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OF

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BATHONIAN AMMONITES

BY THE LATE

W. J. ARKELL, M.A., D.Sc., F.R.S.

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## TABLE OF CONTENTS

SECTION I. INTRODUCTION . . . . .	1
1. THE BATHONIAN AMMONITE FAUNA . . . . .	1
2. PREVIOUS WORK: ACKNOWLEDGMENTS . . . . .	4
3. STRATIGRAPHY . . . . .	6
The Great Oolite Series and its subdivisions, and the distribution of ammonites . . . . .	6
Dorset and South Somerset . . . . .	7
TABLE I.—Stages, Formations and Zones . . . . .	8
Bath and the South Cotswolds . . . . .	11
North Cotswolds and Oxfordshire . . . . .	13
Summary of the distribution of Bathonian ammonites . . . . .	15
Provisional table of Bathonian Zones . . . . .	19
TABLE II.—Bathonian Zones . . . . .	21
SECTION II. SYSTEMATIC PART . . . . .	27
HARPOCERATAEÆ ( <i>recte</i> Hildocerataeæ) . . . . .	27
SONNINIDÆ . . . . .	27
<i>Vastites</i> . . . . .	27
CLYDONICERATIDÆ . . . . .	30
Synopsis of genera . . . . .	30
Specific descriptions . . . . .	33
<i>Clydoniceras</i> . . . . .	33
<i>Delecticeras</i> . . . . .	44
<i>Micromphalites</i> . . . . .	45
OPPELIACEÆ ( <i>recte</i> Haplocerataeæ) . . . . .	47
HAPLOCERATIDÆ . . . . .	48
<i>Lissoceras</i> . . . . .	49
OPPELIIDÆ . . . . .	50
Synopsis of genera . . . . .	50
Specific descriptions . . . . .	55
<i>Oppelia</i> ( <i>Oxyerites</i> ) . . . . .	55
<i>Æcotraustes</i> . . . . .	67
<i>O.</i> ( <i>Paræcotraustes</i> ) . . . . .	69
<i>Hecticoceras</i> ( <i>Prohctioceras</i> ) . . . . .	72
STEPHANOCERATAEÆ . . . . .	74
TABLE III.—Evolution of Stephanocerataeæ . . . . .	75
STEPHANOCERATIDÆ . . . . .	79
<i>Cadomites</i> . . . . .	80

TULITIDÆ . . . . .	82
Synopsis of genera . . . . .	84
Specific descriptions . . . . .	91
<i>Tulites</i> . . . . .	91
<i>T. (Rugiferites)</i> . . . . .	104
<i>Bullatimorphites</i> . . . . .	105
<i>Krumbeckia</i> . . . . .	111
MACROCEPHALITIDÆ . . . . .	113
Synopsis of genera . . . . .	113
Specific descriptions . . . . .	119
<i>Morrisiceras</i> . . . . .	119
<i>Lyceticeras</i> . . . . .	124
PERISPINCTACEÆ . . . . .	129
MORPHOCERATIDÆ . . . . .	129
Synopsis of genera . . . . .	129
Specific descriptions . . . . .	132
<i>Morphoceras</i> . . . . .	132
<i>Polysphinctites</i> . . . . .	138
<i>Ebrayiceras</i> . . . . .	139
PARKINSONIIDÆ . . . . .	142
Synopsis of genera . . . . .	143
Specific descriptions . . . . .	146
<i>Parkinsonia</i> . . . . .	146
<i>P. (Gonolkites)</i> . . . . .	153
<i>P. (Durotrigensia)</i> . . . . .	160
PERISPINCTIDÆ . . . . .	163
LEPTOSPINCTINÆ . . . . .	166
Synopsis of genera . . . . .	166
ZIGZAGICERATINÆ . . . . .	169
Synopsis of genera . . . . .	169
Specific descriptions . . . . .	177
<i>Zigzagiceras</i> . . . . .	177
<i>Procerozigzag</i> . . . . .	179
<i>Procerites</i> . . . . .	181
<i>P. (Gracilispinctes)</i> . . . . .	197
<i>P. (Phaulozigzag)</i> . . . . .	203
<i>Wagnericeras</i> . . . . .	204
<i>W. (Suspensites)</i> . . . . .	206
PSEUDOPERISPINCTINÆ . . . . .	211
Synopsis of genera . . . . .	211
Specific descriptions . . . . .	215
<i>Choffatia</i> . . . . .	215
<i>C. (Loboplanulites)</i> . . . . .	219
<i>C. (Homæoplanulites)</i> . . . . .	225

TABLE OF CONTENTS.

v

<i>Siemiradzka</i> . . . . .	227
<i>S. (Planisphinctes)</i> . . . . .	230
<i>Berbericeras</i> . . . . .	230
ADDITIONAL SPECIES . . . . .	231
<i>Polyplectites periami</i> . . . . .	231
SECTION III. CONCLUSIONS . . . . .	233
1. CONCLUDING REMARKS ON THE PHYLOGENY OF THE ENGLISH BATHONIAN AMMONITES . . . . .	233
2. GEOGRAPHICAL ORIGIN OF THE BATHONIAN AMMONITE FAUNAS . . . . .	236
3. CONCLUDING REMARKS ON BATHONIAN STRATIGRAPHY . . . . .	237
4. STRATIGRAPHICAL SUMMARY . . . . .	238
5. ADDITIONS AND CORRECTIONS . . . . .	243
BIBLIOGRAPHY . . . . .	246
INDEX . . . . .	259

AUTHOR'S PREFACE.<sup>1</sup>

The beginning of this monograph was the first piece of work undertaken when I came to Cambridge in November, 1947, and it has been much stimulated and facilitated by the fine collection of relevant ammonites in the Sedgwick Museum. At that time I was much interested in the possibilities of correlating the Great Oolite and Fuller's Earth provinces by means of ammonites and geological mapping, and of zoning the Bathonian, and every spring and autumn vacation I went to the Cotswolds on a mapping expedition. Besides the maps published in Arkell & Donovan, 1952, from Lansdown to the Stroud district, maps were also made of the Great Oolite of the Evenlode Valley ('Proc. Geol. Assoc.', lviii, 1947) and the Windrush Valley ('Oxford Stone', 1947, folding fig. 27 at end) with the object of establishing the stratigraphical succession, and of assessing the precise stratigraphical significance of ammonites found in the Great Oolite of Asthall and Hampen and in the Chedworth railway-cuttings. Minchinhampton Common was also mapped to determine the position and sequence of the beds that had yielded Morris & Lycett's types, but this map was not published because of major uncertainties about the succession and the obscuring of outcrops round the plateau-edge by extensive slips. Accordingly, statements about stratigraphy in the early part of this work were made with a sound field knowledge which was not available when I wrote the 'Geology of Oxford', and the correlations there made were unfortunately wrong (p. 35 and Chapter 4). During most of the time the monograph has been in progress I have also been mapping the area where the Great Oolite first appears, between Wellow and Norton St. Philip, south of Bath, and it is hoped to publish the results in a paper in collaboration with Dr. D. T. Donovan now in preparation.

After sudden illness in September, 1956, had deprived me of the use of my left limbs and of half my eyesight, completion of the monograph would have been impossible without the help of friends. While I was in hospital, Mr. A. G. Brighton kindly took Parts VII and VIII to be typed by Mrs. D. M. Stockbridge as before, and checked the typescript and gave much valued help in reading the proofs. The Editor, Mr. R. V. Melville, did far more work than could normally have been expected of an editor, especially on the Stratigraphical Summary and the Bibliography. Miss Erica Panzer in 1957 and 1958 lent me her quick young eyes and was my left hand, and without her untiring help and encouragement I could have done nothing at all.

W. J. A.

February, 1958.

<sup>1</sup> The author died suddenly on 15th April, 1958, while the last part of his Monograph was in the Press.—EDITOR.



## W. J. ARKELL, D.Sc., F.R.S., F.G.S.

The death of W. J. Arkell on 15th April, 1958, at the age of 53, has deprived the world of a figure of unique authority in all aspects of Jurassic geology. Much could still have been expected from him, yet the record of his achievement would be exceptional even for a much older man. His devotion to his work was so complete and his techniques were so highly developed that it might almost be thought that he foresaw the too-early closing of his career. If this was so, he was not lacking in courage to meet the challenge of time. For the last 15 years of his life he was handicapped by illness of a kind which could well have explained a loss of both quantity and quality in his work, and after a severe stroke in September, 1956, he was in constant pain. Yet the very fact of his ill-health was unknown to many (and could not have been deduced from any change in his work), and to the last he made daily efforts to beat his paralysis and half-blindness in confidently-expressed hope of working on.

He joined the Palæontographical Society in 1927 and served as a Member of Council in 1930—34, 1936—40, 1947—52 and 1953—57. His publications in the Society's volumes are the Monographs on Corallian Lamellibranchia (1929—37), Corallian Ammonites (1935—48), Bathonian Ammonites (1951—58) and (with Dr. L. R. Cox) A Survey of British Great Oolite Mollusca (1948—50). This last was the first of a series of synoptic supplements to earlier monographs the idea of which originated with him.

Perhaps his outstanding quality was his power to relate accurately observed detail to underlying principles, and to present this relationship in prose of exceptional clarity and strength. His reserved manner was a symptom of intense shyness, yet he was capable of warm friendship which, once given, was never withdrawn.

R. V. MELVILLE.

5. *Wagnericeras (Suspensites) suspensum* (S. Buckman). Plate XXIX, figs. 6—8.

*Ammonites arbustigerus* Morris & Lycett, 1851, p. 12, pl. ii, figs. 4, 4a (non d'Orbigny).

*Suspensites suspensum* S. Buckman, 1922, TA, iv, pl. CCCXLVI.

? *Perisphinctes (Suspensites) suspensum* de Grossouvre, 1930, p. 370.

? *Suspensites suspensum* Wetzel, 1937, p. 111.

*Wagnericeras suspensum* Cox & Arkell, 1950, p. 94.

*Dimensions.*—

Higher Alham, SM. J28994.	Max. 138 mm.	At 120 mm. :	·48,	·42,	·24.
		At 100 mm. :	·45,	·45,	·30.
Minchinhampton, SM. B3790.	Max. 95 mm.	At 95 mm. :	·46,	·?,	·24.
		At 70 mm. :	·44,	·455,	·285.
Holotype, GSM. 25609.	Max. 69 mm.	At 69 mm. :	·435,	·45,	·28.
		At 55 mm. :	·42,	·42,	·33.

*Description.*—The Higher Alham Fuller's Earth Rock specimen is septate to about 80 mm. and has nearly a whorl of body-chamber. In the wholly septate holotype the coiling is involute, the umbilicus deep and crater-like, the ribbing coarse and strong, gently prorsiradiate, with a slight forward swing across the venter. There are 23 primaries and 61 secondaries on the holotype at about 70 mm. The primaries are short and the secondaries arise by bifurcation and as intercalatories. The ribbing on the umbilicus becomes gradually finer towards the centre. Septal sutures are open, perisphinctid rather than proceritid, but with a very tall and radially-directed first auxiliary lobe. The test is preserved on both Minchinhampton specimens but is badly scraped. The Fuller's Earth Rock specimen from Higher Alham is an internal cast. Another cast from the Fuller's Earth Rock of Lovers Lane, Sherborne, is septate to 213 mm. and just retains the beginning of the body-chamber. This is identified specifically only with hesitation, but it shows all the characters of *W. suspensum*, allowing for the much larger size than other material known so far.

*Comparisons.*—Morris & Lycett's identification of this species with *Am. arbustigerus* d'Orbigny was very close. Indeed, at the size of their specimen the two species are hardly distinguishable. A small specimen from Niort, Deux-Sèvres, in the d'Orbigny collection (Text-fig. 76) which is identical with the lectotype at the beginning of the last whorl, serves to show that the inner whorls are very close to those of *W. suspensum*. *W. arbustigerum* begins to differ after about 50 mm. by earlier fading of the primary ribs, by flattening and heightening of the whorls, and by narrowing of the umbilicus.

A fragment from the Upper Fuller's Earth clay of Langton Herring, near Weymouth, recorded as ? *Wagnericeras* sp. (Arkell, 1940, p. 48) is comparable with this species but is too small for definite identification.

*Distribution.*—Great Oolite: Minchinhampton, in white shelly oolite (holotype, GSM. 25609; topotype, SM. B3790).

Fuller's Earth Rock: Roadside 500 ft. W. of Higher Alham Farm, Somerset (P. C. Sylvester Bradley Coll., 1949, SM. J28994). Duncorn Hill, field brash, a fragment

probably of this species (W. S. McKerrow Coll., 1948). Lovers Lane, Sherborne (J. Fowler Coll., 1950, pipe trench, SM. J34792).

France : Recorded by de Grossouvre (1930, p. 370) from Montreuil-Bellay and by Wetzel (1937, p. 111) from Vandenesse.

## Subfamily PSEUDOPERISPHINCTINÆ Schindewolf (1925, pp. 316, 318).

(Synonyms *Grossouvriinæ* Spath, 1930; *Berbericeratinæ* Westermann, 1956 [excluding *Schwandorfia* and *Krumbeckia* Arkell, see above, pp. 87, 89, Tullitidæ].)

1. **CHOFFATIA** Siemiradzki (1898, pp. 79, 333). Genosyntypes: "Mutationsreihe des *Perisphinctes cobra* Waagen". Genolectotype *P. cobra* Waagen (1875, p. 174, pl. xlv, fig. 1) designated by Buckman (1920, TA, iii, p. 29); from the Middle Callovian, Cutch, India. The type species has been discussed and redefined, but not refigured, by Spath (1931, p. 344), who states that it was misinterpreted by all authors. According to Spath it belongs to the group of *P. balinensis* Neumayr (1871, p. 42, pl. xv, fig. 2), to which it is connected by transitions, and *P. furcula* Neumayr (1871, p. 41, pl. xv, fig. 1). In using the name *Choffatia* for several English and European Bathonian forms he wrote (1931, p. 325): "While *Choffatia* thus differs from *Procerites* (with which it is connected by forms like *C. furcula* and *C. balinensis* Neumayr sp.) chiefly in having distant and blunt primaries at an early stage, and in remaining evolute, it is distinguished from *Siemiradzki* principally by the pronounced differentiation of the costæ into primaries and secondaries," and again (1931, p. 281): "*Choffatia* . . . differs from its possible ancestor, the similarly evolute *Siemiradzki*, in the differentiation of primary and secondary costation and the absence of characteristic single ribs." The course of development of the ribbing in *Siemiradzki* is entirely different.

The type species and *C. balinensis* and perhaps *C. furcula* are a Middle and Lower Callovian group of large constricted forms with gradually-modifying ribs and smoothing venter, and no lappets, analogous with the subgenus *Arisphinctes* among Upper Oxfordian Perisphinctids. To judge by Waagen's figures, the type species, *C. cobra*, belongs to the distinctive group of *Choffatia waageni*, which has been well figured by Petitclerc (1915, pl. ix, fig. 1), Corroy (1932, pl. xviii, fig. 1) and Pfaehler-Erath (1938, pl. ii, figs. 1, 2). The genus begins in the Middle Bathonian, and is common in the Upper Bathonian.

2. **HOMÆOPLANULITES** S. Buckman (1922, TA, iv, pl. CCCXXVIII). Type species by original designation *H. homæomorphus* S. Buckman, from the Cornbrash, Stalbridge Weston, Dorset. Though the inner whorls are more finely ribbed, the last half whorl of the holotype has the smooth and widened simple ribs and constrictions and parabolæ of *Choffatia waageni* (Teisseyre), but combined with lappets, though shorter than in *Siemiradzki* and *Grossowria*. *Homæoplanulites* may be ancestral to some Callovian *Grossowria* such as *G. cheyensis* Petitclerc (1915, p. 66, pl. vi, figs. 3, 4). Provisionally it is here regarded as a subgenus of *Choffatia* separated subgenerically as a microconch on account of the lappets.

**Anaplanulites** S. Buckman (1922, TA, iv, pl. CCCXXIX). Type species by original designation *A. difficilis* S. Buckman, Kellaways Rock, South Cave, Yorkshire. A perfect topotype collected by Mr. C. W. Wright shows a lappet. Except for smaller size, it is hard to find any specific distinction from *H. homæomorphus*. Synonym of *Homæoplanulites*.

3. **LOBOPLANULITES** S. Buckman (1925, TA, vi, pl. DXCVI). Type species by original designation *L. longilobatus* S. Buckman, from the Lower Cornbrash, Long Hanborough, Oxford (Text-fig. 81). Spath asserted (1931, p. 283) "The specimen is of course too badly preserved to be definitely identified", and for a long time I took the same view. However, having been kindly allowed by the Geological Survey to keep the specimen on loan for some 6 years, during which I have repeatedly compared it with a steadily growing number of Cornbrash and other *Choffatia*, I have come to the conclusion that the generic name must be used for a subgenus, to which I had originally given a new MS. name with "*Choffatia cerealis* sp. nov." (see p. 219) as type. This subgenus comprises what has usually been called "the *recuperoi* group" (Text-fig. 80, no. 1; Gemmellaro, 1872, p. 26, pl. v, figs. 9—11), which is analogous with the subgenus *Kranaosphinctes* of the Upper Oxfordian *Perisphinctes*, just as *Choffatia sensu stricto* is analogous with *Arisphinctes*, and *Homæoplanulites* with *Dichotomosphinctes*. It is a macroconch subgenus with simple aperture, like *Choffatia sensu stricto*, but characterized by stouter, rounded-convergent or circular, or even depressed, whorl section and more massive ribbing.

4. **SIEMIRADZKIA** Hyatt (1900, p. 582). Type species by original designation *Am. bakerice* d'Orbigny *pars* (1847, p. 424, pl. 149, fig. 1) (*non* pl. 148; *non* pl. 149, fig. 2; *non* Sowerby). This figure is usually considered type and is now designated lectotype of *Am. aurigerus* Oppel (1857, p. 476), for although Oppel referred to it only with a query, and under the wrong figure number (d'Orbigny's pl. 149, fig. 2, instead of fig. 1), he gave no other figure or reference, and the mistake in the number was obviously a slip, as pointed out by de Grossouvre (1888, p. 390), for the correct figure was referred to in the text, which also independently makes it clear which figure Oppel had in mind. There is no specimen resembling this figure in the d'Orbigny collection. Accordingly I regard de Grossouvre's photograph (1919, pl. xv, fig. 6) as illustrating the neotype. The type horizon is the Lower Bathonian of the Nièvre.

*Siemiradzka* is characterized by rather small size, evolute coiling, large lappets, and above all a peculiar "untidy" style of ribbing; the ribs are fine and wiry and more or less alternately simple and bifurcated, and sometimes tend to be interrupted and deflected by the parabolæ and parabolic nodes. On the last half-whorl of the adult the ribs become enlarged and more irregular. A number of species have been figured by Lissajous (1923) under the generic name *Grossouvria*, and generic distinction from *Grossouvria* except on stratigraphical grounds is difficult. *Siemiradzka* in the Bathonian is replaced by *Grossouvria* in the Callovian. The Bathonian forms are as a rule less constricted and have flatter whorl-sides than the Callovian *Grossouvria*. Some *Grossouvria* may have originated from *Homæoplanulites* rather than *Siemiradzka*; which for all these reasons (and because it has been in the literature for half a century) is worthy of retention as a separate genus, and has been placed on the Official List (Opinion 301).

5. **PLANISPHINCTES** S. Buckman (1922, TA, iv, pl. CCCXXVII). Type by original designation *P. planilobus* S. Buckman, from the Zigzag Bed, Burton Bradstock. Round or depressed-whorled, evolute, small, with large lappets, simple

suture-lines, and bifurcated ribs with rather widely-splayed secondaries and many simple ribs which do not bifurcate. There is little or no modification of the ribs on the body-chamber. The inner whorls at least, with their many simple ribs, are very similar to those of *Siemiradzkia* and *Pseudoperisphinctes* (e.g., de Grossouvre, 1919, pl. xv, figs. 3, 4, *Siemiradzkia procerus* Seebach sp.) and *Planisphinctes* is here regarded as a subgenus of *Siemiradzkia*. To it also belongs "*Bigotites*" *gredingensis* P. Dorn (1927, p. 243, pl. vi, fig. 7). This stock is probably on the direct line of descent from Leptosphinctinæ to Pseudoperisphinctinæ and closer to both than to Zigzagiceratinæ, which are a side shoot.

6. **PSEUDOPERISPHINCTES** Schindewolf (1923, p. 346). Type species by monotypy *Perisphinctes rotundatus* J. Roemer (1911, p. 44), Bathonian, Aspidoides Beds, of Lechstedt, near Hildesheim, N.W. Germany. Schindewolf's later nomination (1925, p. 319) of *Am. sulciferus* Oppel as genotype, which would have made *Pseudoperisphinctes* a synonym of *Siemiradzkia*, was invalid. It remained, however, to restrict and define *P. rotundatus* Roemer. Roemer's numerous figures and my own collecting at Lechstedt clay-pit in 1933 reveal the difficulties, owing to the rarity of outer or even middle whorls. The only figure showing some body-chamber, Roemer's pl. viii, fig. 2, was therefore designated lectotype (Arkell, 1950, p. 363). It is a medium-sized form, the outer whorl much as in *Choffatia* (especially *C. subbakeriæ* d'Orb.) and unlikely to be auriculate, but the inner whorls (Roemer's pl. ix) are much closer to those of *Siemiradzkia*. Spath (1931, pp. 280, 336) has referred them to *Siemiradzkia* on one page and to "*Indosphinctes* rather than *Procerites*" on another. At least Roemer's pl. ix, fig. 6, probably is a *Siemiradzkia* (cf. de Grossouvre, 1919, pl. xv, figs. 3, 4, 5). There are still numerous Bathonian species of Perisphinctids by no means fully understood, and as knowledge of their ontogenies improves no doubt this genus will be useful. It may be defined as comprising Perisphinctids with inner whorls like the inner and middle whorls of *Siemiradzkia*, combined with outer whorls like the middle whorls of *Choffatia* and *Gracilisphinctes*; and so far as known it is not auriculate. Wetzel's use of the genus (1937, p. 100 ff.) disregards the Rules of Nomenclature.

7. **BERBERICERAS** Roman (1933, p. 67). Type species by monotypy *B. sekikense* Roman (1933, p. 67, pl. ii, fig. 15), Lower Bathonian, Zigzag Zone, Gebel Sekika, Algeria. The holotype, the only specimen known to Roman, is a small nucleus only 12 mm. in diameter. Allied species occur in the Subcontractus Zone of England (Fuller's Earth Rock) and Bavaria ("*Aspidoides*"-Schichten). The general aspect is *Perisphinctes*-like, the inner whorls circular in section, the outer tending to heighten and become laterally compressed. The ribbing is fine and swept strongly forward on the umbilical margin, then swings round to almost radial on the outer half of the whorls and the venter. It is simple or irregularly bifurcating, the furcation taking place anywhere from the umbilical margin to the middle of the whorl-sides. Roman describes the type species as having a faint and impersistent siphonal groove, but none occurs on the European species. On the body-chamber of some species the ribs fade on the inner half of the whorl-sides and become accentuated on the venter, as

in *Siemiradzka aurigera* (Oppel). There are no constrictions. Sutures simple with few elements; second lateral lobe trifid. Roman (1938, p. 252) placed the genus tentatively in Kosmoceratidæ, by which he meant that it was allied to *Strenoceras* and *Garantiana*, but he described it originally (1933) between *Morphoceras* and *Ebrayiceras*. The marked prorsiradiate sweep of the ribbing on the inner half of the whorl is matched in *Ebrayiceras*, though in *Berbericeras* there is no bundling of the ribs, but better understanding of the type species has convinced me that the closest ally of this genus is *Siemiradzka*.

**Præsutneria** Model MS. in Schmidtil & Krumbeck (1931, p. 851). Type by monotypy *P. schwandorfensis* Krumbeck MS. Both genus and species were *nomina nuda* and the genus falls as a synonym of *Berbericeras* (confirmed by Prof. Krumbeck, 1949, *in lit.*). The type species is described below as *Berbericeras schwandorfense*.

8. **GROSSOUVRIA** Siemiradzki (1898, pp. 76, 79). Genoelectotype species *Perisphinctes subtilis* Neumayr, designated by S. Buckman (1920, TA, iii, p. 28). Buckman wrote "This makes *Per. subtilis* the genoholotype, which may be fixed with further precision on the holotype of the species, Neumayr, Balin, xiv, 3." Not only is the word genoholotype wrongly used in this sentence for genoelectotype, but also, as Spath (1931, p. 325) has pointed out, Neumayr's Balin figure (1871, pl. xiv, fig. 3) is not the holotype of *Per. subtilis*, which name was introduced a year earlier by Neumayr (1870, p. 156) as a substitution name for *Ammonites sulciferus* Oppel "non Münster", which by the Rules is thus the type species of *Grossouvria*.

The type specimen of *A. sulciferus* Oppel is in turn the original of the only figure cited by Oppel, namely *Am. convolutus ornati* Quenstedt (1846 (1849), pl. xiii, fig. 1), from the Callovian of Gammelshausen, Württemberg, a form which Oppel stated was common in the Athleta Zone of the Swabian Alb. Neumayr (1870, p. 156) renamed *Am. sulciferus* Oppel, alleging that the name was preoccupied by Münster, but gave no reference. No *Am. sulciferus* prior to Oppel is noted in Sherborn's 'Index Animalium', and Dr. J. H. Callomon kindly informs me that a systematic search of Münster's works leads him to suppose that Neumayr had in mind *Ceratites sulcifer* Münster (1841, 'Beiträge zur Petrefactenkunde' (1839—46), iv, p. 119, pl. xiii, fig. 15) from the Trias of St. Cassian, S. Tyrol, since he can find no ammonite with this name. *Ceratites sulcifer* does not, of course, invalidate *Ammonites sulciferus* Oppel. Oppel's name is therefore now retained and Quenstedt's figure is regarded as the holotype of the type species of *Grossouvria*, notwithstanding that Siemiradzki (1898, p. 81), when founding the genus, based it on Neumayr's later (Balin) figure (see Arkell, 1939, p. 157). *Grossouvria* when adult and complete has lappets (see e.g. Petitclerc, 1915, pls. v, vi). *P. artisulcus* Teisseyre (1889, p. 590) is an objective synonym of *P. subtilis* Neumayr, 1870 (same type specimen), and therefore also of *P. sulciferus* Oppel.

Lissajous (1923) used the name *Grossouvria* for the Bathonian forms now assigned to *Siemiradzka*, but the other Callovian and Lower Oxfordian genera and subgenera do not concern us (*Binatisphinctes*, *Hamulisphinctes*, *Klematosphinctes*, *Poculisphinctes*, *Trinisphinctes* Buckman (1920—22), *Subgrossouvria*, *Prososphinctoides*, *Indosphinctes*, *Orionoides* Spath (1924—31), *Mirosphinctes* Schindewolf (1926)).

Genus **CHOFFATIA** Siemiradzki, 1898 (see p. 211).

1. **Choffatia subbakeriæ** (d'Orbigny). Plate XXX, fig. 2 ; Plate XXXII, figs. 1, 8, 9 ; Text-figs. 78, 79.

*Ammonites bakeriæ* d'Orbigny, 1846, p. 424 *pars*, pl. 148 only (*non* J. de C. Sowerby).

*Ammonites subbakeriæ* d'Orbigny, 1850, Prodrome, i, p. 296 (for preceding).

*Ammonites Moorei* Oppel, 1857, p. 476 (objective synonym of preceding) (*non* Lycett, 1857, a *Dumortieria*).

*Ammonites subbakeriæ* de Grossouvre, 1888, p. 397.

*Ammonites subbakeriæ* de Grossouvre, 1891, p. 250.

*Non Perisphinctes subbakeriæ* Blake, 1905, p. 49, pl. v, fig. 2 (*C. homæomorpha* Buckman sp.).

*Non Perisphinctes subbakeriæ* Roman, 1930, p. 183, pl. xvi, fig. 6 (Callovian ; long secondaries show on umbilicus).

*Non Perisphinctes subbakeriæ* Corroy, 1932, p. 135, pl. xix, figs. 3-6, pl. xx, figs. 7-8, pl. xxi, fig. 7 (Callovian ; becomes coarse-ribbed much earlier).

? *Perisphinctes procerus* Seebach, Antonijevic, 1954, p. 95, pl. v, figs. 10, 11 (east Serbia).

*Choffatia subbakeriæ* Arkell, 1954, p. 119.

*Dimensions of holotype* (Text-fig. 78).—

Niort. Max. 152 mm., wholly septate. d'Orbigny coll. 2605.

At 150 mm. : ·31, c. ·26, ·46.

At 125 mm. : ·33, ·265, ·45.

Est. at 100 mm. : ·33, ·30, ·46.

*The Type*.—De Grossouvre (1888, p. 397) wrote : “ We shall take as type of this species the shell figured by d'Orbigny in his pl. 148 ” ; but he had no choice, for d'Orbigny had explicitly based the species on his pl. 148 to the exclusion of pl. 149. In 100 years no one has attempted to identify and refigure the original of pl. 148, which, if it exists, is the holotype. D'Orbigny stated that it was in his own collection and came from Niort (Deux-Sèvres), and that the figures were reduced by a half.

Dr. Jean Roger kindly allowed me to search in the d'Orbigny collection in Paris in April, 1950. I believe that no. 2605, a Niort specimen, is the holotype, and I now figure it as such (Text-fig. 78). (For a plaster cast of the original I am indebted to Dr. Roger.) The density of the ribbing is greater than in d'Orbigny's figures, and the reduction is a third, not a half, but otherwise agreement is very close. The style of ribbing is the same and there is no fading. The venter is exactly as in d'Orbigny's fig. 2, with the same siphonal smooth band. The sutures show clearly and one that had been painted in red probably served as the original of d'Orbigny's fig. 3, which it resembles even in detail. The specimen is wholly septate and the ribs number 38 at 150 mm., 48 at 125 mm., and 49 at 100 mm.

Corroy (1932, pl. xix, figs. 3, 4) figured as “ type ” a Callovian specimen from Poix, Ardennes, but as this was not a locality mentioned by d'Orbigny, and as the real type came from the Upper Bathonian of Niort, it is difficult to see any basis for Corroy's claim. This Callovian species (including Corroy's figs. 5, 6) differs from





TEXT-FIG. 78.—*Choffatia subbakeriæ* (d'Orb.), plaster cast of holotype, Bathonian of Niort, d'Orbigny Coll. 2605, Paris. Phragmocone, perhaps nearly complete. (Natural size.)

the Bathonian *C. subbakeriæ* by developing coarse distant primary ribs at a much earlier stage of growth. Contrary to the opinion of Roman, of Spath (1931, p. 338) and of Corroy (1932, p. 136), it must be pointed out that this is the species figured by Roman (1924, pl. iv, fig. 2) as *P. patina* Neumayr. The length of the primary ribs indicates that it is a *Choffatia*. On the other hand, a specimen figured as *P. subbakeriæ* by Roman (1930, pl. xvi, fig. 6) and so accepted by Corroy (1932, p. 136) is manifestly an *Indosphinctes* close to *I. patina* (Neumayr) and *I. pseudopatina* (Parona & Bonarelli) and in some respects intermediate between the two.

*Comparisons and Remarks.*—D'Orbigny's name applies to the commonest species of *Choffatia* in the English Cornbrash. The cast of the holotype is identical with the best English specimen of comparable size (Plate XXX, fig. 2; SM. J34925), except that the latter has nearly a whorl of body-chamber, with simple aperture, and is presumably not full grown. Some specimens tend to be slightly more coarsely ribbed and a little more involute, but specific differences do not exist; except perhaps in the specimen in Plate XXXII, fig. 1, where these characters are more marked, but this specimen is not here regarded as specifically distinct.

Blake's "*Perisphinctes* species 2" (1905, p. 53, pl. v, fig. 4, not fig. 5 as stated in error in the text) probably belongs to this species, but it is too small a fragment to be identifiable (BM. C11796, from the Cornbrash of Holwell, Dorset).

Owing to the slightly less coarse ribbing, and especially secondary ribbing, of the French holotype, the commonest English form might be considered a separate variety; but there are intermediate specimens (e.g. the Oxfordshire Cornbrash specimen GSM. 83149).

A closely allied species is *Choffatia caroli* Gemmellaro sp. (1872, p. 28, pl. v, figs. 6—8), of which I have a good specimen, larger than the holotype, collected by Mr. H. R. Warman at the type locality, Rocca chi Parra, Sicily. Spath (1931, p. 353) thought it "probably identical", but it is more compressed than *P. subbakeriæ*, with narrower venter, and more evolute, with secondary ribs conspicuous on the umbilical whorls. In this last respect it is more like the Cornbrash *C. homæomorpha* (see below), but it is much larger. There is no resemblance to a Polish ammonite figured as *P. caroli* by Siemiradzki (1899, p. 291, pl. xxiv, fig. 39), nor to the French Callovian forms so figured by Roman (1930, p. 180, pl. xviii, fig. 2) and Corroy (1932, p. 142, pl. xvi, figs. 1, 2), but considerable resemblance to the Callovian *Choffatia* figured by Roman (1930, pl. xviii, fig. 4) as *P. cf. leiocymon* Waagen, which is from the Athleta Zone.

Another representative of this group, differing from *C. subbakeriæ* only in slightly more distant ribbing and perhaps an even less retracted suspensive lobe with smaller auxiliaries, is "*Anaplanulites*" *hyatti* Crickmay (1933, p. 913, pl. xxxii, fig. 3, pl. xxxiii), from Mount Jura, California. The septal suture figured is too poorly preserved for any firm conclusion to be drawn from it, especially if it is one of the last sutures. (For "*Anaplanulites*", junior synonym of *Homæoplanulites*, see above, p. 211).

D'Orbigny in his 1846 text and on plate 148 wrote the specific name as *bakeriæ*, intending it for *Ammonites bakeriæ* Sowerby, which embodies the patronymic Baker. His subsequent *backeriæ* and *subbackeriæ* were clearly a slip, and Blake (1905) was

right to correct to *subbakeria*. (The holotype of *A. bakeria* J. de C. Sowerby—an Oxford Clay *Grossouvia*?—has been refigured by Spath, 1931, pl. lix, fig. 8).

*Distribution*.—Lower Cornbrash: Long Hanborough, Oxon. (GSM. 83149). Frome railway-cutting, Somerset (GSM. Ht853—4). Berkley, near Frome (GSM. 95039). Sherborne district (Sherborne School Museum, and Bower Coll., Taunton Mus. 3303, 3267, 3266, the last now SM. J34925, with *Meleagrinnella echinata* in the matrix). Bruton (Parson Coll., Taunton Mus. 1779). (For the Frome cutting sections see Arkell, 1954, p. 118).

Upper Fuller's Earth Rock: Whatley (F. Hodson Coll., Reading Univ. 6912).

France: Niort (holotype), uppermost Upper Bathonian *teste* de Grossouvre. Boulonnais, Lower Cornbrash with *Clydoniceras discus* and *Cererithyris intermedia*, *teste* Dutertre (1928, p. 59). St. Benin d'Azy, Nièvre (Coll. de Grossouvre, Univ. Nancy) and Dommartin les Toul (Coll. P. Maubeuge), both Bathonien supérieur. Var, *teste* Parent (1940) and Maconnais, in the Discus Zone *teste* Parent (1942). ? Serbia (Antonijevic, 1954, in the Macrocephalus Zone).

## 2. *Choffatia arisphinctoides* sp. nov. Plate XXXII, figs. 3, 10.

*Description*.—A large, fine-ribbed, somewhat high- and stout-whorled *Choffatia*, bearing a striking resemblance to Upper Oxfordian Perisphinctids of the subgenus *Arisphinctes*, and especially to *P. (A.) pickeringius* (Young & Bird) (see Arkell, 1939, p. 134, pl. xxvi, figs. 1—4), but more involute and with weaker ribbing—in that respect more like *P. (A.) lævipickeringius* Arkell (1939, p. 142, pl. xxx, figs. 1—6). The ribbing tends to fade in the region of furcation, which is from half to two-thirds of the way up the whorl-sides. The secondaries swing slightly forward at first, then pass straight across the venter. There are approximately three times as many secondaries as primaries, but the precise manner of furcation is obscure. Constrictions few and shallow. The Cornbrash holotype is about 160 mm. in diameter with three-quarter whorl of body-chamber, but it is believed to be immature. There is about a quarter whorl of overlap with a wholly septate Fuller's Earth Rock half-whorl 203 mm. in diameter, which seems to be conspecific, there being close agreement in whorl-shape and ribbing, though the earlier whorls are not visible. On this and another Fuller's Earth Rock fragment the ribbing is feeble, the primaries fading entirely before the secondaries, and the sutures are exceptionally distant, with somewhat stocky lobes and strongly retracted suspensive lobe bearing a long median auxiliary which touches the first lateral.

*Comparisons*.—The holotype (GSM. Ht855) had been labelled by Dr. Spath *Choffatia* aff. *furcula* (Neumayr). Among published figures, Neumayr's (1871, p. 41, pl. xv, figs. 1a—c) is the closest, but the English form differs from *P. furcula* in having a stouter, less convergent, whorl-section (no one could describe the shell as "sehr flach, scheibenförmig"), in having feebler ribbing (by no means "narrow and steep" as in *furcula*), which fades at the point of furcation; in the fact that the secondary ribs swing forward from the furcation-points; and (though this is less certain) in having fewer and shallower constrictions. In fact, it is by no means certain that

*Perisphinctes furcula* Neumayr is a *Choffatia* and not a *Gracilisphinctes* or *Procerites*; no subsequent author has published adequate figures, and the Balin fauna badly needs republishing with photographic plates.

*C. arisphinctoides* differs from *C. subbakeriae* in being stouter and more involute, with higher whorl, and its primary ribs become distant later and more gradually.

*P. verciacensis* Lissajous (1923, p. 65, pl. vii, fig. 1, lectotype now chosen, not fig. 2) is close and might prove to be conspecific were more material known; but Roman's version from Morocco (1930a, p. 18, pl. viii, fig. 7) is less like our species.

*Distribution*.—Lower Cornbrash: Frome railway-cutting (holotype, GSM Ht855). Same bed, Berkley, near Frome (GSM. 95035). Nr. Charlbury, Oxon. (OUM. J1392). "Probably Sherborne district" (Bower Coll., Taunton Mus. 3304).

Fuller's Earth Rock: Pinford Farm, Goathill, nr. Sherborne (W. S. McKerrow Coll., SM. J37993). Kingswood School, Bath (SM. J37995). (These fragmentary, not identical.)

France: Near Elary, Meuse (Buvignier Coll., Univ. Nancy). Railway-cutting, Chémery to Maisoncelles, Ardennes (P. Maubeuge Coll.).

Subgenus **LOBOPLANULITES** S. Buckman (see p. 212).

3. **Choffatia (Loboplanulites) cerealis** sp. nov. Plate XXXI, figs. 3—6; Text-figs. 79, 80.

*Perisphinctes* species 1, Blake, 1905, p. 52, pl. v, fig. 5 (whorl-section only).  
cf. *Perisphinctes (Procerites) moorei* Lissajous, 1923, p. 80, pl. xiii, fig. 1 (*non* Oppel, 1857).

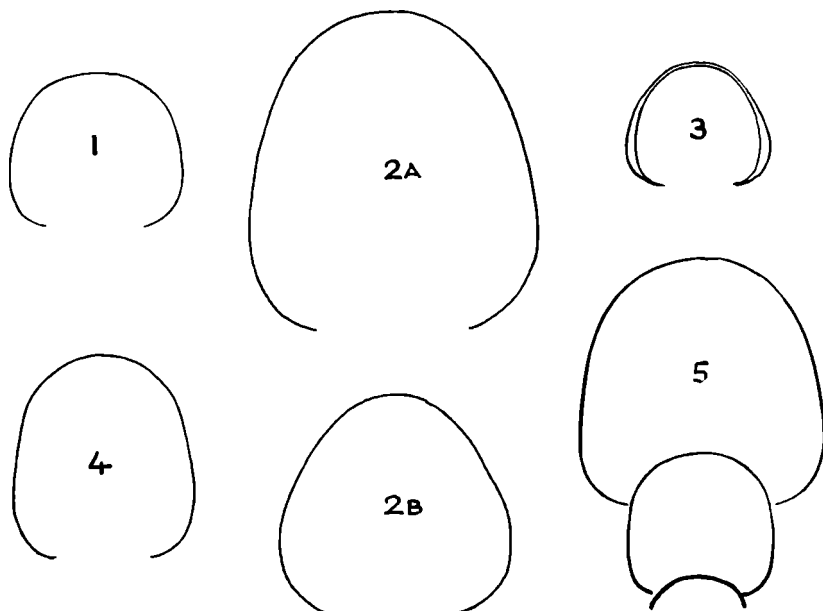
*Dimensions*.—

Holotype, SM. J34926 (Cornbrash).	Max. 222 mm.	At 200 mm. :	·29,	·28,	·50.
			At 180 mm. :	·29,	—, ·49.
Cornbrash, GSM. 95038.	Max. 75 mm.	At 75 mm. :	·35,	·37,	·43.
Gt. Oolite, BM. C32424.	Max. 180 mm.	At 180 mm. :	·33,	—,	·435
		At 150 mm. :	·35,	·295,	·44.

*Description*.—A large, robust *Choffatia* with depressed to circular to rounded-convergent whorl-section and strong, rounded, distant ribbing, the primaries especially strong and distant. The ribs are bifurcated, with intercalatories, which gradually tend to join up to form triplication as growth proceeds. Constrictions narrow, varying in emphasis, sometimes marked only by a simple oblique rib. Venter gradually becoming smooth after about 175 mm. The specimen at Reading (Plate XXXI, fig. 6) has a wider, depressed, whorl-section but is regarded as conspecific.

*Remarks and Comparisons*.—This is mainly a Cornbrash species; the Great Oolite specimen (Text-fig. 80, no. 2) has less prominent ribbing, and on the best Fuller's Earth Rock specimen also the primaries become feeble before septation ceases, but with the material available it does not seem justifiable to separate these latter specifically, for the differences could be accounted for by the much sharper preservation of the Cornbrash specimens.

The species may be the same as one figured from the Maconnais by Lissajous (1923, pl. xiii, fig. 1) as *P. moorei*, but that it rather more involute and even more feebly ribbed than the Great Oolite shell. In any case the name *moorei* cannot be used, for Oppel's holotype by monotypy is *A. subbakeriae* d'Orb. (see above, p. 215), of which it is therefore an objective junior synonym, as pointed out by de Grossouvre (1891, p. 250). It is not apparent why Oppel thought d'Orbigny's name to be invalid. Neumayr's procedure (1871, pp. 39—40), approved by Lissajous, of redefining *A. moorei* from specimens in the Oppel collection to the exclusion of the type is inadmissible. There is also at least a fair presumption that *A. moorei* Oppel (1857) is a junior

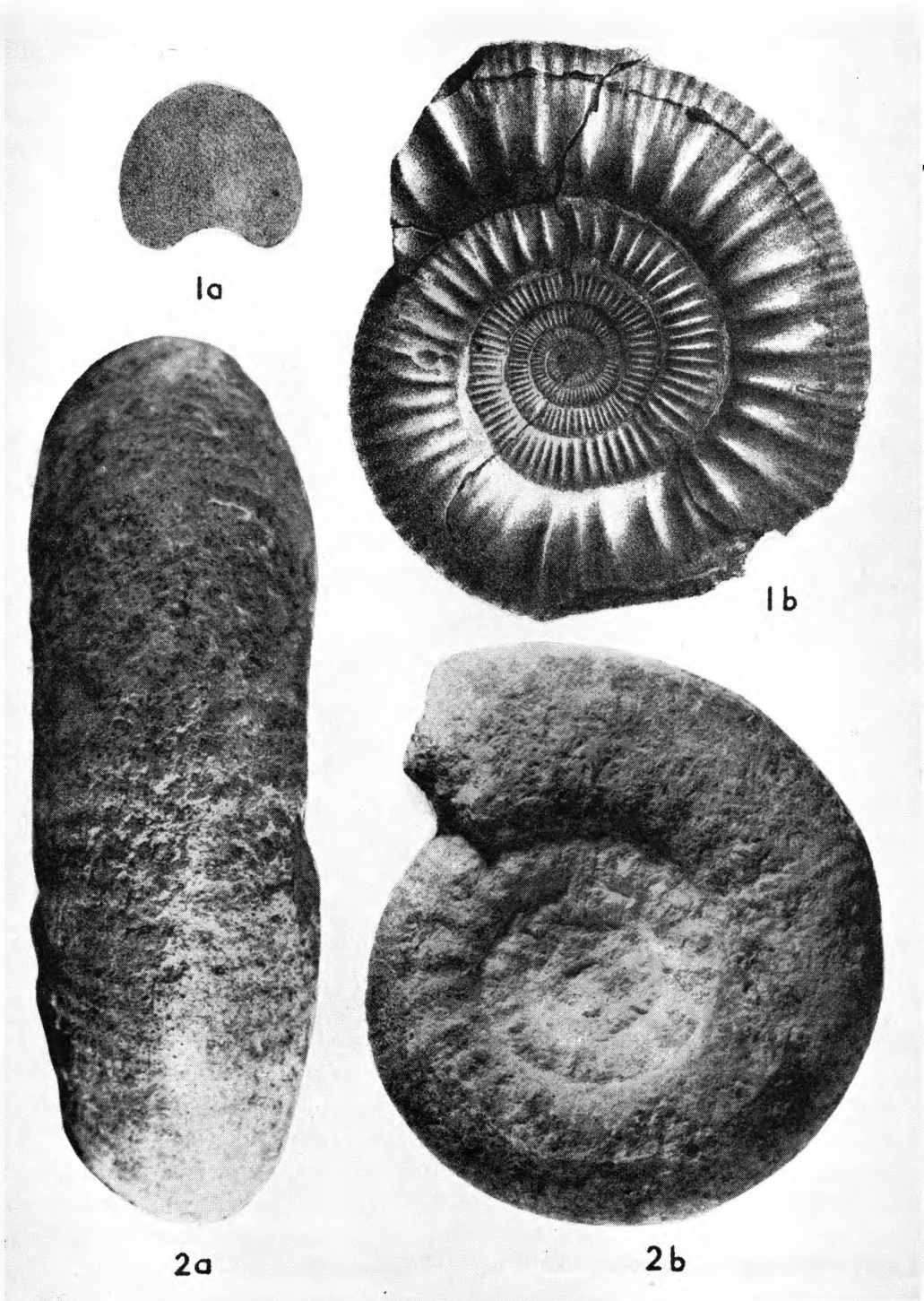


TEXT-FIG. 79.—Whorl-sections of *Choffatia*. 1, *C. kranaiformis* sp. nov., holotype. 2, *C. cerealis*, sp. nov. holotype. 3, *C. cerealis*, Sudbrook, GSM. 95038. 4, *C. subbakeriae*, SM. J34925. 5, *C. (L.) longilobata* Buckman, holotype. All  $\times \frac{1}{2}$ .

homonym of *A. moorei* Lycett (1857) [*Dumortieria*], for Oppel's work appeared "in Jahrgang 1857", which may imply publication in 1858.

*Choffatia cerealis* differs from the type figures of *C. recuperoi* Gemmellaro (1872, pl. v, figs. 9—11) in being less evolute, in acquiring coarse distant ribs much earlier, and in having shallower and less numerous constrictions. Intercalatory secondaries also appear much earlier than in *C. recuperoi* (Text-fig. 80, no. 1).

Blake mentioned, and figured in outline whorl-section only, a specimen of *C. cerealis* from the Cornbrash of South Cerney, Glos. (1905, p. 52, pl. v, fig. 5, not 4 as stated in error in the text). It was included with a query by Spath (1931, p. 359) in his synonymy of *Choffatia* aff. *recuperoi* from the Callovian of Cutch, which he did not figure. The many good photographs of supposed *C. recuperoi* from the European Callovian published by Petittclerc (1915, p. 77, pl. viii, fig. 2), Loczy (1915, p. 420, pl. xiii, fig. 8), Couffon (1919, p. 215, pl. xvi, fig. 2), Roman (1924, p. 99, pl. xi, figs. 3 and 6), and Pfaehler-Erath (1938, p. 15, pl. iv, figs. 2a, b) confirm the differences



TEXT-FIG. 80.—1a, b, *Choffatia (Loboplanulites) recuperoi* (Gemmellaro), the original figures after Gemmellaro. 2a, b, *C. (Loboplanulites) cf. cerealis* sp. nov., Great Oolite, Moulton Hall House pit, Northampton. BM. C32424. (2a  $\times$  1.0 at front, 2b  $\times$  0.51.)

pointed out above between the English Cornbrash species and Gemmellaro's figure, and some show additional points of difference. For instance, in Pfaehler-Erath's figure the whorl is less inflated, the ribs more irregular, as if passing to *Grossouvria*; and in Roman's figure (especially) the whorl enlarges suddenly after constrictions, as in *Kranaosphinctes* of the Corallian Beds (Upper Oxfordian). Passendorfer's version of *C. recuperoi* from the Tatra Mts. (1938, pl. iii, fig. 1) might yield fragments of outer whorls indistinguishable from *C. cerealis*, but the complete shell is much more evolute and has more finely-ribbed and serpenticonic inner whorls. *Choffatia uriniacensis* (Lissajous) (1923, p. 69, pl. vii, fig. 3) is also much more evolute although similarly ribbed; and the whorl-section is subcircular.

*Grossouvria cardoti* Petitclerc sp. (1915, p. 64, pl. v, fig. 2) from the Callovian of Deux-Sèvres, is almost a homœomorph or perhaps a direct descendant; but its whorl-section is much less inflated.

*Distribution*.—Cornbrash: Radipole, Weymouth (GSM. 95034). "Yeovil district?" (holotype, SM. J34926, ex Bower Coll., Taunton Castle Mus. 3269). South Cerney, Glos. (BM. C11795, fig'd. Blake, 1905). Rectory Farm, Emberton, near Olney, Bucks. (? var., J. R. Howie Coll., SM. J28973). Sudbrook, Lincs. (GSM. 95038). A specimen in Reading Univ. (Plate XXXI, fig. 6) is labelled Cornbrash but the locality is obliterated; a *Meleagrinnella echinata* in the matrix supports the lithology as Lower Cornbrash.

Great Oolite: Moulton Hall Housepit, Northampton (G. Thornton Coll., 1929, BM. C32424).

Fuller's Earth Rock: Cliff Hill quarry, Shepton Montague (W. S. McKerrow Coll., SM. J 37992); Englishcombe reservoir (Donovan & Fry Coll., 1955, Bristol Univ.).

France: Bathonien marneuse, Vилley-St. Etienne (P. Maubeuge Coll.). ? Maconais (Lissajous).

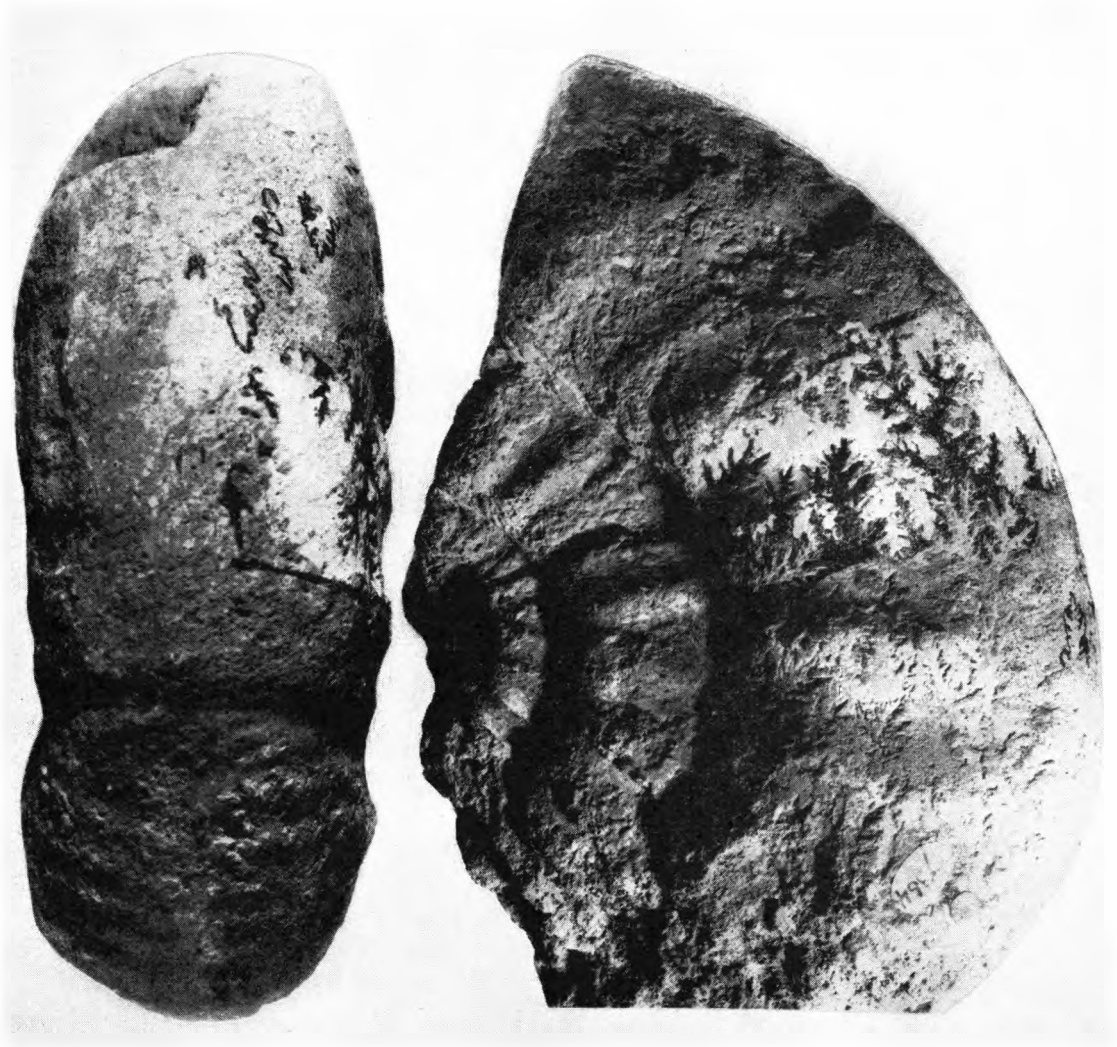
#### 4. *Choffatia (Loboplanulites) longilobata* (S. Buckman). Text-figs. 79, 81.

*Loboplanulites longilobatus* S. Buckman, 1925, TA, vi, pl. DXCVI.

*Description of Holotype*.—The holotype is a wholly septate quarter of a large, robust *Choffatia*, showing parts of three whorls, all of which have strong, coarse but blunt ribbing, and the two outer whorls each a strong oblique constriction. The whorl-section has the height and width equal, and convergent sides, but a wide venter. The secondary ribbing fades on the venter after a constriction at a whorl height of 53 mm. The greatest whorl-height is 56 mm. (still septate), which represents a diameter of about 195—200 mm. The sutures show clearly and are typically perisphinctid, with wide saddles and moderately retracted suspensive lobe.

*Comparisons*.—Differs from *C. cerealis* by having a broader venter, and less convergent whorl sides; also the ribbing on its innermost whorl is less distant. The nearest match seen by me is with two specimens of *Choffatia* kindly sent me on loan by Prof. G. Dubar from Lille, from the Upper Bathonian of 300 metres N. of Haymoy

Farm. on the Rancourt road, in the region south of the Ardennes. These were recorded by Bonte (1941, p. 126) as "*Perisphinctes (Sivajiceras) aureus* Spath and *kleidos* Spath", which if correct would indicate Middle Callovian, about Jason Zone. They are, however, undoubtedly *Choffatia*, comparable in side view with



TEXT-FIG. 81.—*Choffatia (Loboplanulites) longilobata* (Buckman). Holotype, Lower Cornbrash, Long Hanborough, Oxford. GSM.37364. For whorl section, see Text-fig. 79, 5. (Natural size.)

"*C. moorei*" as figured by Lissajous (1923, pl. xiii, fig. 1) and even more with *C. longilobata*, but not identical. I have not seen any specimen that could be specifically identified with the holotype of *C. longilobata*. The large Fuller's Earth Rock specimens identified on p. 218 with *C. arisphinctoides* are much more weakly ribbed and become nearly smooth at a stage corresponding to the outer whorl-fragment of *C. longilobata*.

*Distribution*.—Lower Cornbrash: Long Hanborough, near Oxford, with *Meleagrinnella echinata* in the matrix (holotype, GSM. 37364).



5. *Choffatia* (*Loboplanulites*) *kranaiformis* sp. nov. Text-fig. 82.

*Description of Holotype.*—An evolute, round-whorled *Choffatia* with fairly coarse biplicate ribbing and intercalatories, ribbed venter and scarce deep constrictions. There is a striking resemblance to *Kranaosphinctes* spp. (*P. kranaus*, etc.) from the Corallian Beds (Upper Oxfordian). The dimensions are 130 mm. max.; at 130 mm. ·30, c. ·29, ·48; est. at 100 mm. ·32, ·34, ·50. No sutures visible.



TEXT-FIG. 82.—*Choffatia* (*Loboplanulites*) *kranaiformis* sp. nov., holotype, Lower Cornbrash, Frome railway-cutting. GSM. BW144. (Natural size.)

*Comparisons.*—Differs from *C. cerealis* in having more numerous and less prominent primary ribs, deeper constrictions, more evolute coiling, and rounder whorl-section, not rounded-convergent. It is closest of the English species to *C. recuperoi* (Gemmelaro) (Text-fig. 80, no. 1), but the whorl-section is more depressed, the venter flatter and wider, and the ribs are more flexuous. Passendorfer's version of *C. recuperoi* (1938, pl. iii, fig. 1) is closer, but its primary ribs become coarse and distant much

earlier and more suddenly, so that at a diameter of only 60—65 mm. they resemble those of *C. cerealis*. *C. uriniacensis* Lissajous sp. (1923, pl. vii, fig. 3) acquires distant ribs much earlier. A form at least similar occurs in the Macrocephalus Zone of eastern Serbia (Antonijevic, 1954, pl. iv, figs. 8, 9, a fragment described as *Perisphinctes funatus* Oppel), associated with *Choffatia* cf. *subbakeriae* (d'Orb.) (*ibid.*, pl. v, figs. 10, 11).

*Distribution.*—Lower Cornbrash : Frome railway-cutting (holotype, GSM. BW144 and topotype, GSM. BW147). Part of inner whorls believed to belong to this species, Long Hanborough, Oxon. (J. M. Edmonds Coll., 1950, OUM. J1370) see Pl. XXXI, fig. 7).

Subgenus **HOMŒOPLANULITES** S. Buckman, 1922 (see p. 211).

6. **Choffatia (Homœoplanulites) homœomorpha** (S. Buckman). Plate XXX, figs. 1, 3, 4, 5 ; Plate XXXI, figs. 1, 2.

*Perisphinctes subbakeriae* Blake, 1905, p. 49, pl. v, fig. 2 (*non* d'Orbigny).

*Homœoplanulites homœomorphus* S. Buckman, 1922, TA, iv, pl. CCCXXVIII.

*Homœoplanulites stabilis* S. Buckman, 1924, TA, v, pl. DXV.

*Homœoplanulites homœomorphus* Douglas & Arkell, 1928, p. 135.

*Choffatia homœomorpha* Arkell, 1954, p. 119.

*Dimensions.*—

GSM. 8654. Holotype.	Max. 107 mm.	At 100 mm. :	·30,	·25,	·46.
		Est. at 77 mm. :	·325,	·275,	·43.
Holotype of <i>H. stabilis</i> .	Max. 135 mm.	At 130 mm. :	·27,	·235,	·50.
		At 100 mm. :	·30,	·25,	·465.

*Description of Holotype.*—The specimen appears to be full grown, with seven-eighths of a whorl of body-chamber and a short, wide lappet. It is believed to be a stunted individual, however, growth having perhaps been inhibited by an injury which disturbs and distorts the ribbing on the last sixth of the outer whorl. The rest of the ribbing is normal : close, bifurcated passing to trifurcated, with an occasional intercalatory. The secondaries pass straight on to the venter, which has a median smooth band. The roots of the secondaries are visible in the umbilicus. There are several shallow constrictions and oblique simple ribs. Sutures not decipherable (the one figured by Buckman is almost wholly imaginary).

*Comparisons and Remarks.*—The holotype of *H. stabilis* Buckman (1924, TA, v, pl. DXV) is 28 mm. larger in diameter, but comparison of the two type specimens and with a number of others confirms Spath's conclusion (1931, p. 353) that they belong to the same species. As just stated, the holotype of *C. (H.) homœomorpha* suffered an injury during life, which may have stunted its growth. The holotype of *H. stabilis* (Plate XXX, fig. 1) probably represents the normal full-grown shell. It too has seven-eighths of a whorl of body-chamber, and the coiling, proportions, ribbing, and every visible character, are identical. It comes from Fairford. Another specimen from the same district (Cirencester) is 150 mm. in diameter and identical in every

respect with the holotype of *H. stabilis*, but has the aperture more nearly complete and shows unmistakable signs of a short, wide lappet like that of *C. (H.) homœomorpha*. I know of no evidence that any other Cornbrash species of *Choffatia* possessed lappets, and by analogy with the similar large Corallian Beds Perisphinctids, most are unlikely to have done so. For both *C. subbakeria* and *C. cerealis* there is positive evidence that lappets were absent. Inner whorls of the two subgenera, however, are as hard to separate as are those of the analogous Corallian subgenera. In general, *Choffatia homœomorpha* may be distinguished from the species most like it, *C. subbakeria*, by its more compressed whorls and feebler ribbing, almost dying out on the venter much earlier, and by its much smaller adult size.

*Horizon of the Type Specimens.*—Blake (1905, p. 51) wrote of the species as “a constant companion of *A. macrocephalus*”, and of the holotype as “obtained at Stalbridge Weston in a matrix exactly resembling the upper part of the limestone at Holwell, whence I obtained a fragment of apparently the same species”. The upper limestones at Holwell are Upper Cornbrash (see Douglas & Arkell, 1928, p. 148). But on another page (p. 9) Blake confessed that he “could neither find nor hear of” the quarry at Stalbridge Weston.

The old (and only) quarry at Stalbridge Weston is on both sides of the Stalbridge road, about  $\frac{1}{4}$  mile N.E. of the hamlet. Enquiry established that it was already disused at the beginning of this century, but a little stone had been removed recently on the west side of the road. In April, 1948, I obtained a fragment of a topotype of *C. homœomorpha* (SM. J20354) *in situ* in the highest 2 ft. ever quarried there (under the hedge on the north face); it was associated with *Meleagrinnella echinata*, *Pholudomya lirata*, *Modiolus plicatus*, *Pleuromya uniformis*, and *Gervillia* sp., and was undoubtedly in the upper part of the Lower Cornbrash. The arable field in which the quarry was formerly continued on the east side of the road, south of the old limekiln, yielded *Ornithella grandobovata* and an abundant Lower Cornbrash fauna. Similarly at the nearest other quarry, at Drakes Mill, 1 mile to the E.S.E., only Lower Cornbrash was seen, including *Cererithyris intermedia* near the base.

This result accords with the evidence of complete sections of the Cornbrash afforded in 1931—32 by fresh railway-cuttings at Frome, where the main *Choffatia* horizon (including *C. homœomorpha*) was found to be in the top bed of the Lower Cornbrash (descriptions and discussion in Arkell, 1954, p. 118). It does not, however, preclude the possible occurrence of *C. homœomorpha*, and other species, in the Upper Cornbrash as well.

The holotype of *H. stabilis*, an old specimen from Fairford, Glos., was stated by Buckman to be in “yellowish-brown sandy matrix [Upper] Cornbrash”. Buckman’s interpolation of “Upper” may have been influenced by the fact that Fairford is a celebrated Upper Cornbrash locality; but Lower Cornbrash exists there also, though the junction has not been observed in the district in recent years (Douglas & Arkell, 1928, pp. 133—4). The brownish-buff limestone matrix of the holotype (for the loan of which I am indebted to Prof. H. H. Swinnerton and Nottingham University Museum), on solution with acid leaves a copious residue of fine quartz sand. Although this would pass for Upper Cornbrash lithologically, it is closely matched by the

*Choffatia* bed at the top of the Lower Cornbrash in Frome cutting and at Berkley, and chips taken from the matrix of *Choffatia* from those localities leave a similar quartzose residue. An identical specimen from Cirencester (at Reading Univ.) is in a normal shelly, rubbly Cornbrash matrix, in which is a specimen of *Pseudolimea interstincta* (Phillips); and though commonest in the Upper Cornbrash, this species ranges throughout both the Great Oolite and Inferior Oolite (Cox & Arkell, 1948, p. 17).

*Fuller's Earth Specimens.*—Well-preserved specimens from the Upper Fuller's Earth at Midford are slightly stouter and slightly less involute (umbilicus up to 5 per cent. narrower), so that secondary ribs do not show on the umbilical whorls, but otherwise agreement is so close in every character that it would be hair-splitting to separate them specifically.

*Distribution.*—Lower Cornbrash, near Oxford (OUM. J920). Cornbrash, Fairford (Nottingham Univ. Mus.). Lower Cornbrash, bed 1, Shornicote, Glos. (author's coll., recorded Douglas & Arkell, 1928, p. 135). Cornbrash, Cirencester (Reading Univ.). Lower Cornbrash, Frome railway-cutting, Somerset (GSM. BW150, BW148) (see Arkell, 1954, p. 118). Stalbridge Weston, Dorset (holotype, GSM. 8654, and fragment of a topotype, author's coll., SM. J20354). Cornbrash, probably Sherborne district (Bower Coll., Taunton Mus. 3268).

Upper Fuller's Earth: Combe Hay Fuller's Earth Mine, near Midford, near Bath (BM. C36347—8, GSM. 69934, and J. H. Williams Coll., 1948, SM. J23007).

Upper Fuller's Earth Rock: Whatley (F. Hodson Coll., Reading Univ. 6753, 6911).

Genus **SIEMIRADZKIA** Hyatt, 1900 (see p. 212).

1. **Siemiradzka aurigera** (Oppel). Plate XXXIII, figs. 8, 10; Text-fig. 83.

*Ammonites bakeria* d'Orbigny, 1847, pl. 149, fig. 1 only (*non* J. de C. Sowerby).

*Ammonites aurigerus* Oppel, 1857, p. 476 (*nom. nov.* for preceding).

*Non Perisphinctes aurigerus* Neumayr, 1871, pl. xii, fig. 4 (*Grossouvria de Mariae* Parona & Bonarelli, 1897, *nom. nov.*).

*Grossouvreia aurigera* de Grossouvre, 1919, p. 385, pl. xv, figs. 6–8 (*non* 3, 4, 5).

*Perisphinctes (Grossouvreia) aurigerus* Roman, 1930, p. 13, pl. vii, fig. 9.

*Siemiradzka aurigera* Arkell, 1951, p. 13, pl. iii, fig. 7.

*Remarks.*—English material contributes nothing to the very full description and discussion of this species by de Grossouvre (1919, p. 385), who remarked on its wide range of variation and stated that there was enough French material to furnish a monograph to illustrate the range of variability within the species. It may be suspected that when de Grossouvre wrote this he understood by *Am. aurigerus* almost what would now be the genus *Siemiradzka*. Yet even accepting the species in the wide sense, as represented by d'Orbigny's type figure and de Grossouvre's figs. 6–8 (1919, pl. xv), there are only one or two English specimens that fall within it (Plate XXXIII, figs. 8, 10).

Dr. Jean Roger informs me that no specimens agreeing with the type figure have been found in the d'Orbigny collection, and I was unable to find any in 1950.

*Distribution*.—Lower Fuller's Earth : Wincanton boring, Somerset, depth 533 ft. (GSM. WE131). (*Ostrea acuminata* at 432½ ft., and top of Inferior Oolite taken at 548 ft.—information from Mr. R. V. Melville). ? Fragment, basal Fuller's Earth, Bonneyleigh Hill, Frome, with *Procerites fullonicus* (Buckman) (D. T. Donovan Coll., 1956). France : Lower Bathonian.

2. **Siemiradzka maticsonensis** (Lissajous). Plate XXXII, fig. 2 ; Text-fig. 83.

*Perisphinctes* (*Grossouvreia*) *aurigerus* de Grossouvre, 1919, pp. 385, 458, pl. xv, figs. 3, 5 only.

*Perisphinctes* (*Grossouvreia*) *maticsonensis* Lissajous, 1923, p. 59, pl. v, figs. 3, 4, 4a, only.

*Remarks*.—This species differs from *S. aurigera* (Oppel) in having much finer ribbing, especially on the outer whorl, and a smaller and simpler spatulate lappet instead of the greatly expanded *Ebrayiceras*-like lappets of *S. aurigera* as figured by both d'Orbigny and de Grossouvre.

It is at first puzzling that Lissajous in founding a number of new species of *Siemiradzka* (sub *Grossouvreia*) in his memoir published in 1923 did not mention de Grossouvre's full discussion of *S. aurigera* published in 1919, and in fact apparently overlooked the species altogether. But Lissajous died in July, 1921, and since de Grossouvre's paper is dated 25 Dec., 1919, Lissajous probably did not see it until after he had written the 'Bathonien de Mâcon'.

*Distribution*.—Fuller's Earth Rock : Harwood Farm, West Cranmore, bed 14 (P. C. Sylvester-Bradley Coll., SM. J28990).

France : Lower Bathonian, Nièvre. Lower or Middle Bathonian, Maconnais.

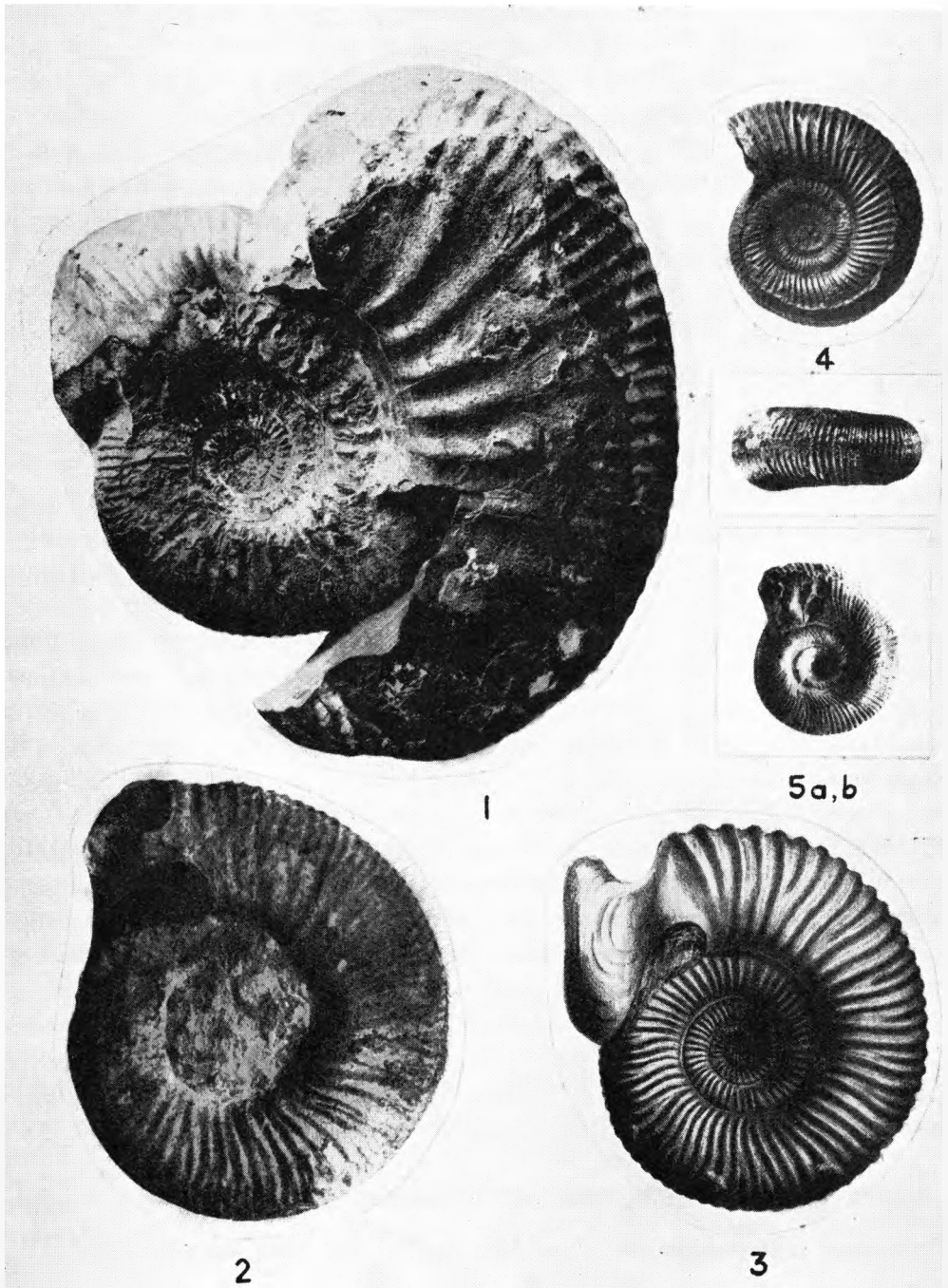
3. **Siemiradzka pseudorjazanensis** (Lissajous). Plate XXXII, fig. 7.

*Perisphinctes* (*Grossouvreia*) *pseudo-rjazanensis* Lissajous, 1923, p. 57, pl. iv, figs. 4, 4a.

*Description and Remarks*.—Lissajous called this a species with "few whorls, higher than thick, overlapping by one third of the whorl-height, the whorl-sides barely convex, the venter almost flat". The material available and Lissajous' photographs bear out this description rather than the whorl-section shown in his text (fig. 7), in which the whorl-sides are shown as rounder and more convergent. The photographs agree very closely with French material sent me by Dr. P. L. Maubeuge from Amermont (Meuse), and with the English Forest Marble ammonite.

*Distribution*.—Forest Marble : Blue House Quarry, Ewen, near Cirencester : see Woodward, 1894, p. 364 (SM. B9964). A worn nucleus which may be the same was obtained in 1953 by the Geological Survey from field brash on Kemble Beds, 1380 yds. N. 54° E. of Westwell Church, Oxon. (GSM. BN654).

France : Bathonian. Verzé, Maconnais (type) : railway-cutting to the mine of Amermont-Dommary, Meuse, in Bath. sup. marneux à *Ostrea knorrii* (P. L. Maubeuge Coll., two specimens). Persia, Elburz Mts. (E. J. White Coll., OUM.)



TEXT-FIG. 83.—1, *Pseudosphinctes rotundatus* (Roemer), lectotype, after J. Roemer. 2, *Siemiradzkia matisonensis* (Lissajous), lectotype after Lissajous. 3, *Siemiradzkia aurigera* (Oppel), type figure from d'Orbigny, pl. 149. 4, *S. aurigera*, inner whorls after de Grossouvre, 1919, pl. xv, fig. 3, Lower Bathonian, Nièvre. 5, *Berbericeras sekikense* Roman, holotype after Roman, Lower Bathonian, Jebel Sekika, Algeria ( $\times 2$ ). (1—4 natural size.)

4. *Siemiradzka* ? *pseudoannularis* (Lissajous). Plate XXXII, fig. 4.

*Perisphinctes* (*Grossouwia*) *pseudoannularis* Lissajous, 1923, p. 54, pl. iv, figs. 6, 6a.

*Perisphinctes pseudoannularis* de Grossouvre, 1930, p. 365, pl. xxxix, fig. 4.

*Remarks.*—The half-whorl figured in Plate XXXII, fig. 4, and two similar specimens correspond exactly with Lissajous' description but throw no light on the adult aspect of the species. It is distinguished in the early stages from the similar *P. fusciacensis* (Lissajous) only by its rounder whorl-section. Only more "serpenticone" coiling distinguishes it on the other hand from the nucleus of *Choffatia acuticosta* J. Roemer sp. (1911, pl. ix, figs. 11, 12).

*Distribution.*—Lower Fuller's Earth: Jack's Hill quarry, S.W. of Beaminster, Dorset (GSM. Ht2162, Ht2169—70).

Subgenus **PLANISPINCTES** S. Buckman, 1922 (see p. 212).

5. *Siemiradzka* (*Planisphinctes*) *planilobus* (S. Buckman). Plate XXXIII, fig. 7.

*Planisphinctes planilobus* S. Buckman, 1922, TA, iv, pl. CCCXXVII.

*Description of Holotype.*—The diameter is 63 mm. and the peristome is preserved, with parts of a large simple lappet on each side; the body-chamber occupies just under three-quarters of a whorl. At 50 mm. the dimensions are ·32, ·35, ·50. The whorls are circular in cross-section until near the end of the body-chamber, when they become slightly compressed. Coiling is very evolute. Ribs are sharp and rod-like, with a high proportion of simple ribs up to the beginning of the body-chamber. The secondaries are interrupted and distorted by an injury or malformation of the venter of almost the whole last whorl.

*Comparisons.*—*S. (P.) gredingensis* Dorn sp. (1927, p. 243, pl. vi, fig. 7) from the zone of "*Parkinsonia ferruginea*" (i.e. about Zigzag Zone) of Franconia, is still more evolute (umbilicus ·58 at 53 mm.) and its ribs are fewer at all stages. These interesting species may be at the parting of the ways leading to *Choffatia* such as *C. acuticosta* J. Roemer sp. (1911, pl. viii, figs. 3, 4, nuclei pl. ix, figs. 11, 12; note circular whorl and simple ribs) on the one hand, and to the finer-ribbed *Siemiradzka* of the Upper Bathonian on the other.

*Distribution.*—Zigzag Bed: Burton Bradstock (holotype, GSM. 47140); Powerstock station (Bomford Coll., 3284); Loders Cross, S.W. quarry (author's coll., now Bomford Coll. 3783).

Genus **BERBERICERAS** Roman, 1933 (see p. 213).

1. *Berbericeras schwandorfense* Arkell (*ex* Krumbeck MS.). Plate XXXIII, figs. 1—3.

*Præsutneria schwandorfensis* Krumbeck in Schmidtil & Krumbeck, 1931, p. 851 (*nomen nudum*).

*Berbericeras schwandorfense* Arkell, 1951, p. 12, pl. i, figs. 6, 8, 11.

*Description.*—The largest known English specimen is 36 mm. in diameter. At 35 mm. the dimensions are ·40, ·34, ·32. The diameter of the largest German specimen sent me is 33 mm. Engelmann, who had 25 specimens, states in his unpub-

lished thesis that 10 of these were a tumid variety with whorl-thickness exceeding whorl-height. The six English specimens also show variation in dimensions and size but are unmistakably the same species. None of the English material shows sutures or peristome. For further description see the generic diagnosis (p. 213).

*Distribution*.—Fuller's Earth Rock : Upper Swanswick, near Bath (SM. J18342—3). Bruton [Shepton Montague], Somerset (SM. J18338). Lane cutting near Maperton, Somerset (L. Richardson Coll. GSM. 52181). Englishcombe reservoir (two, Donovan & Fry Coll., 1955, Bristol Univ.).

Bavaria : "Aspidoides" Beds, Holz-Berg, near Schwandorf, type locality, with *Tulites* spp., *Morrisiceras morrissi* (Oppel), etc. (Krumbeck Coll., six specimens sent me, including the holotype).

## 2. *Berbericeras sekikense* Roman. Plate XXXIII, figs. 4—6, and Text-fig. 83.

? *Cadomites compressus* de Grossouvre, 1930, p. 374, pl. xl, fig. 5.

*Berbericeras sekikensis* Roman, 1933, p. 67, pl. ii, fig. 15.

*Description*.—Size the same as *B. schwandorfense*, from which *B. sekikense* differs by its more rounded whorls with less flattened sides, and finer ribbing, which (especially) does not become so coarse on the venter of the body-chamber.

*Comparisons and Remarks*.—I visited the type locality, Jebel Sekika, near Nemours, western Algeria, under the guidance of Monsieur G. Lucas, in February, 1952. We collected most of the other small pyritic ammonite species figured from there by Roman (1933) but failed to find *Berbericeras*. On the other hand we obtained two specimens (poorly preserved) of the adult *B. sekikense* in another exposure of the same beds near Beni Bahdel barrage, and Prof. Pruvost has kindly allowed me to borrow another in the Sorbonne from the dark ironshot oolite of Deglen, in the Ghar Rouban massif. This material does not seem to be distinguishable specifically from the finer-ribbed English *Berbericeras* of the Fuller's Earth Rock.

If more French material were available it is possible that *Cadomites compressus* de Grossouvre (1930, p. 374, pl. xl, fig. 5), from the Bathonian of the Nièvre, might prove to be conspecific. (It should be noted that the type figure is enlarged  $\times 2$ ).

*Distribution*.—Fuller's Earth Rock : Kelston Round Hill, near Bath, Bomb-crater 28 (three specimens, T. Fry Coll., Bristol Univ. Mus.); Bruton [Shepton Montague], Somerset (J. F. Walker Coll., 1908, SM. J22997). Goathill, near Sherborne, quarry  $\frac{1}{2}$  mile N.E. of Pinford Farm (W. S. McKerrow Coll., 1951, "about half way up the rock.").

Algeria : Jebel Sekika ; road-cutting near Beni Bahdel barrage ; Deglen, Ghar Rouban.

## ADDITIONAL SPECIES.

Genus **POLYPLECTITES** Mascké, 1907 (see p. 80).

### *Polyplectites periami* sp. nov. Plate XXXIII, fig. 9.

*Description of Holotype*.—A specimen from the Forest Marble sent me by Mr. C. E. Periam in May, 1954 (after publication of Part IV) is the first Bathonian *Polyplectites*



found in Britain and cannot be matched with any named species. It is 42 mm. in diameter and has at least half a whorl of body-chamber (perhaps three-quarters of a whorl) but lacks the aperture. The whorl-section is circular, becoming depressed near the end through damage. The ribs are very sharp, rather distant for the genus, mainly biplicate with single intercalatories, but occasionally triplicate. The distinctive feature is that at the point of furcation every third or fourth rib carries a large spine or tubercle, and towards the aperture these become more numerous until in the last one-fifth of a whorl every rib is spinous. The general effect is reminiscent of the Tithonian-Infra-Valanginian *Micracanthoceras* Spath. Sutures and peristome unknown.

*Comparisons.*—The specimen is placed in *Polyplectites* rather than *Cadomites* on account of the circular whorl-section; and the implication of this is that the aperture had lappets. All true *Cadomites* (i.e. species without lappets) have a coronate whorl-section. The only species in either genus that at all resembles *P. periami* is *Polyplectites richei* Lissajous (1923, p. 106, pl. xxiii, fig. 2), from the Upper Bathonian ("Retrocostatium Zone") of Daveyé, Maconnais, but that lacks the sporadic lateral spines.

Maubeuge (1955, p. 40) includes *Stephanoceras daubenyi* Gemmellaro (1872—82, pl. xix, figs. 3—5) in *Polyplectites*; but if Gemmellaro's fig. 4 (which Maubeuge includes) belongs to the same or even an allied species, *daubenyi* has the simple-lipped aperture of *Cadomites*. The same type of aperture is shown by *C. deslongchampsii*, type species of the genus (see above, p. 79, Text-fig. 21) and (though less lipped) by the Bathonian *Cadomites rectelobatus* Hauer sp. (1857, p. 156, pl. i, fig. 5, lectotype now designated). In both these the whorl-section is much more depressed than in any proved *Polyplectites*, as is confirmed by Bathonian specimens of *C. rectelobatus* from Swinitza figured by Kudernatsch (1852, pl. iii, figs. 5, 6), from Mount Strunga by Popovici-Hatzeg (1905, pl. vi, figs. 5, 10), and from the Carpathians by Passendorfer (1935, pl. iii, figs. 6, 7, pl. iv, figs. 1, 9). *C. arbenzi* Thalmann sp. (1925a), from the Zigzag Zone of Engelberg, Switzerland, has an extremely depressed whorl and is probably a synonym of *C. deslongchampsii* (d'Orb.).

Considering the difficulty of separating *Cadomites* generically from some species of *Stephanoceras*, the separation of a subfamily Cadomitinæ (Westermann, 1956, p. 251) seems completely unjustified.

*Distribution.*—Lower Forest Marble, a peculiar oyster-filled marly limestone band near the top, not far below the horizon of the Hinton Sands, exposed in a ditch and later a deep trench across the outcrop, N.W. side of Rudge Hill, near Beckington, Somerset (C. E. Periam Coll., 1954, Reading Univ. 6900). The oysters of this bed are mainly of the common *O. hebridica* style, but some show incipient radial ornament as in *O. subrugulosa* Morris & Lycett.

## SECTION III. CONCLUSIONS

## 1. CONCLUDING REMARKS ON THE PHYLOGENY OF THE ENGLISH BATHONIAN AMMONITES.

Superfamilies **HILDOCERATACEÆ** and **STEPHANOCERATACEÆ**.

Family **CLYDONICERATIDÆ** (p. 30).

On pp. 30—32 this family was removed from the Oppeliaceæ (*recte* Haplocerataceæ)<sup>1</sup> where it had customarily been placed, and transferred to the Harpocerataceæ (*recte* Hildocerataceæ)<sup>1</sup>, on the assumption that it was a surviving offshoot analogous with the Lower Bajocian *Staufenia* from Leioceratidæ. The Arabian collections referred to on p. 32, when they came to be worked out (Arkell, *in* Arkell, Bramkamp & Steineke, 1952, p. 283), suggested strongly that *Clydoniceras* was derived from the bicarinate Lower Bathonian *Thambites* and Upper Bajocian *Thamboceras*, and that this probably arose from early-Upper Bajocian *Ermoceras*, which seems to be an oriental genus of the Stephanocerataceæ. "If these inferences are correct, Clydoniceratidæ must be regarded as Stephanocerataceæ. The origin from [Hild]ocerataceæ nevertheless still holds, for Stephanocerataceæ originated from [Hild]ocerataceæ by way of Hammatoceratidæ and *Erycites*; this sufficiently accounts for the (doubtless reversionary) [Hild]oceratacean characters shown by Clydoniceratidæ" (1952, *loc. cit.*).

Since then, new material collected by Prof. Gabriel Lucas in Algeria (see Arkell & Lucas, 1953) has suggested that *Ermoceras* and the Thamboceratidæ and Clydoniceratidæ may have to be regarded as a new cryptogenic superfamily.

Families **TULITIDÆ** (p. 82) and **MACROCEPHALITIDÆ** (p. 113).

The origin of the Tulitidæ in the Bajocian Sphæroceratidæ, and the origin of Macrocephalitidæ in the Middle Bathonian Tulitid genus *Morrisiceras*, were demonstrated above. This origin, however, applies only to the non-Boreal genera of the Macrocephalitidæ, and probably not to the Boreal *Cranocephalites* and *Arctocephalites* and the families Kosmocerotidæ and Cardioceratidæ (subfamily Cadoceratinæ) which have generally been regarded as descendants of *Macrocephalites*. As shown by distribution maps (Arkell, 1956, pp. 607—11), the Arctic Ocean appears to have become completely isolated in the Middle Bajocian and to have remained so until the Lower Callovian, when the newly evolved fauna of the Boreal Realm spread out of it over the surrounding continents. The early Kosmocerotidæ, such as *Kepplerites* and the

<sup>1</sup> In accordance with decisions of the Int. Com. Zool. Nomenclature, Copenhagen, 1953 (2 years after Part I of the present work was published).

Cadoceratinae, belong to this Boreal fauna, and it is therefore likely that they originated, not from the Tethyan-Pacific Macrocephalitidae, but from some unknown isolated Arctic collateral line derived independently from a common Bajocian ancestor.

It was the Boreal stock that gave rise to the last great waves of the Stephanocerataceae, the Cardioceratidae and also, apparently through Pachyceratidae, to the Mayaitidae, which populated the Indo-Pacific region in the Oxfordian and took on the aspect of a southern and eastern autochthonous family. The truly autochthonous Tethyan and Indo-Pacific stock, the Tullitidae, died out in the Callovian as rare "bullatiform" degenerated end-forms which made no advance on those so characteristic of the Bathonian.

### Superfamily **PERISPHINCTACEÆ**.

Families **MORPHOCERATIDÆ** (p. 129) and **PARKINSONIIDÆ** (p. 141).

In support of the postulated origin of Morphoceratidae from Perisphinctidae may be mentioned two analogous generations of *Morphoceras*-like forms from Perisphinctidae later in the Jurassic. In the Upper Oxfordian there is the dwarf *Neomorphoceras* Arkell (1953), which must have originated quite independently from some contemporary perisphinctid stock such as *Mirosphinctes*; and in the late Upper Oxfordian of S.W. Germany Dr. Hölder has discovered a remarkable new genus (unpublished) which has deeply and repeatedly constricted inner whorls almost without ribs, resembling an involute *Morphoceras*, but which on the last whorl suddenly becomes a normally ribbed and typical-looking *Perisphinctes* (cf. *Orthosphinctes*).

The two principal characters of the Parkinsoniidae are the ventral smooth band and simple suture with unretracted suspensive lobe. Similar characters appeared again in the Kimeridgian in the family Ataxioceratidae, producing the genera *Idoceras* and *Kossmatia*. (The origin of *Kossmatia* from Ataxioceratidae, not Berriasellidae as usually supposed, is indicated by New Zealand material collected by Dr. C. A. Fleming, unpublished.)

### Family **PERISPHINCTIDÆ** (p. 163).

The foregoing attempt to bring order into the difficult complex of Bathonian Perisphinctids leads to the following conclusions.

The main ancestral stock of most of the Bathonian (and therefore also later) Perisphinctidae is *Procerites*, the dominant genus of the Lower Bathonian, but still common at least locally (Whatley, Vилley-le-Sec, and the Maconnais) in the Middle or early-Upper Bathonian. The most likely root of *Procerites* and all the other Zigzagiceratinae is *Lobosphinctes* (p. 173) of the Upper Bajocian.

*Procerites* comprised a wide variety of forms, both macroconchs and microconchs, and various branches of the genus gave rise to *Choffatia* and *Wagnericeras* and their subgenera.

Of the macroconchs (with simple aperture), common species such as *Procerites fullonicus* (Plate XXIV, figs. 3, 4) grade into the Middle Bathonian evolute forms of

*Wagnericeras*, such as *W. fortetostatum* (Plate XXIX, figs. 2, 3), while still more thick-whorled and heavily ribbed species such as *P. imitator* (Plate XXVI, figs. 2—4) probably gave rise to the more involute *Suspensites* (Plate XXIX, figs. 6—8). The fine-ribbed *Procerites*, on the other hand, like *P. costulatosus* (Plate XXI, fig. 8), probably produced the typical *Choffatia* of the *subbakeriæ* group (Plate XXXII, fig. 3), while the round-whorled and coarse-ribbed *Loboplanulites* (Plate XXXI, figs. 4—6) are probably derived from the evolute branch of *Wagnericeras* (e.g. Plate XXIX, fig. 1).

The microconch *Procerites* (with lappets), such as *P. (Pharulozigzag) lenthayensis* (Plate XXIII, fig. 6) seem already transitional to some of the microconch *Choffatia* such as *C. (Homæoplanulites) homæomorpha* (Plate XXX, figs. 1, 3—5).

If these inferences are correct, the genera *Choffatia* and *Wagnericeras* are polyphyletic and genetically intermixed, much as has been deduced for the various subgenera of *Cardioceras*, etc. However, in view of all the uncertainties and the undoubted incompleteness and inadequacy of the material, a conservative stand has been taken in the classification, using the time-honoured generic names *Procerites*, *Choffatia* and *Wagnericeras* in their legal and traditional interpretation. The basis of this interpretation is rib-style, which has proved itself the most valuable basis for classification in all Perispinctids, if a system is wanted of practical applicability and stratigraphically serviceable. Such genera and subgenera are probably to a large extent collections of grades in parallel lineages, whose genealogy has become overlaid by "fashionable" characters of the age.

The rare Lower Bathonian auriculate microconch genus or subgenus *Planispinctes* and the commoner and longer-ranged microconch *Siemiradzkia*, which persists into the Upper Bathonian (Forest Marble) (Plate XXXIII, figs. 7, 8, 10 and Pl. XXXII, fig. 7), presumably originated from the Upper Bajocian *Vermispinctes*. Bathonian *Siemiradzkia* are difficult to separate from Callovian *Grossouvria* and they were all assigned to *Grossouvria* in Lissajous' monograph (1923); but no connexions through Cornbrash and Kellaways Beds have been proved. It is possible that *Grossouvria* had a separate origin, from *Choffatia (Homæoplanulites)*, at least in part.

Similarly, *Wagnericeras* is usually supposed to have been the root stock of the Lower Callovian Proplanulitidæ (e.g. Buckman, 1921, TA, iii, p. 33, following Siemiradzki, 1898), but no direct link has been found in the Lower Cornbrash or anywhere in the uppermost Bathonian. The simple open sutures, long secondary ribs and compressed whorl-shape of the typical and earliest *kœnigi* group of *Proplanulites* (e.g. *P. laboratus*, *P. fabricatus*, *P. lævigatus*, *P. subcuneiformis*, *P. majesticus*, *P. excentricus*, *P. crassicosta*, *P. crassiruga*, all of Buckman, TA, iii—vi) certainly make attractive the hypothesis of derivation from *Wagnericeras (Suspensites)*. On the other hand, some later forms from the South Cave Kellaways Rock (Planicerclus Subzone), and perhaps higher and lower (e.g. *P. lobatus* Buckman, 1922, TA, iv, pl. CCCXXX), can be said with some confidence to be derived from *Choffatia* (subgenus *Homæoplanulites*, with its synonym *Anaplanulites*).

*Choffatia*, embracing both macroconchs and microconchs, is the only ammonite genus known to pass in strength across the boundary between the Bathonian and

Callovian, being found in the Lower and Upper Cornbrash and in both earlier and later beds.

There remains the peculiar little genus *Berbericeras* Roman, the existence of which in Britain was unsuspected before the present revision, although specimens from the Fuller's Earth Rock existed in museums, overlooked as miniature or incomplete examples of *Siemiradzkia*. When they were first identified (Arkell, 1951, p. 12) I was influenced by Roman's opinion and left them, with a query, in the family Morphoceratidæ. I have since come to the conclusion, however, that they are true Perisphinctidæ and have more characters of *Siemiradzkia* than of any Morphoceratidæ. They might have a common origin with *Siemiradzkia* in *Vermisphinctes* but this seems unlikely. It is significant that *Berbericeras* was first described from Algeria, where it occurs in the Zigzag Zone and is rare, whereas in England and Germany it has not been found in the Zigzag Zone but is abundant in the Middle Bathonian Subcontractus Zone, associated with many immigrant Tulitidæ and Macrocephalitidæ which seem to have no direct ancestors in the European Lower Bathonian. This suggests that *Berbericeras* is an immigrant and originated elsewhere, independently of *Siemiradzkia*, perhaps from some African or oriental Leptosphinctid microconch genus.

A suggestion has recently been made (Westermann, 1956, p. 263) to transfer *Berbericeras* to the family Macrocephalitidæ, as a new subfamily with the two Middle Bathonian Tulitid genera *Schwandorfia* and *Krumbeckia* (see above, pp. 87—89). The chief objections that come to mind are the essentially perisphinctid ribbing of *Berbericeras*, the fact that it originated in the Lower Bathonian (Zigzag Zone) whereas the other two genera are first known in the Middle Bathonian (Subcontractus Zone) and show essentially tulitid characters; and the fact that no other genera of Macrocephalitidæ are known to possess lappets or other apertural modifications, so that *Schwandorfia* and *Krumbeckia* would make singularly ill-fitting additions to the family (see Arkell, 1957).

## 2. GEOGRAPHICAL ORIGIN OF THE BATHONIAN AMMONITE FAUNAS.

Notwithstanding the marked change of fauna between the underlying Inferior Oolite and the Zigzag Bed (see pp. 7—9), all the characteristic ammonites of the Zigzag Zone can reasonably be derived from ancestors in the Upper Bajocian of England or adjacent parts of N.W. Europe. Some genera died out in the Lower Bathonian (*Zigzagiceras*, *Procerozigzag*, *Morphoceras*), others persisted into the Middle and even Upper Bathonian in the same area (*Procerites*, *Siemiradzkia*, *Ebrayiceras*, Oppeliidæ, and even *Parkinsonia* locally, to judge from the evidence of Whatley, p. 238).

The characteristic ammonite genera of the Middle Bathonian, however (*Tulites*, *Morrisiceras*, *Lyceticeras*, *Berbericeras*, *Clydoniceras*, *Delecticeras*, *Micromphalites*), are all cryptogenic in the British area: in other words, they appeared here "unannounced" and have no likely local ancestors. *Micromphalites* is recorded (as a single specimen) in the Lower Bathonian of the S.E. of France (though this record is not above suspicion stratigraphically), and as just pointed out, *Berbericeras* first appears in the Lower Bathonian of Algeria. *Tulites*, *Micromphalites* and *Clydoniceras* are all

strongly represented in Arabia in beds consequently assigned to Middle Bathonian, and there the last two genera have probable ancestors in underlying beds believed to represent post-Zigzag Zone Lower Bathonian. From this evidence it is tempting to infer that the characteristic English Middle Bathonian ammonite fauna immigrated into N.W. Europe from the south and east. Nevertheless, an almost pure strain of the Zigzag Zone fauna, not found in Arabia or anywhere in the Middle East, occurs still farther east, in the Persian Elburz Mountains (Arkell, 1956, pp. 370—1). The assemblage from here is almost identical with that which can be collected in the Zigzag Bed on the coasts of Dorset or Normandy. This occurrence demands caution in inferring that the Lower Bathonian assemblage is European in origin and the Middle Bathonian assemblage oriental.

### 3. CONCLUDING REMARKS ON BATHONIAN STRATIGRAPHY.

In the 7 years during which this monograph has been passing through the press there has come to light little new information entailing modification of the outline of stratigraphy printed in Part I, pp. 6—22. A systematic investigation for the 'Lexicon of Stratigraphy' into the history of all Middle and Upper Jurassic zones produced corrections to the dates and attributions of some of the zones discussed and sifted on pp. 19—22. These corrections are listed under "Additions and corrections" on p. 243. They concern the *Subcontractus*, *Hollandi* and *Discus* Zones, but do not involve any change in the zonal index species or disturb the priority and are merely a matter of academic accuracy.

No new information is available for or against retaining the *Fallax* (olim *Fusca*) Zone, which was tentatively retained in brackets in the table on p. 21. In a later table of zones for the N.W. European Jurassic I have omitted it (Arkell, 1956, p. 10) since on balance it lacks justification. I also omitted from this later table the *Hollandi* Zone, since the naming of a zone after a species of which only two specimens have been found in the whole of Britain is open to criticism. This is, however, a matter of systematic stratigraphical convenience and rules. The formations assigned to the *Hollandi* Zone on p. 21 are an important part of the Bathonian stage and are easily recognized by their brachiopod, lamellibranch, echinoderm and bryozoan fauna. They were recognized as a zone a hundred years ago by Oppel, who named as index *Terebratula digona* (part of Oppel's *Lagenalis* Zone — Forest Marble — now also included). No one can deny that a faunizone exists at this horizon in Britain and northern France; and if the rule is to be obeyed that full zones in the Jurassic should have an ammonite species as index, there is no other ammonite to fill this role but *Clydoniceras hollandi*.<sup>1</sup> For British and north French tables of zones, therefore, I would still retain the *Hollandi* Zone.

In view of the rising cost of printing (which is much more expensive now than 7 years ago), the "more detailed correlations . . . at the end of the monograph", envisaged on p. 7, do not seem justified. The main British problem, the complicated

<sup>1</sup> Three other species of ammonites are now known from the *Hollandi* Zone (see p. 239), but only one specimen of each had been found.

relations between the southern Fuller's Earth province and the midland Great Oolite province, has been treated in detail already (Arkell & Donovan, 1952), and a closer investigation into the first incoming of the Great Oolite in the country between Wellow and Norton St. Philip, which has been pursued over a number of years by Dr. D. T. Donovan and myself, will also be offered for publication elsewhere. Wider correlation of the Bathonian and the distribution of the accepted zones and the stage over the whole world have been discussed recently (Arkell, 1956).

The most important new discovery in the Bathonian since this monograph began to appear is the remarkable ammonite assemblage obtained from material belonging to the upper part of the Fuller's Earth Rock excavated from a road-widening at Whatley, near Frome, Somerset. This has already been briefly alluded to under Parkinsoniidae (pp. 143, 150, 156) and in the previous part under Perisphinctidae (p. 190), and a number of the ammonites from Whatley have been figured by kind permission of Dr. F. Hodson and Mr. P. C. Sylvester-Bradley. The stratigraphy and its implications for ammonite studies have been published elsewhere (Sylvester-Bradley & Hodson, 1957; Arkell, 1957).

As regards formation names, it emerged from the investigation for the 'Lexicon of Stratigraphy' that the current terms Wattonensis Beds and Lenthayensis Beds (see p. 7) are antedated by Watton Cliff Brachiopod Beds (1940) and Lenthay Beds (1918) respectively.

The Callovian zones tabulated on p. 8 have been illuminatingly discussed, together with the base of the Callovian, by Dr. J. H. Callomon (1955), who has shown that the Koenigi Zone ought to be accepted only as a subzone of the Calloviense Zone, if at all. For the history, nomenclature and definitions of these and the somewhat tangled Upper Bajocian zones revised on pp. 8—9, reference should be made to the forthcoming 'Lexicon of Stratigraphy'.

I cannot close without paying a tribute to the high value of the researches of Brigadier G. Bomford in South Dorset. His remarkable collections made under minute stratigraphical control have been generously put at my disposal while this monograph was in progress and they have shed a flood of light on the distribution of ammonites in the Zigzag Zone and underlying zones of the Inferior Oolite. In the Sherborne area, a great deal of excellent ammonite material from the Crackment Limestones and Lenthay Beds has been salvaged over the years from temporary excavations—foundations, pipe trenches, even bomb craters—by Mr. Joseph Fowler of Sherborne, and all this material has also been most generously made available, and most of it is now permanently in the Sedgwick Museum. A number of other collectors have also contributed smaller quantities of material from many parts of the outcrop; in addition to those already thanked on p. 6 I wish to thank Dr. F. Hodson, Mr. C. E. Periam, Mr. A. J. Martin and Mr. H. S. Torrens, who have thrown new light on the stratigraphical distribution of Bathonian ammonites.

#### 4. STRATIGRAPHICAL SUMMARY.

In this concluding section an attempt is made to bring together in tabular form the ammonite-records scattered through the monograph, so as to make the strati-

graphical sequence within the English Bathonian readily and clearly accessible to the worker seeking information on general results.

### UPPER BATHONIAN.

#### Discus Zone.

##### Lower Cornbrash.

*Clydoniceras discus* (J. Sowerby) and vars., *C. thrapstonense* Arkell, *C. douglasi* Arkell (pp. 33—41), ? *Delecticeras legayi* (Rigaux & Sauvage), ? *D. delectum* Arkell, ? *D.* cf. *ptychophorum* (Neumayr) (pp. 44—45), *Choffatia subbakeriæ* (d'Orbigny), *C. arisphinctoides* Arkell (pp. 215—219), *C. (Loboplanulites) cerealis* Arkell, *C. (L.) longilobata* (S. Buckman), *C. (L.) kranaiiformis* Arkell (pp. 219—225), *C. (Homæoplanulites) homæomorpha* (S. Buckman) (p. 225).

#### Hollandi Zone.

##### Forest Marble.

*Polyplectites periami* Arkell (p. 231), *Siemiradzkia pseudorjazanensis* (Lissajous) (p. 228).

##### Bradford Clay.

*Clydoniceras hollandi* (S. Buckman) (p. 41).

##### Boueti Bed.

*Delecticeras* sp. (p. 244).

#### Aspidoides Zone.

##### Kemble Beds.

*Siemiradzkia pseudorjazanensis* (Lissajous) (p. 228).

##### Bath Stone and Lower Rags.

*Procerites hodsoni* Arkell (p. 190).

##### Twinhoe Ironshot.

*Oppelia (Oxycerites) aspidoides* (Oppel) (p. 62), *Procerites twinhoensis* Arkell (p. 189), *P. imitator* (S. Buckman) (p. 192), *P. (Gracilisphinctes) mirabilis* Arkell (p. 201), *Wagnericeras (Suspensites) arbustigerum* (d'Orbigny) (p. 206).

##### Fuller's Earth above Wattonensis Beds.

*Delecticeras* sp., near *D. legayi* (Rigaux & Sauvage) (p. 44), *Hecticoceras (Prohcticoceras) costatum* (J. Roemer) (p. 72), *Procerites (Gracilisphinctes) mirabilis* Arkell (p. 201), *Choffatia (Homæoplanulites) homæomorpha* (S. Buckman) (p. 225).

### MIDDLE BATHONIAN.

#### Rugitela Beds (Upper Fuller's Earth Rock) of Whatley, Somerset.

*Parkinsonia (Parkinsonia)* sp. indet. (p. 150), *P. (Gonolkites) convergens* (S. Buckman) (p. 153), *Procerites fullonicus* (S. B.), *P. hodsoni* Arkell, *P. imitator* (S. B.), *P. quercinus* (Terquem & Jourdy), *P. wattonensis* Arkell (p. 189—196), *Wagnericeras fortocostatum* (de Grossouvre) (p. 204), *Choffatia subbakeriæ* (d'Orbigny) (p. 215), *C. (Homæoplanulites) homæomorpha* (S. B.) (p. 225), *Æcotraustes (Paræcotraustes) serrigerus* (Waagen) (p. 245).



The following forms have also been recorded from here (Arkell, 1957). *Oppelia* (*Oxycerites*) sp. indet. cf. *intermedia* Roemer, *Parkinsonia* (*P.*) aff. *pachypleura* S. B., *Procerites* cf. or aff. *tmetolobus* S. B., *Cadomites* or *Polyplectites* sp.

Wattonensis Beds of Dorset (= Watton Cliff Brachiopod Beds; p. 238).

*Morrisiceras* cf. *morrissi* (p. 241), *Procerites quercinus* (Terquem & Jourdy), *P. wattonensis* Arkell (p. 196).

#### Subcontractus Zone.

Fuller's Earth Rock of Dorset and Somerset.

*Æcotraustes* (*Paræcotraustes*) *serrigerus* (Waagen) (p. 245), *Æ. (P.)* cf. *serrigerus* (p. 69), *Æ. (P.) splendens* Arkell (p. 70), *Hecticoceras* (*Prohæcticoceras*) *costatum* (J. Roemer) (p. 72), *Tulites cadus* S. Buckman, *T. tula* S. B., *T. præclarus* (S. B.), *T. modiolaris* (Smith), *T. subcontractus* (Morris & Lycett), *T. calvus* (S. B.), *T. pravus* (S. B.), *T. glabretus* (S. B.), *T. pumilus* Arkell, *T. mustela* Arkell (pp. 91—103), *T. (Rugiferites) rugifer* (S. B.), *T. (R.) polypleurus* (S. B.), *T. (R.) defontiformis* Arkell (pp. 104—5) *Bullatimorphites serpenticonus* Arkell (p. 111), *Krumbeckia reuteri* Arkell (p. 111), *Morrisiceras morrissi* (Oppel), *M. sphaera* S. B., *M. fornicatum* (S. B.), *M. tolmerum* S. B. (pp. 119—124), *Lyceticeras comma* (S. B.), *L. sknipum* (S. B.), *L. lycetti* Arkell, *L. aff. bulbosum* Arkell (pp. 124—128), *Procerites quercinus* (Terquem & Jourdy), *Wagnericeras fortcostatum* (de Grossouvre), *W. bathonicum* Arkell (pp. 204—5), *W. (Suspensites) suspensum* (S. B.) (p. 209), *Choffatia arisphinctoides* Arkell (p. 218), *C. (Loboplanulites) cerealis* Arkell (p. 219), *Siemiradzka matisconensis* (Lissajous) (p. 228), *Berbericeras schwandorfense* Arkell, *B. sekikense* Roman (pp. 230—231).

Great Oolite, Gloucestershire to Northamptonshire.

*Oppelia* (*Oxycerites*) *aspidoïdes* (Oppel), *O. (Oxycerites) waterhousei* (Morris & Lycett) (pp. 62—66), *Tulites cadus* S. Buckman, *T. præclarus* (S. B.), *T. modiolaris* (W. Smith), *T. subcontractus* (Morris & Lycett), *T. glabretus* (S. B.), *T. mustela* Arkell (pp. 91—103), *Bullatimorphites bullatus* S. B. (p. 105), *Morrisiceras morrissi* (Oppel), *M. fornicatum* (S. B.), *M. korustes* S. B. (pp. 119—23), *Lyceticeras sknipum* (S. B.), *L. lycetti* Arkell (pp. 125—7), *Procerites hodsoni* Arkell, *P. imitator* (S. B.) (pp. 190—2), *Wagnericeras pseudosubtile* (Lissajous) (p. 205), *W. (Suspensites) suspensum* (S. B.), *W. (S.) arbustigerum* (d'Orbigny) (pp. 206—9), *Choffatia (Loboplanulites) cerealis* Arkell (p. 219).

#### Progracilis Zone.

Stonesfield Slate.

*Clydoniceras tegularum* Arkell (p. 42), *Micromphalites micromphalus* Arkell (p. 46), *Oppelia* (*Oxycerites*) *limosa* (S. Buckman), *O. (Oxycerites) oxus* (S. B.) (pp. 60—66), *Æcotraustes* (*Paræcotraustes*) *formosus* Arkell (p. 71), ? *Tulites pravus* (S. B.) (p. 100), *Procerites* (*Gracilisphinctes*) *progracilis* Cox & Arkell, *P. (G.) mirabilis* Arkell, *P. (G.?) magnificus* Arkell, *P. (G.) vineta* Arkell (pp. 197—203).

*Possible Subdivisions of the Subcontractus Zone.*—At present it is only possible to say that different quarries in the Fuller's Earth Rock have yielded somewhat different assemblages of the ammonites listed above. According to the doctrine of dissimilar faunas this would mean that deposits of recognizably different ages are present, but this inference has not been proved to be correct.

Examination of the collections in the Sedgwick Museum showed that nearly all the specimens of *Lycetticeras* had come from Alham Lane Quarry, near Bruton, Somerset. I revisited this quarry in 1956, when only some three or four feet of rock was visible, and that with difficulty. Nevertheless, a good specimen of *L. sknippum* (S. Buckman) was soon collected, and despite further search no other ammonite was found. About a foot of the *Ornithella* Beds rested on the main Fuller's Earth Rock in another part of the quarry, but no ammonites were found there.

Dancing Cross Quarry, Maperton, Somerset, was then revisited and the whole long face was well exposed, although not worked for some time. *Tulites* is recorded from this quarry, and within a few minutes I collected four *T. modiolaris* (or *T. cf. præclarus*; the two species may in fact be one) in a band about four inches below the base of the *Ornithella* Beds; yet no *Lycetticeras* was found, nor is any known from this locality in old collections.

Two brachiopod subzones have already been established, and are distinct as far north as Whatley, near Frome (Sylvester-Bradley & Hodson, 1957). The higher subzone, or Wattonensis Beds, corresponds to the "Upper Fuller's Earth Rock" of the Sherborne district, Dorset (Kellaway & Wilson, 1941) and *Morrisiceras cf. morrissi* persists in it (see pp. 119—121). The Lower, or true Fuller's Earth Rock of Dorset and Somerset, is itself divisible, as Richardson showed, into an upper rubbly part, the *Ornithella* Beds, and a lower massive part, in which the ammonites are found. The peculiar distribution of *Lycetticeras* and *Tulites* discussed above would thus, according to the doctrine of dissimilar faunas, suggest the existence of ammonite subzones within the true Fuller's Earth Rock; but an equally satisfactory explanation can be found by postulating ecological differences or mere vagaries of distribution. Some minor subdivision within the Wattonensis Beds may also be discernible (House, 1957).

From the lists of ammonites given above (pp. 239—240), it appears that three faunas may be distinguished in the Middle Bathonian. The lowest is that of the Progracilis Zone. The second is the true Subcontractus Zone fauna of the White Limestone of Gloucestershire and Oxfordshire and the Fuller's Earth Rock from Bath to North Dorset. The third is that of the Wattonensis Beds, but this is known in any quantity only from one locality (Whatley) where the fauna is so anomalous that it is difficult to say what it implies. As I have pointed out elsewhere (Arkell, 1957) there is an association of forms found otherwise in Lower, Middle and Upper Bathonian beds, but never all together in one fauna; and none of the index species or genera is present. The presence of *Morrisiceras* indicates a late Middle Bathonian age, though the fauna certainly cannot be included in the Subcontractus Zone. Some items, especially *Choffatia* spp., point to an early Upper Bathonian age, but there is not enough evidence to put the assemblage in the Aspidooides Zone.

## LOWER BATHONIAN.

## Fallax Zone.

## Lower Fuller's Earth.

*Oppelia (Oxycerites) fallax* (Guéranger) (p. 56), *Morphoceras recinctum* (S. Buckman) (p. 137), *Siemiradzkia aurigera* (Oppel) (p. 227), *S. ? pseudoannularis* (Lissajous) (p. 230).

## Chipping Norton Limestone.

*Oppelia (Oxycerites) limosa* (S. Buckman) (p. 60), ? *Parkinsonia pachypleura* S. B. (p. 146).

## Zigzag Zone.

## Zigzag Bed, Scroff and basal Fuller's Earth, Dorset and Somerset.

*Vastites vastus* Arkell (p. 27), *Lissoceras psilodiscus* (Schloenbach) (p. 45), *Oppelia (Oxycerites) fallax* (Guéranger), *O. (Oxycerites) knapheutica* (S. Buckman), *O. (Oxycerites) limosa* (S. B.), *O. (Oxycerites) nivernensis* de Grossouvre, *O. (Oxycerites) pygmaea* Arkell (pp. 56—62), *Æcotraustes costiger* S. B., *Æ. bradleyi* Arkell, *Æ. bomfordi* Arkell (pp. 67—68), *Cadomites cf. deslongchampsii* (d'Orbigny) (p. 80), *Morphoceras multiforme* Arkell, *M. patescens* (S. B.), *M. macrescens* (S. B.), *M. densicostatum* Thalmann, *M. pingue* de Grossouvre, *M. repletum* (S. B.) (pp. 132—6), *Polysphinctites polysphinctus* S. B., *P. ebrayoides* Arkell (p. 138), *Ebrayiceras pseudo-anceps* (Ebray), *E. rursum* S. B., *E. jactatum* S. B., *E. filicosta* Wetzel (pp. 139—41), *Parkinsonia (Parkinsonia) pachypleura* S. B., *P. (P.) cf. dorni* Arkell (pp. 150—1), *P. (Gonolkites) convergens* (S. B.), *P. (G.) subgaleata* (S. B.) (pp. 153—6), *P. (Durotrigensia?) vermicularis* (S. B.) (p. 160), *Zigzagiceras zigzag* (d'Orbigny), *Z. euryodos* (Schmidt), *Z. plenum* Arkell (pp. 177—9), *Procerozigzag crassizigzag* (S. B.), *P. pseudo-procerus* (S. B.) (pp. 179—80), *Procerites schloenbachi* de Grossouvre, *P. subprocerus* (S. B.), *P. clausiprocerus* (S. B.), ? *P. costulatosus* (S. B.), *P. fullonicus* (S. B.), *P. tmetolobus* S. B. (pp. 181—91), ? *P. (Phaulozigzag) phaulomorphus* (S. B.), *Siemiradzkia (Planisphinctes) planilobus* S. B. (p. 230).

## Crackment Limestone.

*Oppelia (Oxycerites) fallax* (Guéranger) (p. 56), *Æcotraustes costiger* S. Buckman, *Æ. nodifer* S. B. (pp. 67—68), *Parkinsonia (Parkinsonia) pachypleura* S. B., *P. (P.?) subtilis* Arkell (pp. 150—2), *P. (Gonolkites) convergens* (S. B.), *P. (G.) subgaleata* (S. B.) (pp. 153—6), *Zigzagiceras plenum* Arkell (p. 179), *Procerozigzag crassizigzag* (S. B.) (p. 179), *Procerites subprocerus* (S. B.), ? *P. costulatosus* (S. B.), *P. incognitus* Arkell (pp. 183—97).

## Lenthay Beds.

*Procerites fowleri* Arkell (p. 191), *P. ? (Phaulozigzag?) lenthayensis* Arkell (p. 204).

## Hook Norton Beds.

? *Parkinsonia* (*Parkinsonia*) *pachypleura* S. Buckman (p. 146), *P.* (*Gonolkites*) *subgaleata* (S. B.) (p. 156), *P.* (*Durotrigensia*) *oxonica* Arkell, *P.* (*D.*) *cf. crassa* Nicolesco (pp. 160—2), *Procerozigzag pseudoprocerus* (S. B.) (p. 180), *Procerites subprocerus* (S. B.) (p. 183).

*Zigzag Zone.*—The Zigzag Bed of Burton Bradstock and Broad Windsor consists largely of ammonites and contains in abundance all the important genera and most of the known species. Among the commonest are *Parkinsonia pachypleura*, *P. dorni*, *P.* (*Gonolkites*) *convergens*, *P.* (*G.*) *subgaleata*, *Zigzagiceras* spp., *Procerozigzag* spp., *Procerites subprocerus*, *P. tmetolobus*, *Morphoceras* spp., *Ebrayiceras* spp., *Æcotraustes costiger*, *Æ. nodifer*, *Oppelia* (*Oxycerites*) *fallax* and *limosa*, etc.

The Crackment Limestone of North Dorset, on the other hand, yields a much poorer fauna. The only common forms are *Parkinsonia pachypleura* and *P.* (*G.*) *convergens*, with which occur occasionally a large *Procerites* and rarely an *Æcotraustes*. Only one *Zigzagiceras* is known, *Z. plenum* from Osborne (p. 179).

Regarding possible subdivisions of the Zigzag Zone I have no more to say than I wrote on pp. 9—10 of Part I. Opportunities may come at any time to collect from new exposures, such as the pipeline recently described (Fowler, 1957). The succession in the Holy Cross Mountains of Poland (p. 155) suggests that several subzones will be recognizable when good sections become available. One of the most promising localities for further investigation of the Lower Bathonian is the Elburz Mountains of Northern Persia, where the late Mr. E. J. White of British Petroleum Co. Ltd. collected all the characteristic genera—*Oppelia* (*Oxycerites*), *Morphoceras*, *Ebrayiceras*, *Procerites* and *Parkinsonia*, as well as *Æcotraustes* and *Cadomites* (Arkell, 1956, pp. 370—1)—a typically European assemblage, reminiscent of Engelberg in the Swiss Alps (Thalmann, 1923, 1925) or of Dorset. Those interested in the wider application of Bathonian zoning will find a summary up to 1955 arranged continent by continent in the book cited (Arkell, 1956). In view of the title of the present monograph, it would be inappropriate to attempt a fuller analysis here.

## 5. ADDITIONS AND CORRECTIONS.

*The J. W. TUTCHER COLLECTION* (pp. 5, 56, 124, 125, 138).—In 1948—49 when in preparation for this monograph I was worrying curators of all museums likely to contain Bathonian ammonites, most of the Tucher collection could not be found at Bristol, owing to disorganization caused by the bombing of parts of the City Museum during the recent war, and I was informed that most of it, including the types of species figured in Buckman's 'Type Ammonites' must be considered destroyed. A few years later Mr. Philip Curnow, of that museum, informed me that it had been established that only the displayed material had been destroyed and that the rest had survived intact in store in another part of the building, but that unfortunately no type specimens were to be found. In April, 1956, Mr. D. Phillips of the Department of Palæontology, British Museum (Natural History),

wrote to report that he had come across two of the missing Bathonian types in that Museum, although I had been assured that I had seen all the Bathonian ammonites there. I asked him to search for others, and he later reported two more types, and two Upper Inferior Oolite ammonites figured by Buckman and believed missing. The list of Mr. Phillips' discoveries, with their registered numbers, is as follows :—

*Oppelia (Oxycerites) knapheutica* (p. 56), C41725.

*Morrisiceras korustes* (p. 124), C41721.

*Lycetticeras comma* (p. 125), C41720.

*Morphoceras recinctum* (p. 138), C41724.

*Vermisphinctes subdivisus*, C41722.

*Glyphosphinctes glyphus*, C41723.

- p. 3, lines 16—18. The Zigzagiceratinae are now believed to be monophyletic (see p. 234).
- p. 8, zonal table. All the zonal indices are figured in Arkell, 1956.
- pp. 9, 11, fauna of the Zigzag Zone. Some of the names are revised in later parts of the monograph. The correct names can be got from the index.
- p. 11, lines 6—7. "Thereafter ammonites are unknown until the Cornbrash". This was in 1950. In 1956 Mr. H. S. Torrens found a small *Delecticeras* in the Boueti Bed of the Thornford water-pipe trench in Honeycombe Woods, near Sherborne. Unfortunately it is only half a specimen 18 mm. in diameter and is too small for specific identification, but its generic placement is quite clear. It is the first ammonite ever recorded from the Boueti Bed. The other half is still embedded in a block which contains *Goniorhynchia boueti*. Mr. Torrens has kindly presented both pieces to the Sedgwick Museum (SM. J46367).
- p. 15, para. 2. A more northerly record for the Great Oolite is "*Ammonites bullatus*" from between Alwalton and Peterborough (Sharp, 1873, p. 279). (See pp. 110—1).
- p. 20. Subcontractus Zone. This was first proposed by H. B. Woodward (1894, p. 231), a reference overlooked by me in 1951. Buckman in 1898 and 1901 in any case cited it only as a hemera, not as a zone, and this does not count for priority as a zone according to a decision taken by the compilers of the 'Lexicon of Stratigraphy'.
- p. 22. Hollandi Zone. In accordance with the above decision, this zone takes priority only from this monograph, p. 22, 1951.
- p. 22. Discus Zone. Buckman in 1898 cited this only as a hemera. The first mention by him of a Discus Zone is believed to be in 1913, TA, ii, p. x.
- p. 27. According to a decision of the Copenhagen Congress of the International Commission on Zoological Nomenclature in 1953, superfamilies have to be attributed, not to their own author and date, but to the author and date of the typical family, which must be the family first named. Harpocerataceae thus is displaced by Hildocerataceae (from Hildoceratidæ Hyatt, 1867).

- pp. 30—31. The Arabian evidence mentioned on p. 32, first paragraph, subsequently led to the conclusion that Clydoniceratidæ were derived by way of *Thambites*, *Thamboceras* and *Ermoceras* from Stephanoceratacæ. See p. 233.
- p. 33. Delete *Oraniceras*, which has turned out to be a Parkinsoniid (see p. 145).
- pp. 47—48. The superfamily Oppeliacæ becomes Haploceratacæ (from Haploceratidæ Zittel, 1884) under the 1953 Copenhagen decision referred to above in connexion with p. 27. The family Oppeliidæ dates from 1894. I am indebted to Dr. Arnold Zeiss, Munich, for the information that the 1893 volume of the 'Bull. Soc. Malacol. Italiana' (vol. xviii) was published in 1894. (My reprint belonged to J. F. Pompeckj and has the reference and date 1893 upon it in his handwriting.) Whether Bonarelli or Buckman first published the name is not known. Dr. Zeiss points out that the expression "Oppéliidés" was used by H. Douvillé, 'Bull. Soc. géol. France' [3], xviii, p. 287 (1890); but this French vernacular form of family group names is not recognized by the International Commission on Zoological Nomenclature.
- p. 48. *Iokastelia* (and *Amblyoxyites*?) is a junior synonym of *Bradfordia* Buckman.
- pp. 52—53. *Paroxycerites* Breistroffer (1947, 'Proc.-verb. mensuel Soc. Sci. Dauphiné', 26 année, no. 195, pages not numbered) had been proposed as substitution name for *Alcidia* Rollier, with type species *Am. subdiscus* d'Orbigny. In my opinion this is a synonym of *Paralcidia* Spath, 1928.
- p. 61, paragraph 3. Delete nos. 1964, 3286—7, Bomford Coll.
- p. 70. *Æcotraustes serrigerus* Waagen. A good specimen was obtained in 1953 from Fuller's Earth at 270 ft. in a boring at Patterdown, near Chippenham, Wilts. (GSM. Bi9651), and several were collected in 1953 by Dr. F. Hodson from the upper part of the Fuller's Earth Rock of the road-widening at Whatley, Somerset.
- p. 73, last paragraph, fourth line. For 350 yds. read 850 yds. (Information from Mr. R. V. Melville.)
- p. 74, last paragraph, eleventh line. *S. quenstedti* Roché, 1939, is a junior objective synonym of *S. frechi* Renz, 1913 ('N. Jahrb. Min. Geol.', Beil.-Bd. xxxvi, p. 684) (See Arkell, 1954, 'Phil. Trans. Roy. Soc.', vol. 237B, p. 582.)
- p. 77, lines 2—5. The name *Sphæroceras* Bayle has now been validated by the International Commission, Opinion 300.
- pp. 79—81. For further discussion of *Cadomites* and a new species of *Polyplectites* from the Forest Marble, see p. 232.
- p. 82, line 5. Add "or Garantiana Zone".
- pp. 95—98. *Tulites modiolaris* and *T. subcontractus*. In 1956 I obtained three good *Tulites in situ* in Dancing Cross Quarry, Maperton, Somerset, all on one level, 1 ft. below the top of the more massive limestone and 1 ft. below the rubbly *Ornithella* beds. One is *T. subcontractus* (SM. J46374). The other two I identify as *T. modiolaris* (SM. 46372—3), but they are also identical with small specimens collected by Mr. Sylvester-Bradley in 1950 from Henover Hill and Purse Caundle, which I previously identified (p. 95) as *T. præclarus*. It seems likely that as more material comes to be collected *T. præclarus* (Buckman) will be found to fall in synonymy

- with *T. modiolaris* (W. Smith), just as *T. madarus* (Buckman) and *T. sphaeroidalis* have already done (p. 95).
- pp. 98—99. *Tubites subcontractus* and *T. calvus* are both represented from the Great Oolite, Minchinhampton, by specimens in Reading University (seen April, 1953).
- p. 113. The subtle but important question of the relationship of the Bathonian genera *Morrisiceras* and *Lyceticeras* to the Callovian Macrocephalitidæ, discussed on pp. 113—5, is only obscured by the creation of a separate subfamily Morrisiceratinæ (Westermann, 1956, p. 262), which suggests that they are something distinct and apart rather than on the direct line of descent. This is the old procedure of Buckman: when in doubt make new names. (The supposed Bathonian *Reineckeia* referred to by Westermann on the same page, p. 262, footnote, has been kindly sent me on loan by Dr. K. Hoffmann, and although it is only 11 mm. in diameter I believe it to be a nucleus of a *Parkinsonia*).
- p. 117, last paragraph, first line. For **Cericereras** read **Cerericeras**.
- pp. 127—8. *Lyceticeras lycetti*. In 1956 I obtained a fine specimen *in situ* in the Fuller's Earth Rock of Alham Lane Quarry, Chesterblade, Somerset (SM J46371).
- p. 134. *Morphoceras macrescens*. Add Brambleditch Quarry, Doultling (Bristol Univ.).
- p. 139, Text-fig. 52. See also Plate XXXII, fig. 5. In this connexion see also a keeled *Aspidoceras* figured by Quenstedt, 1887, pl. xciv, fig. 50.

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<sup>1</sup> The above is the reference given in Neave, 1939 'Nomenclator Zoologicus', p. 428 for the name *Bigotella* Cossmann. This name was first proposed in Cossman, M.—1913. 'Mém. Soc. géol. France', Paléont., xx, no. 46, pp. 128, 140.—Editor.

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## INDEX

Clarendon type indicates a page where a diagnosis is to be found. Roman and arabic-numerals following a semicolon indicate illustrations of species.

- acuticosta, 230  
 admirandus, 157, 167  
 Alcidia, **52**, 245  
 althoffi, 168  
 Anaplanulites, **211**  
 anceps, 132  
 angelomontanense, 133-4  
 angulicostatum, 104  
 arbustigerum, 177, 189, 194, **206-8**, 209; Text-figs. 76, 77  
 arisphinctoides, **218**, **219**, 223; XXXII, 3, 10  
 artiusculus, 214  
 asinus, 169  
 Asphinctites, **131**, 138  
 aspidoides, 51, 55-8, 60, 61, **62-5**, 66; VI, 7; Text-figs. 12, 17  
 augescens, 30  
 aureus, 223  
 aurigera, 173, 212, 214, **227**, **228**; XXXIII, 8, 10
- bajociensis, 50  
 Bajocisphinctes, **167**  
 bakeriæ, 212, 215, 227  
 balinensis, 211  
 banaticum, 205  
 bathonicum, **205**, **206**; XXIX, 1  
 Benedictites, 30, **32**  
 Berbericeras, **213**, **214**, 230-31  
 Bigotella, 166, **167**  
 Bigotites, **166**, **167**  
 Bigotitinæ, 166  
 bombur, 90  
 Bomburites, 89, **90**  
 bomfordi, *Æcotraustes*, **68**, **69**; VII, 10-14  
 bomfordi, *Parkinsonia*, 157; Text-fig. 55  
 bradleyi, **68**, 69; VII, 1, 2, 9  
 brighti, 70  
 brongniarti, 76, 77, 119; Text-fig. 20  
 brunsvicensis, 19  
 buckmani, 88
- bulbosum, 116, 119, 120, aff. *bulbosum*, 128; Text-fig. 46  
 Bullatimorphites, **87**, 88, 105-11  
 bullatimorphus, 87, **105**, **107**; Text-fig. 24  
 bullatum, *Sphæroceras*, 87, 107  
 bullatum, *Stephanoceras*, 89  
 bullatus, *Ammonites*, 105, 107, 119, 244  
 bullatus, *Bullatimorphites*, 107, 108, 110; Text-fig. 34  
 busqueti, 47; Text-fig. 9
- cadomensis, 49  
 Cadomites, **79**, **80**, 80-2, 232  
 Cadomoceras, **49**  
 cadus, 84, **91-3**; IX, 2, 4, 6; X, 1; XII, 8; Text-fig. 28  
 calloviensis, 51, 58  
 calvus, **99**, **100**, 246; Text-fig. 31  
 cardoli, 222  
 caroli, 217  
 Caumontisphinctes, **145**  
 cereale, *Cerericeras*, 117; Text-fig. 42  
 cerealis, *Loboplanulites*, 212, **219-22**, 224, 226; XXXI, 3-6; Text-figs. 79, 80  
 Cerericeras, **117-19**  
 cheyensis, 211  
 Choffatia, **211**, 215-27; XXVIII, 5  
 Chondroceras, 78; Text-fig. 20  
 clausiprocerus, 181, 183, 184, **185**, 189; XXIII, 5; Text-fig. 67  
 Cleistophinctes, **168**, **169**  
 cleistus, 168  
 Clydoniceras, **32**, 33-44  
 Clydoniceratidæ, 30-33, 233  
 cobra, 211  
 comma, 113, 116, 124-5, 127; XV, 1, 2, 8; Text-fig. 44  
 complanatus, 58, 64  
 compressus, *Ammonites*, 146, 153, 155  
 compressus, *Cadomites*, 231

- conjungens, 67, 68  
 convergens, 59, 145, 150, **153-6**; XVIII, 2, 8;  
 XIX, 1, 2; Text-fig. 57  
 cosmopolita, 89; Text-fig. 26  
 costatum, Hecticoceras, **72, 73**; VIII, 5-7;  
 Text-fig. 19  
 costatus, Bullatimorphites, 87, **107**  
 costiger, **67**, 68, 69; VII, 3-6  
 costulatus, 168, **185, 186, 188**, 189, 197, 203;  
 XXI, 8; Text-fig. 69  
 Cranocephalites, **117**  
 crassa, 153, 162-3; Text-fig. 58  
 crassizigzag, 170, **179, 180**, 181; XX, 6-9;  
 XXII, 6; Text-fig. 61  
 curvatus, 167  
  
 daubenyi, 80, 81  
 davaiacense, 39, 41; Text-fig. 6  
 davidsoni, 167  
 defontiformis, **105**; XIII, 3  
 defrancci, 167  
 Delecticeras, **32**, 44-5, 244  
 delectum, **32, 45**; IV, 12; Text-fig. 8  
 densecostatus, 71  
 densicostatum, 133, **134, 135**; XVII, 4; Text-  
 fig. 48  
 depressa, 133  
 deslongchampsii, **80-2**; IX, 3; Text-fig. 21  
 Deslongchampsia, **80**  
 devauxi, 90; Text-fig. 27  
 dicosmum, 117  
 difficilis, 211  
 Dimorphinites, **131**  
 dimorphus, 131  
 discus, 25, **33-40**, 41-5; II, 1-10; III, 1-10;  
 Text-fig. 6  
 discus, var. blakei, **36, 37**; II, 3, 4, 7-10;  
 Text-fig. 5  
 discus, var. crenellatus, **36**, 41; II, 3; III, 1, 3, 6  
 discus, var. digitatus, **36**; II, 6; III, 6  
 discus, var. discus, **35, 37**; II, 1  
 discus, var. hochstetteri, 32, 34, 35, **36, 37, 40, 41**,  
 115; I, 4; II, 9; III, 2-5, 7, 8; Text-fig. 6  
 divisa, 144  
 dorni, 9, **151, 152**; XVIII, 5; XIX, 5-7, 10,  
 11; Text-fig. 56  
 dorsetensis, 145, 155  
 douglasi, 37, **41**; III, 11  
 dundriensis, 49  
 Durotrigensia, **145, 155**  
  
 Ebrayiceras, **131, 132**, 138, 139-42  
 ebrayoides, **138**; XVI, 3  
 eimensis, Oxycerites, 71  
 eimensis, Parkinsonia, 153, 155  
 eimensis, Sulcohamites, 132  
 erato, 48  
 Euprocerites, **173**  
 euryodos, 169, 177, **178, 179**, 180; XXI, 1, 3, 6;  
 Text-fig. 60  
 evolutus, 117  
  
 fallax, 33, 55, **56-60**, 61, 64, 66, 67; V, 1-3;  
 VIII, 11; Text-figs. 15, 16  
 ferruginea, 143, 151, 153, 155  
 filicosta, **141, 142**; XVII, 6  
 flexa, 50  
 Flexoxyites, 51  
 folliformis, 119  
 formosus, **71, 72**; VIII, 8-10; Text-fig. 18  
 fornicatum, **122, 123**; XIV, 11, 12  
 fortocostatum, **204, 205**; XXIX, 2, 3; Text-fig.  
 76  
 fowleri, **191**; XXIV, 5; Text-fig. 69  
 Frechiella, 31  
 fullonicus, 173, **189, 190**, 191, 196, 197; XXIV,  
 1-4; Text-fig. 69  
 furcula, 211, 218  
 fuscicacensis, 230  
 fusca, Oppelia, 56, 57, 60, 65  
 fuscum, Hecticoceras, 55, 57, 73; Text-fig. 19  
  
 Garantianidæ, 142  
 gautieri, 140  
 geerzense, 95  
 genicularis, 53, 54, 68, 69; Text-fig. 13  
 gervillii, 78; Text-fig. 20  
 gignouxii, 140  
 glabella, 52  
 glabretus, **100-3**; XI, 1; Text-figs. 32, 33  
 globuliforme, 90; Text-fig. 27  
 Glyphosphinctes, **168**  
 Gonolkites, **145**, 153-60  
 Gonoxyites, 51  
 gracililobata, 29  
 gracilis, 174, 193, 197, 203  
 Gracilisphinctes, **174, 175**, 197-203  
 grandiforme, Text-fig. 20  
 gredigensis, 213, 230  
 Grossouvria, **214**  
 guérangeri, 33, 34, 39, 40; Text-fig. 6

- hamyanense, 33, 145  
hannoveranus, 108, 123  
Haploceras, **49**  
Haploceratidæ, 47—50  
Harpocerataceæ, 27—47  
Harpoceratidarum, **32**  
Harpoxyites, 51  
Haselburgites, 157, **167**  
haugi, 54, 72  
Hecticoceras, **55**, 70, 72, 73  
Hecticoceratinæ, 54—73  
hecticus, 55  
hersilia, 51
- Hildocerataceæ, 233  
hochstetteri, *See* discus var. hochstetteri  
hodsoni, **190**, **191**; XXV, 1; Text-figs. 68—69  
hollandi, 32—4, **41**, **42**, 43; I, 5, 6; Text-fig. 6  
homœomorpha, 211, 217, **225—7**; XXX, 1, 3—5; XXXI, 1, 2  
Homœoplanulites, **211**, 225—7  
homœoticum, 113, 120, 124; Text-fig. 40  
hyatti, 217
- imitator, 173, 176, **192**, **193**, 201; XXVI, 2—4; Text-fig. 69  
incognitus, **197**, 203; XXVI, 5  
inflatum, Lissoceras, 49, 50  
inflatus, Ammonites, 130, 132, 133, 141  
inflexa, 53  
intermedia, 54  
intersertus, 173  
irregulare, 122; XIV, 11, 12
- jacobi, 119  
jactatum, **141**, 142; XVII, 1, 2, 12, 13  
jaworskii, 167
- Keplerites, 117, 119  
khengari, 52  
Kheraicerias, 77, **89**, **90**, 119  
kleidos, 223  
knapheutica, **55**, 56; Text-fig. 14  
korustes, **123**, **124**; Text-fig. 43  
kranaiformis, **224**, **225**; XXXI, 7; Text-figs. 79, 82  
krumbecki, 115, 117, 120  
Krumbeckia, **89**, 111
- lævipickeringius, 218  
lævis, 153  
lanquinei, 87, 110; Text-fig. 25  
latecentratus, 107, 111; Text-fig. 35  
lateumbilicata, 54, 73  
lectotypa, 50  
legayi, 39, **44**, 45; IV, 9—11; Text-figs. 7, 8  
leiocymon, 217  
lenthayensis, **204**; XXIII, 6  
Leptosphinctes, 167  
Leptosphinctinæ, 166—9  
leptus, 167  
limosa, **60**, **61**, 62, 64—66, 157; V, 7, 8; VI, 5, 6  
linguiferus, 80, 81, 88; Text-fig. 21  
Lissoceras, **48**, 49, 50  
Lissoceratinæ, 48  
Lissoceratoides, **48**  
Loboplanulites, **212**, 219—35  
Lobosphinctes, **173**, **174**  
longilobata, 212, **222**, **223**; Text-figs. 79, 81  
lucasi, 87, 110; Text-fig. 25  
lycetti, 116, **127**, **128**, 246; XV, 3, 9; Text-fig. 41  
Lycetticeras, **116**, **117**, 124—8, 246
- macrescens, **133**, **134**; 135, 246; XVI, 4; XVII, 3  
Macrocephalites, 78, **117**  
Macrocephalitidæ, 113—28, 233, 234  
macrocephalus, 115, 117, 119  
Madarites, **85**  
madarus, 85, 95, 96, 99; IX, 1  
magnificus, **201**, **203**; XXVII, 6; Text-fig. 92  
major, 191, 192  
marginata, 87; Text-fig. 25  
martinsi, 168  
matisconensis, **228**; XXXII, 2; Text-fig. 83  
michalskii, 146  
Micromphalites, 33, 45—7; Text-fig. 9  
micromphalus, **45—7**; IV, 1—6  
microstoma, 87, 88, 108, 110; Text-fig. 35  
mirabilis, 196, **201**, 203; XXVII, 3; XXVIII, 6—9; Text-figs. 72, 75  
modiolaris, 85, **95—7**, 99, 245; IX, 1; X, 3; XI, 2—4, 6, 7  
moorei, 189, 215, 219, 220, 223  
Morphoceras, **130**, 131, 132—9, 141, 142  
Morphoceratidæ, 129—42, 234  
morrissi, Macrocephalites, 116, 119  
morrissi, Morrisiceras, 113, 115—17, **119—21**, 122, 124; XIV, 3—6; Text-fig. 40  
morrissi, Pionoceras, 116, 119, 128  
Morrisiceras, **115**, 116, 117, 119—24, 246  
Morrisites, **115**, 116

- multiforme, 17, 130, **132**, **133**, 134, 137 ; XVI, 1,  
 2 ; Text-figs. 47, 50  
 mustela, **103** ; XII, 1 ; XIII, 4, 5  
  
 Neactinoceras, 33  
 neuffensis, 143, 145, 153, 154, 156, 157  
 nivernense, Clydoniceras, 33, 40 ; Text-fig. 6  
 nivernensis, Oppelia, **61**, **62** ; V, 9  
 nodifer, **68** ; VII, 7, 8  
 nodosum, 70  
 notabilis, 54, 72 ; Text-fig. 19  
  
 ocellatum, 131, 139, 140 ; XVII, 7—11  
 Ochetoceras, 54  
 Ecotraustes, 49, **53**, 55, 66—72  
 okribensis, 144  
 Okribites, **144**  
 Oppelia, 50, **51**, 52, 55—67  
 Oppeliaceæ, 47—73  
 Oppeliidæ, 30, 33, 47, 48, 50—73, 84  
 Oppelina, **54**  
 Oppeliinæ, 50—5  
 Oraniceras, 33, **145**, **146**, 155, 245  
 orbignyana, 148  
 orbignyi, Cadomites, 80, 81  
 orbignyi, Normanites, 76  
 orbis, 51, 58, 64  
 orientale, 39  
 otiophora, 169  
 Otoitidæ, 76  
 oxonica, **160—2** ; Text-fig. 59  
 oxus, **66**, **67** ; VI, 8, 9 ; Text-fig. 16  
 Oxycerites, **51**, 53, 55—67  
 Oxynoticeras, 42  
  
 pachypleura, **146—8**, 150, 151, 155 ; XVIII, 1, 4,  
 9 ; XIX, 8, 9 ; Text-figs. 54, 57  
 paradoxus, 54, 70  
 Paralcidia, **52**, 53, 245  
 parkinsoni, 132, 143, 146 ; Text-fig. 53  
 Parkinsonia, 142, **143**, **144**, 145—63 ; XVIII, 3  
 Parkinsoniidæ, 142—63, 234  
 Parkinsonites, 173  
 Parœotraustes, **54**, 69—72 ; Text-fig. 13  
 Paroxycerites, 245  
 parvum, 137  
 Patemorphoceras, **130**  
 patescens, 130, **133**, 134 ; XVII, 5  
 patina, 217  
 pariami, **231** ; XXXIII, 9  
 perinflata, 133  
 Perisphinctaceæ, 129—231, **234**  
 Perisphinctidæ, 163—231, 234—6  
 Perisphinctinæ, 129  
 perisphinctoides, **107**  
 petri, 166, 167  
 Phanerosphinctes, **168**  
 phanerus, 168  
 phaulomorphus, 175, **203** ; Text-fig. 64  
 Phaulozigzag, **175**, 203, 204  
 phaulus, 145  
 phlyctænodes, 29  
 Phlycticeras, 33, 47  
 pickeringius, 218  
 pingue, 133, **135**, 137, 142 ; Text-fig. 49  
 Pionoceras, **116**  
 planilobus, 212, **230** ; XXXIII, 7  
 Planisphinctes, **212**, **213**, 230  
 planula, 175  
 planulata, 148, 152  
 planum, 33, 39 ; Text-fig. 6  
 Platystomaceras, **119**  
 platystomus, 90, 110, 119  
 plenum, 177, **179**, 180 ; XX, 5 ; XXI, 2, 4, 5 ;  
 XXII, 7  
 pleurifer, 56  
 Pleurocephalites, 90, 119  
 Pleurophorites, 86, **87**  
 pleurophorus, 87, 104, 105  
 Pleuroxytes, 51, 56  
 pollubrum, 171, 179, 180  
 polygyralis, 145  
 polymorphus, 130, 132—5  
 Polyplectites, 74, 79, **80**, 81, 231, 232  
 polypleurus, **104**, **105** ; XIII, 2  
 Polysphinctites, **131**, 136, 138, 139 ; XXXII, 5 ;  
 Text-fig. 52  
 polysphinctus, 131, 136, 137, **138** ; XVI, 6—8 ;  
 Text-fig. 50  
 Polystephanus, **80**  
 Præbigotites, **167**  
 præclarus, **93—5**, 245 ; IX, 5 ; X, 2 ; Text-fig. 29  
 Præleptosphinctes, **167**  
 Præsutneria, **214**  
 pravus, **100**, 103 ; XI, 5  
 primævum, 67  
 problematicum, 140, 141  
 Procerites, **171—3**, 181—204 ; XXVIII, 5  
 Procerozigzag, **170**, **171**, 179—81  
 procerus, Perisphinctes, 206, 215  
 procerus, Procerites, 181, 182  
 procerus, Siemiradzka, 171—3 ; Text-fig. 62

- progracilis*, 174, 193, **197—200**, 201 : XXVII, 5 :  
 XXVIII, 1—4 : Text-figs. 63, 72—4  
*Prohcticoceras*, 53, **54**, 57, 72, 73  
*propinquans*, 29  
*Prosisphinctes*, **167**, **168**  
*Protæcotraustes*, **49**, 68  
*pseudoanceps*, 131—3, **139**, **140**, 141 : XVII,  
 7—11  
*pseudoannularis*, **230** : XXXII, 4  
*pseudoaspidoides*, 60  
*Pseudobigotella*, 167  
*Pseudocosmoceras*, **146**  
*pseudomartinsi*, 167  
*pseudoparkinsoni*, 143  
*pseudopatina*, 217  
*Pseudoperisphinctinæ*, 211—4  
*Pseudoperisphinctes*, **213**  
*pseudoprocerus*, 180, 181 : XX, 1—4, 10 : XXI, 7  
*pseudonodosum*, 70  
*pseudorjazanensis*, **228** : XXXII, 7  
*pseudosubtile*, 204, **205** : XXIX, 4, 5  
*psilodiscus*, 48, **49**, **50** : VIII, 1 : Text-fig. 10  
*ptychophorum*, 33, 40, 41, **45** : III, 14 : IV, 8 :  
 Text-fig. 7  
*pulchra*, 54, 69  
*pumilus*, **103** : XII, 3, 4, 7  
*pustuliferus*, 47 : Text-fig. 9  
*pygmæa*, **62** : VI, 1—4  
  
*quenstedti*, 110, 245  
*quercinus*, **193—6** : XXV, 4, 5 : XXVI, 1 :  
 Text-figs. 68, 71  
  
*radiata*, 150  
*rarecostata*, 148  
*recinctum*, 131, **137**, **138** : Text-fig. 51  
*rectangularis*, 153  
*recuperoi*, 212, 220, 224 : Text-fig. 80  
*reparator*, 168  
*replctum*, 129, **136**, **137**, 138, 142 : XVI, 5, 9, 10 :  
 Text-fig. 50  
*retrocostatus*, 54  
*reuteri*, 89, **111** : Text-figs. 25, 37  
*rhabdouchus*, 180, 181 : XX, 10  
*richei*, 232  
*romani*, 177  
*rotundatus*, 213 : Text-fig. 83  
*rugifer*, 85, 87, **104**, 105 : XIII, 1, 6  
*Rugiferites*, **85—7**, 89, 104, 105, 107, 111, 124  
*rugosus*, 54, 70  
*rursum*, **140**, **141** : XVII, 14, 15  
  
*schlippei*, *Clydoniceras*, 34, 39, 40  
*schlippei*, *Lycetticeras*, 116, 119, 120  
*schlippei*, *Tulites*, 97, **98**  
*schloenbachi*, *Oppelia*, 69  
*schloenbachi*, *Parkinsonia*, 9, 19, 148 : Text-fig.  
 55  
*schloenbachi*, *Procerites*, 173, **181—3** : XXI, 9 :  
 Text-figs. 62, 66  
*schwandorfense*, 214, **230**, 231 : XXXIII, 1—3  
*Schwandorfia*, **87**, **88**, 110  
*sekikense*, 213, **231** : XXXIII, 4—6 : Text-fig.  
 83  
*serpenticonus*, 111 : Text-fig. 38  
*serrigerus*, 54, 69—71, 245 : VIII, 4 : Text-fig. 13  
*Shirbuirnia*, 29, 30  
*Siemiradzka*, **212**, 227—30 : XXXII, 6  
*sknipum*, 116, 123, **125—7** : XIV, 1, 10 : XV,  
 4—7 : Text-fig. 45  
*Sonninia*, 27, 29  
*Sonninidæ*, 27—30, 33, 48  
*Spathia*, 168  
*sphæra*, 113, 115, 120, **121**, **122**, 124 : XIV, 2, 7 :  
 Text-fig. 39  
*Sphæroceratidæ*, 76—8 : Text-fig. 20  
*sphæroidalis*, 84, 85, 95, 96 : Text-fig. 23  
*Sphæromorphites*, 84, 85  
*Sphæroptychius*, **88**, 130  
*splendens*, **70**, **71** : VIII, 2, 3 : Text-fig. 18  
*stabilis*, 225, 226  
*Staufenia*, 31, 36, 37  
*staufensis*, 31, 33, 115 : I, 2 : Text-fig. 4  
*Stegeostephanus*, **80**  
*stegeus*, 80, 81  
*Stemmatoceras*, 74  
*Stephanoceras*, 74, 80  
*Stephanoceratacæ*, 74—128, 233  
*Stephanoceratidæ*, 74, 75, 79—82  
*Stepheoceratacæ*, 74  
*Stomphosphinctes*, **168**  
*stomphus*, 168  
*subarietis*, 144  
*subbakeriæ*—*see* *subbakeriæ*  
*subbakeriæ*, **215—18**, 219, 220, 225, 226 : XXX,  
 2 : XXXII, 1, 8, 9 : Text-figs. 78, 79  
*subcarinata*, I, 3  
*subcongenor*, 191, **197**  
*subcontractum*, *Stephanoceras*, 97, 98  
*subcontractus*, *Tulites*, 89, **97**, 98—100, 103,  
 245, 246 : XII, 2, 5, 6, 9 : Text-fig. 30  
*subcosmopolita*, 93  
*subdiscus*, 52, 245



- subfluctuosus*, 204  
*subfurcatum*, 169  
*subfuscus*, 54, 70 ; Text-fig. 13  
*subgaleata*, **156—60** : XVIII, 7 : XIX, 3, 4 :  
 Text-figs. 57, 58  
*subparkinsonia*, **144**  
*subplanulata*, 152, 153  
*subplicatello*, 29  
*subprocerus*, **183—5**, 186, 192, 203 ; XXII, 1—5  
*subradiata*, 50, 51, 56, 61 ; Text-fig. 11  
*subtilis*, **152**, 153, 214 ; XVIII, 6 ; Text-fig. 57  
*suevicus*, 87, 108, 110 ; Text-figs. 24, 36  
*sulcatum*, 140  
*sulciferus*, 213, 214  
*Sulcohamites*, **132**  
*Suspensites*, **177**, 206—9  
*suspensum*, 177, 206, **209** : XXIX, 6—8  
  
*tegularum*, **42—4** ; IV, 7 ; Text-fig. 7  
*tenera*, Oppelia, 67  
*tenera*, Parkinsonia, 153  
*thrapstonense*, 39, **40, 41** ; III, 12—14  
*tmetolobus*, 184, 186, **191, 192** : XXIII, 1—4 :  
 XXV, 2, 3 ; Text-fig. 69  
*tolmerum*, 124  
*transylvanicum*, 137  
*trigonalis*, 29  
*tula*, 84, **93, 95** ; Text-fig. 22  
*Tulites*, **84, 85, 86, 89**  
*Tulitidæ*, 82—91, 233, 234  
*Tulophorites*, **84, 85**  
*tulotus*, 84, 93, 95, 103 ; IX, 5  
*twinhøensis*, **189** ; XXVI, 6 ; Text-figs. 68, 69  
*typus*, 32—4, 37 ; Text-fig. 6  
  
*uhligi*, 108 ; Text-fig. 36  
*umbilicata*, 54, 69  
*uriniacensis*, 222, 225  
  
*v-costatum*, 90  
*vaschaldi*, 141  
*Vastites*, **27**  
*vastus*, **27—30** ; 1, 1 ; Text-figs. 2, 3  
*verciacensis*, 175, 219  
*vermicularis*, 160 ; Text-fig. 57  
*vermiformis*, 168  
*Vermisphinctes*, **168**  
*verus*, 117  
*vesaignensis*, 119  
*viator*, 119  
*villersensis*, 51  
*vineta*, **203** ; XXVII, 4 ; XXVIII, 5 ; Text-fig.  
 72  
*vulgaris*, 117  
  
*wagneri*, 175—77, 204—6, 211 ; Text-fig. 65  
*Wagnericeras*, **175, 176**, 204—9  
*waterhousei*, **66, 67, 71** ; V, 4, 6 ; Text-fig. 16  
*wattonensis*, **196** ; XXVII, 1, 2 ; Text-fig. 69  
*westfalicus*, 167  
*württembergica*, 145, 155  
  
*ybbensis*, 203  
*yeovilensis*, 56, 57, 60  
*ymir*, 83, 104, 108 ; Text-fig. 35  
  
*zigzag*, 169, **177, 178**, 179, 182 ; Text-fig. 60  
*Zigzagiceras*, 111, 148, **169, 170**, 177—79  
*Zigzagiceratinae*, 169—209  
*Zigzagites*, **173**

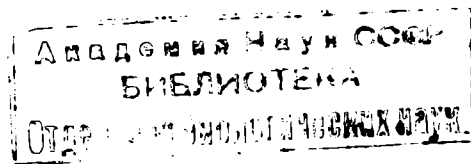


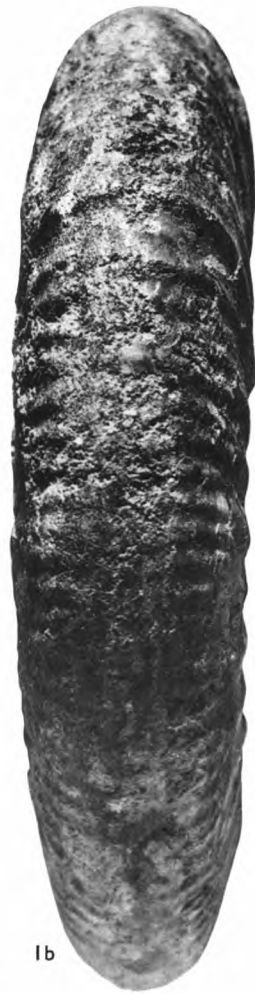
PLATE XXX.

FIG.		PAGE
1a, b.	<i>Choffatia (Homœoplanulites) homœomorpha</i> (S. Buckman), Cornbrash, Fairford (Nottingham Univ. Mus.). Holotype of <i>Homœoplanulites stabilis</i> Buckman.	225
2a, b.	<i>Choffatia subbakeriæ</i> (d'Orb.), Cornbrash, "probably Sherborne district", Bower Coll., ex Taunton Mus., SM. J34925.	215
3—5.	<i>Choffatia (Homœoplanulites) homœomorpha</i> (S. Buckman). 3a, b, Upper Fuller's Earth, Combe Hay mine, nr. Bath, BM. C36347. 4a, b, Cornbrash, Stalbridge Weston, Dorset, holotype, GSM. 8654. 5a, b, Upper Fuller's Earth, Combe Hay Mine, nr. Bath, BM. C36348.	225

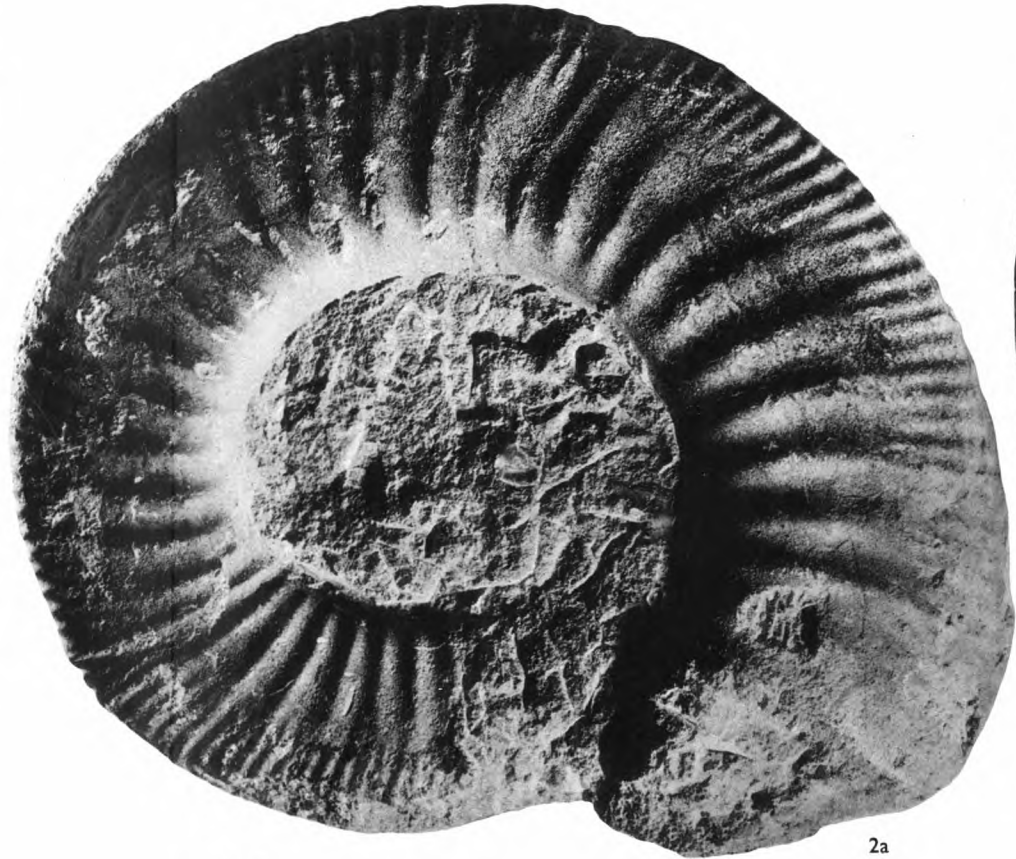
All photos natural size.



1a



1b



2a



2b



3a



3b



4a



4b



5a



5b

PLATE XXXI.

FIG.		PAGE
1a, b, 2a, b.	<i>Choffatia (Homæoplanulites) homæomorpha</i> (S. Buckman). 1a, b, Lower Cornbrash, near Oxford, OUM. J920. 2a, b, Upper Fuller's Earth, Combe Hay Mine, nr. Bath, SM. J23007.	225
3a, b.	<i>Choffatia (Loboplanulites) aff. cerealis</i> sp. nov., Cornbrash, Rectory Farm, Emberton, nr. Olney, Bucks., J. H. Howie Coll., SM. J28973. Finely-ribbed specimen.	
4—6.	<i>Choffatia (Loboplanulites) cerealis</i> sp. nov. 4a, b, holotype, Cornbrash, "Yeovil district?", Bower Coll., ex Taunton Mus., SM. J34926. 4a × 0·57, 4b, lower left-hand portion, lit from different angle, natural size. 5a, b, Cornbrash, Sudbrooke, Lincs., GSM. 95038. 6a, b, Lower Cornbrash, locality unknown, Reading Univ.	219
7.	<i>Choffatia (Loboplanulites) kranaiiformis?</i> sp. nov., Lower Cornbrash, Long Hanborough, Oxon., J. M. Edmonds Coll., OUM. J1370.	225

All photos natural size except Fig. 4a.

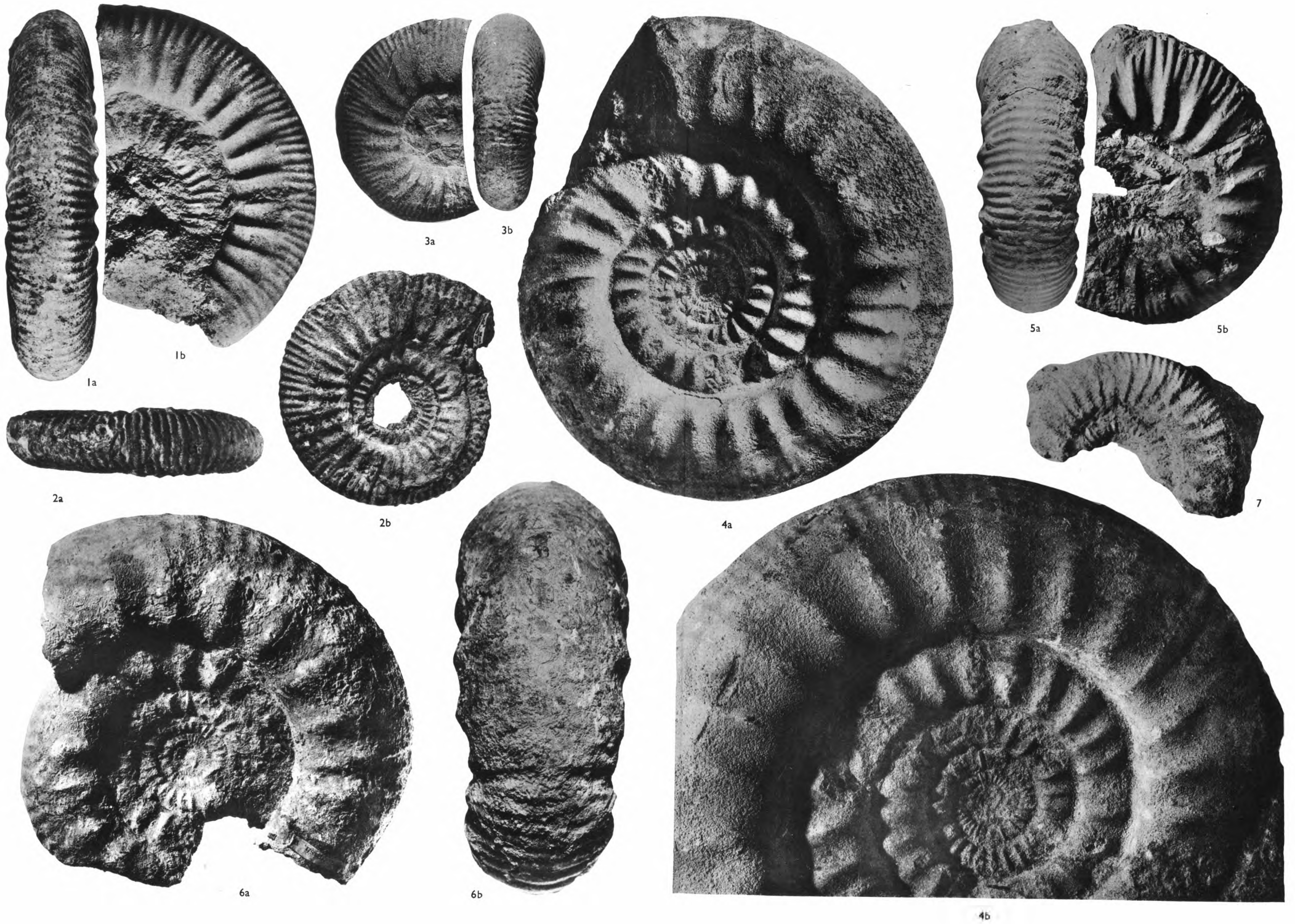


PLATE XXXII.

FIG.		PAGE
1.	<i>Choffatia subbakeriæ</i> (d'Orb.), specimen with coarse secondary ribs, Cornbrash, Holwell, Dorset. Sherborne School Museum.	215
2a, b.	<i>Siemiradzkia matisconensis</i> (Lissajous), Fuller's Earth Rock, Harwood Farm, West Cranmore, Somerset, P. C. Sylvester-Bradley Coll., SM. J28990.	228
3a, b.	<i>Choffatia arisphinctoides</i> sp. nov., holotype, Lower Cornbrash, Frome railway-cutting (1931), GSM. Ht855. See also fig. 10.	218
4a, b.	<i>Siemiradzkia? pseudoannularis</i> (Lissajous), Lower Fuller's Earth, Jack's Hill Quarry, S.W. of Beaminster, Dorset, GSM. Ht2170.	230
5.	Keeled <i>Polysphinctites</i> , previously figured in Text-fig. 52, p. 139. Latex mould of umbilicus after preparation by Mr. Martin Rudwick.	138
6a, b.	<i>Siemiradzkia</i> sp. nucleus, Kingswood School, Bath. SM. J24663.	
7a, b, c.	<i>Siemiradzkia pseudorjazanensis</i> (Lissajous), Forest Marble, Blue Quarry, Ewen, near Cirencester, SM. B9964.	228
8a, b, 9.	<i>Choffatia subbakeriæ</i> (d'Orb.). 8a, b, Cornbrash, Sherborne district, Bower Coll., Taunton Mus. 3267. 9, Lower Cornbrash, Long Hanborough, Oxon., GSM. 83149.	215
10a, b.	<i>Choffatia arisphinctoides</i> sp. nov., Cornbrash "probably Sherborne district", Bower Coll., Taunton Mus. 3304.	218

All photos natural size.



1



2a



2b



3a



3b



4a



4b



5



6a



6b



8a



8b



9



7a



7b



7c



10a



10b

PLATE XXXIII.

FIG.		PAGE
1—3.	<i>Berbericeras schwandorfense</i> Arkell, Fuller's Earth Rock. 1a, b, c, 2a, b, Upper Swanswick, near Bath, SM. J18342—3. 3, Bruton, SM. J18338.	230
4—6.	<i>Berbericeras sekikense</i> Roman, Fuller's Earth Rock, bomb crater 28, Kelston Round Hill, Bath, Bristol Univ.	231
7a—c.	<i>Planisphinctes planilobus</i> S. Buckman, holotype, Zigzag Bed, Burton Bradstock, GSM. 47140.	230
8.	<i>Siemiradzkia aurigera</i> (Oppel), Lower Fuller's Earth, Wincanton boring, Somerset, depth 533 ft., GSM. WE131.	227
9a, b.	<i>Polyplectites periami</i> sp. nov., holotype, Forest Marble, Beckington, Somerset, C. E. Periam Coll., Reading Univ. 6900.	231
10.	<i>Siemiradzkia</i> aff. <i>aurigera</i> (Oppel), surface outcrop at base of Fuller's Earth, Kelston, near Bath, Bristol Univ. Note large lappet.	227

All photos natural size.





1a

1b

1c

2a

3



4

5

2b

6a

6b



7a



7b



7c



8



9a



9b



10