *a* and *b*.—*Dicellograptus divaricatus* var. *salopiensis*, nov.



a. Proximal thecæ. Enlargement of part of Pl. XX, fig. 7 *a*.
b. More distal thecæ. Enlargement of part of Pl. XX, fig. 7 *e*.

Another variety of *D. divaricatus* is found in the Glenkiln Beds of Shropshire and of S. Scotland. It is characterised by its slender stipes, which have throughout their extent a uniform width of ·5 mm. only. The thecæ are of the same general type as those of *D. divaricatus*, and number twelve to ten in 10 mm.

Affinities.—Var. *salopiensis* is distinguished from the other members of the group of *D. divaricatus* by its slender stipes, and from *D. pumilus* and *D. exilis*, which it resembles somewhat in shape, by the character of its thecæ.

Horizon and Localities.—Llandeilo ("*Cœnograptus*" beds, above the Llandeilo Limestone), Glenkiln Shales.

Shropshire: Spy Burn. *S. Scotland:* Birnock Water; Meggat Water, etc. *Wales:* Llandrindod Quarry, Builth?

Associates.—Var. *salopiensis* occurs in Shropshire usually associated with *Nemag. gracilis, Leptog. latus* and *Dicranog. brevicaulis.* It has also been found in S. Scotland associated with the typical Glenkiln species. Good specimens are in the collections of Lapworth, the Sedgwick Museum, and the Geological Survey of England.

Dicellograptus intortus, Lapworth. Plate XX, figs. 4 *a—f.*

1880. *Dicellograptus intortus,* Lapworth, Ann. Mag. Nat. Hist. [5], vol. v, p. 161, pl. 5, fig. 19 *a.*
1902. ?*Dicellograptus affinis,* T. S. Hall, Geol. Survey, N.S. Wales, vol. vii, pt. 2, p. 50, pl. xii, fig. 2; pl. xiii, fig. 2.

Stipes 4 cm. or more in length, gently curved or crossing, diverging at an angle of 340° or more; axillary angle therefore very small. Sicula rarely seen. Virgella and lateral spines conspicuous. Thecæ fourteen to eleven in 10 mm., free outer wall approximately straight, overlapping for one half to one third of their length of 1·5 mm. Apertures slightly introverted, ventral excavation wide, deep, oblique, and roughly triangular in form, occupying about half the width of the stipe.

Description.—The stipes diverge from each other at a large angle, and hence the axillary angle is characteristically small, smaller indeed than in any other *Dicellograptus* except *D. anceps.* The angle of divergence appears to be approximately constant in young forms; but in fully developed specimens, after 10 or 15 mm., the stipes show gentle convex curvature of their ventral margins and grow upward, with their stipes approximately parallel to each other, or else cross each other at a point 2—3 cm. vertically above the initial region. The stipes widen gradually from ·5 mm. at their origin to 1 mm. in breadth.

Figs. 90 *a* and *b.*—*Dicellograptus intortus,* Lapw.

a *b*

a. Obverse view. Enlargement of part of Pl. XX, fig. 4 *f.*
b. Reverse view, showing apex of sicula. On same slab as Fig. 90 *a.*

The sicula exceeds 1 mm. in length when perfect, but is frequently broken at the apex, and is concealed for the greater part of its length by the earliest formed thecæ. Its apertural spine, however, can usually be detected. The proximal thecæ originate basally and grow horizontally for the greater part of their length, thereby giving to the axil the appearance noted in *Dicellog. anceps.* In well preserved specimens a short stout spine is seen to be given off from each of the two proximal thecæ at the point where they bend round to grow upward, and similar spines may also be detected on other thecæ near the proximal extremity.

All the thecæ resemble those of the *Climacograptus* type in having their outer walls approximately straight, but the apertures are introverted and the ventral excavations are deeper, wider, and more oblique.

FIGS. 90 *c* and *d*.—*Dicellograptus intortus*, Lapw.

c. Distal thecæ. Enlargement of part of Pl. XX, fig. 4 *d*.
d. Distal view, showing somewhat different aspect. Enlargement of part of Pl. XX, fig. 4 *f*.

Affinities.—In general form *D. intortus* bears some resemblance to *D. caduceus*, but the stipes never cross more than once, and often not at all, while the thecæ are of a very different type.

Horizon and Localities.—Glenkiln Shales.

Radnorshire: Builth Road (Gwernyfed); Wellfield. *N. Wales:* Tiddyndicwm. *S. Scotland:* Crawick Water; Dobb's Linn; Mount Benger Burn; Glenkiln Burn; Glencaple Burn, Abington; Rein Gill. *Ireland:* Carnalea; Belvoir, Co. Clare.

Associates, etc.—The typical form of the species is found in the Glenkiln Shales of the Builth district, associated with *Nemag. gracilis.*, *Dicellog. sextans*, and other forms. In S. Scotland and Wales it occurs with similar fossils, and in addition with *Didymog. superstes* and *Climacog. Scharenbergi*. The best specimens are in the collections of Lapworth, Dr. Fraser of Wolverhampton, the Geological Survey of Scotland, and the Sedgwick Museum.

GROUP III.—*Type D. patulosus.*

Dicellograpti, in which the thecæ narrow aperturally, have gently curved walls, and slightly introverted apertural portions.

Dicellograptus patulosus, Lapworth. Plate XXI, figs. 5 *a*—*e*.

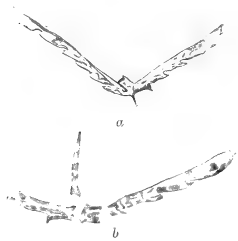
1880. *Dicellograptus patulosus*, Lapworth, Ann. Mag. Nat. Hist. [5], vol. v, p. 162, pl. 5, fig. 18 *a*—*f*.

Stipes several cm. in length, widening very gradually for greater part of their extent, somewhat flexed, diverging at a large angle (320° to 240°). Sicula very conspicuous; virgella stout, lateral spines insignificant. Thecæ ten to seven in 10 mm., overlapping nearly half their length, free part of outer wall gently curved, narrowing towards aperture. Apertural margin slightly introverted and oblique, opening partly within a narrow triangular excavation, which occupies about one third the width of the stipe.

Description.—The greatest length attained by the stipes is unknown, but they must have been fully 8 cm. long, and after gradually increasing in breadth from

·4 mm. to 1 mm., maintain this width for the remainder of their length. The angle of divergence is very variable, as is also the amount of curvature. In some specimens there is a persistent convex curvature from their proximal to their distal ends; in others the curvature is hardly perceptible; while in others, again, it may be slightly concave.

Figs. 91 *a* and *b*.—*Dicellograptus patulosus*, Lapw.

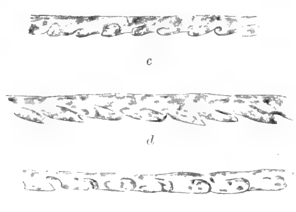


a. Proximal end showing oblique position of sicula. On same slab as Pl. XXI, fig. 5 *e*.
b. Proximal end, showing complete sicula. Enlargement of part of Pl. XXI, fig. 5 *b*.

The sicula when perfect is very long, measuring 2·5—3 mm.; its apex is, however, frequently broken off either partially or entirely, though its apertural spine is more frequently seen, and is stout and of considerable length. The sicula is rarely shown in its normal position with respect to the dorsal angle of the stipes, but is bent over to one side or the other —sometimes, indeed, lying right across one or other of the stipes, and being occasionally united to the nearest stipe by a distinct membranous film.

The thecæ are eminently characteristic, and differ essentially from those of the majority of *Dicellograpti* in the fact that they narrow towards their aperture, which is itself oblique and directed inwards. There is but slight introtorsion of the apertural portion. A very small fraction only of the apertural margin lies outside the line formed by the ventral edge of the polypary; hence the thecal border has a very smooth appearance. The excavation is both shallow and narrow, and occupies about one third the width of the stipe, and a very small fraction of the length of the theca.

Figs. 91 *c*, *d*, and *e*.—*Dicellograptus patulosus*, Lapw.



c, Proximal thecæ, showing introtorsion of apertural region. Dobb's Linn, Glenkiln Shales. Coll. Wood.
d. Distal thecæ, showing characteristic narrowing towards aperture. Specimens on same slab as Pl. XXI, figs. 5 *a* and 5 *b*.
e. Scalariform view of thecæ. Rein Gill, Wandel Water; Glenkiln Shales. Coll. Geol. Survey of Scotland.

Affinities.—*D. patulosus* bears some slight resemblance to *D. Forchammeri* in the form of the axil, but differs from it in the characters of the thecæ. From all other *Dicellograpti* its habit is sufficient to distinguish it.

Horizon and Localities.—Glenkiln Shales.

S. Scotland: Dobb's Linn; Craigmichan Scaurs; Glenkiln Burn; Belcraig Burn, etc. *Radnorshire:* Builth Road; Wellfield.

Associates, etc.—*D. patulosus* occurs in great abundance in a single zone in the Glenkiln Shales near their upper limit, associated with various *Diplograpti*, *Dicranog. ziczac*, *Thamnograptus*, sp., etc.

There are good specimens in the Sedgwick Museum and in the private collections of Lapworth and the Authors.

Dicellograptus pumilus, Lapworth. Plate XXI, figs. 3 *a—f*.

1876. *Dicellograptus pumilus,* Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 81.

Stipes 1—3 cm. in length, widening gradually and persistently from their origin to a maximum breadth of ·8 mm., diverging at about 310° from a conspicuous sicula; virgella and lateral spines small, axil wide. Thecæ twelve to ten in 10 mm., overlapping half their length, narrowing aperturally, free part of outer wall slightly curved. Apertural margins slightly introverted, aperture opening within shallow excavation.

Description.—The stipes are commonly short, not exceeding 1—1·5 cm. in length as a general rule, though longer specimens have occasionally been found; they are characteristically straight, but may be very slightly curved, and the angle of divergence is very uniform. They measure about ·5 mm. at their origin and increase in width gradually throughout their extent.

FIGS. 92 *a* and *b*.—*Dicellograptus pumilus,* Lapw.

a. Proximal end, showing typical form of axil. Same slab as Pl. XXI, fig. 3 *b*.
b. Ditto, with complete sicula. Ditto.

The sicula has a length of 1·3 mm.; it is as a rule clearly visible between the dorsal walls of the stipes, but its apertural spine is inconspicuous.

The thecæ are frequently obscure, as the stipes have often been slightly twisted; but when seen in profile their characters are clear, they are gently curved, and have their apertures but slightly introverted, approaching the *Leptograpti* in this respect.

Affinities.—The small size and wide axil of this species, combined with the characters of the thecæ, serve to distinguish it from all others at present known.

Horizon and Localities.—Hartfell Shales.

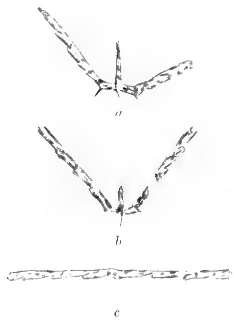
Scotland: Hartfell. *Wales:* Conway.

Associates, etc.—*D. pumilus* occurs in some abundance in the lower Hartfell Shales associated with *Diplog. truncatus*; the best specimens are in Lapworth's collection.

Dicellograptus angulatus, sp. nov. Plate XXI, fig. 4.

Stipes from 1—2 cm. in length, very slender, and of uniform width throughout their length, diverging at about 270°—300° from a conspicuous sicula; virgella and lateral spines slender, but conspicuous; axil square. Thecæ ten to eight in 10 mm., overlapping for one quarter to one third their length, narrowing aperturally, free outer wall with gentle curvature. Apertures slightly introverted, opening within a small excavation, which occupies about one third the width of the stipe.

Figs. 93, *a*, *b*, and *c*.—*Dicellograptus angulatus*, nov.



a. Obverse aspect, lateral spines conspicuous. Enlargement of part of Pl. XXI, fig. 4.
b. Reverse aspect. Ibid.
c. Distal thecæ, showing narrowing at apertures. Ibid.

The polypary in this species is very slender, but markedly rigid; the stipes are commonly short and very narrow throughout their extent, never exceeding ·4 mm. in width.

The sicula is conspicuous within the axil, having a length of fully 1·5 mm. and passing insensibly upward into the nema. The virgella and lateral spines are slender, but are usually well exhibited.

Affinities.—*D. angulatus* resembles closely *D. Forchammeri* in its general manner of growth; but it is a much shorter and more slender form, its stipes are more uniform in width throughout their length, and the characters of its thecæ are also markedly different.

Horizon and Localities.—Upper Glenkiln and Lower Hartfell Shales.

S. Scotland: Morroch Bay; Dobb's Linn.

Associates.—*D. angulatus* has generally a gregarious habit and is occasionally associated with *Cryptog. tricornis?* The best specimens known are in the collection of the Geological Survey of Scotland.

Group IV.—Type *Dicellog. Morrisi.*

Dicellograpti in which the thecæ have markedly curved ventral walls, and strongly introverted and introtorted apertural portions.

Dicellograptus Forchammeri, Geinitz. Plate XXII, figs. 1 *a—d.*

1852. *Cladograpsus Forchammeri*, Geinitz, Die Graptoliten, p. 31, pl. v, figs. 28—31.
1862. *Didymograpsus Forchammeri*, Bailey, Quart. Journ. Geol. Soc., Dublin, vol. ix, p. 305, pl. iv, fig. 7.
1871. *Dicellograpsus Forchammeri*, Hopkinson, Geol. Mag., vol. viii, p. 23, pl. i, fig. 1.
1876. *Dicellograptus Forchammeri*, Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 88.
1877. *Dicellograptus Forchammeri*, Lapworth, Grapt. Co. Down, pl. vii, fig. 7.

Stipes 14 cm. or more in length, generally straight, widening gradually and persistently from their origin up to 1·2 mm., diverging from a conspicuous sicula at varying but always large angles (240°—320°). Thecæ ten to eight in 10 mm., overlapping for one third to one half their length; free outer wall curved, apertural portion introverted. Aperture opening within a shallow pouch-shaped excavation, which occupies one third the width of the stipe.

Description.—The stipes frequently attain a great length, and are straight or slightly curved, their curvature at the proximal end being always convex, though it may become concave distally. They are only ·5 mm. in breadth at their origin, but widen gradually up to 1·2 mm., after which the increase is hardly perceptible. The angle of divergence varies within wide limits.

The sicula is always conspicuous within the axil; it has a length of 1·5 mm. exclusive of the stout apertural spine; it becomes very slender towards the apex and merges gradually into the nema. The earliest thecæ, th. 1^1 and th. 1^2, are large, and play a more important part in the formation of the axil than th. 2^1 and th. 2^2, which is unusual; hence too the whole proximal end is decidedly thinner in appearance than is generally the case. The axil has a characteristic wide-open appearance, and the lateral spines on th. 1^1 and th. 1^2 are conspicuous in all good specimens, though, being slender, they are not always discernible in poorly preserved examples. The development of th. 2^1 from th. 1^2 is clearly seen; it grows obliquely upward, then proceeds horizontally outward, and is finally again directed upward; hence the sigmoid ventral curvature of the thecæ in this species is obvious even at this early stage.

FIGS. 94 *a* and *b*.—*Dicellograptus Forchammeri*, Geinitz.

a

b

a. Proximal end. Enlargement of part of Pl. XXII, fig. 1 *a*.
b. Proximal thecæ with mesial spines. Specimen on same slab as fig. 1 *c*.

The mature thecæ have an average length of 2 mm., and are free for one third to one half of their extent; the free part of the outer wall is curved and oblique in the typical profile view, but varies very much with the direction of compression, being sometimes almost straight and sometimes even crenulate in appearance. A few proximal thecæ, and occasionally even some of the distal thecæ exhibit mesial spines. The aperture is always introverted, and opens wholly within the ventral margin of the stipe, in a narrow pouch-shaped excavation. This is usually clearly seen; occasionally, however, it is almost completely filled by the thecal aperture and then is discernible merely as an oblique slit.

FIGS. 94 *c* and *d*.—*Dicellograptus Forchammeri*, Geinitz.

c

d

c. Distal thecæ, showing various aspects. Specimen on same slab as Pl. XXII, fig. 1 *a*.
d. Distal thecæ, profile view. Enlargement of part of Pl. XXII, fig. 1 *c*.

Remarks.—*D. Forchammeri* was originally described by Geinitz from the Alum Shales of Bornholm. Judging from his figures (*loc. cit.*, *supra*) he may have included two different species under this name. Figs. 28 and 29 represent a form with strong concave ventral curvature of its stipes throughout, but his figs. 30 and 31 are similar to those which are now generally recognised as the typical *D. Forchammeri.*

Affinities.—D. Forchammeri shows resemblances to *D. complanatus* in its general form, but it differs in the character of the proximal end and the introversion of its thecal apertures. The proximal extremity is similar in some respects to that of *D. elegans*, but the curvature of the stipes serves to distinguish the two species.

Horizon and Localities.—Glenkiln and Hartfell Shales (especially the zone of *Dicranog. Clingani*).

S. Scotland.—Moffat Area: Dobb's Linn; Hartfell; Syart Law; Moffat Water; Mount Benger Burn. *Girvan Area*: Tralodden; Ardwell Bay, etc. *Wales.*—Cynghordy, Derwendêg, Tiddyndicwm. *Ireland.*—Kilmacreagh, Co. Clare; Carnalea; Ballygrot; Coalpit Bay.

Associates, etc.—D. Forchammeri is a rare fossil in the upper zones of the Glenkiln Shales of S. Scotland and Wales, where it occurs associated with *Nemag. gracilis* and *Dicellog. sextans*; it is, however, very common in the Hartfell Shales, especially in the zone of *Dicranog. Clingani*, where it occurs associated with *Leptog. flaccidus*, *Diplog. foliaceus* (*auct.*), *D. truncatus*, and other forms. It has also been found in the zones of *Climacog. Wilsoni*, and *Pleurog. linearis*. The best specimens are in Lapworth's collection and in those of the Sedgwick and Natural History Museums.

Var. **flexuosus**, Lapworth. Plate XXII, figs. 2*a*—*d*.

1876. *Dicellograptus Forchammeri*, var. *flexuosus*, Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 90.

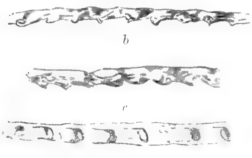
In addition to the typical *D. Forchammeri*, a well-marked variety is occasionally met with, in which the stipes are much narrower and are conspicuously flexed. They are only ·5 mm. wide at their origin and never exceed 1 mm. in breadth. The sicula is more conspicuous than that of the type form, and is both longer and narrower. The apertural excavation of the thecæ is relatively broad, generally occupying about half the width of the stipe; and the spinous outgrowths from the walls of the distal thecæ are more fully developed than in the typical form.

FIGS. 95 *a*.—*Dicellograptus Forchammeri*, var *flexuosus*, Lapw.

a

a. Reverse view in low relief. Enlargement of part of Pl. XXII, fig. 2 *b*.

FIGS. 95 *b*, *c*, and *d*. — *Dicellograptus Forchammeri*, var *flexuosus*, Lapw.



b. Proximal thecæ, showing mesial spines. Specimen on same slab as Pl. XXII, fig. 2 *b*.
c. More distal thecæ. Ibid.
d. Scalariform view. Specimen on same slab as Pl. XXII, figs. 2 *a* and 2 *d*.

Horizon and Localities.—Hartfell Shales. (Zones of *Climacog. Wilsoni* and *Dicranog. Clingani*).

S. Scotland: Hartfell; Glenkiln Burn; Syart Law; Garryhorn Burn; Rein Gill.

Associates, etc.—Var. *flexuosus* occurs in the zone of *Climacog. Wilsoni* associated with *Climacog. Scharenbergi* and the zone fossil. It is, however, of commoner occurrence in the zone of *Dicranog. Clingani*, where it occurs in company with *Leptog. flaccidus*, *Diplog. truncatus*, and their usual associates. The best specimens known are in Lapworth's collection and in that of the Geological Survey of Scotland.

Dicellograptus sextans, Hall. Plate XXI, figs. 1 *a*—*e*.

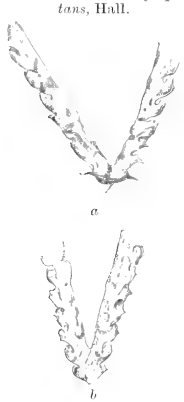
1843. *Graptolithus sextans*, Hall, Pal. New York, vol. i, p. 273, pl. 74, figs. 3 *a*—*e*.
1849. *Graptolithus sextans*, Salter, Quart. Journ. Geol. Soc., vol. v, p. 17, pl. i, fig. 10.
1855. *Diplograptus? sextans*, McCoy, Brit. Pal. Foss., p. 9.
1865. *Dicranograptus sextans*, Hall, Grapt. Quebec Group, p. 57.
1870. *Didymograpsus sextans*, Nicholson, Ann. and Mag. Nat. Hist. [4], vol. v, p. 356, fig. 9.
1870. *Dicranograptus sextans*, Hopkinson, Geol. Mag., vol. vii, p. 356, pl. xvi, figs. 1 *a*—*c*.
1870. *Dicranograptus formosus*, Hopkinson, Geol. Mag., vol. vii, p. 356, pl. xvi, fig. 2.
1876. *Dicellograptus sextans*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 78.
1877. *Dicellograptus sextans*, Lapworth, Grapt. Co. Down, pl. vii, fig. 4.

Stipes straight or with slight curvature, commonly 1—2 cm. in length, maintaining an approximately uniform width of rather less than ·8 mm. for the greater part of their extent, though somewhat narrower proximally; diverging at 300° from an inconspicuous sicula; virgella and lateral spines conspicuous; axil pointed. Thecæ short, thirteen to eleven in 10 mm., overlapping about one fourth of their length; free part of outer wall oblique, curved. Apertural portion slightly introverted and introtorted, opening within a pouch-shaped excavation, which occupies one third the width of the stipe.

Description.—The stipes in the shorter forms are usually straight, but some of the longer specimens show slight concave curvature of their ventral margins. The angle of divergence is very constant and characteristic, as is also the pointed shape of the axil.

The sicula is short and blunt, measuring only ·7 mm. in length. It never appears conspicuously within the axil, though its apex can occasionally be detected; in the reverse aspect of the polypary it seems to be entirely concealed by the growth of the earliest thecæ, though in the obverse aspect it is more or less clearly visible throughout its length in well-preserved specimens. The earliest thecæ, th. 1^1 and th. 1^2, are of considerable size, and unlike the corresponding thecæ of most of the other *Dicellograpti*, only a small fraction of their length assumes a horizontal direction, most of their growth being obliquely upward and outward. The same is also the case with th. 2^1 and th. 2^2, which, however, develop alternately as in other species. Hence the proximal end, owing to this alteration in the direction of growth, approximates (like *D. anceps*) closely to what may be termed the Diplograptid type.

FIGS. 96 *a* and *b*.—*Dicellograptus sextans*, Hall.



a. Proximal end, showing initial and lateral spines and typical form of axil. Enlargement of part of Pl. XXI, fig. 1 *d*.
b. Form of axil approximating to that of a *Dicranograptus*. Enlargement of part of Pl. XXI, fig. 1 *a*.

The thecæ subsequently developed measure only 1 mm. in length, and on the free part of their outer walls short projecting spines may frequently be detected, especially on the more proximal thecæ. These are, however, only visible in the better preserved specimens, and good examples of this species are very rare.

Affinities.—The direction of growth of the earliest thecæ, and hence the "Diplograptid" appearance of the proximal end, brings *D. sextans* into close relationship with the *Dicranograpti*. This was probably the reason why many earlier observers referred it to that genus. This form of the proximal end, however, is practically identical with that of some other species of *Dicellograptus*, as, for example, *D. anceps*, and varies so little from the more ordinary type exemplified in *D. divaricatus*, etc., that there is no reason to exclude *D. sextans* from the genus *Dicellograptus* on this account. It may, however, be regarded as one of the intermediate forms connecting this genus with that of *Dicranograptus*. Hopkinson separated from *D. sextans* (Hall) as a distinct species a form, which he called *Dicranog. formosus*, as having "a longer stem, a smaller angle of divergence, longer and more robust stipes and more elegantly curved thecæ." A comparison, however, of a large number of specimens seems to show the existence of every variation between this and the typical form, and we therefore consider it best to include both under the one name of *Dicellog. sextans*.

D. sextans can be readily distinguished from other *Dicellograpti* by its angle of divergence and by its close-set thecæ.

Horizon and Localities.—Llandeilo, Glenkiln Shales.

Radnorshire: Builth Road. *Wales:* Tiddyndicwm. *S. Scotland—Moffat Area:* Glenkiln Burn; Belcraig Burn; Hawkwood Burn; Berrybush Burn; Slate Burn;

W. of Douglas, Peebles; Cairn Ryan, etc. *Girvan Area:* Benan Burn, etc. *Ireland:* Tramore Bay, Co. Waterford; Ballymoney, Co. Waterford; Six Mile Bridge, Co. Clare.

Associates, etc.—*D. sextans* is a very abundant fossil in the graptolitic facies of the Llandeilo beds (Glenkiln Shales). It occurs associated with *Didymog. superstes*, *Nemag. gracilis*, *Climacog. Scharenbergi*, *Diplog. Whitfieldi*, and other forms. It is but rarely well preserved in spite of its abundance. Fairly good specimens are in the collections of the Sedgwick Museum, the Geological Survey of Scotland, British Museum of Natural History, and the private collections of Lapworth and the Authors.

Var. **exilis,** var. nov. Plate XXI, figs. 2 *a—d.*

FIG. 97.—*Dicellograptus sextans*, var. *exilis*, nov.

Proximal end. Enlargement of part of Pl. XXI, fig. 2 *a*.

In addition to the typical *Dicellog. sextans*, there is also found on the same horizon a form which agrees with it in all its characters, except that it is far more slender, being only about half the breadth of the true *D. sextans*. Owing to its common occurrence, this form seems to be worthy of varietal distinction.

Its horizon and associates are those of *D. sextans* itself.

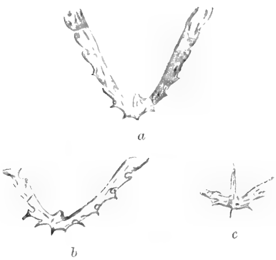
Dicellograptus Morrisi, Hopkinson. Plate XXI, figs. 6 *a—d.*

1867. *Didymograpsus flaccidus*, Nicholson, Geol. Mag., iv, p. 110, pl. viii, figs. 1—3.
1868. *Didymograpsus elegans*, Carruthers (pars), Geol. Mag., vol. v, pl. v, figs. 8 *b* and 8 *c*.
1871. *Dicellograpsus Morrisi*, Hopkinson, Geol. Mag., viii, p. 24, pl. i, figs. 2 *a—h*.
1876. *Dicellograptus Morrisi*, Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 85.
1877. *Dicellograptus Morrisi*, Lapworth, Grapt. Co. Down, pl. vii, fig. 6.

Stipes 10—12 cm. or more in length, robust and somewhat flexed, ultimately attaining a width of 1·3 mm., diverging at 320° from a small but conspicuous sicula; virgella and lateral spines short and thick. Axil somewhat rounded. Thecæ twelve to nine in 10 mm., overlapping one third to one half their length; free part of outer wall curved. Apertural margin introverted and introtorted, opening within a pouch-shaped excavation which occupies one half to one third the width of the stipe.

Description.—The stipes, which are frequently very long, have as a rule a very gentle convex curvature throughout, though occasionally there are indications of a slight concave curve near the proximal end, changing distally, however, to a convex one. They measure ·5 mm. at their origin and widen fairly rapidly to a breadth of 1·3 mm.; there is little or no further increase in width after the first 2—3 cm., however long the stipes may be.

FIGS. 98 *a*, *b*, and *c*. — *Dicellograptus Morrisi*, Hopk.

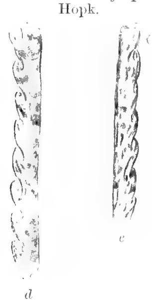


a. Proximal end showing typical rounded form of axil. Hartfell Spa, Hartfell Shales. Coll. Wood.
b. Ditto, showing mesial spines. Specimen on same slab as Pl. XXI, fig. 6 *b*.
c. Young specimen showing nema and apex of sicula. On same slab as Pl. XXI, fig. 6 *d*.

The sicula is short and narrow, and measures 1·5 mm. in length; its apex is, however, frequently broken off, and then it appears as a blunt protuberance within the axil. The earliest developed thecæ are wide, giving a thickened look to the proximal end as a whole. The virgella and lateral spines are thick. The axil is characteristically round, and does not present the square appearance of that of many other *Dicellograpti*, as, for example, *D. elegans*.

The thecæ are more closely set in the proximal than in the distal region, where they have an average length of 2 mm. All the proximal thecæ have mesial spines. When preserved in true profile the free part of the outer wall is oblique and curved or crenulate, but in certain specimens where the stipes are somewhat twisted, this wall appears nearly straight. The ventral excavation often appears to be completely filled by the introverted thecal aperture.

FIGS. 98 *d* and *e*.—*Dicellograptus Morrisi*, Hopk.



d. Distal thecæ, profile view. Enlargement of part of Pl. XXI, fig. 6 *b*.
e. Thecæ, various aspects. On same slab as Pl. XXI, fig. 6 *b*.

Affinities.—*D. Morrisi* resembles *D. Forchammeri* in the general characters of its thecæ, but it differs from it in its smaller axillary angle and in its mode of growth. It approaches most nearly to *D. moffatensis*, but it is a less robust form, the stipes are more uniform in width throughout, and the axil is more open and rounded.

Horizon and Localities.—Lower Hartfell Shales (zone of *D. Clingani* and *Pleurog. linearis*); Ardmillan Beds (Bala) of Girvan.

S. Scotland.—*Moffat Area:* Dobb's Linn; Hartfell Spa; Garryhorn Burn; Belcraig Burn. *Girvan Area:* Myoch Bay; Penwhapple Burn, etc. *Ireland:* Bynehill; Carighalea; Tramore, Co. Waterford.

Associates, etc.—*D. Morrisi* is an extremely abundant fossil in the zone of *D. Clingani* and *P. linearis*, and it sometimes occurs in such numbers as to exclude all other forms. It is often, however, found associated with *D. Clingani*, *Diplog. foliaceus* (auct.), and *Diplog. truncatus*.

There are good specimens in the collections of the Geological Survey of Scotland, the Sedgwick Museum, and also in the private collections of Lapworth and the Authors.

Dicellograptus moffatensis, Carruthers. Plate XXIII, figs. 1 *a—f*.

1858. *Didymograpsus moffatensis*, Carruthers, Proc. Roy. Soc. Edin., vol. i, pt. 2, p. 469, fig. 3.
1871. *Dicellograpsus moffatensis*, Hopkinson, Geol. Mag., vol. viii, p. 25, pl. i, figs. 4 *a*, 4 *b*.
1875. *Dicellograptus moffatensis*, Hopkinson and Lapworth, Quart. Journ. Geol. Soc., xxxi, p. 654, pl. xxxiv, fig. 3, pl. xxxv, fig. 5 *a*.
1876. *Dicellograptus moffatensis*, Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 84.
1877. *Dicellograptus moffatensis*, Lapworth, Grapt. Co. Down, pl. vii, fig. 9.
1895. *Dicellograptus moffatensis*, Elles, Quart. Journ. Geol. Soc., vol. liv, p. 516.

Stipes robust, 8 cm. or more in length, straight or slightly curved, sub-parallel for a short distance proximally, then diverging at large but varying angles; increasing abruptly in width at the proximal end and then more gradually throughout; frequently connected at their origin by a corneous membrane. Thecæ eleven to nine in 10 mm., overlapping one half to one third their length, ventral wall strongly curved. Apertures introverted, opening within a wide and rather shallow excavation which occupies about one third the width of the stipe and one third to one quarter of the free part of the ventral wall.

Description.—The typical shape of the stipes is characteristic, but varies somewhat in different specimens. The stipes, however, always show a tendency to sub-parallelism for the first cm. of their length, then either diverge continuously, or curve slightly towards each other distally. The stipes measure less than ·5 mm. in width at their origin and increase abruptly until a breadth of 1 mm. is reached, after which the increase is gradual, and a maximum of 1·5 mm. may be attained. The corneous membrane is present in most specimens, and may extend from the proximal end as far as the level of the fourth thecal aperture. As Hopkinson has observed, when the stipes are joined proximally by this membrane the axillary angle is smaller than when they are not thus united, but we find that this is not invariably the case.

Figs. 99 *a* and *b*.—*Dicellograptus Moffatensis*, Carr.

a. Proximal end, with "web." On same slab as Pl. XXIII, fig. 1 *a*.
b. Proximal end, showing sicula. Enlargement of part of Pl. XXIII, fig. 1 *c*.

The sicula is rarely discernible, being often concealed by the membrane, but when shown is seen to have a length of about 1 mm., and is narrow and tapering. The virgella and lateral spines of th. 1^1 and th. 1^2 are short but generally conspicuous. Th. 2^1 and th. 2^2 are also furnished with spines, but the remaining thecæ are devoid of ornament.

The thecæ themselves are 2 mm. in length, and overlap for about half their length; the ventral margins generally show marked convex curvature, but as the result of compression may appear much more gently curved. The apertures open wholly inside the general line of the ventral margin of the polypary within conspicuous pouch-like excavations.

FIGS. 99 *c* and *d*.—*Dicellograptus Moffatensis*, Carr.

c. Proximal thecæ. Enlargement of part of Pl. XXIII, fig. 1 *b*.
d. Distal thecæ. Enlargement of part of counterpart of Pl. XXIII, fig. 1 *b*.

Remarks.—The original figure of Carruthers' type specimen, on which his species *D. moffatensis* was founded, is somewhat diagrammatic and shows little but the general form. The specimen which is generally considered as his type occurs on a slab in association with several other examples, and is now in the British Museum of Natural History. It is figured on Plate XXIII, Fig. 1 *a*. Unfortunately, it is somewhat compressed and distorted, and does not appear to be as representative of the majority of the individuals belonging to the species as are the specimens figured by other authors (*loc. cit., supra*). Carruthers' type specimen (?) shows the general form of the polypary with the corneous membrane at the proximal end, but it does not exhibit the characteristic abrupt widening of the stipes, nor even their robust nature. Indeed, in these particulars it resembles more closely specimens of *D. Morrisi.* The specimen figured by Hopkinson (1871) (Plate XXIII, Fig. 1 *f*) is also unfortunately poorly preserved, though it shows the characters of the species fairly well. Perhaps it would be more satisfactory to regard in future Lapworth's specimen, figured Plate XXIII, Fig. 1 *b*, as the type of this species, as it is well preserved, represents a form closely allied to, if not identical with Carruthers' presumed type, and is characteristically distinct from all other species.

Affinities.—In its general form *D. moffatensis* bears some resemblance to *D. Morrisi*, but is a more robust species, and the initial axillary angle is smaller. In the characters of the thecæ it approaches *D. elegans*, but differs conspicuously from that species in its mode of growth.

Horizon and Localities.—Llanvirn (Upper Arenig of Hicks), Lower Llandeilo (Hicks), Upper Skiddaw Slates, Glenkiln, Lower Hartfell (zone of *Climacog. Wilsoni*).

S. Scotland: Dobb's Linn; Craigmichan Scaurs; Glenkiln Burn; Hartfell; etc. *Lake District:* Thornship Beck; Mosedale Beck; Barf; Randal Crag; Bassenthwaite Sandbeds. *Wales:* Tiddyndicwm; Abereiddy Bay; Llanvirn Quarry; Llandrindod Wells; Gwernybrain Dingle, Welshpool. *Ireland:* Ballygrot.

Associates, etc.—*D. moffatensis* has a somewhat longer range in time than most of the *Dicellograpti.* It occurs in the Upper Skiddaw Slates (Llanvirn) associated with *Diplog. dentatus*, and it appears to be present at an even lower horizon in S. Wales associated with *Didymog. bifidus*, *Didymog. Nicholsoni*, *Didymog. patulus*, and other forms.

In S. Scotland and N. Wales it occurs associated with *Nemag. gracilis*, *Didymog. superstes*, *Dicellog. sextans*, *Climacog. Scharenbergi*, and other Glenkiln forms, and has also been found in Scotland in the lowest beds of the Hartfell Shales associated with *Climacog. Wilsoni*.

There are specimens in the collections of the Sedgwick Museum, the Natural History Museum, the Geological Survey of Scotland, Lapworth, and the Authors.

Dicellograptus elegans, Carruthers. Plate XXIII, figs. 2 *a—e*.

1868. *Didymograpsus elegans*, Carruthers, Geol. Mag., vol. v, p. 129, pl. v, figs. 8 *a* and *d*.
1871. *Dicellograpsus elegans*, Hopkinson, Geol. Mag., vol. viii, p. 24, pl. 1, figs. 3 *a – e*.
1876. *Dicellograptus elegans*, Lapworth, Cat. West Scott. Foss., pl. 4, fig. 87.
1877. *Dicellograptus elegans*, Lapworth, Grapt. Co. Down, pl. 7, fig. 8.

Stipes 7—10 cm. or more in length, showing pronounced and graceful curvature of their walls, diverging at various angles from a conspicuous sicula, and maintaining an approximately uniform width for the greater part of their length, but narrowing somewhat proximally. Virgella and lateral spines always well developed. Thecæ ten to eight in 10 mm., overlapping for about one third of their length, and having their free ventral wall strongly curved. Apertures markedly introverted and slightly introtorted, opening within a somewhat deep excavation, which in profile view occupies approximately half the width of the stipes.

Description.—In symmetrical specimens the stipes become nearly parallel to each other in the proximal region, or diverge but slightly with an average distance of 1·5—2 mm. between their dorsal walls, the base of the axil being somewhat square; after a short distance, however, they make a decided outward bend with more conspicuous divergence; they are thus at first straight, next concavely and ultimately convexly curved, though the degree of convexity varies in different specimens. The final direction of growth assumed by the stipes also varies in different individuals, but the proximal double curvature is eminently characteristic of the species. The stipes have an approximately uniform width of ·8—1 mm., except at their proximal ends, where they are slightly narrower (·6—·7 mm.).

The sicula is long and narrow when perfect, and has a length of 2—3 mm.

exclusive of the apertural spine; it is often clearly seen in the axil of well preserved specimens. Its apex, however, is frequently broken off, and it then appears as a mere node between the stipes and hence has often escaped detection. Its apertural spine and the lateral spines of th. 1^1 and th. 1^2 are always conspicuous, and are sometimes as much as 2 mm. in length. Occasionally traces of a membranous film are visible within the axil extending for a short distance up the stipes, never, however, to a sufficient extent to conceal the apex of the sicula. The proximal thecæ grow horizontally for the greater part of their length, giving off a spine where a change to the upward direction takes place; they are narrower than those developed later. Th. 2^1 and th. 2^2 grow also for a considerable portion of their length in a horizontal direction, and hence the square form of the axil is acquired.

FIGS. 100 *a* and *b*.—*Dicellograptus elegans*, Carr.

a

b

a. Proximal end, with "film." On same slab as Pl. XXIII, fig. 2 *d*.
b. Proximal end with abnormally developed lateral spines. Hartfell Spa, Hartfell Shales. Coll. Lapworth.

The thecæ overlap for about one third of their length, which averages 1·5—2 mm.; the free outer wall generally shows marked sigmoid curvature, but in certain states of preservation is straighter, though never parallel to the axis of the stipe. The pouch-shaped excavation into which the introverted aperture opens is wide and occupies half the breadth of the stipe.

FIGS. 100 *c* and *d*.—*Dicellograptus elegans*, Carr.

c

d

c. Proximal thecæ, showing marked introtorsion. Part of same specimen as Fig. 100 *a*.
d. Distal thecæ, not true profile view, and thus showing less introtorsion. On same slab as Fig. 100 *b*.

Affinities.—The general form of the polypary of *D. elegans* is characteristic and serves to distinguish it from all other *Dicellograpti*.

Horizon and Localities.—Lower Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Dobb's Linn; Hartfell Spa; Craigmichan Scaurs, etc. *Ireland*: Carnalea; Craigavad; Coalpit Bay, etc.

Associates, etc.—*D. elegans* is an abundant species in the zone of *Pleurog. linearis*, where it occurs associated with the zone fossil, *Leptog. flaccidus*, *Diplog. truncatus*, *Diplog. foliaceus* (*auct.*), *Climacog. tubuliferus*, *Dicellog. Morrisi*, *Dicellog. pumilus*, etc. There are good specimens in the collections of the Natural History Museum, Sedgwick Museum, and Lapworth.

Var. **rigens,** Lapworth, MS. Plate XXIII, fig. 3.

FIGS. 101 *a* and *b*.—*Dicellograptus elegans*, var *rigens*, nov.

a. Proximal end. Mt. Benger Burn, Hartfell Shales. Coll. Lapworth.
b. Proximal thecæ, showing introtorsion. Ibid.

At Mount Benger Burn, instead of the typical *D. elegans*, there occurs a variety which, while agreeing with the typical form in the character of the thecæ, etc., differs from it in the almost entire absence of curvature of the stipes. They diverge continuously from their origin, and are characteristically straight and rigid.

So far as we are aware, this variety has only been recognised at Mount Benger Burn, and its horizon and associates are the same as those of the typical form. The best specimens are in Lapworth's collection.

Dicellograptus caduceus, Lapworth. Plate XXIII, figs. 4 *a—c*.

1876. *Dicellograptus caduceus*, Lapworth, Cat. West. Scott. Foss., pl. iv, fig. 83.
1877. *Dicellograptus caduceus*, Lapworth, Grapt. Co. Down, p. 141, pl. vii, fig. 3.
1902. *Dicellograptus* or *Dicranograptus*, T. S. Hall, Rec. Geol. Survey, N. S. Wales, vol. vii, p. 3, pl.xiii fig.4.

Stipes 6 cm. or less in length, typically crossing and twisting, to form a figure of 8, diverging at an angle of 340°, or rather less; sicula rarely seen, but conspicuous when present; virgella and lateral spines clearly visible. Thecæ fourteen to twelve in 10 mm.; ventral walls curved, overlapping one half to one third their length, which does not exceed 1·5 mm. Apertures markedly introverted and introtorted; excavation semicircular in form, and occupying one half to one third of the total width of the stipe.

FIGS. 102 *a* and *b*.—*Dicellograptus caduceus*, Lapw.

a. Thecæ showing growth lines and two dorsal lines. Enlargement of part of Pl. XXIII, fig. 4 *a*.
b. Proximal end, showing sicula and mesial spines. Dobb's Linn, Hartfell Shales. Coll. Elles.

Description.—The stipes are ·4 mm. wide at their origin, but increase to 1 mm. in their more distal portions. They are embedded more or less face downward upon the stone, so that their dorsal surface is turned towards the observer. Down the centre of this dorsal surface runs a longitudinal line, or sometimes two. Growth lines are generally very conspicuous; thus it would appear that the

FIG. 102 *c*.—*Dicellograptus caduceus*, Lapw.

c

c. Thecæ showing extreme introtorsion. Enlargement of part of Pl. XXIII, fig. 4 *c*.

chitin was of considerable thickness in this species, and it may be suggested that the twisting of the polypary so characteristic of all specimens of *D. caduceus* was due to the stiff and wire-like nature of the polypary caused in part by this thickened chitinous covering. When the stipes cross more than once, the spaces included by their crossing become larger each time; thus while the first crossing of the stipes usually takes place about ·5—1 mm. above the initial region, the second point of crossing is 1·5 mm. from the first, and the third crossing is still more distant.

The sicula has a length of 1·5 mm.

The introversion and introtorsion of the thecæ are

Specific Characters of Forms belonging

	GROUP I.			GROUP II.			
	D. complanatus,		*D. anceps.*	*D. divaricatus*,			*D. intortus.*
		var. *ornatus.*			var. *rigidus.*	var. *salopiensis.*	
Characters of stipes	Widely divergent,	—	Slightly convergent,	Divergent,	—	—	Convergent or crossing,
	straight.	—	straight, or with slight curvature distally.	approximately straight,	—	—	curved.
		lateral spines conspicuous.	—	widening rapidly.	Uniform width throughout.	—	—
Maximum width of stipes	1 mm.	·7 mm.	1·2 mm.	1 mm.	—	·5 mm.	1 mm.
Length of sicula	1·5 mm.	+ 1 mm.	1·3 mm.	?	—	—	+ 1 mm.
No. of thecæ in 10 mm.	10—8	—	—	12—10	8	12—10	14—11
Characters of thecæ— (*a*) Free outer wall	Straight,	—	—	Approximately straight,	—	—	—
(*b*) Aperture	horizontal, slightly introtorted.	—	—	slightly introverted and introtorted.	—	—	—
Apertural excavation	Semicircular,	—	—	Wide, deep, and oblique.	—	—	—
	⅓ width of stipe.	—	½ width of stipe.	—	—	—	—

very evident, and so pronounced as to cause a conspicuous protuberance of the apertural region in the form of a knob projecting from the general ventral margin of each theca. At least five thecæ near the proximal end are distinctly spinose; upon the remaining thecæ, however, spines appear to be absent.

Affinities.—*D. caduceus* presents a superficial resemblance to *D. intortus*, but from this and all other species the peculiar shape of the polypary and the characters of the thecæ easily distinguish it.

Horizon and Localities.—Lower Hartfell Shales (*Dicranog. Clingani* zone).

S. Scotland.—Dobb's Linn; Hartfell Spa, etc.

Associates, etc.—*D. caduceus* occurs in some abundance in a single band of the Lower Hartfell Shales (*Dicranog. Clingani* zone) of Dobb's Linn and elsewhere, where it is found in association with *Dicellog. Forchammeri* and various *Diplograpti*. There are good specimens in the Sedgwick Museum and in Lapworth's collection.

to the Genus Dicellograptus.

Group III.			Group IV.								
D. patulosus.	*D. angulatus.*	*D. pumilus.*	*D. sextans,*		*D. Forchammeri,*		*D. Morrisi.*	*D. moffatensis.*	*D. elegans,*		*D. caduceus.*
				var. *exilis.*		var. *flexuosus.*				var. *rigens.*	
Widely divergent,	—	Divergent,	—	—	Widely divergent,	—	Slightly divergent,	Sub-parallel, then divergent,	Divergent,	—	Crossing twice to form an 8.
slightly flexed.	straight.	—	—	—	—	flexed.	slightly curved,	—	graceful, double curvature.	straight.	—
axil square.	—	axil rounded.	axillary angle 60°.	—	axil square.	—	axil rounded.	—	—	—	—
1 mm.	·4 mm.	·8 mm.	—	·4 mm.	1·2 mm.	1 mm.	1·3 mm.	1·5 mm.	·8—1 mm.	—	1 mm.
2·5—3 mm.	1·5 mm.	1·3 mm.	·7 mm.	—	1·5 mm.	—	1·5 mm.	1 mm.	2—3 mm.	—	1·5 mm.
10—7	10—8	12—10	13—11	—	10—8	—	12—9	11—9	10—8	—	14—12
Gently curved, narrowing aperturally.	—	—	Curved,	—	—	—	Strongly curved.	—	—	—	Very strongly curved,
—	—	—	introverted and introtorted.	—	—	—	—	—	—	—	strongly introverted and introtorted.
Triangular,	Small,	Shallow.	Pouch-shaped,	—	—	—	—	—	Deep,	—	—
$\frac{1}{3}$ width of stipe.	—	—	—	—	—	—	$\frac{1}{2}$—$\frac{1}{3}$ width of stipe.	$\frac{1}{3}$ width of stipe.	$\frac{1}{2}$ width of stipe.	—	$\frac{1}{2}$—$\frac{1}{3}$ width of stipe.

Genus **DICRANOGRAPTUS**, *Hall.*

1865. *Climacograptus* (*Dicranograptus* s—g.), Hall, Grapt. of Quebec Group, p. 112.
1868. *Dicranograptus*, Hall, 20th Rept. on State Cabinet, p. 218.

Polypary bilaterally symmetrical, consisting of a proximal biserial portion, dividing distally into two uniserial stipes with an axillary angle of less than 90°.

Thecæ of the type characteristic of the family.

The polypary in *Dicranograptus* varies much in size in the different species, and also in the relative lengths of the biserial and uniserial portions. Most of the species are characteristically robust, though a few are comparatively slender.

The sicula is small and is rarely visible, being as a general rule more or less completely embedded in the polypary. It is seen only in the obverse aspect, being completely concealed in the reverse aspect by the growth of the proximal thecæ. Its apertural spine (virgella), however, can be frequently detected. The "lateral" spines so often visible at the proximal extremity of the polypary are of a precisely similar nature to those in *Dicellograptus*.

The development of the biserial portion of the polypary (the "stem" of some authors) affords some features of interest. Th. 1^1 develops on the left of the sicula (obverse aspect), grows at once partly upward, and partly outward, for a short distance, then bends somewhat abruptly and becomes more or less vertical for the remainder of its length. Th. 1^2 is developed from the initial end of th. 1^1, and grows in a similar manner, but towards the other side of the sicula. Thus the "crossing canal" is theoretically reduced to a minimum and as such may be said to be practically non-existent. Th. 2^1 is developed from the initial part of th. 1^2 and its aperture lies immediately over that of th. 1^1.

In some forms the alternate arrangement of these four primary thecæ thus brought about seems to persist throughout the whole of the biserial portion, so that we have the appearance of a double series of thecæ with a single "common canal." In most species, however (*D. Nicholsoni*, etc.), after the growth of a few thecæ, a septum is developed, and then each of the succeeding thecæ on both sides of this septum grow vertically from the theca immediately below. Thus from the commencement of the septum onwards there are two rows of thecæ, each with its own "common canal."

At the termination of the biserial portion the thecæ begin to grow in a more oblique direction, the two series become separated in the form of distinct branches, and so continue throughout the remainder of their length.

Thus in the biserial portion of the polypary of *Dicranograptus* the type of development is identical with that which rules in the whole of the polypary in the

Diplograptidæ; while in the uniserial portion the type of development is that which obtains throughout the whole of the polypary in *Dicellograptus*.

The various species of *Dicranograpti* can be arranged according to the details of the thecæ in groups similar to those of the *Dicellograpti*. Owing, however, to their frequent imperfect state of preservation, this is often a matter of some difficulty.

Group I.—*Dicranograpti* in which the thecæ have approximately straight ventral walls and horizontal apertures.	Type *Dicranog. Clingani.* *D. Clingani.*
Group II.—*Dicranograpti* in which the thecæ have gently curved ventral walls and horizontal apertures.	Type *Dicranog. tardiusculus.* *D. tardiusculus.* *D. brevicaulis.*
Group III.—*Dicranograpti* in which the thecæ have gently curved ventral walls, and slightly introverted and introtorted apertures.	Type *Dicranog. celticus.* *D. celticus.* *D. rectus.*
Group IV.—*Dicranograpti* in which the thecæ have strongly curved ventral walls, and markedly introverted and introtorted apertures.	Type *Dicranog. Nicholsoni.* *D. Nicholsoni.* *D. cyathiformis.* *D. ramosus.* var. *spinifer.* var. *longicaulis.* *D. zic zac.* *D. furcatus*, var. *minimus.*

Group I.—Type *Dicranog. Clingani.*

Dicranograpti in which the thecæ are of the general *Climacograptus* type, having approximately straight ventral walls and horizontal apertures.

Dicranograptus Clingani, Carruthers. Plate XXIV, figs. 1 *a—i.*

1868. *Dicranograptus Clingani,* Carruthers, Geol. Mag., vol. v, p. 132, pl. v, figs. 6 *a, b, c.*
1870. *Dicranograptus Clingani,* Hopkinson, Geol. Mag., vol. vii, p. 358, pl. xvi, fig. 4.
1876. *Dicranograptus Clingani,* Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 76.

Polypary consisting of a very short biserial portion about 2·5—4 mm. long and two straight uniserial stipes 2 cm. or more in extent, including between them an axillary angle of about 40°. Thecæ short, ten in ten mm., of the general *Climacograptus* type, with the outer walls straight, and with horizontal apertures opening within a shallow and approximately semicircular excavation, which occupies about one third the width of the stipe.

Description.—The biserial portion of the polypary is short, commonly composed of from 4 to 6 thecæ on each side, and is of fairly uniform width throughout. The uniserial stipes are also short (2 cm. or more) and are typically straight, with a uniform width of rather less than 1 mm. They diverge at an angle of about 40°, and the angular form of the axil is characteristic of the species.

The structure of the proximal end is somewhat obscure in the specimens at our disposal, but the mode of development of the earliest thecæ is undoubtedly similar to that in all other *Dicranograpti.* The sicula, being visible only in one aspect (obverse) of the polypary, is rarely seen. It appears to be narrow and about 1 mm. in length. Thecæ 1^1 and thecæ 1^2 are far smaller than any of those subsequently developed, measuring ·8 mm. in length.

FIG. 103.—*Dicranograptus Clingani*, Carr.

Enlargement of Pl. XXIV, fig. 1 *g*, showing type of thecæ.

The remaining thecæ of the biserial portion and those of the uniserial stipes measure 1·5 to 2 mm.; they generally overlap for half their length.

Affinities.—*D. Clingani* resembles in general form *D. rectus* and *D. brevicaulis;* but from both of these it may be distinguished by the relative shortness of the biserial and uniserial portions and by the characters of the thecæ. From all other *Dicranograpti* its form affords a sufficiently distinguishing character.

Horizon and Localities.—Hartfell Shales.

S. Wales: Robeston Wathen. *N. Wales:* Railway Cutting, Conway. *S. Scotland:* Dobb's Linn; Hartfell; Berrybush Burn, etc. *Ireland:* Carnalea, Coalpit Bay.

Associates, etc.—*D. Clingani* is a fairly common fossil in the Hartfell Shales (zone of *D. Clingani*) of South Scotland, and also occurs in some abundance at Conway. In S. Scotland it is usually associated with *Dicellog. Morrisi, Dicellog. Forchammeri, Climacog. bicornis, Diplog. foliaceus* (*auct*), *Diplog. truncatus, Corynoides calicularis*, and other forms. The best specimens known to us are in the collections of Lapworth, the Geological Survey of Scotland, the Sedgwick Museum, and the British Museum of Natural History.

GROUP II.—Type *Dicranog. tardiusculus.*

Dicranograpti in which the thecæ have gently curved ventral walls and horizontal apertures.

Dicranograptus tardiusculus, Lapworth, MS. Plate XXIV, figs. 2 *a—b*.

1882. *Dicranograptus tardiusculus,* Lapworth, Quart. Journ. Geol. Soc., vol. xxxviii, p. 586.

Polypary consisting of a rather long biserial portion, 8—9 mm. in length, and two approximately straight uniserial stipes 1—3 cm. in length and of uniform width; axillary angle about 35°. Thecæ twelve to ten in 10 mm., having free outer wall slightly curved, and horizontal apertures opening within wide and deep excavations which occupy nearly two thirds of the width of the stipe.

Description.—The biserial portion of the polypary is generally composed of about ten thecæ on each side, and it widens very markedly throughout its length, measuring only ·6 mm. at its origin, but from 1·5—2 mm. at the axil. The uniserial stipes have a uniform breadth of about ·8 mm. and are typically straight, but occasionally exhibit slight curvature. They diverge at an angle of about 35°. Unlike that of *Dicranog. Clingani*, the axil is somewhat rounded.

Fig. 104.—*Dicranograptus tardiusculus*, Lapw.

Biserial portion in full relief, showing sicula (*s*) and septum. Ardmillan Brae, Balclatchie Beds. Coll. Mrs. Gray.

The sicula is obscure, but it appears to be short and broad (see fig. 104), with a length of only ·5 mm. The virgella is slender, but is usually visible.

The thecæ are very markedly alternate in their arrangement. There is distinct evidence of a septum for part, if not for the whole of the length of the biserial portion. Spines are commonly present as outgrowths from the free part of the outer thecal wall on all the thecæ of the biserial portion, and occasionally on the most proximal thecæ of the uniserial stipes. The thecæ have an average length of about 1·5 mm. and overlap for about one third of their length.

Affinities.—*D. tardiusculus* has, perhaps, some slight resemblance in general form to both *D. rectus* and *D. Nicholsoni*. From *D. rectus* it should be readily distinguished by the greater length of its biserial portion and by the characters of the thecæ, and from *D. Nicholsoni*, which it resembles in the length of the biserial portion, by its smaller and more slender polypary and also by the characters of the thecæ. The unusually wide and deep apertural excavations are also distinctive characteristics.

Horizon and Localities.—Highest beds of Glenkiln or Lowest Hartfell (Balclatchie Beds).

S. Scotland.—Balclatchie Bridge; Ardmillan Brae; Benan Burn.

Associates, etc.—*D. tardiusculus*, up to the present, has only been recognised in Britain from the Balclatchie Beds of the Girvan District, where it occurs associated with *Diplog. foliaceus* (*auct*) and *Cryptog. tricornis*, etc. The best specimens are in the well-known collection of Mrs. Gray of Edinburgh, and there are also a few in that of Lapworth.

Dicranograptus brevicaulis, sp. nov. Plate XXIV, figs. 3 *a—d*.

1876. *Dicranograptus formosus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 75.

Polypary consisting of a very short biserial portion 2—4 mm. in length, and two slightly curved uniserial stipes which may attain a length of 8 cm. or more; axillary angle about 30°. Thecæ short, twelve to ten in 10 mm., with free part of outer wall slightly curved; apertures approximately horizontal, opening within pouch-shaped excavations which occupy one half to one third the width of the stipe.

Description.—The biserial portion of *D. brevicaulis* is composed of 3—5 thecæ on each side and widens throughout its extent from ·8 mm. at the proximal end to 1·5—2 mm. at the axil. The uniserial stipes include between the dorsal walls an angle of 30° and are as a rule approximately straight for at least the first 4 cm. of their length; subsequently, however, they curve inward so as to become almost parallel to each other. In small specimens, owing to the straight early growth, there is as a rule no indication of this ultimate parallelism of the stipes.

FIG. 105.—*Dicranograptus brevicaulis*, sp. nov.

Biserial and uniserial portions in partial relief, showing form of thecæ. Enlargement of part of Pl. XXIV, fig. 3 *c*.

The sicula has not been observed, but its apertural spine has been detected at the proximal end of the polypary, and all the thecæ of the biserial portion are furnished with spinose outgrowths from their outer walls. Spines are present only on the most proximal thecæ of the uniserial stipes and are often inconspicuous.

The thecæ have an average length of about 1·5 mm. and overlap each other for about half their extent. In some aspects the thecæ resemble those of *Dicranog. rectus*, but more usually they approximate closely to the *Climacograptus* type, and *D. brevicaulis* is therefore placed in the same group as *D. tardiusculus*.

Affinities.—*D. brevicaulis* is very similar in form to all the short-stemmed *Dicranograpti*. It differs from *D. Clingani* in the greater length of the stipes and in the character of the thecæ; and from *D. rectus* in its shorter stem.

Horizon and Localities: Llandeilo (*Leptograptus* Beds), Glenkiln Shales. *Shropshire:* Spy Burn. *Radnorshire*: Castell, West of Builth. *S. Scotland:* Glenkiln Burn; Rein Gill; Water of Deuch; Stinchar Valley; Birnock Water, etc. *Ireland:* Ballygrot.

Associates, etc.—*D. brevicaulis* is a fairly abundant form in the higher part of the Glenkiln Shales of S. Scotland, where it occurs associated with *Dicellog. sextans*, *Nemag. gracilis*, *Dicranog. rectus*, *Dicranog. celticus*, *Diplog. angustifolius*, *Diplog. Whitfieldi*, *etc.* It is also met with in the *Leptograptus* (Glenkiln) Beds of Shropshire associated with *Dicranog. rectus*, *Dicellog. divaricatus*, var. *salopiensis*, and *Nemag. gracilis.* The best specimens known to us are in the collections of Lapworth and the Geological Surveys of England and Scotland.

Group III.—Type *Dicranog. rectus.*

Dicranograpti in which the thecæ have gently curved ventral walls and slightly introverted and introtorted apertures.

Dicranograptus rectus, Hopkinson. Plate XXIV, figs. 4 *a*—*e*.

1849. *Graptolithus ramosus*, Salter, Quart. Journ. Geol. Soc., vol. v, p. 16, pl. 1, fig. 7.
1872. *Dicranograptus rectus*, Hopkinson, Geol. Mag., vol. ix, p. 508, pl. xii, fig. 10.

Polypary consisting of a fairly long biserial portion 6—8 mm. in extent, and two straight uniserial stipes 6 cm. or more in length; these include an angle of 20°—30° between their dorsal walls, while their ventral margins practically form a straight line with those of the biserial portion. Thecæ twelve to ten in 10 mm., of the general *Dicellograptus* type, with free outer walls gently curved, and slightly introverted apertures, which open within narrow pouch-shaped excavations occupying about one third the width of the stipe.

Description.—The biserial portion of the polypary is commonly made up of about eight thecæ on each side; it is very narrow at its origin, measuring only ·6 mm., but at the point of divergence of the uniserial stipes the breadth is fully 2 mm. The uniserial stipes are long relatively to the biserial portion, frequently attaining a length of 6 cm., and having a uniform width of 1 mm. They are typically straight.

Details regarding the proximal extremity are obscure, but there are indications of the existence of a septum, although the thecal apertures on each side are alternate.

The thecæ earliest formed are small, but throughout the biserial portion they increase steadily in size, and ultimately in the uniserial stipes have a length of 2 mm.; they overlap for one third to one half their length. There are frequently indications of spines on the thecæ of the biserial portion, and also on the more proximal parts of the uniserial stipes, but not on the distal portions so far as we have been able to observe. As a general rule, the free outer walls of the thecæ in the biserial portion of the polypary appear to be more curved than those on the uniserial portions, but this is probably due to their mesial spines.

FIGS. 106 *a* and *b*. — *Dicranograptus rectus*, Hopk.

a. Biserial portion showing mesial spines. Enlargement of part of Pl. XXIV, fig. 4 *a*.
b. Uniserial stipe. Ibid.

Affinities.—In general form, with its short biserial portion and long uniserial stipes, *D. rectus* perhaps most closely resembles *D. Nicholsoni*, with which it also agrees in showing marked increase in width throughout the biserial portion. It differs from this species, however, in the characteristic straight line of the ventral margin throughout the whole polypary, there being no break like that in *D. Nicholsoni* where the uniserial stipes diverge. Small forms of *D. rectus* bear a certain resemblance to *D. tardiusculus* and *D. Clingani*, but in *D. tardiusculus* the biserial portion is longer. The thecæ of *D. Clingani* are of a very different type.

Horizon and Localities.—Llandeilo (*Leptograptus* Beds), Upper Glenkiln Shales, Lower Hartfell Shales.

S. Scotland: Laggan Gill, Glengonnar Water; Glenkiln Burn; Dobb's Linn; Rein Gill; Wandel Water; Loch Ryan. *Shropshire:* Spy Burn. *N. Wales:* Tiddyndicwm.

Associates, etc.—*D. rectus* is a fairly abundant fossil at some S. Scottish localities in the higher beds of the Glenkiln Shales, where it has been found in association with *Dicellog. sextans*, *Dicranog. brevicaulis*, *Diplog. Whitfieldi*, *Glossog. Hincksii*, and *Diplograpti* of the "*foliaceus*" type. It is a rare fossil in the zone of *Climacog. Wilsoni*, at the base of the Hartfell Shales, but it has been found there in association with the zone fossil.

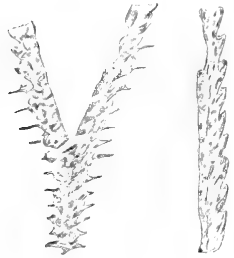
The best specimens are in the collection of the Geological Survey of Scotland and those of Lapworth and G. L. Elles.

Dicranograptus celticus, sp. nov. Plate XXIV, figs. 5 *a*, *b*,

Polypary consisting of a short biserial portion about 4 mm. in extent, and two straight uniserial stipes of a length of 6—7 cm., which widen throughout; axillary angle 30°—40°. Thecæ eighteen to twelve in 10 mm., with free outer wall slightly curved, and introverted apertures opening within a narrow excavation which occupies less than one third the width of the stipe.

Description.—The biserial portion of the polypary is usually composed of 6 to 8 thecæ on each side, and widens from 1 mm. at its origin to about 2 mm. at the axil. The uniserial stipes are of great length and are typically straight; this width increases (exclusive of spines) from 1 mm. at their origin to 1·4 mm. near their distal ends.

Figs. 107 *a* and *b*.—*Dicranograptus celticus*, sp. nov.



a. Biserial portion showing spines. Enlargement of part of Pl. XXIV, fig. 5 *a*.
b. Uniserial stipe. Ibid.

The sicula is unknown, but its apertural spine is stout; the earliest thecæ are rather smaller than those subsequently developed.

All those in the biserial portion appear to be closely set (this may be partly due to compression) and are distinctly alternate in their arrangement; they are provided with spines, as are also the proximal thecæ of the uniserial stipes. The mature thecæ have an average length of 2 mm. and overlap for about half their extent.

Affinities.—*D. celticus* bears some resemblance to *D. Nicholsoni* and *D. rectus* in general form. It differs from *D. Nicholsoni*, however, in the closely set thecæ of the stem, in the widening of the uniserial stipes, and in the simpler character of the thecæ; and from *D. rectus* in the first two of these characters, and also in the absence of the unbroken line of the ventral margin of the polypary.

Horizon and Localities.—Glenkiln Shales.

S. Scotland: Rein Gill, Wandel Water; Dobb's Linn; Glentewing Burn, etc.

Associates, etc.—*D. celticus* is a fairly abundant form at certain localities in the higher beds of the Glenkiln Shales, where it occurs associated with *Dicellog. sextans*, *Leptog. flaccidus*, *Dicranog. formosus*, *Dicranog. rectus*, and certain *Diplograpti*.

The best specimens are in the collections of the British Museum of Natural History, Geological Survey of Scotland, and that of G. L. Elles.

Group IV.—Type *Dicranog. Nicholsoni*.

Dicranograpti in which the thecæ have strongly curved ventral walls and markedly introverted and introtorted apertures.

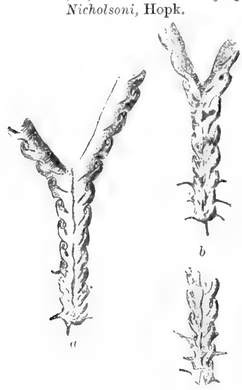
Dicranograptus Nicholsoni, Hopkinson. Plate XXV, figs. 1 *a*—*h*.

1870. *Dicranograptus Nicholsoni*, Hopkinson, Geol. Mag., vol. vii, p. 357, pl. xvi, fig. 3.
1876. *Dicranograptus Nicholsoni*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 79.
1877. *Dicranograptus Nicholsoni*, Lapworth, Grapt. co. Down, Proc. Belfast Nat. Field Club, p. 141, pl. vii, fig. 2.

Polypary consisting of a fairly long biserial portion, 5—8 mm. in extent, and two uniserial stipes of a length of 7—8 cm.; axillary angle 40°—60°. Thecæ twelve to nine in 10 mm., of the form of those of *Dicellograptus elegans*, with curved free outer walls, and introverted and introtorted apertures which appear to fill more or less completely the pouch-shaped excavation that occupies rather more than one third the width of the stipe.

Description.—The biserial portion of the polypary is composed of about 8 thecæ on each side; it widens conspicuously throughout its extent from 1 mm. to 2·5 mm. (·8 mm. and 2 mm. when in relief), so that near the point of origin of the uniserial stipes it is fully two and a half times as wide as at its proximal extremity. The uniserial stipes are commonly straight, but sometimes exhibit slight curvature; they are always long relatively to the biserial portion, and have an approximately uniform breadth of 1·3 mm. (1 mm. in relief). A few specimens have been found with a somewhat longer biserial portion (9—11 mm.), and a more marked curvature of the stipes; but at present it is doubtful if they are worthy of varietal distinction (Pl. XXV, figs. 1 *g*, *h*).

FIGS. 108 *a*, *b*, and *c*.—*Dicranograptus Nicholsoni*, Hopk.



a. Biserial portion in full relief (reverse view), showing septum, etc. On same slab as Pl. XXV, fig. 1 *c*.
b. Biserial portion showing apex of sicula (?) and mesial spines, etc. Dobb's Linn, Lower Hartfell Shales. Coll. Lapworth.
c. Biserial portion (obverse view) showing sicula. Ibid. Coll. Elles.

The sicula is small, measuring only ·6 mm. It is seldom seen owing to the rarity of individuals presenting the obverse aspect, but the stout apertural spine may almost always be detected. From specimens of *D. Nicholsoni* preserved in relief, the following structural details have been made out:

Th. 1^1 is small, and is developed from the left side of the sicula (obverse view); it grows first outward and upward for a short distance; next it bends round approximately at right angles, giving off a spine at the bend; and then growing vertically upward opens within a small excavation. Th. 1^2 is developed from the initial region of th. 1^1, and th. 2^1 from the initial region of th. 1^2, while th. 2^2 appears to develop from its apertural region. A septum is produced between the two thecal series thus originated, and thereafter each theca develops from the next proximal theca immediately below it, and grows at first straight upward, then outward and upward, and finally upward again, forming the sigmoid curve so characteristic of the thecæ belonging to this genus and that of *Dicellograptus*.

The thecæ gradually increase in size throughout the biserial portion, but never attain their maximum length of 2 mm. until the two uniserial stipes have been developed. They overlap for half their length. In well-preserved specimens the thecæ of the biserial portion of the polypary are seen to be furnished with stout mesial spines fully 1 mm. in length, and in some cases these spines may assume abnormal proportions (fig. 109 *f*). There is a marked change in the direction of growth of the thecæ where the uniserial stipes diverge, the thecæ growing chiefly outward and but very slightly upward in their apertural regions. This change, combined with their increase in length, gives the appearance pointed out by Hopkinson of the stipes "being joined beyond the point of bifurcation." In specimens preserved in relief this effect disappears.

FIGS. 108 *d* and *e*. — *Dicranograptus Nicholsoni*, Hopk.

d. Uniserial stipe in full relief, showing one aspect of thecæ. On same slab as fig. 108 *c*.
e. Thecæ in another aspect. Enlargement of part of Pl. XXV, fig. 1 *c*.

Affinities.—D. Nicholsoni perhaps approximates most closely to *Dicranog. rectus* in general form, but it differs in the shape of the thecæ and in the uniform width of the uniserial stipes. From other species its form is sufficient to distinguish it.

Horizon and Localities.—Glenkiln Shales and Lower Hartfell Shales.

S. Scotland: Dobb's Linn; Hartfell; Berrybush Burn; Gairy, head of Garryhorn Burn; Glenkiln Burn; Birnock Burn, head of Wandel Water; Craigmichan Scaurs; Morroch Bay; Cardockan Burn, Loch Dee, etc. *N. Wales:* Tiddyndicwm. *S. Wales:* Southhill Ford; between Peblewin and Stoneyford Railway, Pendwr. *Ireland:* Ballygrot.

FIGS. 109 *f* and *g*. — *Dicranograptus Nicholsoni*, Hopk.

f. Biserial portion of a flattened specimen, showing abnormal spines and appearance of web in axil. Enlargement of part of Pl. XXV, fig. 1 *e*.
g. Thecæ of uniserial stipes. On same slab as Pl. XXV, fig. 1 *e*.

Associates, etc.—D. Nicholsoni is a very abundant fossil at certain horizons in S. Scotland, especially towards the top of the Glenkiln Shales, where it occurs with *Dicellog. sextans*, *Glossog. Hincksi*, and other forms; and in the lowest beds of the succeeding Hartfell Shales, where it is associated with *Climacog. Scharenbergi*, *Climacog. bicornis*, *Climacog. Wilsoni*, and other *Diplograpti*. It is exceedingly abundant and beautifully preserved in the exposure of the zone of *Climacog. Wilsoni* in the main cliff at Dobb's Linn, and from this locality the best specimens known to us were obtained. There are good examples in the collections of the Geological Survey of Scotland, the Sedgwick Museum, the British Museum of Natural History, and in the private collections of Lapworth and the Authors.

Dicranograptus cyathiformis, sp. nov. Plate XXV, figs. 2 *a—c*.

Polypary funnel- or vase-shaped, consisting of a short biserial portion about 5 mm. in length, and two uniserial stipes which first run subparallel to each other for a distance of 1 cm., including between them an exceedingly small axillary angle, next make a sharp outward curve so as to include an angle of about 45° between their dorsal walls, and finally are continued in a straight for a distance of 1—1·5 cm. Thecæ twelve to nine in 10 mm. of the same general type as those of *Dicranog. Nicholsoni.*

Description.—The biserial portion of the polypary is composed of 6 thecæ or more on each side; it is narrow, and increases in breadth from ·9 mm. at the proximal end to 1·5—2 mm. at the point of origin of the uniserial stipes. The uniserial stipes have an average uniform width of 1 mm.

The sicula has not been observed, though its apertural spine is visible at the extreme proximal end. The "lateral" spines of th. 1^1 and th. 1^2 are prominent. Small and inconspicuous mesial spines are present on all the remaining thecæ of the biserial portion, but they appear to be absent on those of the uniserial stipes. The thecæ in the biserial portion are markedly alternate, and there are indications of the presence of a septum.

FIG. 110.—*Dicranograptus cyathiformis,* nov.

Enlargement of part of Pl. XXV, fig. 2 *b*.

The thecæ are far more closely set in the biserial portion, where there are twelve in 10 mm., than in the uniserial stipes, where there are only nine in the same unit of length. They have an average length of 1·5—2 mm., and usually overlap for one third.

Affinities.—The peculiar form of this species is sufficient to distinguish it from all other *Dicranograpti.*

Horizon and Localities.—Glenkiln Shales, Lower Hartfell Shales (?).

S. Scotland.—Dobb's Linn; Hartfell Spa.

Associates, etc.—*D. cyathiformis* is a rare fossil in the Glenkiln Shales of S. Scotland, where it occurs associated with certain spinose *Diplograpti.* A specimen, probably referable to this species, has been found in the Hartfell Shales, in the zone of *Dicranog. Clingani.* The best specimens known to us were collected by Swanston, and presented by him to the Sedgwick Museum.

Dicranograptus ramosus (Hall). Plate XXIV, figs. 6 *a*, *b*.

1847. *Graptolithus ramosus*, Hall, Pal. New York, vol. i, p. 270, pl. lxxiii, fig. 3.

1851. *Diplograpsus ramosus*, M'Coy, Brit. Pal. Foss., p. 8.

1865. *Climacograptus* (s.g. *Dicranograptus*) *ramosus*, Hall, Grapt. of Quebec Group, pp. 15, 31, 45, 46, and 112, pl. A, figs. 18—21.

1866. *Dicranograptus ramosus*, Salter ? ; Mem. Geol. Survey, vol. iii, p. 530, pl. xi A, figs. 1, 1 *a*.

1868. *Dicranograptus ramosus*, Hall, 20th Rept. of State Cabinet, p. 218.

Polypary consisting of a long biserial portion about 1·5 cm. in extent, and two straight uniseral stipes 4—10 cm. or more in length. Thecæ ten to eight in 10 mm. of the general *Dicellograptus* type, with free outer walls curved, and apertural portion strongly introverted and introtorted. Apertures opening within a small but well-defined, oblique, pouch-shaped excavation which occupies one third of the breadth of the stipe.

Description.—The biserial portion of the polypary is usually composed of from 15 to 18 thecæ on either side, and never exceeds 1·5 cm. in length. It increases gradually in width from ·7 mm. to a maximum of about 1 mm., which is attained at the axil. The uniserial stipes include between their dorsal walls an angle of about 30°, and have an average uniform breadth of 1·2 mm. They are typically straight, but specimens are occasionally met with showing a conspicuous double curvature (Pl. XXIV, fig. 6 *b*). Should the discovery of more examples prove that this latter form was a permanent one, it would be worthy of a varietal name.

FIGS. 111 *a* and *b*.—*Dicranograptus ramosus*, Hall.

a. Specimen (nat. size) of *D. ramosus*, from Hall's typical district, Norman's Kill Beds. Coll. Lapworth.
b. Enlargement of proximal portion. (× 5)

Details regarding the structure of the proximal extremity of the biserial portion are unfortunately obscure; the sicula has not been observed, but its apertural spine, when well preserved, is conspicuous. Th. 1^1 and th. 1^2, as usual, give off spines when they commence their upward growth.

The remaining thecæ of the biserial portion are destitute of visible spines, as are also those of the stipes. They have an average length of 2 mm. and overlap for half their extent in the uniserial stipes. Their outer walls are curved, and their apertures are distinctly introverted.

Remarks.—The typical form of Hall's *Dicranog. ramosus*, which occurs so abundantly in the Norman's Kill fauna, New York, is by no means the most common form of this species in British rocks, in which it is found at a somewhat higher horizon (Lower Hartfell Shales). The species, however, is well represented by the two following varieties (var. *spinifer* and var. *longicaulis*), which have not hitherto received distinct names, although their peculiarities have long been recognised and examples have been figured.

Affinities.—*D. ramosus* may easily be distinguished from all other species of *Dicranograpti* by its long biserial portion, which far exceeds in length that of any other known species. The long uniserial stipes are also characteristic.

Horizon and Localities.—Upper Glenkiln Shales and Lower Hartfell Shales.

S. Scotland: Dobb's Linn; Hartfell; Moory Syke; Syart Law; Mount Benger Burn; Railway cutting opposite Kirkton; Gairy, head of Garryhorn Burn, etc. *N. Wales:* Tiddyndicwm, Conway. *S. Wales:* Prendergast Farm Lane. *Ireland:* Ballygrot; Craigavad; Crawford's Burn (?); Ballymoney (?); Tramore Bridge, etc.

Associates, etc.—*D. ramosus* is generally restricted to the Lower Hartfell Shales, and is associated with *Corynoides calicularis*, etc. A few specimens have been found in the Upper Glenkiln. In America, at the typical locality, it is associated with characteristic Glenkiln species.

The best specimens are those in the collections of the Geological Survey of Scotland, the Natural History Museum, the Sedgwick Museum, and that of Lapworth.

Var. **spinifer**, Lapworth, MS. Plate XXIV, figs. 8 *a*—*c*.

1870. *Dicranograptus ramosus*, Hopkinson, Geol. Mag., vol. vii, p. 358, pl. xvi, fig. 5.
1877. *Dicranograptus ramosus*, Lapworth, Grapt. Co. Down, Proc. Belfast Nat. Field Club, p. 140, pl. vii, fig. 1.
1882. *Dicranograptus spinifer*, Lapworth, Girvan Succession—Quart. Journ. Geol. Soc., 1882. p. 610.

Perhaps the most characteristic variety of *D. ramosus* is that which Lapworth recognised in 1877 (*loc. cit.*, *supra*) as distinctive of the Glenkiln Beds, and for which he employed the MS. name of *spinifer* (*loc. cit. supra*). This is characterised by (*a*) the fusiform shape of the biserial portion, which is also considerably longer than that of the typical form, and (*b*) by its strongly spinose thecæ.

Fig. 112.—*Dicranograptus ramosus*, var *spinifer*, Lapw.

Biserial portion showing form of thecæ and mesial spines. On same slab as Pl. XXIV, fig. 8 *a*.

The biserial portion is 2·5 to 3 cm. in length and is composed of some 30 thecæ on each side. It has a breadth of ·5 mm. at the proximal extremity, but widens rapidly to a maximum width of 2 mm. (exclusive of spines) about the middle of its length, and then decreases slightly towards the point of bifurcation.

All the thecæ of the biserial portion (with the possible exception of some of the distal ones) are provided with long and stout mesial spines. In consequence of the presence of these spines the outer walls of the thecæ appear to be strongly curved. The apertures frequently show strong introversion and introtorsion.

Horizon and Localities.—Glenkiln Shales and Lower Hartfell (Balclatchie Beds).

S. Scotland.—Cairn Hill; Wandel Water; Abington; Glenkiln Burn; Sowen Dod; Wanlockhead; Berrybush Burn; Little Letterpin, Ayrshire, etc.

Associates.—Var. *spinifer* is associated with most of the characteristic Glenkiln forms, such as *Dicellog. sextans, Nemag. gracilis, Dicranog. ziczac, Leptog. flaccidus,* etc. The best specimens are in the collections of Lapworth and the Geological Surveys of Scotland and England.

Var. **longicaulis,** Lapworth, MS. Plate XXIV, figs. 8 *a—c.*

1872. *Dicranograptus ramosus,* Lapworth, Cat. West Scott. Foss., pl. iv, fig. 80.

Another common variety of *D. ramosus,* which has not hitherto been found in Britain at a lower horizon than the Hartfell Shales, is that designated by Lapworth in his collection as var. *longicaulis.*

As its name implies, the biserial portion is considerably longer than that of the typical form. It has usually a length of 2—3 cm., and is composed of at least 20 thecæ on each side. Some specimens, indeed, have been found (zone of *D. Clingani*) in which the biserial portion is nearly 4 cm. long, and includes 33 thecæ, but these examples are exceptional.

The characters of the thecæ are similar to those of the typical *D. ramosus,* and are not spinose.

Horizon and Localities.—Lower Hartfell Shales (zones of *Dicranog. Clingani* and *Pleurog. linearis*).

S. Scotland.—Dobb's Linn; Hartfell Spa, etc.

Associates.—Var. *longicaulis* occurs in association with *Dicranog. Clingani, Corynoides calicularis, Diplog. foliaceus* (*auct*), etc.

Good specimens are in the collections of the Geological Survey of Scotland, the Natural History Museum, the Sedgwick Museum, and that of Lapworth.

Dicranograptus ziczac, Lapworth. Plate XXV, figs. 3 *a—d.*

1876. *Dicranograptus ziczac,* Lapworth, Cat. West Scott. Foss., pl. 3, fig. 77.
1877. *Dicranograptus ziczac,* Lapworth, Proc. Belfast Nat. Field Club, Grapt. Co. Down, p. 141, pl. 6, fig. 42 *a.*

Polypary somewhat variable in form, consisting of a very short biserial portion 3—4 mm. in length, and two uniserial stipes with characteristic ziczac curvature. Thecæ short, fourteen to ten in 10 mm., overlapping one third to one half their length, of the general type of those of *Dicellog. elegans.*

Description.—The biserial portion of the polypary is approximately constant in size and is usually made up of 4 or 5 thecæ on each side. There is, however, great variability in the amount and the direction of curvature of the uniserial stipes, and this curvature is always accompanied by a certain amount of torsion. Diverging at first to include between them an axillary angle of about 90°, they commonly grow outward for a length of 7—10 mm. and then bend sharply round towards each other in a direction nearly perpendicular to that of their original growth; they next grow towards each other until they are almost in contact, when they usually bend away again at 90° without crossing (figs. 3 *a*, *b*). Sometimes, however, they cross each other (fig. 3 *c*), and occasionally they even interlock before growing apart again (fig. 3 *d*). In the most perfect specimens known to us they are seen to grow towards each other for a second time and eventually to meet (fig. 3 *d*). Specimens with three bends are very rare; those showing two bends (or a **Z** form) are of common occurrence.

FIG. 113.—*Dicranograptus ziczac,* Lapw.

Complete specimen in full relief, with unusually short biserial portion. Dobb's Linn, Glenkiln Shales. Coll. Lapworth.

The sicula has not been observed by us, though its strong apertural spine can frequently be detected at the extremity of the proximal portion of the polypary. The development of the thecæ is essentially similar to that in all other *Dicranograpti.* It is doubtful, however, if there is a septum in the biserial portion.

Mesial spines are given off from the outer wall of all the thecæ of the biserial portion. The proximal thecæ have a length of about 1·2 mm., and it is possible that they are longer in the more distal portions of the polypary; but this cannot be determined with accuracy, since the uniserial stipes appear to be always twisted, and their thecæ are therefore seen in profile only for very short distances.

Affinities.—*D. ziczac* is easily distinguished from all other British *Dicranograpti* by the peculiar curvature of the uniserial stipes. It is somewhat similar in form to *Dicranog. furcatus* of Hall, but differs from it in the more marked "ziczac" curvature of the stipes and the greater length of the biserial portion.

Horizon and Localities.—Glenkiln Shales.

S. Scotland: Dobb's Linn; Belcraig Burn; Glenkiln Burn; Morroch Bay; Berrybush Burn; Craigmichan Scaurs, etc. *Ireland:* Ballygrot. *N. Wales:* Tiddyndicwm.

Associates, etc.—*D. ziczac* occurs in some abundance in the Glenkiln Shales of S. Scotland. It has also been recognised in Ireland and N. Wales. In all these localities it occurs associated with *Nemag. gracilis, Didymog. superstes, Dicellog. sextans, Dicellog. patulosus, Dicellog. intortus, Diplog. Whitfieldi, Hallog. bimucronatus, Thamnograptus,* etc. The most complete specimens known to us were collected by

Mr. William Swanston, of Belfast, and were presented by him to the Sedgwick Museum; other good ones are in the collections of Lapworth and the Authors.

Dicranograptus furcatus, Hall, var. **minimus**, Lapworth. Plate XXV, figs. 4 *a—c*.

1876. *Dicranograptus ziczac*, var. *minimus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 77 *a*.
1877. *Dicranograptus ziczac*, var. *minimus*, Lapworth, Grapt. Co. Down, Proc. Belfast Nat. Field Club, p. 141, pl. vi, fig. 42 *b*.

In addition to *Dicranograptus ziczac* there occurs in the Glenkiln Shales a nearly allied form, to which Lapworth gave the distinctive varietal name of *minimus*. This form, however, is more closely allied to *Dicranog. furcatus* (Hall), and should, therefore, be regarded as a variety of that species rather than of *Dicranog. ziczac*. In this variety the uniserial stipes never exceed 1·5 cm. in length, and form a single gentle curve. The biserial portion resembles that of *D. ziczac*. All the thecæ, not only of the biserial portion, but also of the uniserial stipes, are provided with mesial spines.

FIG. 114.—*Dicranograptus furcatus*, var. *minimus*, Lapw.

Distal thecæ showing mesial spines. Enlargement of part of Pl. XXV, fig. 4 *c*.

FIGS. 115 *a* and *b*.—*Dicranograptus furcatus*, Hall.

a. Specimen (nat. size) from Hall's typical locality in Norman's Kill Beds. Coll. Lapworth.
b. Distal thecæ. (× 5.)

Affinities.—Var. *minimus* may be distinguished from all other British *Dicranograpti* by its peculiar shape. It is very similar to Hall's *D. furcatus*, but differs from it in having a longer biserial portion and less closely set thecæ. The stipes of var. *minimus* also have never been observed to meet, whereas in *D. furcatus* they typically cross.

Horizon and Localities.—Glenkiln Shales.

S. Scotland: Dobb's Linn; Glenkiln Burn; Belcraig Burn, etc. *Ireland:* Coalpit Bay; Ballygrot. *N. Wales:* Tiddyndicwm.

Associates.—Var. *minimus* is a fairly abundant form in some of the Scotch localities. It occurs associated with *Dicellog. sextans*, *Dicellog. patulosus*, *Nemag. gracilis*, *Diplog. Whitfieldi*, and other forms. The best specimens are in Lapworth's collection and that of the Sedgwick Museum.

Specific Characters of Forms belonging to the Genus Dicranograptus.

	Group I.	Group II.		Group III.		Group IV.						
	D. Clingani.	*D. tardiusculus.*	*D. brevicaulis.*	*D. rectus.*	*D. celticus.*	*D. ramosus,*	var. *spinifer.*	var. *longicaulis.*	*D. Nicholsoni.*	*D. cyathiformis.*	*D. zic-zac.*	*D. furcatus,* var. *minimus.*
Characters of stipes— (*a*) Biserial portion	very short, non-spinose;	fairly long, spinose;	very short, —	fairly long, —	short, —	long, non-spinose;	very long, spinose;	— non-spinose.	fairly long, spinose;	short, non-spinose;	very short, spinose;	— —
(*b*) Uniserial portion	straight, short.	— —	slightly curved, long.	straight — in one straight line with biserial portion.	— —	straight or slightly curved. —	— —	— —	— —	curved, short, sub-parallel proximally, divergent distally.	zic-zac curvature. —	curved. — convergent distally.
Maximum width of stipes	1 mm.	·8 mm.	1·2 mm.	1 mm.	1·4 mm.	1·2 mm.	—	—	1·3 mm.	1 mm.	—	·8 mm.
Length of sicula	?	·5 mm.	?	?	?	?	?	?	·6 mm.	?	?	?
No. of thecæ in 10 mm.	10	12—10	—	12—10	18—12	10—8	—	—	12—9	—	14—10	—
Characters of thecæ— (*a*) Free outer wall	straight,	slightly curved,	—	slightly curved;	—	strongly curved;	—	—	—	—	—	—
(*b*) Apertures	horizontal.	approximately horizontal.	—	introverted and introtorted.	—	strongly introverted and introtorted.	—	—	—	—	—	—
Apertural excavation	semicircular, $\frac{1}{3}$ width of stipe.	wide and deep, $\frac{2}{3}$ width of stipe.	pouch-shaped, $\frac{1}{2}$—$\frac{1}{3}$ width of stipe.	narrow, $\frac{1}{3}$ width of stipe.	— —	pouch-shaped, $\frac{1}{3}$ width of stipe.	— —	— —	— —	— —	— —	— —

PLATE XX.

Genus **Dicellograptus,** Hopkinson.

FIGS.

1 *a—d.*—*Dicellograptus complanatus*, Lapworth. (Page 139.)
- 1 *a*. Typical form. Dobb's Linn, Moffat. Upper Hartfell Shales (base of "Barren Mudstones"). Lapworth's Collection.
- 1 *b*. Typical form, showing "initial" and "lateral" spines. Same slab as 1 *a*.
- 1 *c*. More convergent form. Dobb's Linn, Moffat. Upper Hartfell Shales. Wood's Collection.
- 1 *d*. Form with slightly curved stipes. On same slab as figs. 1 *a* and 1 *b*.

2 *a—c.*—*Dicellograptus complanatus*, var. *ornatus*, Elles and Wood, nov. (Page 140.)
- 2 *a*. Typical specimen, showing apex of sicula. Dobb's Linn, Moffat. Upper Hartfell Shales (zone of *D. anceps*). Sedgwick Museum.
- 2 *b*. Specimen with extremely inconspicuous "lateral" spines. Dobb's Linn, Moffat. Upper Hartfell Shales. Elles' Collection.
- 2 *c*. Small specimen with more divergent stipes. Dobb's Linn, Moffat. Upper Hartfell Shales. Elles' Collection.

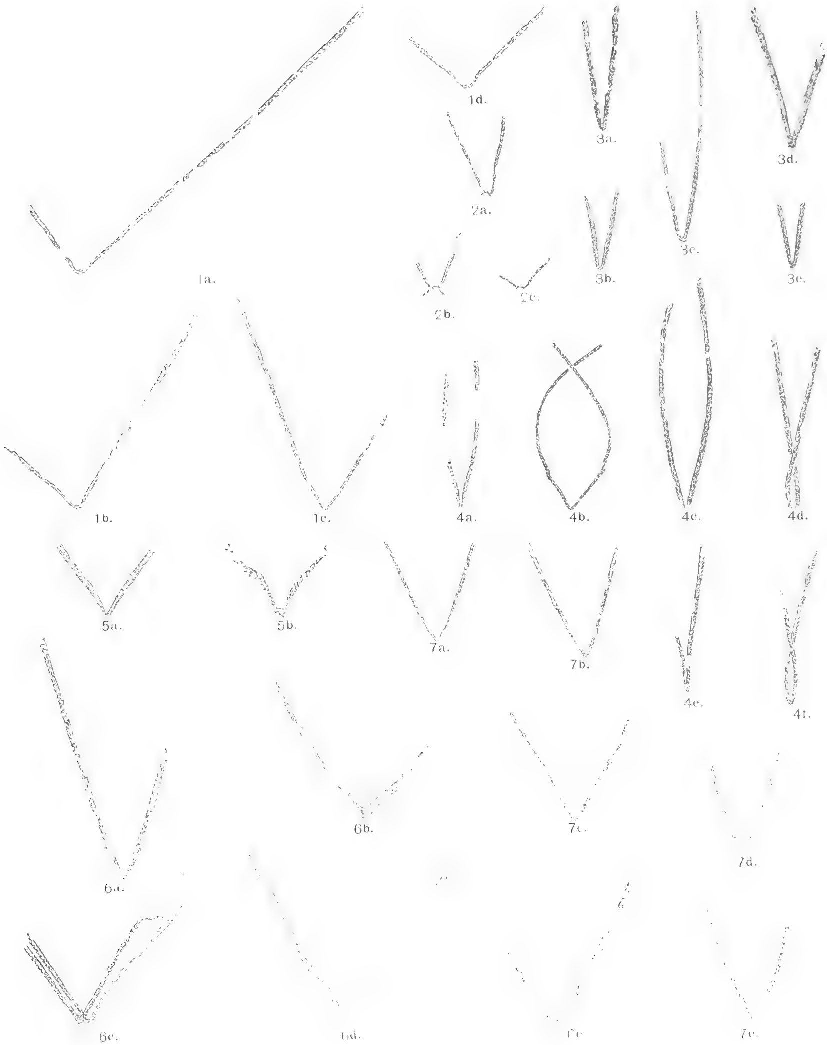
3 *a—e.*—*Dicellograptus anceps*, Nicholson. (Page 141.)
- 3 *a*. Typical form in low relief. Dobb's Linn, Moffat. Upper Hartfell Shales (zone of *D. anceps*). Wood's Collection.
- 3 *b*. Smaller specimen, showing apex of sicula. Ibid. Lapworth's Collection.
- 3 *c*. Very long specimen, but indifferently preserved. Ibid.
- 3 *d*. Broad specimen, somewhat distorted, with indications of a "web" in the axil. Ettrick-bridge-end. Upper Hartfell Shales. Geological Survey of Scotland, Edinburgh Museum.
- 3 *e*. Small, but well-preserved specimen in low relief showing mesial spines. Dobb's Linn, Moffat. Upper Hartfell Shales. Wood's Collection.

4 *a—f.*—*Dicellograptus intortus*, Lapworth. (Page 146.)
- 4 *a*. Typical form. Birnock Water, S. Scotland. Glenkiln Shales. Lapworth's Collection.
- 4 *b*. Somewhat narrow specimen with stipes crossing. Carco, Crawick Water. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
- 4 *c*. Large, but incomplete specimen. Gwernyfed, Builth Road, Radnorshire. "*Cœnograptus*" Beds, Glenkiln. Dr. Fraser's Collection, Wolverhampton.
- 4 *d*. Specimen showing crossing of stipes near proximal extremity. Ibid.
- 4 *e*. Specimen showing parallelism of stipes near proximal extremity. Ibid.
- 4 *f*. Specimen showing proximal extremity. Same slab as fig. 4 *d*.

5 *a, b.*—*Dicellograptus*, cf. *divaricatus*, Hall. (Page 143.)
- 5 *a*. Wide form showing sudden increase in breadth of stipes. Wanlock Head, S. Scotland. Glenkiln Shales. Lapworth's Collection.
- 5 *b*. Very poorly preserved specimen. Figured as *D. moffatensis*, Hopkinson and Lapworth, Quart. Journ. Geol. Soc., 1875, vol. xxxi, pl. xxxv, fig. 5 *b*. Abereiddy Bay, S. Wales. Middle Llandeilo (Hicks). Sedgwick Museum.

6 *a—e.*—*Dicellograptus divaricatus*, var. *rigidus*, Lapworth. (Page 144.)
- 6 *a*. Typical form without "web" in axil. Birnock Water, S. Scotland. Glenkiln Shales. Lapworth's Collection.
- 6 *b*. Typical form with "web" in axil. Ibid.
- 6 *c*. Two narrower specimens in association, probably referable to this variety. Dobb's Linn, Moffat. Lower Hartfell Shales. Sedgwick Museum.
- 6 *d*. Specimen similar to fig. 6 *b*.
- 6 *e*. Specimen similar to fig. 6 *a*.

7 *a—e.*—*Dicellograptus divaricatus*, var. *salopiensis*, Elles and Wood. (Page 145).
- 7 *a*. Typical form. Spy Burn, Shropshire. Rorrington Flags ("*Cœnograptus*" Beds). Professor T. McK. Hughes' Collection, Sedgwick Museum.
- 7 *b*. Ibid.
- 7 *c*. Specimen with somewhat more widely divergent stipes. Birnock Water, S. Scotland. Glenkiln Shales. Lapworth's Collection.
- 7 *d*. Specimen showing sicula and "lateral" spines. Meggat Water, S. Scotland. Glenkiln Shales. Lapworth's Collection.
- 7 *e*. Typical specimen. Birnock Water. Glenkiln Shales. Lapworth's Collection.



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DICELLOGRAPTUS.

PLATE XXI.

Dicellograptus—(*continued*).

FIGS.

1 *a—e.*—*Dicellograptus sextans*, Hall. (Page 153.)

1 *a*. Type specimen of Hopkinson's *Dicranograptus formosus*, Geol. Mag., 1870, vol. vii, pl. xvi, figs. 2 *b*, 2 *c*, 2 *d*. Belcraig Burn. Glenkiln Shales. Sedgwick Museum.

1 *b*. Ibid. Fig. 2 *a*.

1 *c*. More widely divergent form. Belcraig Burn. Glenkiln Shales. Lapworth's Collection.

1 *d*. Typical form. Belcraig Burn. Glenkiln Shales. Wood's Collection.

1 *e*. Ditto. Lapworth's Collection.

2 *a—d.*—*Dicellograptus sextans*, var. *exilis*, Elles and Wood, nov. (Page 155.)

2 *a*. Typical form. Dobb's Linn, Moffat. Upper Glenkiln Shales. Wood's Collection.

2 *b*. Ditto. Birnock, S. Scotland. Glenkiln Shales. Lapworth's Collection.

2 *c*. Ditto. Wandel Water, Abington. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.

2 *d*. Ditto. On same slab as fig. 2 *c*.

3 *a—f.*—*Dicellograptus pumilus*, Lapworth. (Page 149.)

3 *a*. Large typical specimen. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

3 *b*. Imperfect specimen, but with typical form of axil. Hartfell Spa, Hartfell Shales. Lapworth's Collection.

3 *c*. Well-preserved specimen showing sicula. Ibid.

3 *d*. Incomplete specimen. Ibid.

3 *e*. Specimen showing sicula. Ibid.

3 *f*. Ditto. Conway Railway Cutting, N. Wales. Hartfell Shales. Lapworth's Collection.

4.—*Dicellograptus angulatus*, Elles and Wood, sp. nov. (Page 149.)

4. Portion of slab with examples showing typical habit. Morroch Bay. Upper Glenkiln to Lower Hartfell Shales. Geological Survey of Scotlaand, Edinburgh Museum.

5 *a—e.*—*Dicellograptus patulosus*, Lapworth. (Page 147.)

5 *a*. Typical form. Craigmichan Scaurs. Glenkiln Shales. Lapworth's Collection.

5 *b*. Typical form with long sicula. Same slab as fig. 5 *a*.

5 *c*. Somewhat more slender form. Builth. Glenkiln Shales. Lapworth's Collection.

5 *d*. Specimen widened by compression, showing prominent "initial" and "lateral" spines. Belcraig Burn. Glenkiln Shales. Wood's Collection.

5 *e*. Slender specimen. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.

6 *a—d.*—*Dicellograptus Morrisi*, Hopkinson. (Page 155.)

6 *a*. Young specimen, doubtfully referable to this species. Figured, Hopkinson, Geol. Mag., 1871, vol. viii, pl. i, fig. 2 *e*. Dobb's Linn. Hartfell Shales. Sedgwick Museum.

6 *b*. Typical form. Glenkiln Burn. Hartfell Shales. Lapworth's Collection.

6 *c*. Ditto. Dobb's Linn. Hartfell Shales. Lapworth's Collection.

6 *d*. Ditto. Hartfell Spa. Wood's Collection.

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DICELLOGRAPTUS.

PLATE XXII.

Dicellograptus—*continued*.

FIGS.

1 *a—d.*—*Dicellograptus Forchammeri*, Geinitz. (Page 150.)

1 *a*. Typical form. Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iv, fig. 88. Dobb's Linn. Hartfell Shales (zone of *Dicranog. Clingani*). Lapworth's Collection.

1 *b*. Typical form, on same slab as fig. 1 *a*.

1 *c*. Less widely divergent form. Syart Law. Hartfell Shales. Lapworth's Collection.

1 *d*. Less rigid form. Figured, Hopkinson, Geol. Mag., 1871, vol. viii, pl. i, fig. 1 *a*. Hartfell Spa. Hartfell Shales. Sedgwick Museum.

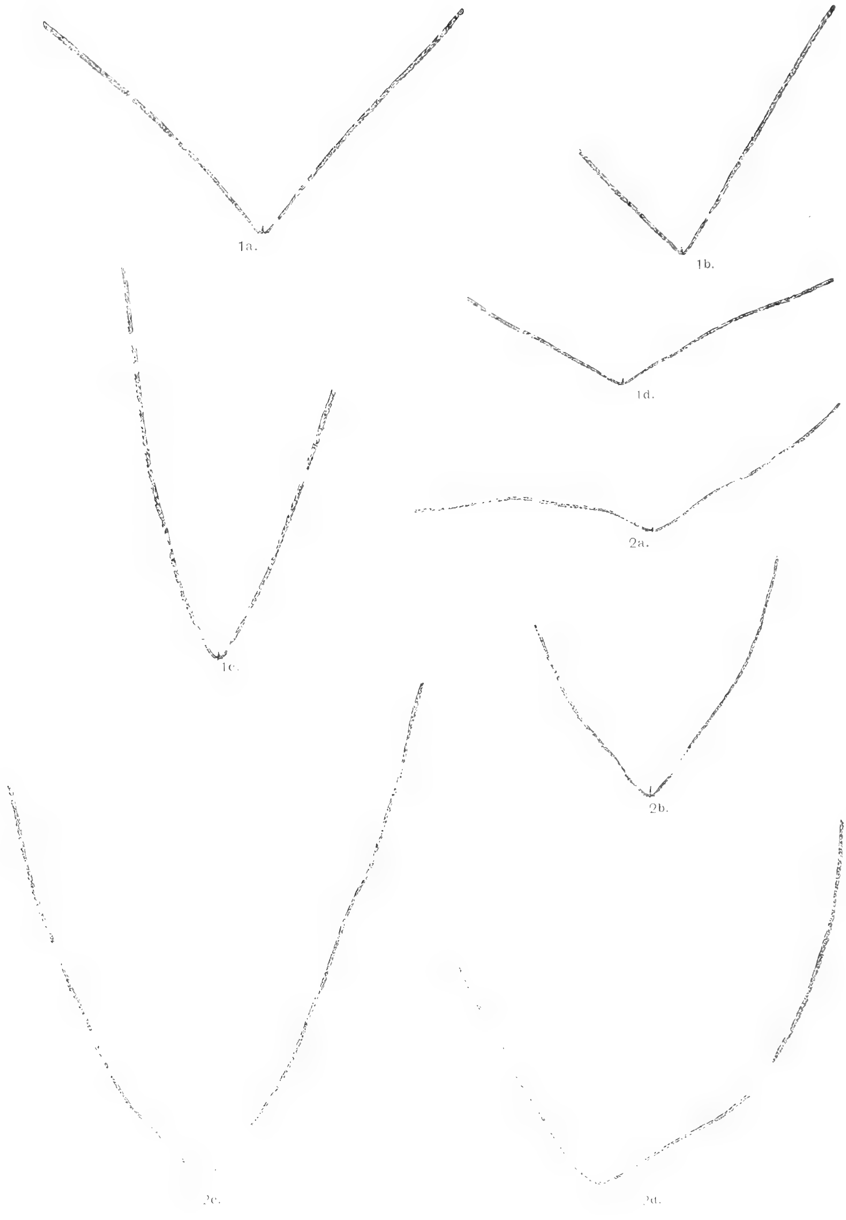
2 *a—d.*—*Dicellograptus Forchammeri*, var. *flexuosus*, Lapworth. (Page 152.)

2 *a*. ? Type specimen. Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iv, fig. 90. Dobb's Linn. Hartfell Shales. Lapworth's Collection.

2 *b*. Less widely divergent form, obverse aspect. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

2 *c*. Large form, reverse aspect. Ibid.

2 *d*. On same slab as fig. 2 *a*.



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DICELLOGRAPTUS.

PLATE XXIII.

Dicellograptus—*continued.*

FIGS.

1 *a—f.*—*Dicellograptus moffatensis*, Carruthers. (Page 157.)

1 *a.* ? Type specimen. Figured, Carruthers, Trans. Roy. Phys. Soc. Edinb., p. 469, fig. 3. Hartfell Spa. Hartfell Shales. Museum of Natural History, S. Kensington.

1 *b.* Typical form. Glenkiln Burn. Hartfell Shales (zone of *Dicranog. Clingani*). Lapworth's Collection.

1 *c.* Specimen with continuously divergent stipes. On same slab as fig. 1 *b.*

1 *d.* Widely divergent form, doubtfully referable to this species. Craigmichan Scaurs, Selcoth Burn. Hartfell Shales. Lapworth's Collection.

1 *e.* Specimen figured, Hopkinson, Geol. Mag., 1871, vol. viii, pl. 1, figs. 4 *a*, *b*. Hartfell Spa. Hartfell Shales. Sedgwick Museum.

1 *f.* Poorly preserved specimen. Figured, Hopkinson and Lapworth, Quart. Journ. Geol. Soc., 1875, vol. xxxi, pl. xxxv, fig. 5 *a.*

2 *a—e.*—*Dicellograptus elegans*, Carruthers. (Page 159.)

2 *a.* Type specimen. Figured, Carruthers, Geol. Mag., 1868, vol. v, pl. v, fig. 8 *d.* Dobb's Linn. Hartfell Shales. Museum of Natural History, S. Kensington.

2 *b.* Small specimen. Figured, Hopkinson, Geol. Mag., 1871, vol. viii, pl. i, figs. 3 *a*, *b*. Dobb's Linn. Hartfell Shales. Sedgwick Museum.

2 *c.* Ibid., figs. 3 *c*, *d.*

2 *d.* Typical form. Dobb's Linn. Hartfell Shales (zone of *Pleurog. linearis*). Lapworth's Collection.

2 *e.* Typical form, showing prominent "lateral" spines. Hartfell Spa, Hartfell Shales. Lapworth's Collection.

3.—*Dicellograptus elegans*, var. *rigens*, Lapworth, MS. (Page 161.)

3. Typical rigid form. Mount Benger Burn, Selkirkshire. Hartfell Shales. Lapworth's Collection.

4 *a—c.*—*Dicellograptus caduceus*, Lapworth. (Page 161.)

4 *a.* Typical form. Dobb's Linn. Hartfell Shales. Lapworth's Collection.

4 *b.* Large specimen. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

4 *c.* Specimen with stipes crossing only once. Ibid.

BRITISH GRAPTOLITES. *PLATE XXIII.*

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DICELLOGRAPTUS.

PLATE XXIV.

Genus **Dicranograptus,** Hall.

FIGS.

1 *a—i.—Dicranograptus Clingani*, Carr. (Page 165.)

1 *a*. Type specimen. Figured, Carruthers, Geol. Mag., 1868, vol. v, pl. v, fig. 6 *a*. Hartfell Spa. Hartfell Shales. Museum of Natural History, S. Kensington.

1 *b*. Specimen figured, Hopkinson, Geol. Mag., 1870, vol. vii, pl. xvi, figs. 4 *a—b*. Dobb's Linn. Hartfell Shales. Sedgwick Museum.

1 *c*. Specimen with small axillary angle. Dobb's Linn. Hartfell Shales. Lapworth's Collection.

1 *d*. Typical form. Hartfell Spa. Hartfell Shales. Museum of Natural History, S. Kensington.

1 *e*. Specimen with large axillary angle. Railway cutting, Conway, N. Wales. Hartfell Shales. Lapworth's Collection.

1 *f*. Typical form. Dobb's Linn. Hartfell Shales. Lapworth's Collection.

1 *g*. Small, well-preserved specimen. Ibid.

1 *h*. Ditto.

1 *i*. Ditto.

2 *a—b.—Dicranograptus tardiusculus*, Lapworth, MS. (Page 167.)

2 *a*. Specimen with long stipes. Ardmillan Brae, Girvan. Balclatchee Beds. Mrs. Gray's Collection, Edinburgh.

2 *b*. Specimen with well-preserved biserial portion. Ibid.

3 *a—d.—Dicranograptus brevicaulis*, Elles and Wood, sp. nov. (Page 168.)

3 *a*. Typical form in low relief. Spy Burn, Shropshire. Rorrington Flags (" *Cœnograptus* " Beds). H.M. Geological Survey Collection.

3 *b*. Somewhat flattened specimen. Ibid.

3 *c*. Typical specimen in partial relief. Spy Burn. Rorrington Flags. Lapworth's Collection.

3 *d*. Small specimen, figured, Lapworth, as *D. formosus*, Hopk., Cat. West. Scott. Foss., pl. iii, fig. 75. Birnock Water. Glenkiln Shales. Lapworth's Collection.

4 *a—e.—Dicranograptus rectus*, Hopkinson. (Page 169.)

4 *a*. Well-preserved typical specimen. Birnock Water. Glenkiln Shales. Lapworth's Collection.

4 *b*. Poorly preserved specimen. Wanlockhead. Glenkiln Shales. Lapworth's Collection.

4 *c*. Poorly preserved specimen. Figured, Salter, as *D. ramosus*, Quart. Journ. Geol. Soc., 1849, vol. v, pl. i, Fig. 7. Loch Ryan. Glenkiln Beds. Geological Society of London.

4 *d*. Ditto.

4 *e*. Typical form, but indifferently preserved. Laggan Gill, Glengonner Water. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.

5 *a—b.—Dicranograptus celticus*, Elles and Wood, sp. nov. (Page 170.)

5 *a*. Typical specimen, slightly distorted. Glentewing Burn, Duneaton Water. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.

5 *b*. Undistorted specimen. Rein Gill, Wandel Water. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.

6 *a—b.—Dicranograptus ramosus*, Hall. (Page 175.)

6 *a*. Typical form. Dobb's Linn. Hartfell Shales. Sedgwick Museum.

6 *b*. Flexed form, doubtfully referable to this species. Syart Law, Peebleshire. Hartfell Shales. Lapworth's Collection.

7 *a—c.—Dicranograptus ramosus*, var. *longicaulis*, Lapworth, MS. (Page 177.)

7 *a*. Typical form. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

7 *b*. Specimen figured, Hopkinson, as *D. ramosus*, Geol. Mag., 1870, vol. vii, pl. xvi, fig. 5 *a*. Dobb's Linn. Hartfell Shales. Sedgwick Museum.

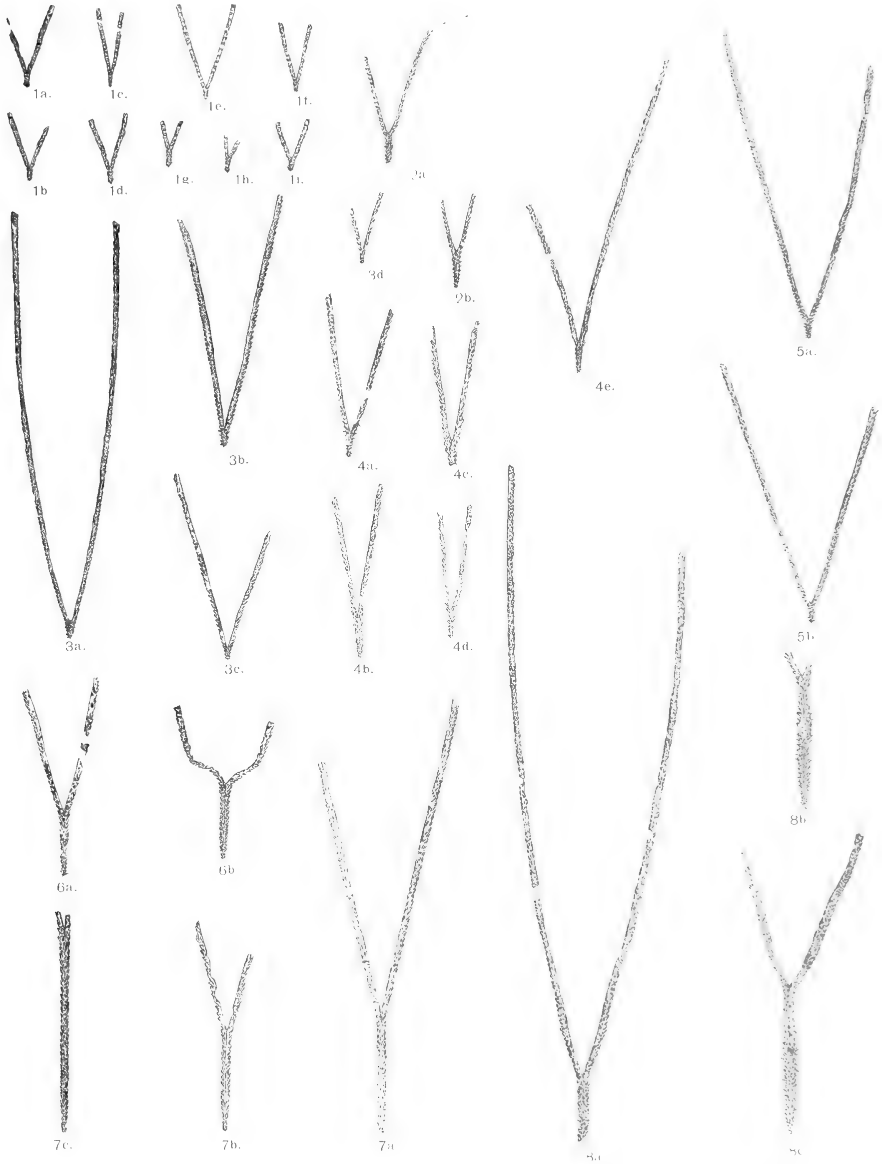
7 *c*. Specimen with very long biserial portion. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

8 *a—c*. *Dicranograptus ramosus*, var. *spinifer*, Lapworth, MS. (Page 176.)

8 *a*. Large specimen with incomplete biserial portion. Sowen Dod, Wanlockhead. Glenkiln Shales. Lapworth's Collection.

8 *b*. Biserial portion showing spines. Cairn Hill. Glenkiln Shales. Lapworth's Collection.

8 *c*. Typical form. Railway Cutting, Kirkton. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.



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DICRANOGRAPTUS.

PLATE XXV.

Dicranograptus—(*continued*).

FIGS.

1 *a*—*h*.—*Dicranograptus Nicholsoni*, Hopkinson. (Page 171.)

1 *a*. Very large typical specimen. Hartfell Spa. Hartfell Shales. Wood's Collection.

1 *b*. Ditto. Dobb's Linn. Hartfell Shales. Lapworth's Collection.

1 *c*. Specimen in partial relief. Dobb's Linn. Hartfell Shales (zone of *Climacog. Wilsoni*). Wood's Collection.

1 *d*. Wide, flattened specimen. Hartfell Spa. Hartfell Shales (zone of *D. Clingani*). Lapworth's Collection.

1 *e*. Specimen with abnormally developed spines. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

1 *f*. Type specimen. Figured, Hopkinson, 'Geol. Mag.,' 1870, vol. vii, pl. xvi, fig. 3 *a*. Dobb's Linn. Hartfell Shales. Sedgwick Museum.

1 *g*. Specimen with long biserial portion and curved stipes. Craigmichan Scaurs. Glenkiln Shales. Geological Survey of Scotland. Edinburgh Museum.

1 *h*. Specimen on same slab as, and lying in a direction at right angles to, Fig. 1 *g*.

2 *a*—*c*.—*Dicranograptus cyathiformis*, Elles and Wood, sp. nov. (Page 174.)

2 *a*. Typical form. Dobb's Linn. Hartfell Shales. Sedgwick Museum. (Presented by Mr. William Swanston, Belfast.)

2 *b*. Counterpart of same specimen.

2 *c*. Larger specimen doubtfully referable to this species. Hartfell Spa. Hartfell Shales. Wood's Collection.

3 *a*—*d*.—*Dicranograptus ziczac*, Lapworth. (Page 177.)

3 *a*. Type specimen. Figured, Lapworth, Cat. West Scott. Foss., pl. iii, fig. 77. Dobb's Linn. Glenkiln Shales. Lapworth's Collection.

3 *b*. Large specimen. Craigmichan Scaurs. Glenkiln Shales. Lapworth's Collection.

3 *c*. Specimen with stipes crossing. Belcraig Burn. Glenkiln Shales. Sedgwick Museum. (Presented by Mr. Swanston.)

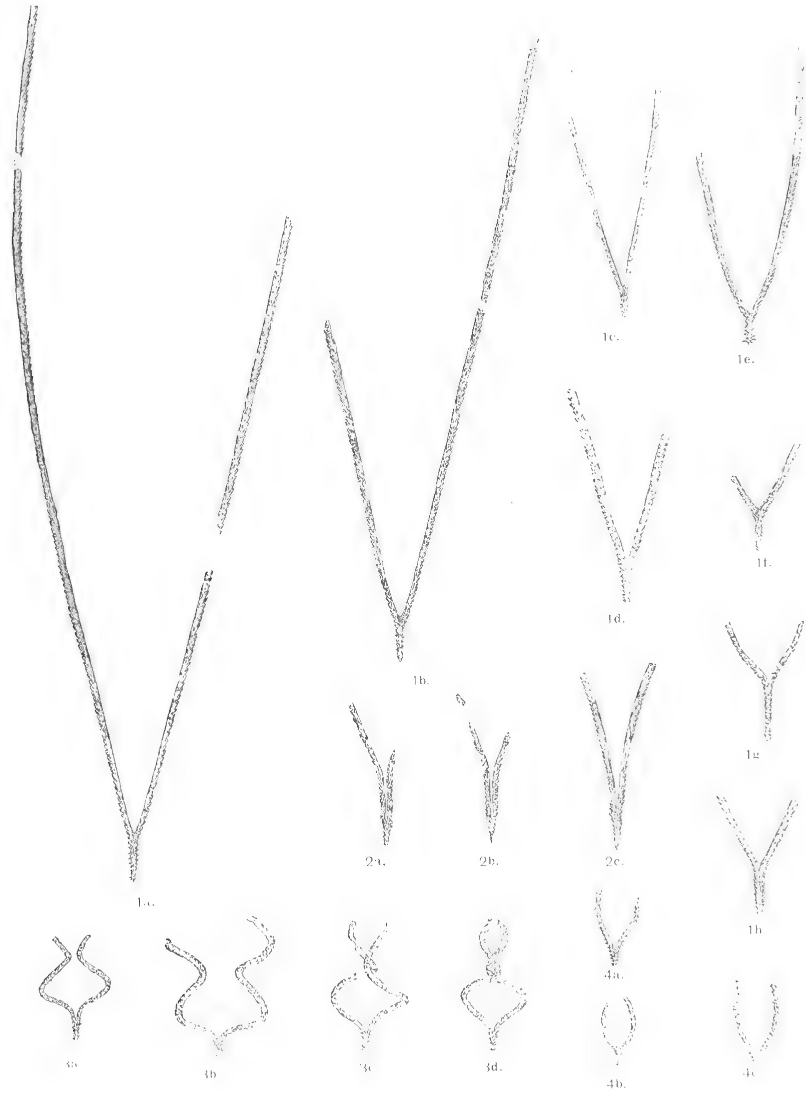
3 *d*. Specimen with stipes interlocking. Ibid.

4 *a*—*c*.—*Dicranograptus furcatus*, var. *minimus*, Lapworth. (Page 179.)

4 *a*. Specimen showing mesial spines. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.

4 *b*. Type specimen. Figured, Lapworth, Cat. West Scott. Foss., 1876, pl. iv, fig. 77 *a*. Cairn Hill. Glenkiln Shales. Lapworth's Collection.

4 *c*. Specimen with biserial portion incomplete, but showing mesial spines on the most distal thecæ of the uniserial stipes. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.



E. M. R. Wood, del.

DICRANOGRAPTUS