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F. R. Cowper Reed

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A MONOGRAPH

OF THE

BRITISH ORDOVICIAN AND SILURIAN BELLEROPHONTACEA.

BY

F. R. COWPER REED, M.A., Sc.D., F.G.S.

PART I.

PAGES 1—48; PLATES I—VIII.

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BRITISH ORDOVICIAN AND SILURIAN BELLEROPHONTACEA.

INTRODUCTORY REMARKS.

THERE has been no recent detailed study of the species of the Bellerophontacea occurring in the British Ordovician and Silurian rocks, and the existing nomenclature, particularly of the genera, is in a state of considerable confusion.

The poorness of most of the material has always proved a serious obstacle to the satisfactory determination of British species, and this difficulty has only been partly removed by the author's examination of a large number of specimens. The types of Sowerby's species have been re-examined, and a revised and fuller description of them has been drawn up with the additional aid of further examples from the original localities, whenever such has been possible.

The material from Girvan which has been submitted to me by Mrs. Gray, is occasionally in a good state of preservation and comprises many new forms. Mr. Turnbull's collection from Haverfordwest has also proved of considerable interest. But apart from Mrs. Gray's collection the majority of the fossils which have been studied are in the Sedgwick Museum, Cambridge, the Museum of Practical Geology, Jermyn Street, London, and the British Museum (Nat. Hist.), South Kensington, and my thanks are due to the authorities, who have given me every assistance in studying the specimens.

CLASSIFICATION.

Our knowledge of the structure of this interesting group of Mollusca as represented in Ordovician and Silurian beds, has been much advanced of late years by the labours of Koken,[1] Lindström,[2] Ulrich and Scofield,[3] and Perner,[4] while

[1] Koken, 'Neues Jahrb. f. Miner.,' suppl. vol. vi (1889), pp. 375—395; 'Die Leitfossilien' (Leipzig, 1896), pp. 100, 392, 393; "Die Gastrop. Balt. Untersilurs." ('Bull. Acad. Imp. Sci. St. Petersburg' [v], vol. vii, no. 2, 1897), pp. 115—143; and 'Neues Jahrb. f. Miner.,' 1898, vol. i, pp. 3—11.

[2] Lindström, "Silur. Gastrop. Pterop. Gotland" ('Kongl. Svensk. Vet.-Akad. Handl.,' vol. x, no. 6, 1884), pp. 69—88.

[3] Ulrich and Scofield, "Lower Silur. Gastrop. Minnesota" ('Final Rep. Geol. Nat. Hist. Surv. Minnesota,' vol. iii, pt. ii, 1897), pp. 844—929.

[4] Perner, 'Syst. Silur. Bohême,' vol. iv, Gastrop. I (1903), pp. 54—162.

reference must be made to the work of Clarke,[1] Knod,[2] Spitz,[3] and others in connection with the usage of the generic names.

We need not here concern ourselves with the earlier views on the classification of the group, or with the discussion of its true zoological affinities and position. If we follow the last edition (1913) of Zittel-Eastman's 'Text-book of Palæontology' we place it in the vicinity of the Pleurotomariidæ. Ulrich and Scofield instituted a separate sub-order for the group and called it Bellerophontacea, and this seems a convenient, if not quite natural, method of designating an assemblage of gastropods possessing certain distinctive features in common.

The further division into two sections or groups characterised by the absence or presence of a slit-band, was adopted by Perner (*op. cit.*, pp. 58, 59), and seems more suited to the present imperfect state of our knowledge than the elaborate arrangement into families which is employed in Zittel-Eastman's 'Text-book.'

The group-names chosen by Perner for the two sections are unfortunate, and do not express the fundamental feature on which his classification is based. If names are required we might suggest Integridorsata as more suitable than his Cyrtolitoidea, and Fissidorsata in place of his Bucanioidea, for neither *Cyrtolites* nor *Bucania* are the originally described or characteristic representatives of the groups. A third section or sub-group is required for those in which the slit is replaced by a chain of pores, and the name Terebridorsata might be applied to it.

The following are the British Genera so far recognised from Ordovician and Silurian beds:

Group I.

Integridorsata (dorsum without median fissure, band, or row of perforations).

Sinuites.	*Cyrtolites.*
Sinuitopsis.	*Bucaniella.*
Oxydiscus.	

Group II.

Fissidorsata (dorsum with median fissure or band).

Bellerophon sens. str.	*Temnodiscus.*
Bucania.	*Bucaniopsis.*
Kokenospira.	*Cymbularia.*
Tetranota.	*Zonidiscus.*
Conradella. (= *Phragmolites*)	[*Salpingostoma.*]

Sub-Group II a.

Terebridorsata (dorsum with median row of perforations).

Trematonotus.	*Phragmostoma.*

Incertæ sedis. *Carinaropsis.*

[1] Clarke, "Palæozoic Faunas of Para" ('Arch. Mus. Nac. Rio de Janeiro,' vol. x, 1899), English edition, 1900, pp. 34—43; "Foss. Devon. Parana" ('Mon. Serv. Geol. Minèr. Brasil,' vol. i, 1913, Rio de Janeiro), pp. 165—175.

[2] Knod, 'Neues Jahrb. f. Miner.,' suppl. vol. xxv (1908), pp. 503—508.

[3] Spitz, "Gastrop. Karnischen Unterdevons" ('Beitr. Palæont. Geol. Oesterr. u. Orients,' vol. xx, 1907, p. 124).

HISTORICAL REVIEW OF BRITISH SPECIES.

J. de C. Sowerby in 1839 (Murchison's 'Silurian System') described and figured the following new species[1]:

Bellerophon bilobatus.
„ *acutus.*
[*Euomphalus*] *perturbatus.*
[„] *tenuistriatus.*
Bellerophon wenlockensis.
„ *dilatatus.*
„ *apertus* (*non* Sowerby, 1820).
Bellerophon aymestriensis.
„ *globatus.*
„ *carinatus.*
„ *expansus.*
„ *striatus* (*non* Bronn).
„ *trilobatus.*
„ „ var.

J. E. Portlock in 1843 ('Geological Report on Londonderry, Tyrone, and Fermanagh') described the following species from the Ordovician rocks of Tyrone:

Bellerophon bilobatus, var. nov. *compressus.*
„ *elongatus*, Portlock.
„ *gibbus*, Portlock.
Bellerophon dilatatus, Sow. var.
„ *alatus*, Portlock.

F. McCoy in 1846 ('Synopsis of Silurian Fossils of Ireland') described a species as *Euomphalus furcatus*, but it has subsequently been regarded as identical with *B. perturbatus*, Sow. He also recorded many of Sowerby's and Portlock's species from Irish localities.

J. Phillips in 1848 ('Mem. Geol. Surv.,' vol. ii, pt. i, p. 356) established a new species under the name of *Bellerophon obtectus* for a shell from the Silurian of Marloes Bay.

J. W. Salter in 1851 ('Quart. Journ. Geol. Soc.,' vol. vii, p. 172) recorded several of Sowerby's species from the Lower Palæozoic of the Girvan district, and figured one from Drummuck as *B. acutus*, Sowerby (*op. cit.*, pl. ix, fig. 18).

J. W. Salter in 1854 ('Quart. Journ. Geol. Soc.,' vol. x, p. 74) described a Bala species from Shropshire as *Bellerophon* (*Bucania*) *sulcatinus*, Emmons?, but the name *lingualis* was proposed for it. The name *B. nodosus* was applied to another species previously described by McCoy as *B. ornatus* (Conrad).

F. McCoy in 1851—4 ('Synopsis of the British Palæozoic Fossils in the Woodwardian Museum, Cambridge,' pp. 308—311) redescribed several of Sowerby's species, and established a new species under the name *Bellerophon subdecussatus*. *Bellerophon ornatus* (Conrad) was also recorded.

J. W. Salter in 1866 ('Mem. Geol. Surv.,' vol. iii, p. 350, pl. xi B, fig. 2) described a new Arenig species as *Bellerophon hippopus*.

J. W. Salter in 1873 ('Catalogue of the Cambrian and Silurian Fossils in the Woodwardian Museum') introduced the name *Bellerophon Ruthveni* for a species

[1] The original generic names in square brackets are now regarded as erroneous or proved to be preoccupied.

from the Ludlow beds, and he recorded most of Sowerby's Ordovician and Silurian species from various localities.

H. Hicks in 1873 ('Quart. Journ. Geol. Soc.,' vol. xxix, p. 50) briefly described and figured two new species from the "Tremadoc" beds of the St. David's district under the names *Bellerophon solvensis* and *B. ramseyensis*.

H. Hicks in 1875 ('Quart. Journ. Geol. Soc.,' vol. xxxi, p. 318) described and figured a new Arenig species from Wales under the name *Bellerophon llanvirnensis*.

R. Etheridge in 1877 ('Proc. Roy. Phys. Soc., Edinburgh,' vol. iv, p. 175) described a fossil from Drummuck, Girvan, as *Bellerophon* cf. *subdecussatus*, McCoy.

In 1878 was published the 'Catalogue of the Cambrian and Silurian Fossils in the Museum of Practical Geology, Jermyn Street,' and the following MS. names were recorded (without descriptions) for various Ordovician and Silurian species:

Bellerophon bilobatus, var. *anceps*	Ordovician.	*Bellerophon discus*, Edgell, MS.	Silurian.
„ *Griffithi*, MS.		„ *falcatus*, MS.	
„ *lingualis*, MS.		„ *ionicus*, Salt., MS.	
„ *semirugosus*, Salt., MS.		„ *ventriculatus*, Edgell, MS.	

R. B. Newton in 1892 ('Geol. Mag.' [3], vol. ix, p. 339) described a Wenlock species as *Trematonotus britannicus*.

F. R. C. Reed in 1901 ('Geol. Mag.' [4], vol. viii, p. 358) described and figured the species to which Salter had applied the MS. name *Bellerophon Ruthveni*.

F. R. C. Reed in 1906 ('Geol. Mag.' [5], vol. iii, pp. 363—367) defined four new species from the Bala beds of the Haverfordwest district under the names *Bellerophon* (*Sinuites*) *crypticus*, *Bellerophon? multirugatus*, *Bellerophon* (*Bucaniopsis*) *secundus*, and *Conradella*, sp.

Group I. INTEGRIDORSATA.

Genus **SINUITES**, Koken.

Generic Characters.—Shell involute, composed of few whorls overlapping and embracing; umbilicus closed or very small. Dorsum rounded or flattened, not carinated. Aperture not abruptly expanded, with dorsal margin excavated by more or less deep rounded or V-shaped sinus and lateral margins projecting forwards as rounded or subangular lobes ("apertural lobes"). Interior of outer whorl with one or more transverse thickenings of shell.

The name *Sinuites*[1] is here adopted in place of Ulrich and Scofield's *Protowarthia*[2] because of its priority. The genotype is *Bellerophon bilobatus*, Sowerby, sens. str.

[1] Koken, 'Leitfossilien' (Leipzig, 1896), p. 392.

[2] Ulrich and Scofield, *op. cit.*, pp. 848, 867.

Perner[1] and Bassler[2] have employed this generic name. Unfortunately the species *B. bilobatus* has been made to comprise a somewhat miscellaneous assortment of forms, and the customary usage of the specific name has become loose and unsatisfactory, as the author[3] pointed out in 1906.

The chief criteria of the various species included in this genus lie in the shape of the transverse section of the whorl, the height of the umbilicus, the internal thickenings of the shell, and the outline of the apertural lobes and shape of the dorsal sinus. The expression "apertural curve" is used below to indicate the curve described by the lateral margin of the mouth (= apertural lobe) in relation to a straight line let fall vertically through the umbilicus from the base of the dorsal sinus. The external ornamentation would be more often useful as a distinguishing specific feature if more generally preserved.

1. **Sinuites anceps** (Salter, MS.). Plate I, figs. 1—3.

1878. *Bellerophon bilobatus*, Sowerby, var. *anceps*, Salter, MS., Catalogue of Cambrian and Silurian Fossils in the Museum of Practical Geology, Jermyn Street, p. 57.

Specific Characters.—Shell somewhat compressed laterally, outer whorl embracing all the inner whorls; umbilicus closed, minute, subcentral, situated at rather less than half height of shell. Outer whorl gradually increasing in height to mouth, with early part of whorl rounded and subparabolic in section and very faintly trilobed, but becoming subrhomboidal in section towards mouth; sides steep, gently convex below, but excavated above, so as to meet the dorsum at right angles; dorsum becoming increasingly flattened and elevated towards mouth, broad, with sharp, subrectangular lateral edges. Mouth subrhomboidal, with lateral lobes large, angulated (?) and projecting, and with a deep U-shaped sinus occupying the whole flattened dorsum. Surface of shell marked with fine, gently sigmoidal transverse striæ curving back concentric to sinus on dorsum, and with a few stronger transverse ridges. Traces of weak, narrow, internal thickenings crossing sides and dorsum.

Horizon.—Middle Bala Beds (Soudley Sandstone).

Locality.—Horderley; Soudley Quarry, Craven Arms.

Dimensions.—Height, about 23 mm. Thickness at umbilicus, about 12 mm.

Remarks.—The original specimen [28025] named by Salter is in the Jermyn Street Museum. There is some variation in the degree of globosity of the shell and in the excavation of the sides, for in another specimen [28027] (from the same locality) in Jermyn Street these features are more pronounced than in the

[1] Perner, *op. cit.*, p. 59.

[2] Bassler, 'Bibliogr. Index Amer. Ordov. Silur. Foss.' (Bull. 92, U.S. Nat. Mus. 1915), vol. i, p. 1159.

[3] Reed, 'Geol. Mag.' [5], vol. 3, 1906, p. 364.

type. Three specimens in the Sedgwick Museum show similar variation. With regard to affinities, the flattened dorsum recalls the species *Sinuites planodorsatus*, Ulr.,[1] from Kentucky, but the shape of the sides, height of the outer whorl, and depth of the sinus forbid us considering it identical. The apertural curve is in no specimen perfectly preserved.

2. **Sinuites balclatchiensis**, sp. nov. Plate I, figs. 4—7.

Specific Characters.—Shell subglobose, rounded. Outer whorl completely embracing inner whorls, increasing slightly in height and more rapidly in width to mouth, with dorsum high, rounded, strongly arched, but becoming obtusely angulated towards mouth. Mouth about one and a half times as wide as high, slightly expanded at sides, with rounded, U-shaped sinus in outer lip and rounded apertural lobes strongly arched forwards. Apertural curve rounded, not angulated. Umbilicus closed; situated at about half the height of the shell or below the middle.

Surface with very faint transverse striæ near lip, but elsewhere smooth. Interior of shell finely granulose, generally without any marginal thickening of lips but with one transverse internal thickening on dorsum some distance behind mouth. Shell-substance thin.

Dimensions.—Height of shell, 18·0 mm.; height of outer whorl above umbilicus, 11·0 mm.; height of outer whorl below umbilicus, ·7·0 mm.; width of outer whorl above umbilicus, 14·5 mm.; width of outer whorl below umbilicus, 9·5 mm.

Horizon.—Lower Ordovician: Balclatchie Group.

Locality.—Balclatchie, Girvan.

Remarks.—The relations of this species to the typical *S. bilobatus* (Sowerby)[2] are close, but the Girvan form differs by having a more sharply and narrowly arched back, parabolic rather than semi-elliptical in cross-section, and a more rapid increase in the width of the whorls towards the mouth. As mentioned below, the name *bilobatus* has been applied in a very loose and indefinite manner, and several species have been included by British palæontologists under this specific designation, while its varied usage by foreign geologists has still further increased the confusion.

In all of the specimens from Balclatchie in Mrs. Gray's collection the shell is very thin, and has a shining, black, corneous appearance, which seems to be due to its natural and original character, and not to secondary changes or to the state or method of preservation.

The holotype is in Mrs. Gray's collection.

[1] Ulrich & Scofield, *op. cit.*, p. 871, pl. lxiii, figs. 31—35.

[2] Sowerby in Murchison's 'Silur. Syst.,' p. 643, pl. xix, fig. 13.

3. **Sinuites bilobatus** (Sowerby). Plate I, fig. 8.

1839. *Bellerophon bilobatus*, Sowerby, in Murchison's Silurian System, p. 643, pl. xix, fig. 13.
1848. *Bellerophon bilobatus*, Sowerby, Férussac et D'Orbigny, Hist. Nat. Cephal., vol. i, p. 188, pl. viii, figs. 2, 3.
1852. *Bellerophon bilobatus*, Sowerby, McCoy (pars), Syn. Brit. Pal. Foss. Woodw. Mus. fasc. ii, p. 308.
? 1843. *Bellerophon gibbus*, Portlock, Geol. Rep. Londond., p. 398, pl. xxix, fig. 5.

Specific Characters.—Shell subglobose, outer whorl completely embracing all inner whorls; umbilicus minute or closed, subcentral, situated at a little less than half the height of the shell; dorsum and sides rounded. Mouth transverse, wider than high, with prominent sharply rounded or almost bluntly rectangular apertural lobes projecting forwards; dorsal sinus U-shaped or bluntly V-shaped, open, deep; base of mouth scarcely expanded, not reflexed. Surface of shell with fine, regular, transverse arched striæ, distinct near mouth, concentric to edges of lips, sharply arched forward on apertural lobes, well marked behind sinus on dorsum and having a few stronger striæ between them. Interior of shell with faint traces of low, broad, transverse thickenings of shell, usually one or two developed close to oral margins, most distinct on dorsum, obsolete on sides of whorl.

Dimensions.—(Type specimen [6850]). Height, about 35 mm. Thickness, about 25 mm.

Horizon.—Bala Series.

Localities.—(1) Horderley; Cynwyd; Corwen?

Remarks.—The above description is based on Sowerby's type [6850] in the Jermyn Street Museum. The apertural lobes in this specimen have their anterior ends imperfect, but judging from the curve of the striæ must have been bluntly rectangular or obtuse rather than broadly rounded. The ornament is rarely preserved in the majority of specimens, but shows well in the type.

So much confusion has arisen from an indiscriminate use of this specific name that its strict limitation is necessary. Sowerby's original description, which is too brief to be satisfactory, is as follows; "Nearly globose, smooth; aperture two-lobed. Diameter 1½ inch, width of aperture 1 inch 3 lines." The first locality which he gives is Horderley, and then follow Wistanstow, Welch Pool; Michaelwood Chase; Tortworth and Berwyns. Horderley is a Bala locality, and it is highly doubtful if the Silurian localities, Tortworth and Michaelwood Chase, should stand. The Horderley Ordovician shell will therefore be considered the type of the species, which has been re-defined above. A large number of specimens from this locality and its immediate neighbourhood have been examined, but only some have been found to possess the typical characters; many of those identified by Salter and McCoy as *S. bilobatus* must be removed from association with them. McCoy's[1] definition is too comprehensive, as he included more than one species under Sowerby's name.

[1] McCoy, 'Syn. Brit. Pal. Foss. Woodw. Mus.,' p. 308.

The true *S. bilobatus* is more allied to the species *S. subrectangularis*, sp. nov., from Girvan in respect of the shape of the apertural lobes than to *S. soudleyensis*, sp. nov., which has been frequently confused with it. But it differs from the Scottish form in the absence of internal thickenings of the same strength, and in possessing a more rounded dorsum.

In the shell from the Ordovician of Spain attributed by De Verneuil[1] to Sowerby's *S. bilobatus* the presence of two or three concentric internal transverse thickenings is represented in the figure and especially noticed in the description, though owing to the fossil being in the condition of an internal cast they appear as grooves instead of ridges, and are described as such.

4. **Sinuites crypticus**, Reed.

1906. *Bellerophon* (*Sinuites*) *crypticus*, Reed, Geol. Mag. [5], vol. iii, p. 363, pl. xx, figs. 12—14.

Specific Characters.—Shell closely coiled, subglobose, sides somewhat flattened, greatest thickness at umbilicus, back narrowly rounded; outer whorl completely embracing and hiding inner whorls and increasing rather rapidly in size to mouth; umbilicus minute (exposed in casts); section of whorls semi-elliptical to parabolic; aperture higher than wide, not expanded laterally; outer lip thin; inner lip more or less reflexed and thickened; dorsal sinus moderately deep, broadly **V**-shaped; apertural lobes gently rounded below, but angulated obtusely at origin of sinus, where the margin is rather suddenly and sharply curved inwards. Surface of shell ornamented with rather strong concentric growth-lines and ridges on apertural lobes, and generally with one rather strong internal thickening a little inside margin of mouth; general surface of shell ornamented with a minute regular cancellation composed of equal-sized, fine revolving striæ closely placed and crossed by similar transverse, slightly flexuous striæ.

Dimensions.—Height (average) about 20 mm., diameter (average) about 8—10 mm.

The affinities of this shell were discussed by me in the original description of the species, and it only remains to be added that the Girvan form *Sinuites discoides*, sp. nov., appears to resemble it somewhat in ornamentation, and that a similar cancellation of the surface is found in *S. reticulatus*, Perner.[2] The holotype is in the Sedgwick Museum.

Horizons.—(1) Redhill Beds; (2) Slade Beds (Upper Ordovician).

Localities.—(1) Prendergast Place and Lane; (2) Lane near Crundale; Robeston Wathen.

Remarks.—The internal surface of the shell on and near the concentric thickening is covered densely with small granules showing as pits in internal casts.

[1] De Verneuil, 'Bull. Soc. Géol. France' [2], vol. xii (1855), p. 984, pl. xxvii, fig. 1.

[2] Perner, *op. cit.*, p. 64, pl. lvi, figs. 42, 43; pl. lxxxvi, figs. 33, 34; text-figs. 37—40.

5. **Sinuites discoides**, sp. nov. Plate I, figs. 9—11.

Specific Characters.—Shell much compressed laterally, lenticular; outer whorl almost completely enveloping inner whorls and very rapidly increasing in height; umbilicus very small, nearly closed, situated at about one-third the height of shell; umbilical edge angular to subangular. Outer whorl with very gently convex or flattened sides; dorsum sharp, acute, except near mouth, where it becomes narrowly rounded. Mouth high, narrow, not expanded laterally, widest at base, about twice as high as wide, with deep, narrow, acutely V-shaped sinus in upper lip and large projecting subparallel angular apertural lobes, their inner and outer edges meeting at about 75°; base of lips slightly reflected over umbilicus. Surface of shell covered with very fine transverse striæ bending back to meet the sharp dorsal edge at about 30° or less, with very delicate revolving lines decussating them on sides of whorl. Interior with one or two short rounded submarginal thickenings behind sinus on dorsum dying out on sides.

Dimensions.—	I	II
Height of shell	15	13 mm.
Height of outer whorl above umbilicus	10	9 „

Horizon.—Lower Ordovician: Balclatchie Group.

Localities.—Balclatchie; Ardmillan; Dow Hill.

Remarks.—This shell must be referred to the genus *Sinuites*, in spite of its compressed shape and sharp dorsal edge. The apertural lobes, the small or closed umbilicus, the internal ridges, and the embracing whorls indicate its affinities. The revolving lines are rarely visible, but the ornament on the whole reminds us of *S. crypticus*. If the umbilicus were open and larger, and the whorls only just in contact, we might consider its reference should be to *Temnodiscus*, Perner. The shell is thin and corneous in appearance, like that of *S. balclatchiensis*.

There are two specimens [28100, 28101] in the Jermyn Street Museum from the Arenig of White Grit Mine, Shelve, which may be doubtfully referred to this species. They show the general characters and fine revolving lineation of *S. discoides*, but are much crushed and distorted, so that their precise identification is almost impossible.

6. **Sinuites elongatus** (Portlock). Plate I, figs. 12—14.

1843. *Bellerophon elongatus*, Portlock, Geol. Rep. Londond., p. 397, pl. xxix, figs. 4*a*, 4*b*.

Specific Characters.—Shell somewhat compressed, outer whorl completely embracing inner whorls. Umbilicus closed, situated at less than half height of shell. Outer whorl very rapidly increasing in height to mouth, and much less rapidly in width; dorsum narrow, rounded. Mouth higher than wide,

with large, prominent, subangular apertural lobes projecting far forwards; upper lip with deep, U-shaped dorsal sinus. Interior of shell with two principal strong rounded transverse thickenings, both well developed on dorsum, but dying out nearly completely on sides of whorl, one submarginal and the other a little distance behind it, both concentric to margins of apertural lobes. External surface of shell with fine transverse striæ strongly arched back to form sinus on dorsum [and crossed by very delicate revolving lines most distinct on apertural lobes, producing minute cancellation].

Dimensions.—Height of shell, about 30 mm.; thickness at umbilicus, about 11 mm.

Horizon.—Bala Series.

Locality.—Tyrone.

Remarks.—The shape of the apertural lobes is like that in *S. subrectangularis;* but the two strong internal transverse thickened bands on the dorsum having their course concentric to the angulated apertural lobes, and gradually disappearing on the sides of the whorl, as well as the external ornament, distinguish this species. For in *S. subrectangularis* there is only one transverse thickening, and it is not concentric with the margin, and it is strongest on the sides of the whorl instead of on the dorsum. The supposed types of *S. elongatus* [27991 and 27990] which are in the Jermyn Street Museum, are distorted. Another fragment [28031] in the same museum shows the external ornament well as in *S. crypticus.* Some doubtful examples occur in the Starfish Bed, Girvan.

7. **Sinuites maccallumi,** sp. nov. Plate II, figs. 1—4, ? 5.

Specific Characters.—Shell somewhat compressed laterally, with back more or less narrowly rounded and whorls higher than wide. Umbilicus minute or closed, situated at about two-fifths, or less than half the height of shell. Outer whorl completely enveloping inner whorls, higher than wide, increasing more rapidly in height than width, with semi-oval cross-section. Mouth not expanded laterally, semi-oval in shape, higher than wide, with deep U-shaped sinus in outer lip more than one-third width of back and with bluntly pointed, obtuse, subangular, apertural lobes projecting sharply forwards with inner and outer edges inclined at 90°—130°. Surface of shell with very fine transverse growth-striæ concentric with apertural margin. Interior with two successive low-rounded transverse U-shaped marginal thickenings concentric with sinus (but suddenly ending laterally), and placed close together, corresponding with constrictions (represented by shallow rounded broad grooves) on surface of shell.

Dimensions.—Height of shell, 14·0 mm.; height of outer whorl above umbilicus, 9·0 mm.; width of outer whorl above umbilicus, 8·75 mm.; width of outer whorl below umbilicus, 6·0 mm.

Horizon.—Lower Ordovician: Balclatchie Group.

Localities.—Ardmillan; Balclatchie (?), Girvan.

Remarks.—The shape and cross-section of the shell resemble *S. sowerbyi*, Perner,[1] but the angulated apertural lobes are similar to those in *S. rectangularis* (Ulr. and Scof.).[2] From *S. balclatchiensis* it differs in shape, the more rapid increase in height of the whorls, the broader sinus, and angulated apertural lobes and pair of marginal internal thickenings. Similar internal transverse ridges are met with in *S. obesus* (Ulrich)[3] from the Ordovician of America and in "*Bellerophon*" *strangulatus*, Barrande,[4] as well as in De Verneuil's "*Bellerophon bilobatus*" from Spain[5] and Eichwald's *Bellerophon navicula*[6] from the Lyckholm Beds of Dago. Many of the British species described in this memoir possess such thickenings.

This species is dedicated to Dr. Alexander MacCallum, who was one of the earliest geologists to pay attention to the Girvan area.

The types are in Mrs. Gray's Collection.

8. **Sinuites pseudocompressus**, sp. nov. Pl. II, figs. 6—8.

1852. *Bellerophon bilobatus*, Sowerby, McCoy (pars), Syn. Brit. Palæoz. Foss. Woodw. Mus., fasc. ii, p. 308.

Specific Characters.—Shell compressed, rounded; back narrowly rounded, sides somewhat flattened; umbilicus closed or very small, situated at about one-third the height of the shell. Outer whorl increasing rapidly in height to mouth. Mouth higher than wide, widest at base, semi-oval to parabolic, with large sub-angular lateral lobes projecting forwards, and large deep, blunt, V-shaped sinus in outer lip; base of lip slightly reflexed at umbilicus. Surface of lateral lobes marked with fine lines parallel and close to edge of lip; rest of surface of shell smooth?. Interior of shell with weak, broad, rounded, transverse internal thickening forming a rounded band running up from umbilicus with slight sigmoidal curve and touching base of sinus on dorsum. Occasionally traces of similar but weaker posterior transverse narrow internal thickenings are present near the umbilicus and on the sides of the outer whorl at about half to three-fourths the height of shell.

Horizon.—Middle Bala.

Localities.—Cheney Longville; Horderley.

[1] Perner, *op cit.*, p. 61, pl. lxxxvi, figs. 27—32, text-figs. 28—36.

[2] Ulrich and Scofield, *op. cit.*, p. 868, pl. lxiii, figs. 15—20.

[3] *Ibid.*, p. 874, pl. lxiii, figs. 45—47.

[4] Perner, *op. cit.*, p. 159, pl. lxxxvii, figs. 12—14.

[5] De Verneuil, 'Bull. Soc. Géol France,' [2] vol. xii, 1855, p. 984, pl. xxvii, fig. 1.

[6] Eichwald, 'Urwelt Russlands,' pt. 2 (1840), p, 57, pl. iii, fig. 3; Koken, 'Gastrop, Balt. Untersilurs,' p. 120.

Dimensions.—	I	II
Height of shell	27	34·0 mm.
Height of whorl at mouth	20	25·0 „
Diameter at umbilicus	8	11·5 „

Remarks.—Shells of this type have been usually ascribed to *S. bilobatus*, but their more compressed shape, narrower dorsum, more rapid increase in the height of the outer whorl, lower position of the umbilicus and semi-oval or semi-elliptical cross-section of the whorls, distinguish them. *S. sowerbyi*, Perner, is more closely allied, but it has not the internal transverse thickenings. My *S. crypticus* from Haverfordwest is closely allied, but differs in the ornamentation and shape of the apertural lobes. We may also compare the American species *S. subcompressus* (Ulr. and Scof.)[1] and *S. concinnus* (Ulr. and Scof.).[2] The co-types are in the Sedgwick Museum.

9. **Sinuites pusgillensis,** sp. nov. Plate II, figs. 9—12.

Specific Characters.—Shell rounded; outer whorl wider than high, rapidly increasing in size, especially in width, and completely embracing inner whorls; dorsum of proximal part narrowly rounded, strongly arched, becoming broader, lower and less arched towards mouth. Umbilicus small, deep, situated at rather more than one-third the height of shell; umbilical slopes small, steeply bevelled, with distinctly marked umbilical edge. Mouth transverse, nearly twice as wide as high, with very shallow broad emargination in upper lip and short broad, rounded lateral lobes. Internal thickenings absent. External ornament unknown.

Dimensions.—	S.M. 116.	[G. 22066.]	[G. 22064.]
Height of shell	24·5	22·0	14·0 mm.
Height of umbilicus	9·0	7·0	5·0 „

Horizon.—Lower Ordovician: Corona Beds.

Locality.—Pusgill, near Dufton, Cumberland.

Remarks.—All the specimens are internal casts. The type is in the Sedgwick Museum, and the paratypes in the British Museum. The outer whorl expands more rapidly in width than it does in *S. soudleyensis*, and its narrowly arched dorsum becomes lower and broader towards the mouth. The umbilicus also is situated below the centre of the shell, and there are no internal thickenings. In the shape of the shell and the general characters of mouth, sinus and lateral lobes, *S. cancellatus* (Hall),[3] from the Black River and Trenton groups, appears to be closely similar.

[1] Ulrich and Scofield, *op. cit.*, p. 873, pl. lxiii, figs. 40—44.

[2] *Ibid.*, p. 874, pl. lxiii, figs. 36—39.

[3] *Ibid.*, p. 872, pl. lxiii, figs. 1—14.

10. **Sinuites semirugosus** (Salter MS.). Plate II, figs. 13—17.

1878. *Bellerophon semirugosus*, Salter MS., Cat. Camb. Silur. Foss. Mus. Pract. Geol., p. 57.

Specific Characters.—Shell globose to subglobose; outer whorl completely enveloping inner whorls, transverse, inflated, with convex sides and dorsum, increasing in size to mouth; dorsum broad, marked off from sides by narrow revolving raised line, against which thick, low, rounded, equidistant and equal transverse rugæ or ribs on the sides of the whorl end rather abruptly. Umbilicus closed, rather deep, subcentral. Surface of shell covered with fine, closely-placed, small thread-like granulated transverse lines bending back acutely on the dorsum to form a broad, U-shaped sinus, and with minute revolving lines on sides of whorl crossing the transverse ones, so as to cause their granulation and the fine cancellation of the surface.

Dimensions.—Height, about 25 mm.; maximum width, about 19 mm.

Horizon.—Bala Series.

Localities.—Tyn y twyl, Grweiddeau; Vyrnwy Dam, Llanwddyn.

Remarks.—There are only four specimens of this form known to me, three [28039, 28040, and 28041] in the Jermyn Street Museum from Tyn y twyl and one in the Sedgwick Museum from the Vyrnwy Dam. It is an interesting and peculiar species, for the ornamentation is unlike that in any other species of *Sinuites* with which I am acquainted. The shape and sinuation of the mouth are unfortunately unknown, the margins not being preserved, but from the course of the striæ on the dorsum it is probable that there was a broad, U-shaped sinus. The size of the Llanwddyn fragment in the Sedgwick Museum indicates that the shell grew to a larger size than is shown by Salter's type specimens.

11. **Sinuites soudleyensis,** sp. nov. Plate II, figs. 18, 19; Plate III, figs. 1—3.

1884. *Bellerophon bilobatus*, Sowerby, J. D. La Touche, Handbook to the Geology of Shropshire, p. 59, pl. v, fig. 99.

Specific Characters.—Shell globose to subglobose; outer whorl completely enveloping inner whorls; umbilicus subcentral, minute or closed. Outer whorl transverse, broad, low, rounded, slowly increasing in size to mouth; dorsum broadly convex, sometimes rather flattened. Mouth slightly expanded at base; dorsal sinus shallow, open, rounded, broadly U-shaped; apertural lobes short, rounded, simply arched, not subangular. Shell composed of thin smooth outer layer and thicker second layer ornamented with closely-placed regular transverse rounded lines concentric with margin of mouth, crossed by very delicate revolving lines, most distinct near umbilicus; on the dorsum the transverse lines become finer, more closely placed, and bend back rather suddenly to form a U-shaped curve less open than dorsal marginal sinus. Occasionally a few low,

transverse, rounded rugæ are present near umbilicus, but die out on sides. Third or inner layer of shell smooth. Interior of shell with broad, low, rounded, marginal thickening on edge of dorsal lip, dying out laterally.

Dimensions.—Height, 22 mm.; thickness at umbilicus, 16 mm.

Horizon.—Bala Series.

Localities.—Soudley, near Craven Arms; Hope Bowdler; Horderley; Meifod ?.

Remarks.—The presence of three layers to the shell is well seen in some specimens, but the species is usually represented by internal casts. It differs from the true *S. bilobatus* in being more globose, in having rounded apertural lobes to the mouth, and a shallower, more open dorsal sinus. The ornament on the second layer is well seen in a specimen [28026] from Horderley in the Jermyn Street Museum, and this has the outer smooth layer also partly preserved, as well as showing the smooth surface of the innermost layer. This species, which is abundant at Soudley, seems allied to *S. cancellatus* (Hall),[1] but less so than *S. pusgillensis*. *S. balclatchiensis*, above described, has a closely similar apertural curve, but is less globose and differs also in the ornamentation.

The co-types are in the Sedgwick Museum and in Jermyn Street.

12. **Sinuites subrectangularis**, sp. nov. Plate III, figs. 4—11.

Specific Characters.—Shell subglobose or somewhat compressed, higher than wide, with dorsum strongly arched and whorls increasing more rapidly in width than height. Umbilicus closed, situated at rather less than half the height of shell. Outer whorl completely enveloping inner ones, increasing in width to mouth and more slowly in height, with cross-section transverse and dorsum usually becoming broadly rounded towards mouth. Mouth with broad, deep, V-shaped sinus in outer lip and subangular prominent large somewhat flattened apertural lobes, the inner and anterior edges meeting at 75°—90°; base of lip somewhat swollen and decurrent at sides. Surface of shell marked with transverse growth-striæ and ridges somewhat irregular in strength and strongest near apertural margin. Interior of shell with low rounded transverse thickening, situated a little distance behind base of sinus and only weakly sinuated in middle, forming a shallow, rounded, median lobe and a broad, low lateral saddle on each side, making an acute angle with the growth-striæ and continued with somewhat diminished strength down to umbilicus. General surface of interior finely granulose, with coarser granulation on the internal thickening.

Dimensions.—

		(Narrow variety.)
Height of shell . . .	21—28 mm.	. 34 mm.
Width at mouth . . .	25—30 „	. 26 „

Horizon.—(1) Upper Ordovician: Drummuck Group. (2) Bala Series.

[1] Ulrich and Scofield, *op. cit.*, p. 872, pl. lxiii, figs. 1—14.

Localities.—(1) Thraive Glen, Girvan. (2) Tyrone ?

Remarks.—The degree of convexity and rotundity of the dorsum and the breadth and height of the shell vary within somewhat wide limits, some specimens being almost globose and others somewhat laterally compressed, with almost a tectiform dorsum; but as all intermediate stages seem to be present, and the apertural and internal characters completely agree, it is not possible to separate them as definite varieties. One specimen (M. 2888B Geol. Surv. Mus. Edinb.), shows internal transverse thickenings near the umbilical edge.

The general shape of the shell approaches *S. bilobatus* (Sow.) and the angularity of the apertural lobes is almost identical with *S. rectangularis* (Ulr. and Scof.),[1] which has been also compared with *S. maccallumi* from Ardmillan. A similar internal thickening is found in *S. crypticus*, Reed,[2] and in *B.* (*S.*?) *strangulata*, Barr,[3] and in other species of *Sinuites*, as above mentioned.

Ulrich and Scofield have stated (*op. cit.*) that the rectangular outline of the apertural lobes in *S. rectangularis* is not possessed by any other species of the same suborder, and is quite distinct from the true *S. bilobatus*. But our species differs from the American one by the closed umbilicus and the transverse internal thickening. *S. elongatus*, Portl., is closely allied. It appears to occur in Tyrone, judging from poor specimens in the Sedgwick and Jermyn Street Museums.

13. **Sinuites? ramseyensis** (Hicks).

1873. *Bellerophon ramseyensis*, Hicks, Quart. Journ. Geol. Soc., vol. xxix, p. 50, pl. iii, figs. 30—32.

Specific Characters.—Shell laterally compressed, acutely carinated; outer whorl embracing inner whorls and rapidly increasing in height to mouth. Umbilicus small, situated at about one-third the height of shell. Mouth high triangular, not expanded. Dorsal sinus V-shaped? Surface smooth.

Dimensions.—Height about 6—9 mm.

Horizon.—Arenig Series.

Localities.—Ramsey Island; Tremanhire, Pemb.

Remarks.—This small species, which was obtained from beds referred to the Tremadoc by Hicks but now known to be of Arenig age, was briefly described by its founder as follows: "Broad, involute, with the outer whorl greatly expanded and ridged on the back; $\frac{1}{4}$ inch in diameter. Surface smooth." The type specimen and other examples of the species are very poor, but the species may be related to *S. discoides* from the Balclatchie Group of Girvan. Perhaps *Bellerophon shinetonensis*, Callaway,[4] from the Shineton Shales, is also allied to it. Hicks's original specimen of *B. ramseyensis* is in the Sedgwick Museum.

[1] Ulrich and Scofield, *op. cit.*, p. 868, pl. lxiii, figs. 15—20.

[2] Reed, 'Geol, Mag.,' [5] vol. iii (1906), p. 363, pl. xx, figs. 12—14.

[3] Perner, *op. cit.*, p. 159, pl. lxxxvii, figs. 12—14.

[4] Callaway, 'Quart. Journ. Geol. Soc.,' vol. xxxiii (1881), p. 668, pl. xxiv, fig. 10.

14. **Sinuites? separatus,** sp. nov. Plate III, fig. 12.

Specific Characters.—Shell subdiscoidal, somewhat compressed, high, with rather flattened sides and narrowed, flattened dorsum, nearly involute, the outer whorl almost entirely enveloping the others, thickest at umbilicus. Outer whorl higher than wide, rhomboidal in transverse section, narrowing dorsally, slowly increasing in height, with sides somewhat flattened, and having a shallow revolving groove immediately below the edge of the flattened dorsum. Umbilicus minute, deep, situated below middle of shell. Apertural edge and surface unknown.

Dimensions.—Height of shell, 21·0 mm.; height of outer whorl above umbilicus, 13·0 mm.; thickness of shell at base of mouth, about 10·0 mm.; thickness of outer whorl at dorsum, about 4·0 mm.

Horizon.—Lower Ordovician: Balclatchie Group [conglomerate].

Locality.—Balclatchie, Girvan.

Remarks.—Only one specimen of this shell is known to me, and it is in Mrs. Gray's Collection. The true generic position is rather doubtful, and in cross-section the outer whorl with its lateral revolving groove suggests *Bucaniella*; but a somewhat similar groove is seen in some specimens of *Sinuites sowerbyi*, Perner (non *B. Sowerbyi*, D'Orb.) and in *Temnodiscus platynotus*, Perner,[1] the resemblance to the latter species being somewhat close, but the umbilicus in our form is much smaller and placed higher, and the outer whorl increases more slowly in height.

15. **Sinuites sphæroidalis,** sp. nov. Plate III, figs. 13, 14.

Specific Characters.—Shell globose; whorls transverse, more than twice as wide as high; outer whorl completely enveloping inner ones and rather rapidly increasing in size to mouth; umbilicus closed, deep. Dorsum of outer whorl convex. Surface of shell ornamented with fine, sinuous, granulated transverse lines, interlacing and forming a fine reticulation. Mouth with simple rounded apertural lobes and open V-shaped dorsal sinus.

Dimensions.—Height, about 8 mm.; thickness at umbilicus, about 6 mm.; width at mouth, about 7·5 mm.

Horizon.—Lower Ordovician: Balclatchie Group [conglomerate].

Locality.—Balclatchie, Girvan.

Remarks.—None of the specimens, including the type in Mrs. Gray's Collection, are well preserved, most of them being imperfect internal casts. The margins of the mouth are not well preserved, but the ornament shows up clearly in some parts. Perhaps the American *S. granistriata* (Ulrich)[1] is allied to this Girvan species.

[1] Perner, *op. cit.*, p. 76, text-fig. 51 *a*—*c*.

16. **Sinuites** sp.

Certain specimens $\left(\frac{a}{161}\right)$, from the Middle Bala of the Teirw River, in the Sedgwick Museum, do not seem strictly referable to *S. bilobatus* (though they were thus labelled by Salter), or to any of the above described species, but their poor state of preservation and the broken apertural margins do not allow of a specific diagnosis. The umbilicus is situated below the middle of the shell as in *S. balclatchiensis*, and the shell has similarly a more sharply arched and parabolic dorsum than *S. bilobatus*. From both of these it differs by the possession of a strong transverse internal thickening continuous from the umbilicus on one side to that on the other side, gently arched forward laterally and curved back in a broad, shallow, rounded lobe on the dorsum; it is situated at about half the length of the outer whorl, and there are traces of other weaker internal thickenings on the sides of this whorl, but they are not continued across the dorsum between it and the mouth. We may perhaps compare it with *S. subcompressus* (Ulrich),[2] *S. obesus* (Ulrich),[3] and *S. strangulatus* (Barrande).[4]

Dimensions.—Height, about 30 mm.

Horizon.—Middle Bala Beds.

Locality.—Teirw River, S. of Llangollen.

Genus **SINUITOPSIS,** Perner.

Generic Characters.—Shell completely symmetrical, discoidal, of 2—3 whorls, which touch and partly embrace one another. Dorsum of last whorl rounded, but in internal casts carinated or sharply ridged. Transverse section of last whorl subquadrangular. Umbilicus not very deep, partly covered by a callosity. Mouth not much enlarged, with shallow rounded sinus. No slit-band. Test thick, specially thickened in several places.

This genus[5] does not seem to rest on a very firm foundation, and it combines the features of several pre-established ones. Perner himself says that it represents a transitional form of *Sinuites*, connected on one side with *Cyrtolites*, and on the other with *Temnodiscus*. The one Girvan form here described under this generic name may almost equally well be referred to *Temnodiscus*, if we follow Perner in

[1] Ulrich and Scofield, *op. cit.*, p. 870, pl. lxiii, figs. 28—30.
[2] *Ibid.*, p. 873, pl. lxiii, figs. 40—44.
[3] *Ibid.*, p. 874, pl. lxiii, figs. 45—47.
[4] Perner, *op. cit.*, p. 159, pl. lxxxvii, figs. 12—14.
[5] *Ibid.*, p. 67.

regarding as of little importance the umbilical ridge and the lateral notch near the mouth mentioned by Koken[1] in his original definition of the latter genus.

1. **Sinuitopsis congruens**, sp. nov. Plate III, fig. 15.

Specific Characters.—Shell high, coiled in rather loose spiral, composed of about three rounded whorls in contact but scarcely overlapping, rapidly increasing in size, subcircular to elliptical in section, rather higher than wide; dorsum rounded, not compressed. Umbilicus open, exposing inner whorls, with its centre situated at about one-fourth the height of shell; umbilical edges rounded. Mouth not expanded, with deep U-shaped sinus in outer lip, followed by obscure broad median band of same width as sinus, dying out at about half the length of outer whorl. Surface of shell with a few transverse growth-lines and stronger ridges close to apertural margin, curving back to meet band on dorsum at about 10°—15°.

Dimensions.—Height of shell, 8·0 mm.; width of mouth, 5·0 mm.

Horizon.—Lower Ordovician: Balclatchie Group.

Locality.—Balclatchie, Girvan.

Remarks.—The open umbilicus, the rapid rate of increase in the size of the whorls, the small degree of overlapping, and the band-like structure on the last half of the outer whorl resemble *Sinuitopsis neglecta* (Barr),[2] but the deeper U-shaped sinus in the lip is more like that in *Temnodiscus platynotus*, Perner.[3] As above stated there is some doubt as to the genus to which the Girvan species should be referred. The holotype is in Mrs. Gray's Collection.

Genus **OXYDISCUS**, Koken.

Generic Characters.—Shell strongly compressed, disciform; whorls embracing very little, expanding gradually to the aperture, sharply keeled, lanceolate or subtrigonal in cross-section; dorsal lip with deep V-shaped sinus; no slit-band. Umbilicus large, open, exposing most of the whorls. Surface with transverse growth-lines bending backward on the keel.

The definition given by Koken[4] is inadequate, and he mentions the occurrence of traces of a slit-band which seems certainly absent in the British Lower Palæozoic shells here referred to this genus. Shells with a similar external appearance, but possessing a slit-band, are now put in the genus *Zonidiscus*, Spitz (see below). Ulrich and Scofield's[5] definition likewise seems to include species

[1] Koken, 'Gastrop. Balt. Untersilurs,' p. 129.

[2] Perner, *op. cit.*, p. 68, pl. lxxxv, fig. 11; pl. lxxxviii, figs. 28—30, 38—40; pl. xcvii, figs. 39—41; text-figs. 42, 46.

[3] *Ibid.*, p. 76, text-fig. 51.

[4] Koken, 'Neues Jahrb. f. Min.,' suppl. vol. vi (1889), pp. 390, 392, pl. xii, fig. 4; *id.* 'Die Leitfossilien' (1896), pp. 100, 393.

[5] Ulrich and Scofield, *op. cit.*, pp. 852, 912.

possessing a slit-band. The original type chosen preferably by Koken for the genus, is the Middle Devonian shell *O. imitator*, Koken, from the Eifel, instead of *B. curvilineatus*, Conrad, of the Corniferous Limestone, which is the type of Meek's distinct genus *Tropidodiscus*,[1] about which there has been unwarranted confusion. Perner's[2] subgenus of *Oxydiscus*, named *Cyrtodiscus*, is not here regarded as well established.

1. **Oxydiscus acutus** (Sowerby). Plate IV, figs. 1, 2.

1839. *Bellerophon acutus*, Sowerby in Murchison's Silurian System, p. 643, pl. xix, fig. 14.
1848. *Bellerophon acutus*, Férussac et D'Orbigny, Hist. Nat. Ceph., vol. i, p. 208, pl. viii, figs. 10—11.
1852. *Bellerophon carinatus*, Sowerby, McCoy (pars), Syn. Brit. Pal. Foss. Woodw. Mus., fasc. ii, p. 309.

Specific Characters.—Shell lenticular, composed of few whorls; umbilicus about one-third or rather less than one-third the diameter of the shell, with subangular umbilical edges and short steep umbilical slope. Whorls triangular in cross-section, higher than wide; outer whorl large, increasing rather slowly in size, with sharply carinated acute dorsum and more or less flattened sides. Mouth oblique to vertical axis, high, narrow. Surface of shell covered with fine, transverse, oblique striæ, very slightly arched back.

Dimensions.—Height (average), 10—40 mm.; thickness (average), 4—5 mm.

Horizon.—Bala Series.

Localities.—(1) Horderley [6916]; (2) Onny River and Ticklerton [28021—28024, Jermyn Street Mus.]; (3) Twll-du.

Remarks.—The type of this species is from the "upper beds of the Caradoc Sandstone" of Horderley, and Sowerby (*op. cit.*) described it as follows: "Compressed, smooth, umbilicated; whorls keel-shaped, acute: umbilicus broad; aperture triangular, longer [= higher] than wide. Diameter nearly half an inch, width of aperture about two lines."

The original specimen [6916] is in the condition of an internal cast, and there is no sign of a slit-band on it or on any other specimens which I have seen. For this reason it seems necessary to refer the species to the genus *Oxydiscus* rather than to *Zonidiscus*, though the shells bear a considerable resemblance to *Z. grayi* and *Z. shallochensis* from the Girvan area. We may, however, call attention to the resemblance of *O. acutus* to *O. hunteri* and the other species with which the latter is compared. Only in one specimen [28024] have I seen the surface-ornament preserved.

McCoy (*op. cit.*) included *O. acutus* with his *B. carinatus*, putting them both under the name *Bellerophon carinatus*, Sowerby; and consequently his specific diagnosis is based on two distinct forms.

[1] Clarke, 'Palæoz. Faunas of Para' (1900), p. 40; *id.* 'Foss. Devon. Parana' (1913), pp. 390, 391.
[2] Perner, *op. cit.*, p. 72.

2. **Oxydiscus bougangensis,** sp. nov. Plate IV, fig. 3.

Specific Characters.—Shell high, narrow, lenticular, much compressed, of 3—4 whorls, dorsally acute. Umbilicus small, moderately deep, about one-fifth the diameter of the shell and situated at less than half its height. Outer whorl rapidly increasing in height, large, embracing fully three-fourths of preceding whorl, more than twice as high as wide; sides gently convex, more or less flattened, rising to a much compressed very acute sharp dorsal ridge; umbilical edge abruptly subrectangular; umbilical slope short, vertical. Surface smooth?

Dimensions.—Height of shell about 30 mm.

Horizon.—Lower Ordovician: Stinchar Limestone Group.

Locality.—Bougang, Knockdolian, Ayrshire.

Remarks.—This shell may be compared with *O. subacutus*, Ulrich,[1] but in ours the outer whorl is larger and embraces the preceding whorl to a greater extent. The surface is not sufficiently preserved to determine the character of the ornamentation. The type specimens are in Mrs. Gray's Collection.

3. **Oxydiscus hunteri,** sp. nov. Pl. IV, figs. 4–8.

Specific Characters.—Shell lenticular, dorsally acute, composed of 4—5 whorls. Umbilicus large, rather shallow, exposing all the inner whorls, about two-fifths the diameter of the shell and with its centre situated below the middle of the shell; umbilical edge abruptly rounded to subrectangular; umbilical slope vertical. Whorls scarcely overlapping; higher than wide, subtriangular; outer whorl large, gradually increasing in size to mouth, embracing less than half height of preceding whorl, sublanceolate in cross-section, swollen towards base, then becoming slightly concave at base of high narrow compressed solid carina. Surface of shell ornamented with closely-placed transverse lines of somewhat unequal strength strongly arched back, oblique to umbilical edge, and meeting carinal edge at about 30°—45°, having somewhat irregularly developed short fine wrinkles set at right angles to them in interspaces, producing a minute cancellation. Mouth sloping obliquely backwards.

Dimensions.—

	I	II
Height of shell	26·0 mm.	about 17·0
Height of outer whorl without carina at mouth	12·0 „	(ditto with carina) 7·0
Width of ditto at mouth,	about 10·0 „	about 5·5

Horizons.—Lower Ordovician: (1) Balclatchie Group (conglom.); (2) ? Stinchar Limestone Group.

Localities.—(1) Balclatchie, Girvan; (2) Aldons, near Girvan.

[1] Ulrich and Scofield, *op. cit.*, p. 913, pl. lxii, figs. 62—65; pl. lxxxii, figs. 23—25.

Remarks.—Most of the Balclatchie specimens occur as internal casts and in such the solid carina is not represented, but in one specimen (fig. 4) in Mrs. Gray's Collection the shell is fortunately preserved and we see the nature and relations of the carina and the character of the ornamentation. The affinities of the shell are undoubtedly with *O. subacutus*, Ulrich,[1] and probably with *O. annularis*, Perner,[2] though in the high narrow carina it is more like *O.* (*Cyrtodiscus*) *procer*, Barr.[3] The course of the transverse lines is like that of *O. subacutus*, but the fine cross wrinkles are more like those of *Cyrtolites subplanus*, Ulrich,[4] and *Cyrtolitaria nitidula*, Ulrich.[5] There is no slit-band visible on the keel, and this separates it from *Zonidiscus* to which at first sight it might be thought to belong.

The typical examples of *O. hunteri* are in Mrs. Gray's Collection from Balclatchie.

4. **Oxydiscus ? perturbatus** (Sowerby).

? 1839. *Euomphalus tenuistriatus*, Sowerby in Murchison's Silurian System, p. 641, pl. xxii, fig. 14.
1839. *Euomphalus perturbatus*, Sowerby, *ibid.*, p. 641, pl. xxii, fig. 15.
? 1846. *Euomphalus furcatus*, McCoy, Syn. Silur. Foss. Ireland, p. 13, pl. i, fig. 11.
1859. *Bellerophon perturbatus*, Sowerby in Murchison's Siluria, 2nd edit., p. 218, Foss. 39, fig. 6.
1866. *Bellerophon perturbatus*, Sowerby, Salter, Mem. Geol. Surv., vol. iii, p. 350, woodcut 16; *ibid.*, 2nd edit. (1881), p. 557.
1884. *Bellerophon perturbatus*, Sowerby, J. D. La Touche, Handbook to the Geology of Shropshire, p. 57, pl. ii, fig. 46.

Specific Characters.—Shell coiled rather loosely, discoidal, composed of about five whorls in contact but scarcely overlapping each other, enlarging gradually, the outer whorl more rapidly increasing in height to mouth. Umbilicus open, rather shallow, exposing all the inner whorls, situated rather below centre of shell. Whorls higher than wide; sides rounded, somewhat swollen at base; dorsum subangular and weakly carinate in early part of outer whorl but becoming less so towards mouth. Mouth high, with very shallow open dorsal sinus. Surface of shell crossed by closely-placed equidistant or subequidistant regular equal transverse strong lines arched back gently in simple curve obliquely directed to dorsal carina, which they meet at about 75° or less, uniting with those of opposite side; interspaces occasionally show several fine intermediate striæ.

Dimensions.—Height, about 10 mm.

Horizon.—(1) Lower Bala (Llandeilo Flags); (2) Arenig Series.

Localities.—(1) Pensarn, Caermarthen; Middleton, Corndon; ? Shelve; (2) Bath House, Bangor; Long Plantation cutting, Haverfordwest.

[1] Ulrich and Scofield, *op. cit.*, p. 913, pl. lxii, figs. 62—65.
[2] Perner, *op. cit.*, p. 74. pl. lxxxvi, figs. 1—3.
[3] *Ibid.*, p. 74, pl. lxxxviii, figs. 22—24, text-fig. 50.
[4] Ulrich and Scofield, *op. cit.*, pl. lxii, figs. 40—44.
[5] *Ibid.*, p. 866, pl. lxii, figs. 53—55.

Remarks.—The original specimens of *Euomphalus tenuistriatus* [p. 63] and *E. perturbatus* [6964] are in the Jermyn Street Museum. Both are in a poor state of preservation, the latter being especially poor as well as distorted, so that a satisfactory diagnosis of specific characters is impossible. It has generally been considered that these two species are identical, and owing to the pre-occupation of the name *tenuistriatus* by a Carboniferous species of *Bellerophon*, the name *perturbatus* is usually applied to this fossil. It is a common and well-marked species in the Upper Arenig and especially the Llandeilo of Wales, but it is very rare to find a well-preserved and uncrushed example. Salter says that it is one of the most characteristic shells of the Llandeilo Flags in North and South Wales.

The type-specimen of *E. tenuistriatus* [p. 63] consists merely of the impression of the exterior of an imperfect shell. The umbilicus is open and shallow. The whorls rapidly increase in size and are higher than wide, with gently convex sides; the dorsum seems to have been subangular and carinated; the transverse lines are equal, equidistant, and closely-placed and arch back simply but obliquely and seem to meet the carina at about 30°. No slit-band can be detected.

The type-specimen of *E. perturbatus* [6964] is an internal cast, which accounts for its smooth appearance, and is much crushed and distorted. The umbilicus seems to be larger and the whorls to increase more slowly in height than in *E. tenuistriatus*, though this may be due to the distortion which the shell has suffered. The type of *E. perturbatus* was obtained from the Llandeilo Flags of Pensarn, Caermarthen.

In some questionable specimens from Shelve there are 2—4 very fine transverse lines between the stronger ones, the latter being further apart than in the type, though they are closely crowded near the mouth.

The true generic position of these shells is somewhat doubtful, but they are most perhaps referable to *Oxydiscus*, agreeing in general shape, degree of enrolment of the whorls, open umbilicus, and ornamentation. Salter's reference of them to the genus *Bellerophon* is certainly incorrect, for this name, as now understood, is restricted to another group of shells with completely different characters.

Considerable doubt must still exist as to the identity of Sowerby's *E. tenuistriatus* with *E. perturbatus*, the rapid enlargement of the whorls, large round aperture, and angle at which the striæ meet the dorsal edge, being points of difference. The poor condition of the types renders an accurate diagnosis impossible.

5. **Oxydiscus ? llanvirnensis** (Hicks). Plate IV, figs. 9—11.

1875. *Bellerophon llanvirnensis*, Hicks, Quart. Journ. Geol. Soc., vol. xxxi, p. 188, pl. xi, figs. 1, 2.

Specific Characters.—Shell sublenticular, compressed, of 4—5 whorls, the outer whorls rapidly increasing in size and height, scarcely overlapping; dorsum

angulated and sides gently convex. Umbilicus open, shallow, exposing all inner whorls. Whorls crossed by regular strong equidistant thin transverse prominent lamellæ, in places minutely fimbriated, and having several very fine transverse striæ in interspaces; lamellæ more crowded and slightly sigmoidal near mouth, being arched gently back on sides of whorls and then forwards, but apparently sharply bent back close to dorsal keel so as to meet it at about 45°. Slit-band absent?

Dimensions.—Height about 30 mm.

Horizons.—(1) Upper Arenig; (2) Llandeilo Flags.

Localities.—(1) Llanvirn Quarry; (2) Abereiddy Bay; Traethllwyn, Llanrhian, St. Davids.

Remarks.—Hicks's definition of this species was as follows: "Spire of three very rapidly increasing whorls. Outer whorl greatly expanded, but compressed. Lines of growth strongly marked, arched backwards and approximating to each other more closely in the expanded outer portion. Diameter 1⅓ inch." Neither the type [28001] in the Jermyn Street Museum nor the counterpart of the type in the Sedgwick Museum are well preserved, both being flattened and somewhat distorted, but in the latter we seem to be able to detect a sharp bending of the transverse lines close to the dorsal edge, and also the presence of intermediate striæ.

The specimens [28018, 28019, 28020] from the Llandeilo beds of Abereiddy Bay in the Jermyn Street Museum are better preserved than the type, but were labelled *B. perturbatus* [= *E. tenuistriatus*], from which they differ considerably in ornamentation.

The generic reference of this species is a matter of uncertainty, the rapid enlargement of the outer whorl and the ornamentation being unlike that of *Oxydiscus*, and if a slit-band is present it may be referred to *Conradella*.

Genus **CYRTOLITES**, Conrad.

Generic Characters.—Shell composed of few whorls (2—3), not overlapping, scarcely contiguous, the last occasionally free, enlarging rapidly to mouth; dorsum carinated; whorls occasionally with weak lateral carina on each side giving a broadly lanceolate or subquadrate section; no apertural sinus; mouth simple, entire; sides of whorls usually with transverse swellings or ribs more or less developed, or transverse lines meeting the keel at a large angle.

The type of this genus is *Cyrtolites ornatus*, Conrad,[1] and Koken's[2] definition of the genus in 1896 agrees with this form, whereas Ulrich and Scofield's[3] is too wide and includes species probably referable to Koken's *Temnodiscus* (1897 *non* 1896). Perner[4] has remarked that the genus *Cyrtolites* contains a rather heterogeneous assemblage of species, and the Bohemian forms do not appear to

[1] Conrad, 'Ann. Rept. Nat. Hist. Surv., New York,' 1838, p. 118.

[2] Koken, 'Die Leitfossilien' (1896), p. 100. [3] Ulrich and Scofield, *op. cit.*, pp. 846, 858.

[4] Perner, *op. cit.*, p. 79.

conform closely to the above definition. The entire and scarcely sinuated mouth seems a character of primary importance.

1. **Cyrtolites budleighensis,** sp. nov. Plate IV, figs. 12—14.

Specific Characters.—Shell high, somewhat compressed, composed of 2—3 whorls rather higher than wide, in contact with but not overlapping each other, the last whorl rapidly increasing in size. Umbilicus large, open, shallow, completely exposing all the whorls, with centre situated below centre of shell. Whorls broadly lanceolate to subrhomboidal in cross-section, widest at about one-third their height; dorsum narrow, subangular, becoming somewhat rounded near mouth; sides convex, swelling out to maximum diameter below middle, then forming obtuse subangular umbilical edges and sloping inwards to umbilicus. Mouth vertical, rhomboidal in shape, subangular above and widest at umbilical edges; lateral margins obtusely angulated and projecting forwards, with upper edges inclined to dorsum at about 60°. Surface of whorls with faint traces of transverse lines and growth ridges; and with some weak transverse broad ribs or swellings on upper part near mouth.

Dimensions.—

Height of shell	28·0 mm.
Height of outer whorl near mouth . . .	17·0 „
Width of outer whorl near mouth . . .	1·00 „

Horizon.—Ordovician pebbles in Triassic conglomerate.

Locality.—Budleigh Salterton.

Remarks.—Towards the mouth the dorsum almost loses its carination. The specimens [G. 15296, 15298, 15299, 15301], all of which are in the British Museum, are in the state of internal casts and so do not show the external ornament, and the transverse ribs or swellings in any part are somewhat indistinct. The cross-section and enrolment of the shell resemble *C. subplanus*, Ulrich[1] and *C. retrorsus*, Ulrich var. *fillmorensis*,[2] from the Ordovician of Minnesota.

2. **Cyrtolites craigensis,** sp. nov. Plate IV, fig. 15.

Specific Characters.—Shell of 3—4 whorls in contact, but not overlapping, rapidly increasing in size, but more rapidly in height than width, subtriangular to subrhomboidal in section, dorsally carinate, and sharply angular; sides of whorls convex; umbilical edge subangular; umbilical slope steep or almost vertical. Umbilicus wide, deep, open, exposing all inner whorls; centre of umbilicus situated at rather more than one-third the height of shell. Mouth not expanded, higher than wide, oblique, sloping backwards; lateral edges arched gently forwards. Surface unknown (smooth?).

[1] Ulrich and Scofield, *op. cit.*, p. 862, pl. lxii, figs. 40–44. [2] *Ibid.*, p. 861, pl. lxii, figs. 38, 39.

Dimensions.—Height of shell, about 32 mm.; width of outer whorl near mouth, about 10—12 mm.

Horizon.—Lower Ordovician: Stinchar Limestone Group.

Localities.—Craighead, Girvan; (?) Minuntion, Ayrshire.

Remarks.—Only internal casts of this species have been found; so that the surface-ornament is unknown. From the shape of the cross-section, umbilical edge, rate of increase in size of whorls, and general characters there is considerable resemblance exhibited to *C. subplanus*, Ulrich,[1] of the Trenton Formation and to *C. dilatatus* U. and S.[2] of the Black River Group. The types are in Mrs. Gray's Collection.

3. **Cyrtolites nodosus** (Salter). Plate V, figs. 1—2.

1852. *Bellerophon ornatus*, Conrad, McCoy, Syn. Brit. Pal. Foss. Woodw. Mus., fasc. ii, p. 310.
1854. *Bellerophon nodosus*, Salter, Quart. Journ. Geol. Soc., vol. x, p. 73.
1866. *Bellerophon nodosus*, Salter, Mem. Geol. Surv., vol. iii, p. 349, woodcut 15; *ibid.*, 2nd edit. (1881), p. 555.

Specific Characters.—"Spire exposed, of about three rapidly increasing whorls which are half as thick as broad, and of a subrhombic section; the umbilical faces rounded and much shorter than the other flattened ones. Sides marked by thick raised [transverse] ridges which are not so broad as the intervening hollows; they are curved backward towards the flattened dorsal keel and nearly meet it, and extend over the rounded edge of the steep umbilicus. The lines of growth are beautifully regular, and they take a decided curve backward along with the ridges. They are closely crenulate over the sides and back, and on the umbilical face reticulate with each other. Their reticulated appearance arises from the close approximation of the raised crenulate edges which thus decussate each other, and become in some parts connected into a network. The ridges or plaits vary in their distance from each other, but are very prominent."

Dimensions.—

	I	II
Height of shell	26 mm.	22 mm.
Height of outer whorl at mouth	14 „	12 „
Width of outer whorl at mouth	12 „	13 „

Horizon.—Bala Series.

Localities.—Soudley; Onny River; Horderley; Llwyn-yr-hwch; Maen Bras, N. of Bala; Cefn Llwydlo.

Remarks.—The above is Salter's description of the species, and he points out the characters by which *C. ornatus*, Conrad, differs from it. In the American species the lines of growth are direct across, the umbilicus has a sharper edge, and the plaits do not go beyond it. The localities which he gives are Teirw River,

[1] Ulrich and Scofield, *op. cit.*, p. 862, pl. lxii, figs. 40—44.
[2] *Ibid.*, p. 865, pl. lxii, figs. 20—23.

South of Llangollen; Llwyn-yr-hych, Beddgelert; near Llanfyllin; Hope Bowdler, Shropshire.

4. **Cyrtolites nodosus**, var. **llandoveriana**, nov. Plate V, figs. 3—6.

Varietal Characters.—Shell of about three whorls in contact but scarcely overlapping, the outer one rapidly increasing in size to mouth, bluntly carinated, somewhat higher than wide, broadly lanceolate to subcordiform in cross-section, with obtuse umbilical edge at less than half height of whorl. Umbilicus open, deep, exposing all the inner whorls; umbilical slope smooth, without ribs, rather steep. Upper portion of sides of outer whorl ornamented with regular strong subangular transverse slightly oblique and very weakly-arched ribs, set at equal distances apart, separated by gently concave wide interspaces and nearly or quite meeting the corresponding ribs of the opposite side (without any bending back) on the carina. Mouth bell-shaped with margins slightly and suddenly everted.

Dimensions.—

	I	II
Height of shell	13 mm.	25 mm.
Height of outer whorl at mouth .	7 „	14 „

Horizon.—Lower Llandovery.

Localities.—Blaen-y-cwm, Nantyr, Glyn Ceiriog [28050—52]; ? Sevin Llettyrhyddod.

Remarks.—This shell seems to have the transverse ribs rather sharper and narrower than in the type-form, and those of the opposite sides nearly or quite unite on the carinated dorsum. There are three internal casts of this form [28050—52] in the Jermyn Street Museum which have come under my notice, and one from the same locality in the Sedgwick Museum, Cambridge. Another specimen in the latter Museum from the Lower Llandovery of Sevin Llettyrhyddod, which probably belongs to the same species, shows the distal portion of the outer whorl ornamented with equidistant granulated thread-like transverse lines covering the ribs and interspaces and having the same general course as the former so as to meet the carina at an angle of 75°.

This Llandovery form here regarded as a variety of *C. nodosus*, Salter, seems more to resemble *C. retrorsus*, Ulrich,[1] than *C. ornatus*, Conr., and may prove to be specifically distinct from Salter's shell.

5. **Cyrtolites thraivensis**, sp. nov. Plate V, figs. 7—10.

Specific Characters.—Shell of three whorls, coiled discoidally; whorls in contact, not overlapping, rounded, subcircular in section, with weak dorsal carination, rather rapidly increasing in size, without umbilical edge or lateral angulation; outer whorl crossed by 15—20 coarse broad low rounded to

[1] Ulrich and Scofield, *op. cit.*, p. 861, pl. lxii, figs. 32—37.

subangular equidistant transverse ribs, becoming weaker on dorsum and near suture line, set at right angles to dorsal carina, and separated by wider shallow concave interspaces occupied by 10—15 fine concentric lines, not fimbriated but cancellated by fine obliquely spiral lines. Dorsum very obtusely angulated by weak low carina. Umbilicus large, wide, open, exposing all the whorls; centre situated at about one-third the height of shell. Mouth vertical with whole peristome somewhat thickened near edge and inner lip somewhat expanded and reflexed.

Dimensions.—Height of shell, about 30 mm.; width of mouth, about 17 mm.

Horizon.—Upper Ordovician: Drummuck Group (Starfish Bed).

Locality.—Thraive Glen, Girvan.

Remarks.—The shell named *Bellerophon nodosus*, Salter,[1] from the Teirw River, near Llangollen, much resembles this species, but the whorls increase more rapidly in size and have fewer and coarser ribs and fimbriated lines in the interspaces. *Cyrtolites ornatus*, Conrad,[2] has the sides angulated with an umbilical ridge at which the ribs end, but is an allied species.

Genus **ISOSPIRA**, Koken.

Generic Characters. — Shell symmetrically coiled, with rapidly enlarging rounded whorls; growth-striæ pass over dorsum without sinus or bending. No keel. Mouth simple, entire.

Koken's[3] definition of this genus is accepted by Perner (*op. cit.*, p. 88). It appears to be allied to *Cyrtolites*, but we have not a full knowledge of its characters, and its position amongst the Bellerophontacea is open to doubt.

1. **Isospira huttoni**, sp. nov. Plate V, fig. 11.

Specific Characters. — Shell composed of loosely coiled whorls, 1½—3 in number, contiguous, not overlapping, rounded, subcircular in section, rapidly increasing in size; umbilicus situated at about one-third to one-fourth the height of shell. Mouth not expanded, circular, without sinuation of lip. Surface of whorls covered with numerous regular equidistant fine transverse lamellæ, minutely fimbriated, without sinuation except near beginning of outer whorl, separated by rather wider interspaces crossed by faint spiral lines in continuation of fimbriations on transverse lines.

Dimensions.—Height of shell, about 14·0 mm.; height of mouth, about 9·0 mm.

[1] Salter, 'Mem. Geol. Surv. Gt. Brit.,' vol. iii, p. 555, text-fig. 15.

[2] Ulrich and Scofield, *op. cit.*, p. 860, pl. lxii, figs. 27—29.

[3] Koken, 'Gastrop. Balt. Untersilurs' (1897), p. 137.

Horizon.—Middle Ordovician: Whitehouse Group.

Locality.—Shalloch Mill, near Girvan.

Remarks.—All the specimens available are more or less crushed and distorted, but the reference to the genus *Isospira* seems certain. The shell is not unlike *I. bucanioides*, Koken.[1] *C. planicosta*, Perner,[2] *C. tuboides*, Barr.,[3] *C. kokeni*, Perner,[4] and *C. eximius*, Barr.,[5] are comparable in shape or ornamentation.

Genus **BUCANIELLA**, Meek.

Generic Characters.—Shell involute, subglobose with volutions rounded, rapidly enlarging; dorsum trilobate or quadrilobate owing to presence of revolving grooves. Umbilicus more or less open, usually deep; mouth transverse; outer lip sinuate. No slit-band. Surface with fine growth-striæ and occasionally revolving lines.

The name *Bucaniella* was proposed in 1870 by Meek[6] for broad-backed trilobed Silurian species of *Bellerophon* without a slit-band; and the present author follows Clarke[7] in thus restricting the use of the term. Koken[8] would include forms possessing a slit-band, but Ulrich and Scofield[9] (who write the name of the genus *Bucanella*) definitely state that in the type species there is no slit-band and they put it in the same family as *Sinuites* [= *Protowarthia*].

The type species is *B. nana*, Meek.

1. **Bucaniella trilobata** (Sowerby). Plate V, fig. 12; Plate VI, figs. 1—3.

1839. *Bellerophon trilobatus*, Sowerby in Murchison's Silurian System, p. 604, pl. iii, fig. 16.
1848. *Bellerophon trilobatus*, Sowerby, Ferussac et D'Orbigny, Hist. Nat. Cephal., p. 209, pl. vii, figs. 24—27 (? pl. viii, fig. 16).
1852. *Bellerophon trilobatus*, Sowerby, McCoy, Syn. Brit. Palæoz. Foss. Woodw. Mus., fasc. ii, p. 311.
? 1852. *Bucania trilobata* (Conrad), Hall, Palæont. New York, vol. ii, p. 13, pl. iv *bis*.
1884. *Bellerophon trilobatus*, Sowerby, Lindström, Silur. Gastrop. Pterop. Gotland, p. 80, pl. iv, figs. 13—15.
? 1901. *Bucania trilobata* (Conrad), Grabau, Bull. New York State Mus., no. 45, vol. ix, p. 213, fig. 114.
? 1909. *Bellerophon trilobatus*, Sowerby, Moberg and Grönwall, Om Fyledalens Gotlandium, Kungl. Fysiogr. Sällsk. Handl., vol. xx, no. 1, p. 44, pl. iii, figs. 13, 14.

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[1] Koken, *op. cit.* (1897), p. 137, text-fig. 10.
[2] Perner, *op. cit.*, p. 82, pl. lxxxix, figs. 9—11, text-fig. 56 *a*, *b*.
[3] *Ibid.*, p. 85, pl. lxxxviii, figs. 4—5, text-figs. 58, 59.
[4] *Ibid.*, p. 87, pl. lxxxix, figs. 12, 13, text-fig. 61.
[5] *Ibid.*, p. 84, pl. lxxxvii, figs. 5—8, text-fig. 57 *a*, *b*.
[6] Meek, 'Proc. Amer. Phil. Soc.,' vol. v (1870), p. 426.
[7] Clarke, "Foss. Devon. Parana" ('Mon. Serv. Geol. Mineral. Brasil,' vol. i, 1913), pp. 168—170.
[8] Koken, 'Die Leitfossilien' (1896), p. 100.
[9] Ulrich and Scofield, *op. cit.*, p. 848.

Specific Characters.—The original description of this species, the type of which came from the Upper Ludlow Passage Beds of Felindre, is as follows: "Convoluted, smooth, 3-lobed, central lobe largest; inner whorls small, visible; aperture about twice as wide as long; length and breadth four lines." McCoy (*op. cit.*) described it more fully as follows: "Globose, umbilicus small, deep; whorls trilobed by two deep spiral furrows, the lateral lobes half the width of the mesial one; very convex, mesial lobe most prominent, slightly flattened. Width of small specimens three lines, length the same; proportional width of umbilicus $\frac{32}{100}$ as compared with the diameter of the shell." McCoy's specimens are poor internal casts from the Tilestones (Upper Ludlow) of Storm Hill, Llandeilo, which is the only locality he mentions for this species.

Remarks.—There is some doubt as to whether the Wenlock shells attributed to this species ought to be separated as a variety or even distinct species; they agree with those from Gotland figured by Lindström (*op. cit.*) in possessing a very wide flattened back with an unusually broad non-elevated median lobe, such as is found in *Bucania trilobata* (Conrad) from the Niagara Formation in America. One of the Wenlock specimens (a/870) in the Sedgwick Museum, from Dudley, was stated by Salter[1] to be the largest specimen known and measures 45 mm. across the mouth and about 32 mm. in height (Pl. VI, fig. 1).

The specimens from the Upper Ludlow of Storm Hill and of the Kendal district (Pl. VI, figs. 2, 3) have the median lobe relatively more elevated and more convex, and the whole shell seems more laterally compressed and less globose, thus resembling some Lower Devonian species from South America.

All the specimens occur as internal casts, and as the correct generic position of the species depends on the presence or absence of a slit-band, which the state of preservation does not prove, there has been much difference of opinion on this point. As mentioned above, the name *Bucaniella* was proposed by Meek for broad-backed, trilobed Silurian species of *Bellerophon* without a slit-band. For certain early Devonian similarly trilobed shells possessing a slit-band, Clarke[2] suggested the name *Plectonotus*, and he has recently[3] reviewed the whole question of the validity of these genera. Clarke (*op. cit.*, 1900, p. 36) was of the opinion that Sowerby's *Bellerophon trilobatus* was a Devonian shell; but this is erroneous, Sowerby having founded the species on a Silurian specimen. But as no slit-band has been definitely proved to exist in the British Silurian *B. trilobatus* it appears best to refer this species to *Bucaniella*, in the strict sense in which Meek used the term. Many of the Devonian forms described by Sandberger and others from Europe, America, and South Africa bear an external resemblance to this Silurian species, and Whidborne[4] has described a British Upper Devonian shell as *Tropidodiscus*

[1] Salter, 'Cat. Cambr. Silur. Foss. Woodw. Mus.,' p. 157.

[2] Clarke, 'Palæoz. Faunas of Para' (1900), p. 40.

[3] *Id.*, "Foss. Devon. Parana" ('Mon. Serv. Geol. Miner. Brasil,' vol. i, 1913), pp. 168—170.

[4] Whidborne, 'Mon. Brit. Devon. Fauna' (Palæont. Soc.), vol. iii, (1896), p. 68.

trilobatus (Sow.) ? var. *bisulcatus*, Roem., and somewhat superficially discussed the question of its reference to Sowerby's species. But the affinities of the Devonian forms cannot be discussed here.

Horizons.—(1) Upper Ludlow; (2) Wenlock Series; (3) Upper Llandovery; (4) Lower Ludlow.

Localities.—(1) Felindre; Storm Hill, Llandeilo; Kendal; (2) Dudley; (3) Eastnor Park [28061]; Tonlegee, Galway; (4) Freshwater East, Pembrokeshire.

2. **Bucaniella quadrisulcata,** sp. nov. Plate VI, figs. 4, 5.

Specific Characters.—Shell involute, subglobose. Outer whorl nearly completely embracing inner whorls, broader than high, increasing rather rapidly in size towards mouth; dorsum narrowly rounded, strongly convex, separated from lateral portions of whorl by deep revolving groove on each side, and itself divided into three portions by pair of weaker revolving furrows, the median portion of dorsum being the widest; lateral portions of whorl swollen below outermost revolving grooves. Umbilicus deep, small, situated below centre of shell.

Dimensions.—Height, 6 mm.; width of mouth, 5 mm.

Horizon.—Llandovery Series.

Localities.—The Frolic, Haverfordwest; ? Tonlegee, Galway.

Remarks.—This shell differs from *B. trilobata* (Sow.) by possessing two pairs of revolving grooves, but otherwise it closely resembles that species. Only internal casts are known. There is no trace of a slit-band. In the Jermyn Street Museum one of the specimens labelled *B. trilobatus*, from Tonlegee, Co. Galway, shows similar weak additional revolving grooves. The type-specimens are in the Turnbull Collection in the Sedgwick Museum, and come from the Llandovery of Haverfordwest.

Group II. Fissidorsata.

Genus **BUCANIA,** Hall (restr.).

Generic Characters.—Shell involute, composed of few (3—5) whorls; umbilicus large, more or less open. Aperture usually transverse, not abruptly expanded; dorsal sinus broad **V**-shaped with central slit. Slit-band distinct, raised or depressed. Surface of shell ornamented with equal or unequal revolving lines or riblets crossed by oblique transverse growth-lines parallel with the margin of the aperture, the intersections of the two sets of lines being nearly always rectangular.

The definition and limitations of this genus as laid down by Ulrich and Scofield[1] are here followed. The type is *Bellerophon sulcatinus*, Emmons,[2] of the Chazy Limestone.

[1] Ulrich and Scofield, *op. cit.*, pp. 850, 883—886.

[2] Emmons, 'Geol. Rep., 2nd. Distr., New York,' 1842, p. 312, fig. 4.

1. **Bucania evoluta,** sp. nov. Plate VI, fig. 6.

Specific Characters.—Shell composed of 3—4 whorls rather loosely coiled, scarcely overlapping, rapidly increasing in size, rather higher than wide, subelliptical in section. Outer whorl rather rapidly increasing in height to mouth, with dorsum bearing narrow, strongly elevated keel; sides gently convex, with no umbilical edge. Umbilicus shallow, exposing all the whorls, with centre situated at about one-third height of shell. Surface cancellated, being marked with thick, low rounded, oblique spiral lines closely placed, directed forwards to meet slit-band at 45°—30°, and crossed by a few widely separated transverse sublamellose ridges (? fimbriated) and by finer lines arched back and meeting slit-band at about 60°—75°.

Dimensions.—Height of shell, 14·0 mm.; width of whorl near mouth, 7·5 mm.

Horizon.—Lower Ordovician: Balclatchie Group (Conglomerate).

Locality.—Balclatchie, Girvan.

Remarks.—There is only one specimen of this species, and the ornament is only partially preserved. It seems to resemble *B. subangulata*, Ulrich,[1] but is higher and more compressed, and the whorls overlap less than in that species.

2. **Bucania gravida,** sp. nov. Plate VI, figs. 7—9.

Specific Characters.—Shell discoidal, subglobose, composed of 3—4 low transverse whorls slowly increasing in size to mouth. Umbilicus subcentral, deep, exposing inner whorls, with sharp angular umbilical edges and steep flattened umbilical slopes. Whorls transverse, wider than high; dorsum broad, gently convex or somewhat flattened, with the umbilical edges limiting it and situated at about half the height of the whorl. Slit-band narrow, slightly raised. Surface of whorls crossed by transverse strong subequidistant rather remote growth-ridges or lines meeting the slit-band at about 60°, with the broad interspaces occasionally crossed by very delicate minute and somewhat sinuous striæ at right angles to the transverse ridges and interrupted by them.

Dimensions.—Height of shell, 12—14 mm.; width of whorl near mouth, 11—12 mm.

Horizons.—(1) Lower Ordovician: Stinchar Limestone Group; (2) Lower Ordovician: Balclatchie Group.

Localities.—(1) Craighead, Girvan; (2) Balclatchie, Girvan.

Remarks.—This species seems related to *Bucania contorta* (Eichw.)[2] in shape and general characters from stages C and D in the Baltic Provinces. The

[1] Ulrich and Scofield, *op. cit.*, p. 891, pl. lxvi, figs. 20—23.

[2] Eichwald, 'Leth. Ross.,' vol. i, pt. ii (1860), p. 1072, pl. xli, figs. 3 *a*, *b*; Koken, 'Gastrop. Balt. Untersilurs,' p. 123.

American species *B. emmonsi*, Ulr. and Scof.,[1] and *B. halli*, Ulr. and Scof.,[2] may also be compared. The fine ornament in the interspaces is rarely preserved in our specimens, and Eichwald does not show any trace of it in his figures of *B. contorta*.

3. **Bucania playfairi**, sp. nov. Plate VI, fig. 10.

Specific Characters. — Shell subglobose, composed of 3—4 low transverse whorls, broader than high; umbilicus deep, rather more than one-third the diameter of shell, with centre situated at more than one-third the height. Outer whorl gradually increasing in width, swollen and overhanging umbilicus laterally, with convex dorsum, and narrowly rounded umbilical edge; umbilical slope steep, high. Slit-band narrow, with strong raised edges. Mouth slightly expanded at sides, transverse. Surface of shell marked by equidistant coarse imbricated transverse lamellæ, set rather close together, fimbriated at their edges and meeting slit-band at about 60°—75°, with low rounded spiral ridges in interspaces corresponding to fimbriations of lamellæ and interrupted by them, set slightly oblique to slit-band.

Dimensions.—Height of shell, about 16 mm.; width at mouth, about 15 mm.

Horizon.—Middle Ordovician: Whitehouse Group.

Locality.—Shalloch Mill, Girvan.

Remarks.—The affinities of this species seem to be with *Bucania halli*, Ulrich and Scof.,[2] and probably with *B. radiata* (Eichw.).[3] It is dedicated to the famous Scottish geologist, Playfair.

4. **Bucania** *cf.* **punctifrons** (Emmons). Plate VI, fig. 11.

One fragment of the dorsum of the outer whorl of a distorted shell shows an ornamentation apparently identical with that of *B. punctifrons* (Emmons)[4] of the Trenton Formation. The small oval pits on the surface seem formed by the contact of fimbriated lamellose lines, and these pits appear to be arranged in indistinct transverse lines inclined back to the narrow carina at about 45°. The slit-band is not clearly visible, probably owing to the state of preservation and slight crushing of the dorsum, but there is a narrow elevated ridge probably representing it on the broad flattened back.

[1] Ulrich and Scofield, *op. cit.*, p. 887, pl. lxvi, figs. 1—3.

[2] *Ibid.*, p. 886, pl. lxvi, figs. 4—8.

[3] Koken, 'Gastrop. Balt. Untersil.,' p. 121, fig. 5.

[4] Emmons, 'Geol. Rep., 2nd Distr., New York,' 1842, p. 392, fig. 5 (*Bellerophon punctifrons*); Hall, 'Palæont. N.Y.,' vol. i, p. 187, pl. xl A, figs. 1 *a*—*e*; Ulrich and Scofield, *op. cit.*, p. 894, pl. xlvii, figs. 41—44.

Dimensions.—Height of shell (estimated), about 11 mm.
Horizon.—Lower Ordovician : Stinchar Limestone Group.
Locality.—Craighead, Girvan.

5. **Bucania,** sp.

1873. *Bellerophon subdecussatus* (*pars*), McCoy, Salter, Cat. Cambr. Silur. Foss. Woodw. Mus., p. 68 (*non* pp. 97, 83), ref. No. $^{a}/_{163}$*.

Specific Characters.—Shell subdiscoidal, of 3—4 transverse whorls in contact, scarcely overlapping, slowly increasing in size to mouth. Umbilicus deep, exposing all inner whorls; umbilical edge subangular; umbilical slope rather steep. Whorls wider than high, with gently convex or slightly flattened dorsum. Slit-band narrow, slightly raised. Mouth not expanded, with short, broadly V-shaped dorsal sinus. Surface ornamented with regular fine transverse lines, meeting slit-band at 75°—90° [with small oval pits between them ?].

Dimensions.—Height of shell, about 8·0 mm.; width near mouth, about 6·0 mm.

Horizon.—Middle Bala Beds.

Locality.—Allt yr Anker, Meifod.

Remarks.—This specimen, which is in the Sedgwick Museum, is completely distinct from the typical *Bellerophon subdecussatus*, McCoy,[1] from the Denbighshire Flags of Llanrwst, described below under the genus *Kokenospira*, the wide open umbilicus exposing all the inner whorls, and the ornamentation entirely marking it off. The appearance of pits between the transverse striæ does not seem to be due to the texture of the rock, and may be an original character, but the imperfect character of the surface (the specimen being an internal cast) renders the true nature of the ornament rather uncertain. If the pitted appearance is trustworthy, we may compare this shell with *Bucania punctifrons*, Emmons[2]; the shape and general features of our specimen support this comparison, and the whole appearance of the shell recalls that species.

Genus **KOKENOSPIRA,** Bassler.

Generic Characters.—Shell globose or subglobose, involute; umbilicus open, rather large; aperture not expanded; lips thin; dorsal margin deeply excavated. Slit-band wide, flat, elevated, having usually a broad concave space on each side. Surface ornamented with straight uninterrupted revolving lines or ribs, strong on the lateral parts of the dorsum, fine on the slit-band; transverse growth-lines generally very delicate.

[1] McCoy, 'Syn. Brit. Palæoz. Foss. Woodw. Mus.,' p. 311, pl. i L, fig. 25*a* (*non* fig. 25).

[2] Ulrich and Scofield, *op. cit.*, p. 894, pl. lxvii, figs. 41—44.

Ulrich and Scofield,[1] in 1897, separated off the species described by Koken[2] as *Bucanella* [sic] *esthona* under the generic name *Kokenia*, and referred to it also a new American species *Kokenia costalis*, Ulr. & Scof. Unfortunately the generic name was pre-occupied, having been used by Holzapfel in 1895,[3] as Bassler[4] has pointed out, and the latter author has suggested the name *Kokenospira* in its place. Perner does not record any members of it from Bohemia. The genus *Kokenia* is mentioned amongst the Bucaniidæ in Zittel-Eastman's 'Text-book of Palæontology' (2nd edit., 1913, p. 522).

1. **Kokenospira credibilis,** sp. nov. Plate VI, figs. 12—14.

Specific Characters.—Shell globose, whorls broader than high. Umbilicus deep, more than one-third the height of the shell in diameter; umbilical edges subangular; umbilical slopes very steep. Outer whorl large, rapidly increasing in size, about three times as wide as high, laterally overhanging but not concealing most of the inner whorls; dorsum broad, gently convex, more or less flattened. Slit-band wide. Mouth transverse, as wide as, or wider, than total height of shell. Surface of shell ornamented with revolving thread-like lines, parallel to slit-band, near which they are crowded and faint, but becoming stronger and wider apart towards and upon umbilical edge.

Dimensions.—Height of shell, 12—15 mm.

Horizon.—Llandovery Series.

Localities.—Gas Works, Haverfordwest; ? The Frolic, Haverfordwest.

Remarks.—This species is allied to the better known *K. lingualis* and *K. mullochensis* from Girvan (see below). All the specimens, except a few internal casts, are more or less crushed and distorted, and it does not seem possible to separate those from the Gas Works and the Frolic. All the material was obtained by Mr. Turnbull, and is in the Sedgwick Museum.

2. **Kokenospira euphemoides,** sp. nov. Plate VI, fig. 15.

Specific Characters.—Shell subglobose, composed of a few transverse rounded whorls. Umbilicus deep, rather less than one-third the diameter of the shell. Outer whorl rounded, convex, wider than high, with strongly arched

[1] Ulrich and Scofield, *op. cit.*, pp. 849, 882.

[2] Koken, 'Neues Jahrb. f. Miner.,' suppl. vol. vi (1889), p. 389, pl. xiii, figs. 1, 1*a*.

[3] Holzapfel, "Obere Mitteldevon Rhein. Geb." ('Abhandl. k. preuss. geol. Landesanst.,' n.s., pt. 16, 1895), p. 159.

[4] Bassler, Bull. 92, U.S. Nat. Mus., 'Bibliogr. Index Amer. Ordov. Silur. Foss.,' vol. i, 1915, p. 687.

dorsum, subangular? umbilical edge, and short rather steep umbilical slope. Slit-band broad, slightly raised, with 18—20 closely-placed, regular, thick, revolving parallel lines on each side of it, rather smaller and more crowded close to it, 4—5 lines lying in a space equal to its width. No revolving lines on umbilical slope. A few concentric transverse growth-lines are developed close to the apertural margin.

Dimensions.—Height of shell, about 15 mm.

Horizon.—Llandovery Series: Camregan Group.

Locality.—Cuddystone Glen, near Girvan.

Remarks.—Though this species is based on only one specimen in Mrs. Gray's Collection, yet the characters are sufficiently well marked and distinctive as to prove that it cannot be placed in any previously described species, though it is allied to several of the other Girvan forms defined below.

3. **Kokenospira latidorsata,** sp. nov. Plate VII, fig. 2.

Specific Characters.—Shell subglobose, of 3–4 low transverse whorls. Umbilicus very large, conical, deep, about four-fifths the diameter of the shell. Outer whorl increasing slowly in width to mouth, with very transverse cross-section. Dorsum broad, slightly convex; umbilical edge subangular. Slit-band somewhat elevated, broad, not well preserved. Umbilical slope flattened, making an angle of about 30° with dorsum.

Dimensions.—Height of shell, 19 mm.; width of umbilicus, 14 mm.

Horizon.—Bala Series.

Locality.—Cardington, Shropshire. [G. 20706 Brit. Mus.]

Remarks.—Only one internal cast of this species is known, but it shows the entire shell with the dorsum and the wide-open umbilicus. It is uncertain if the surface has any ornament, and the details of the slit-band cannot be observed. The allied species, *K. maccullochi*, from the Balclatchie Beds, differs by possessing a less acute umbilical edge and more rounded whorls.

4. **Kokenospira lingualis** (Salter). Plate VI, fig. 16; Plate VII, fig. 1.

1854. *Bellerophon* (*Bucania*) *sulcatinus*, Emmons?, Salter, Quart. Journ. Geol. Soc., vol. x, pp. 68, 74, (nom. prop. *B. lingualis*).

? 1884. *Bellerophon sulcatinus*, Emmons, J. D. La Touche, Handbook to the Geology of Shropshire, p. 59, pl. v, fig. 101.

Specific Characters.—Shell subglobose, discoid, of few whorls. Umbilicus deep, about three-fifths the diameter of the shell; umbilical edges narrow, subangular; umbilical slopes steep. Whorls transverse, more than twice as wide as high, very slowly increasing in size; dorsum gently convex, becoming

flattened towards mouth. Slit-band wide, slightly sunken between raised edges. Surface of dorsum ornamented with fine revolving lines, about 10 on each side of slit-band, adjoining which they are more crowded, and all decussated by very fine transverse striæ; umbilical slopes smooth?

Dimensions.—	I	II
Height . . .	about 10 mm.	about 13 mm.
Thickness . . .	,, 8 ,,	,, 10 ,,

Horizon.—Bala Series.

Localities.—Onny River, Shropshire; Tyrone.

Remarks.—There are four specimens of this species (Nos. 28006, 28007), three on one piece of rock, in the Jermyn Street Museum, from the Onny River; and these are the shells, so far as can be ascertained, which Salter described in 1854 (*loc. cit.*) as *Bellerophon* (*Bucania*) *sulcatinus*, Emmons?, suggesting the name *lingualis* if they should turn out to be a different species. The specific diagnosis was given in the following words: "B. uncialis et ultra, convolutus, anfractibus a dorso convexiusculo depressis, striatis. Carina lata, plana (sublævis?), marginata, vix elevata. Striæ concentricæ fortes, circiter 10 (ad carinam sæpissime interstriatæ et in ætate plurimæ), a lineis crebris valde reflexis undigue decussatæ. Apertura lata, expansa, semi profundo. This very beautiful shell differs from *B. sulcatinus*, as figured by Hall, in having regular ribs towards the angular edge, which become interlined and form a broad band of close striæ as the shell grows older. The umbilical face, too, is free from ribs, which I have some reason to think is not the case with *B. sulcatinus*. The striæ, too, on that shell appear to meet at a very much more obtuse angle than in ours. It should be called *B. lingualis* if the above characters are sufficient to separate it. It must have been a very thin shell." Salter adds (p. 68) that this shell is also found in Tyrone.[1]

This Onny River species cannot be referred to *Bucania* as now interpreted and restricted, of which genus *B. sulcatina* is the type, and it is obviously referable to *Kokenospira*. The species from the Redhill Beds described by me in 1906 as *Bellerophon* (*Bucanopsis*) *secundus*[2] may be identical (see p. 39).

Bucan[*i*]*ella esthona* Koken,[3] which Ulrich and Scofield have chosen as the type of their genus *Kokenia*, bears a considerable resemblance to Salter's species, and *K. costalis*, Ulr. & Scof.,[4] is also closely allied. Probably *B. lateralis*, Eichw.,[5] is also allied.

[1] 'Cat. Camb. Silur. Foss. Mus. Pract. Geol. Lond.' (1878), p. 57.

[2] Reed, 'Geol. Mag.' [5], vol. iii (1906), p. 366, pl. xx, figs. 15, 15 *a*.

[3] Koken, 'Neues Jahrb. f. Miner.,' suppl. vol. vi (1889), p. 389, pl. xiii, figs. 1, 1 *a*.

[4] Ulrich and Scofield, *op. cit.*, p. 882, pl. lxiv, figs. 46—49.

[5] Eichwald, 'Leth. Ross.,' vol. i, pt. ii (1860), p. 1083, pl. xl, fig. 28; Koken, 'Gastrop. Balt. Untersilurs,' p. 127.

5. **Kokenospira lingualis,** var. **girvanensis,** nov. Plate VII, figs. 3—8.

1877. *Bellerophon* cf. *subdecussatus,* McCoy, Etheridge, Proc. Roy. Phys. Soc. Edinb., vol. iv, p. 175, pl. ii, figs. 9, 10.

Specific Characters.—Shell subglobose, of 3—4 whorls rather closely enrolled. Umbilicus deep, about two-fifths to one-half the diameter of the shell. Whorls transverse, wider than high, subreniform in section, increasing slowly in width and height. Outer whorl embracing about half of preceding one, with rounded convex dorsum, bearing rather broad, slightly elevated slit-band with thin raised edges and very fine closely-placed lunulæ; umbilical edges narrowly rounded; umbilical slope short, steep. Mouth transverse, not expanded (except slightly towards base), with short, broad, V-shaped sinus in outer lip. Surface of dorsum ornamented with 16—28 strong revolving regular longitudinal lines on each side of slit-band and parallel to it, becoming more widely separated outside the inner 8—16, which are rounded, thick, and closely placed, the outer ones being thinner, sharper, and twice as far apart; umbilical edge and slope with 6—10 similar thin widely separated revolving lines; interspaces concave, occupied by fine, regular, equidistant transverse lines at right angles to the revolving ones except near the slit-band, where they bend back and meet it at about 30°—45° A few strong arched growth-ridges concentric with apertural margin near lip meet the slit-band at about 45°.

Dimensions.—	I	II
Height of shell	14·0 mm.	23·0 mm.
Width near mouth	14·5 „	about 23·0 „

Horizon.—Upper Ordovician: Drummuck Group (Starfish Bed).

Locality.—Thraive Glen, near Girvan.

Remarks.—Among the examples of this shell in Mrs. Gray's Collection there is some variation with regard to the number and closeness of the revolving striæ and the transverse growth-lines on the surface; and it seems impossible to consider these Girvan shells as more than a variety of Salter's *K. lingualis* when a comparison is made with a large number of specimens from the same bed. The crushed specimen with unusually strong growth-ridges, which Etheridge described and figured in 1877 (*op. cit.*) as *Bellerophon* cf. *subdecussatus,* McCoy, shows how misleading imperfect and distorted specimens may be.

6. **Kokenospira maccullochi,** sp. nov. Plate VII, figs. 9—12.

Specific Characters.—Shell composed of 4—5 low transverse whorls. Umbilicus very deep, about three-fourths the diameter of the shell, with its centre situated at about two-fifths the height of shell, exposing all the whorls, which only

embrace one another for about half their height. Outer whorl transverse, more than twice as wide as high, with more or less flattened broad dorsum, increasing rather rapidly in size to the mouth; umbilical edges subangular, situated a little below middle of whorl; umbilical slope steep. Slit-band narrow, slightly elevated, with sharp narrow edges. Surface of dorsum with 8—10 thick, low, rounded, equal revolving lines on each side and 6—8 on umbilical slope, becoming rather further apart laterally. Transverse striæ indistinct.

Dimensions.—Height of shell, about 21 mm.; width at mouth, about 18 mm.

Horizon.—Lower Ordovician: Balclatchie Group (Conglomerate).

Locality.—Balclatchie, near Girvan.

Remarks.—This species exposes the inner whorls more than any of the others from Girvan, but it is allied to *K. nicholsoni* and *K. lingualis* var. *girvanensis* in most respects. The wider and more open umbilicus and the sharper angulated umbilical edge in the adult are distinguishing marks. Owing to the state of preservation the transverse striæ are not clearly visible, but the revolving lines seem so close together as to leave little room for them in the interspaces. The types occur in Mrs. Gray's Collection, and the species is dedicated to the Scottish geologist, James MacCulloch.

7. **Kokenospira mullochensis,** sp. nov. Plate VIII, figs. 1, 2.

Specific Characters.—Shell subglobose, of 3 transverse rounded whorls. Umbilicus deep, small, about one-fourth the diameter of the shell. Outer whorl rather rapidly increasing in size and embracing three-fourths of preceding whorl, wider than high, with broad convex dorsum and rounded umbilical edge. Slit-band narrow, not elevated. Mouth slightly expanded at base, wider than high, with broad, shallow, V-shaped sinus in outer lip. Surface of whorl ornamented with closely placed, low, thick, rounded revolving spiral lines parallel to the slit-band, 12—14 on each side of it on dorsum, crossed by obliquely transverse delicate striæ meeting slit-band at 45°—60°.

Dimensions.—	I	II
Height of shell . . .	about 14 mm.	28 mm.
Width of mouth . . .	„ 16 „	32 „

Horizon.—Lower Llandovery: Mulloch Hill Group.

Locality.—Mulloch Hill, near Girvan.

Remarks.—The dorsum is more convex, the umbilicus smaller, the slit-band narrower, and the revolving lines thicker and closer than in *K. lingualis* var. *girvanensis.* The interspaces are also much narrower on the dorsum than in that species, and the revolving lines seem to be equal and equally spaced, with the transverse lines crossing them, thus producing a marked cancellation. As in the case

of the Drummuck species, there seems to be a globose variety with more numerous revolving lines. Most of the specimens in Mrs. Gray's Collection occur as internal casts, but the shell is occasionally preserved both in the case of the type and the variety.

8. **Kokenospira nicholsoni,** sp. nov. Plate VIII, fig. 3.

Specific Characters.—Shell subglobose, of 3 transverse rounded whorls. Umbilicus deep, about one-third the diameter of the shell. Outer whorl large, embracing fully three-fourths of preceding whorl; wider than high, subreniform in section, with dorsum broad, gently convex; umbilical edges narrowly rounded; umbilical slopes short, steep, rounded. Slit-band broad, slightly elevated, with 8—10 strong low revolving lines parallel to it on each side and a few successively wider apart on the umbilical slopes; fine transverse, regular, closely-placed lines crossing them at right angles are present in the larger interspaces.

Dimensions.—Height of shell, about 12·5 mm.; width of mouth, about 15 mm.

Horizon.—Lower Ordovician: Stinchar Limestone Group.

Locality.—Craighead, near Girvan.

Remarks.—This somewhat imperfectly known species appears to be separable from *K. maccullochi* on account of its smaller umbilicus, the more rounded umbilical edges and the more embracing whorls. The mouth is not preserved, and no perfect specimens are available, the only examples of the shell which I know occurring in Mrs. Gray's Collection.

9. **Kokenospira secunda** (Reed).

1906. *Bellerophon (Bucanopsis) secundus,* Reed, Geol. Mag. [5], vol. iii, p. 366, pl. xx, figs. 15, 15 *a*.

Specific Characters.—" Shell subglobose, with broad rounded back; of few volutions; whorls transversely subquadrate, broader than high; umbilicus moderately large, deep, with subangular margins [= umbilical edges], exposing inner whorls; aperture transverse, more or less expanded; inner lip reflexed on inner end of last whorl; slit-band rather broad, with narrow raised margins, not depressed, and fine gently curved lunulæ; surface of shell on each side of band marked with rather strong, regular, straight, parallel, subequal, revolving raised lines, about 24 in number, closely crowded near band but becoming more widely separated laterally, crossed at right angles by very fine, transverse, slightly wavy striæ."

Dimensions.—Height, about 15 mm.

Horizon.—Upper Ordovician: Redhill Beds.

Localities.—Prendergast Place and Lane, near Haverfordwest.

Remarks.—No further specimens of this Welsh species have been found since the above description was given by me in 1906. The true generic position of this shell is in *Kokenospira* as now established, and its nearest affinities are with *K. lingualis* var. *girvanensis* from the Drummuck Group, as above mentioned in the description of that species, and with the type of *K. lingualis* (Salter), with which it may prove to be identical.

10. **Kokenospira subdecussata** (McCoy). Plate VIII, fig. 4.

1852. *Bellerophon subdecussatus*, McCoy, Syn. Brit. Pal. Foss. Woodw. Mus., fasc. ii, p. 311, pl. i L, fig. 25 *a* (*non* fig. 25),

1873. *Bellerophon subdecussatus*, McCoy, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 97 (Lower Wenlock Group [Denbighshire Flags], Llanrwst, Denbigh), *a*/612 (*non* pp. 68, 83).

Specific Characters.—" Globose, of one and a half or two very rapidly enlarging whorls, subcompressed towards the very obtusely angular or rounded circumference; sides gibbous, umbilicus small, deep, partially exposing the whorls; surface with strong transverse ridges, circling backward from the umbilicus to the undefined band, forming a wide V-shaped sinus (about four or five of these transverse ridges in the space of one line near the mouth); they are crossed by much finer spiral striæ, about the same distance apart, from one to three of which are usually stronger than the rest near the band. . . . Rare in the schists of Llanrwst; and fine Bala Sandstone, Mulock [*sic*] Quarry, Dalquorhan, near Girvan, Ayrshire; not very uncommon in the Upper Bala rock of Allt yr Anker, Meifod, Montgomeryshire."

Horizon.—Wenlock Series: Denbighshire Flags.

Locality.—Llanrwst. [*a*/612, Sedgw. Mus. Camb.]

Remarks.—The above is McCoy's diagnosis of the species, but it is a composite one based on specimens from the three different localities and horizons. The type of the species should apparently be the specimen from Llanrwst (*a*/612, pl. i L, fig. 25*a*), of which McCoy only figures a portion of the ornament; Llanrwst is the first locality mentioned and the description of the ornament is undoubtedly derived from this shell. Unfortunately the specimen only consists of the hollow impression of the exterior of a portion of the outer whorl, but it shows the shape of the whorl, the slit-band, and transverse and spiral striæ. The Mulloch specimen (pl. i L, fig. 25) is a nearly complete shell, but is much crushed and distorted; it shows a rather different ornament and a very narrow slit-band poorly preserved, and the shell seems to have been more globose with a broader and less arched dorsum; it was not collected from the Mulloch Hill Group (Llandovery) judging from the character

of the rock, but probably was obtained from the Drummuck Group (Up. Bala). The Allt yr Anker specimen (*a*/163*) recorded also by Salter in his 'Catalogue,' is completely distinct from the Llanrwst shell and has been described on p. 33 of this memoir as an undefined species of *Bucania*.

As here stated, McCoy's definition of the species is made up from the combined characters of the three specimens, and is consequently not applicable strictly to any one; the species, therefore, rests on an insecure foundation, though probably the Mulloch Hill as well as the Llanrwst specimen is referable to the genus *Kokenospira*. The Llanrwst specimen has a rather narrow, strongly-arched dorsum, and the shell could not have been globose as McCoy describes it, the section of the outer whorl being apparently parabolic; the slit-band is of moderate width, well defined by raised edges, between which it is sunken; the revolving lines are strong, equidistant, and few in number, four or five lying on each side of the slit-band on the dorsum, and between these lines are very delicate revolving striæ; the transverse striæ are as strong or rather stronger than the revolving lines, are nearly equidistant, and lie about the same distance apart as the latter, but are rather less regularly placed, and curve back to meet the slit-band at about 45°.

Genus **TETRANOTA**, Ulrich and Scofield.

Generic Characters.—Shell thin, involute; whorls transverse, dorso-ventrally compressed; umbilicus open, large; aperture moderately expanded, chiefly laterally, transverse, wider than high; inner lip without callosity; dorsal sinus more or less deep with a short central slit. Slit-band wide, elevated, bordered on each side by a more or less raised edge; about midway between it and the narrowly rounded or angular umbilical edges there is a marked lateral ridge on each side, occasionally dying out near aperture. Surface-ornamentation composed of rather delicate sublamellose regular transverse lines of growth, often crossed at right angles by another set of minute lines.

No representative of this genus seems to have been previously described from British strata. It was originally described from America by Ulrich and Scofield,[1] with *Bucania bidorsata*, Hall, from the Trenton Formation, as its type-species. The error made by Koken in connecting generically several established European Silurian and Devonian species with this American shell has been pointed out by Ulrich and Scofield (*op. cit.*).

1. **Tetranota carrickensis**, sp. nov. Plate VIII, figs. 5—11.

Specific Characters.—Shell subglobose, composed of 4—5 broad convex whorls, scarcely overlapping. Umbilicus deep, exposing all the whorls, more

[1] Ulrich and Scofield, *op. cit.*, pp. 849, 875—877.

than one-third the diameter of the shell. Outer whorl large, gradually increasing in size and more rapidly in width than height towards mouth, becoming twice as broad as high; umbilical edges acute or subangular, becoming rounded or obtuse near mouth and in old shells; umbilical slopes steep, high; dorsum strongly arched, convex, becoming lower and flattened towards mouth; centre of dorsum raised into a low, broad, rounded, gently elevated revolving ridge carrying slit-band; a narrow, sharp, revolving lateral keel is situated on each side at about three-fifths the distance between the slit-band and the umbilical edge, becoming obtuse or nearly obsolete near mouth; interspaces between central ridge, keels and umbilical edges more or less concave. Slit-band well-marked, gently concave, with sharply raised edges and crossed by strong equidistant regular lunulæ. Mouth transverse, very slightly expanded at sides, with short broad median slit and gently rounded apertural lobes. Surface of shell crossed by regular closely-placed, strong, arched transverse minutely granulated thread-like lines, bending back to meet slit-band at about 30°.

Dimensions.—Height of shell, 13·0 mm; width of mouth, 15·0 mm.

Horizon.—Lower Ordovician: Balclatchie Group.

Localities.—Balclatchie and Ardmillan, Girvan.

Remarks.—The affinities of this species with *Tetranota sexcarinata*, Ulr. & Scof.,[1] are close. The ornamentation in our species is rather finer, and the dorsum is more arched, except towards the mouth. Apparently this is the form which has been frequently entered as "*Bellerophon trilobatus*, Sowerby," in lists of Girvan fossils. The type specimens are in Mrs. Gray's Collection.

2. **Tetranota carrickensis,** var. **craigensis,** nov. Plate VIII, figs. 12, 13.

Varietal Characters.—The only difference between the Craighead and Ardmillan specimens of *T. carrickensis* seems to lie in the position of the lateral keels, which in the Craighead form are placed rather nearer the slit-band, being about half-way between it and the umbilical edges. But none of the Craighead specimens in Mrs. Gray's Collection are well preserved or perfect. It is, however, possible that this form is a distinct species.

Horizon.—Lower Ordovician: Stinchar Limestone Group.

Locality.—Craighead, near Girvan.

3. **Tetranota carrickensis,** var. **etheridgei,** nov. Plate VIII, figs. 14, 15.

Varietal Characters.—Slit-band narrower than in *T. carrickensis*, and surface of shell with the transverse lines crossed by finer ones, causing a minute cancellation of the surface.

[1] Ulrich and Scofield, *op. cit.*, p. 878, pl. lxv, figs. 3–9.

Dimensions.—	I (No. 593 Roy. Scott. Mus.)	II (Young)
Height of shell . . .	19·0 mm.	8·0 mm.
Width of whorl at mouth . .	18·0 „	7·5 „

Horizon.—Upper Ordovician: Drummuck Group.

Locality.—Thraive Glen, Girvan.

Remarks.—The specimens are poor, two of the three in the Geological Survey Collection at Edinburgh being in the condition of internal casts of old shells, the third specimen having part of the shell preserved. The single example in Mrs. Gray's Collection is a young individual and accordingly has the lateral revolving keels sharper, whereas in the older individuals they are almost obsolete. The cancellation of the surface recalls *T. bidorsata* (Hall).[1]

The co-types are in the Royal Scottish Museum, Edinburgh.

4. **Tetranota hippopus** (Salter). Plate VIII, fig. 16.

1866. *Bellerophon hippopus*, Salter, Mem. Geol. Surv., vol. iii, p. 350, pl. ii B, fig. 2; *ibid.*, 2nd edit. (1881), p. 557.

Specific Characters.—Shell subglobose, composed of low transverse whorls much wider than high, with broad flattened dorsum divided into a gently raised median portion bearing broad slit-band, and outer low, rounded convex lateral portions separated from the median elevation by broad, shallow, revolving depressions. Umbilicus large, open?; umbilical edges sharp or subangular. Slit-band with faintly raised edges, and crossed by strong equidistant lunulæ. Mouth with deep U-shaped dorsal sinus and strongly arched lateral lobes. Surface of dorsum ornamented with strong transverse, sublamellose, equidistant lines arching back sharply to meet the slit-band at 20°—30°, with 2—3 finer lines between them.

Horizon.—Arenig Series.

Locality.—Ritton Castle, west of the Stiper Stones, Shropshire.

Remarks.—A fuller diagnosis than the above is not possible owing to the lack of perfect specimens. Salter's figure (*op. cit.*) gave a fair idea of the general characters, but did not sufficiently emphasise the lobation of the dorsum.

The description which he gave of the species was as follows: "B. latissimus, uncialis, striatus, vix costatus, anfractu ultimo maximè dilatato, striis inequalibus conspicuis. Carina lata prominens. Apertura paullulum contracta. Umbilicus profundus." In addition he makes the following remarks: "Broad-involute, the outer whorl very wide, and rather depressed on the back with something of a furrow on each side of the broad band, which is rather prominent and well-defined in all ages. Striæ arched backward, every third or fourth one stronger than the

[1] Ulrich and Scofield, *op. cit.*, p. 877, pl. lxv, fig. 16

rest but not producing prominent ridges as in *B. arfonensis;* nor do they form conspicuous ridges on the band as in that species. Umbilicus open, broad, deep."

The only two specimens (nos. 28008, 28009) of this species are in the Jermyn Street Museum and correspond to Salter's figures; but they are fragmentary, the larger specimen (28009) showing the dorsum of the terminal portion of the outer whorl with the surface ornament, slit-band, dorsal sinus, and part of the lip. The other specimen is a less perfect but larger portion of a smaller shell.

This species appears to belong to the genus *Tetranota* as defined by Ulrich and Scofield, and it seems to be the only English species so far discovered. Its nearest ally appears to be *T. obsoleta*, Ulr. & Scof.,[1] which occurs in several Ordovician beds in Minnesota.

Genus **CONRADELLA**, Ulrich and Scofield.

Generic Characters.—Shell coiled symmetrically; whorls in contact but scarcely overlapping, enlarging gradually, strongly keeled dorsally. Umbilicus open. Aperture oval or subcordiform, widest in middle or below, entire, with margins abruptly expanded and inner lip reflexed, without dorsal sinus or callosities, but having long narrow median dorsal slit with raised edges extending about half the length of outer whorl and followed by elevated slit-band. Surface of shell ornamented with imbricating transverse lamellæ, having their edges often plicated so as to form revolving ridges; fine transverse growth-lines generally present.

The type of this genus is *C. obliqua*, Ulrich and Scofield,[2] from the Black River Group. A species ascribed to this genus has been described by the author[3] from the Slade Beds of the Haverfordwest area, but otherwise it does not seem to have been recorded from the British Isles. Perner (*op. cit.*, p. 158) recognises one species from Etage Ee in Bohemia. Ulrich and Scofield's definition of the genus is here strictly followed. Bassler[4] prefers to use the name *Phragmolites*, Conrad, 1838, in place of *Conradella*, but the type of *Phragmolites* is not the same species, being *P. compressus*, Conrad,[5] from the Trenton Formation.

1. **Conradella girvanensis,** sp. nov. Plate IX, fig. 1.

Specific Characters.—Shell high, subdiscoidal, composed of 3—4 subtriangular rounded whorls, higher than wide. Umbilicus wide, more than one-third the

[1] Ulrich and Scofield, *op. cit.*, p. 880, pl. lxv, figs. 19—23.

[2] Ulrich and Scofield, *op. cit.*, pp. 851, 904, 906, pl. lxvii, figs. 1—6.

[3] Reed, 'Geol. Mag.' [5], vol. iii (1906), p. 367, pl. xx, figs. 5, 5 *a*, *b*.

[4] Bassler, 'Bibliogr. Index Amer. Ordov. Silur. Foss.,' vol. ii, p. 971 (Bull. 92, U.S. Nat. Mus., 1915).

[5] Conrad, '2nd Ann. Rep. New York Geol. Surv.,' 1838, p. 119; Hall, 'Pal. New York,' vol i 1847), p. 188, pl. xl A, figs. 2 *a—f* [*Cyrtolites compressus*].

diameter of the shell, with centre situated at less than half the height. Outer whorl with swollen rounded sides, broadest at base; umbilical edge subangular; umbilical slope steep, short, abrupt; dorsum with high, narrow, suddenly elevated prominent carina bearing slit-band having sharp edges and strong distinct lunulæ. Surface of shell crossed by numerous sharp, regular, concentric imbricating lamellæ, equidistant and finely fimbriated, meeting carina nearly at right angles; interspaces with very delicate revolving interrupted lines.

Dimensions.—Height of shell, 14—15 mm.

Horizon.—Middle Ordovician: Whitehouse Group.

Locality.—Shalloch Mill, near Girvan.

Remarks.—We may compare this species with *C. triangularis*, Ulrich and Scofield,[1] and *C. fimbriata*, Ulr. & Scof.[2] The lamellæ are less numerous, more coarsely fimbriated, and further apart than in the form described below as *Conradella ? multilineata*, sp. nov., from the same Girvan beds, but otherwise the species seem allied to each other. The type specimens are in Mrs. Gray's Collection.

2. **Conradella sladensis**, sp. nov. Plate IX, fig. 2.

1906. *Conradella ?* sp., Reed, Geol. Mag. [5], vol. iii, p. 367, pl. xx, figs. 5, 5 *a*, 5 *b*.

Specific Characters.—Shell of few whorls, coiled in the same plane; whorls higher than wide, carinated, with upper portion compressed, lower portion swollen, with rounded inflated sides. Umbilicus small; umbilical slope steep, short, rounded. Carina elevated and occupied by slit-band, crossed by rather distant strong lunulæ. Sides of whorls ornamented by rather coarse raised fimbriated lines, equidistant and equal in size, curving back in a gentle sigmoidal manner to meet the slit-band at about 75°, and connected by less prominent, short, straight lines at right angles to them and alternately arranged, not forming continuous revolving spirals but making a fairly regular honeycomb pattern.

Dimensions.—Height about 6 mm.

Horizon.—Upper Ordovician: Slade Beds.

Locality.—Upper Slade, Haverfordwest.

Remarks.—No better examples of this small shell have been discovered than those described in 1906, from which the above diagnosis has been drawn up. As then remarked, this species seems allied to *Conradella dyeri* var. *cellulosa*, Ulrich,[3] but the keel seems to be more elevated and the inner whorls less exposed. We may distinguish our species by the name *C. sladensis*.

[1] Ulrich and Scofield, *op. cit.*, p. 908, pl. lxvii, figs. 19—22.

[2] *Ibid.*, p. 907, pl. lxii, fig. 66; pl. lxvii, figs. 7—10.

[3] Ulrich and Scofield, *op. cit.*, p. 910, pl. lxvii, figs. 27—29.

3. **Conradella ? multilineata,** sp. nov. Plate IX, figs. 3, 4.

Specific Characters.—Shell discoidal, composed of 3—4 whorls; umbilicus large, fully half the diameter of the shell; whorls slightly overlapping, very slowly increasing in size, subtriangular in cross-section. Outer whorl with sides somewhat inflated at base; dorsum compressed, subangular, bearing high keel [and slit-band ?]; umbilical edge subangular; umbilical slope steep. Surface ornamented with numerous regular closely-placed, equidistant fine thread-like transverse lines, minutely fimbriated, scarcely arched, meeting keel at about 75°.

Dimensions.—Average height about 12·0 mm.

Horizon.—Middle Ordovician: Whitehouse Group.

Locality.—Shalloch Mill, near Girvan.

Remarks.—None of the available specimens are well preserved, and it is doubtful if a slit-band is present, but it appears probable that this species should be referred to the genus *Conradella* rather than to *Cyrtolites*, for it much resembles *C. girvanensis* from the same horizon and locality, differing chiefly in the ornamentation. All the examples are in Mrs. Gray's Collection.

4. **Conradella fimbriata,** Ulrich and Scofield. Plate IX, fig. 5.

1897. *Conradella fimbriata*, Ulrich and Scofield, Final Rep. Geol. Nat. Hist. Surv. Minnesota, vol. iii, pt. 2, p. 907, pl. lxii, fig. 66, pl. lxvii, figs. 7—10.

Specific Characters.—"Shell discoid, from 18 mm. to 25 mm. in diameter. Volutions about three, enlarging more rapidly than usual for the genus, very strongly and rather abruptly carinate, broadly subcordate in section, wider than high, narrowly rounded in the lower part of the sides; umbilicus comparatively small, equalling two-fifths of the diameter of the shell; slit extending nearly half a volution posterior to the apertural margin. Aperture abruptly expanded at frequent intervals, the expansion left behind forming transverse, imbricating folded lamellæ, the anterior edges of which are strongly serrated and project, collar-like, 3 or 4 mm. forward and outward from the surface of the last volution. Each expansion has seven folds, the lower one faint, the upper one strong. Occasionally a smaller one is developed between each pair of the latter. The entire surface is covered with very fine longitudinal and transverse lines. All the transverse markings cross the volutions obliquely. When, as is generally the case, the projecting lamellæ are broken away the surface presents two or three more or less obscure revolving ribs on each side of the prominent keel" (Ulrich and Scofield).

Horizon.—Upper Ordovician: Drummuck Group (Starfish Bed).

Locality.—Thraive Glen, near Girvan.

Remarks.—The foregoing description is that given by Ulrich and Scofield for *C. fimbriata*, and it appears to apply very closely to a Girvan specimen in Mrs. Gray's collection of which only the impression of part of the outer whorl is preserved. The shell must have measured about 15 mm. in height (*i. e.* diameter), and the outer whorl, which was subcordate in transverse section, rather higher than wide, increases rather rapidly in size towards the mouth, and is crossed by transverse undulated projecting lamellæ, rather oblique to the whorl and set at equal distances apart; the fimbriations are 7–8 in number and form minute rounded saddles and lobes, while in the interspaces between the lamellæ are delicate transverse concentric lines.

Genus **TEMNODISCUS**, Koken.

Generic Characters.—"Symmetrically involute small thin shells consisting of one and a-half or two rapidly enlarging, contiguous or free volutions, with rounded sides and a more or less well-developed slit-band; aperture higher than wide, sinuate dorsally, and somewhat deeply emarginated in front of the slit-band; marks of growth curving strongly backward, more or less distinctly lamellose, with crenulated edges, and, when distant enough, traversed by small longitudinal riblets" (Ulrich and Scofield).

In 1896 Koken[1] gave this name to a genus of Bellerophontacea with the type species, *Cyrtolites lamellifer*, Lindström,[2] but he had already, in 1889[3] grouped this species with four others, *C. pharetra*, *C. arrosus*, *C. obliquus* and *C. euryomphalus*, as a subgenus of *Cyrtolites*, though without defining it by a name. Ulrich and Scofield in 1897[4] chose the same species as the type of their genus *Cyrtolitina*, being apparently in ignorance of Koken's earlier name, *Temnodiscus*. We must, by the rules of priority, use Koken's designation for this group of Silurian shells. But subsequently Koken,[5] in 1897, in describing certain Ordovician shells under this name gave a fresh definition of its characters, in which he stated that it had no slit-band, whereas Ulrich and Scofield distinctly state that there is a "more or less well developed slit-band," such as Lindström clearly describes and figures in the type species. The American authors, moreover, do not include Lindström's *C. euryomphalus* in their genus, but only *C. lamellifer*, *C. pharetra*, *C. arrosus* and *C. obliquus*. Further, they say that in America the European genus *Cyrtolitina* is only repre-

[1] Koken, 'Die Leitfossilien' (1896), p. 100.

[2] Lindström, 'Silur. Gastrop. Pterop. Gotland,' p. 82, pl. vi, figs. 31—38.

[3] Koken, 'Neues Jahrb. f. Miner.' suppl. vol. vi (1889), p. 393.

[4] Ulrich and Scofield, *op. cit.*, p. 847.

[5] Koken, 'Gastrop. Balt. Untersilurs' (1897), p. 129.

sented by the Trenton species *Cyrtolites nitidulus*, Ulrich,[1] and Bassler in 1915 (*op. cit.*, p. 368) has adopted their views. If their generic name has therefore any independent right to stand, the latter species must be its type.

1. **Temnodiscus fletcheri**, sp. nov. Plate IX, fig. 6.

Specific Characters.—Shell lenticular, much compressed, acutely carinated; composed of few (2—3) whorls in contact but not overlapping, rapidly increasing in size but more in height than width, lanceolate in cross-section; sides of outer whorl very gently convex (? becoming flattened towards mouth), meeting at very acute angle (15°—20°) in carina. [Slit-band very narrow.] Umbilicus open, shallow, about one-third or one-fourth the maximum diameter of the shell, with centre situated at about one-third its height; umbilical edges subangular; umbilical slopes very short, vertical. Surface of whorls ornamented with regular, equidistant, narrow, transverse sublamellose ribs, nearly straight on sides but curving back and becoming weaker and closer near carina, which they meet at 30°—45° but do not cross; edges of ribs fimbriated; interspaces slightly concave, crossed by regular, equidistant, raised spiral lines, alternating in successive interspaces and bearing closely-placed small granules; near apertural margins the transverse ribs and spiral lines become finer, less regular and more closely placed.

Dimensions.—Height of shell about 14 mm.; height of mouth about 9 mm.

Horizon.—Wenlock Shale.

Locality.—Dudley.

Remarks.—Only the one specimen [27995] in the Jermyn Street Museum is known to me, but it exhibits such marked characters as to merit a distinct specific name. The mouth is not preserved, nor the slit-band. In shape, but not precisely in ornamentation, the shell resembles *T. pharetra* (Lindström)[2] from the Silurian of Gotland. The ornament, however, is more like that of some American Ordovician species of *Conradella*.

2. **Temnodiscus monilifer**, sp. nov. Plate IX, fig. 7.

Specific Characters.—Shell high, narrow, compressed, sharply angulated on dorsum, cornuate, composed of 1—1½ free curved whorls with the umbilicus open and perforated. Whorl very rapidly increasing in size to mouth, lanceolate in cross-section, with gently convex sides meeting at an acute angle on the dorsum. Mouth oblique, about 1½ times as high as wide. Slit-band flattened, becoming narrower and completely (?) closed to form an acute keel in proximal part of shell. Sides of whorl crossed by regular equidistant thick lamellæ, gently arched

[1] Ulrich, 'Journ. Cincinnati Soc. Nat. Hist.,' vol. ii (1897), p. 12.

[2] Lindström, *op. cit.*, p. 83, pl. vi, figs. 39—51.

PLATE I.

FIG. PAGE

1. *Sinuites anceps* (Salter MS.). Side view. × 1½. Middle Bala, Horderley. Mus. Pract. Geol. [28025]. 5.

1*a*. Dorsal view. × 1½. 1*b*. Front view. × 1½.

2. Ditto. Internal cast. Side view. × 1½. Same horizon and locality. Mus. Pract. Geol. [28027]. 5.

2*a*. Dorsal view. × 1½.

3. Ditto. Internal cast. Dorsal view. × 1½. Bala Series, Soudley Quarry. Sedgwick Mus. 5.

4. *Sinuites balclatchiensis*, sp. nov. Internal cast with portion of shell preserved. Side view. × 1½. Balclatchie Group, Balclatchie. Mrs. Gray's Coll. 6.

4*a*. Front view. × 1½.

5. Ditto. Side view of internal cast, showing transverse groove. × 1½. Same horizon, locality and collection. 6.

5*a*. Sinus view. × 1½.

6. Ditto. Dorsal view. × 1½. Same horizon, locality and collection. 6.

7. Ditto. Restored outline of sinus view. × 1½. 6.

8. *Sinuites bilobatus* (Sow.). Side view of type. Nat. size. Middle Bala, Horderley. Mus. Pract. Geol. [6850]. 7.

8*a*. Sinus view. Nat. size. 8*b*. Front view. Nat. size.

9. *Sinuites discoides*, sp. nov. Internal cast. Side view. × 2. Balclatchie Group, Ardmillan. Mrs. Gray's Coll. 9.

9*a*. Dorsal view. × 2. 9*b*. Ornament. × 20.

10. Ditto. Internal cast. Side view. × 2. Same horizon, locality and collection. 9.

11. Ditto ?. Internal cast. Side view. × 2. Same horizon, locality and collection. 9.

11*a*. Dorsal view. × 2.

12. *Sinuites elongatus* (Portl.). Internal cast. Side view of supposed type. × 1¼. Bala Series, Tyrone. Mus. Pract. Geol. [27990]. 9.

12*a*. Sinus view. × 1¼.

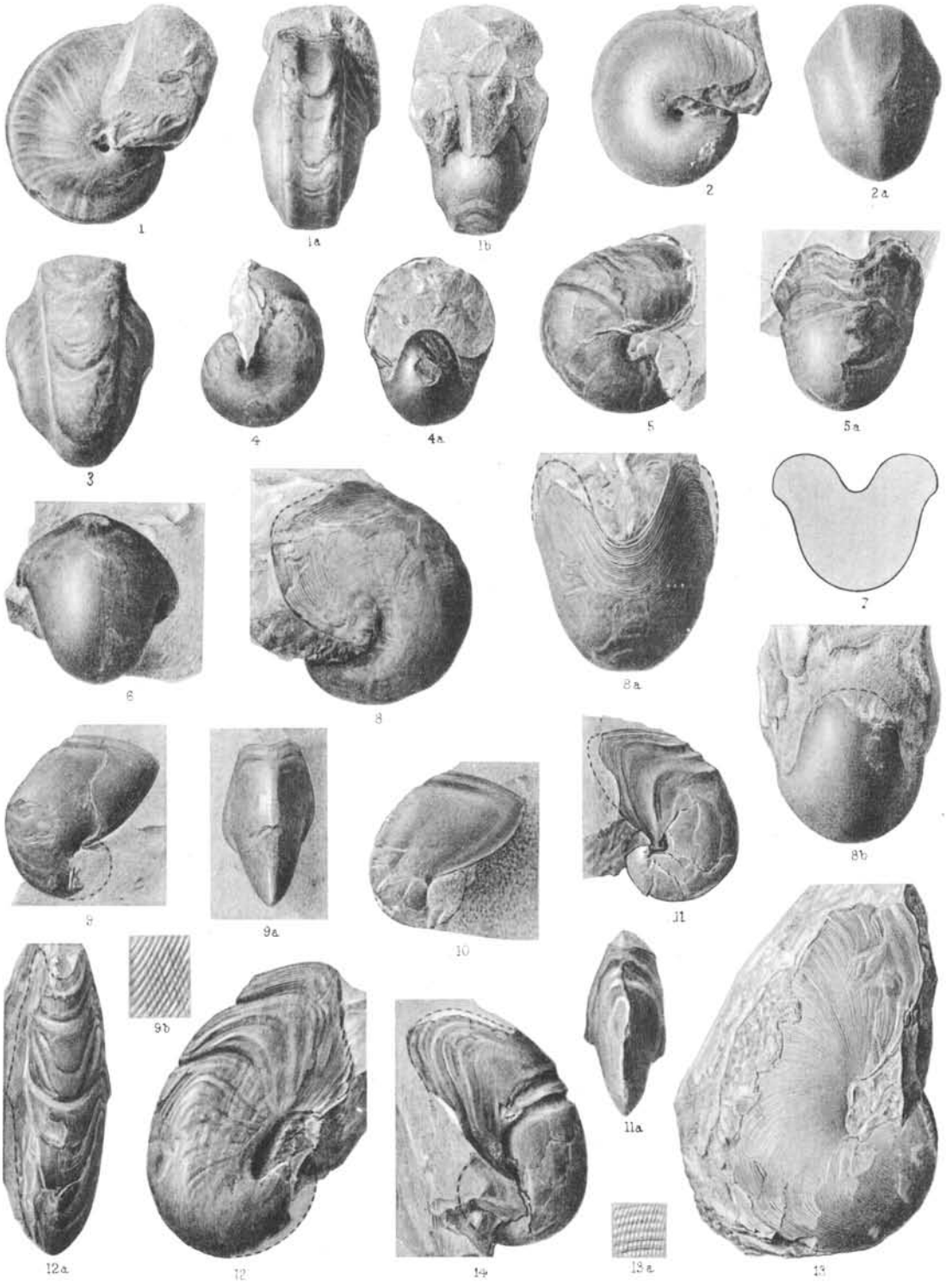
13. Ditto. Side view, showing ornament. × 1½. Same horizon, locality and collection [27991]. 9.

13*a*. Portion of ornament. × 10.

14. Ditto ?. Internal cast. Side view. × 1¼. Starfish Bed, Thraive Glen, Girvan. Mrs. Gray's Coll. 10.

Reed, Bellerophontacea.

PLATE 1

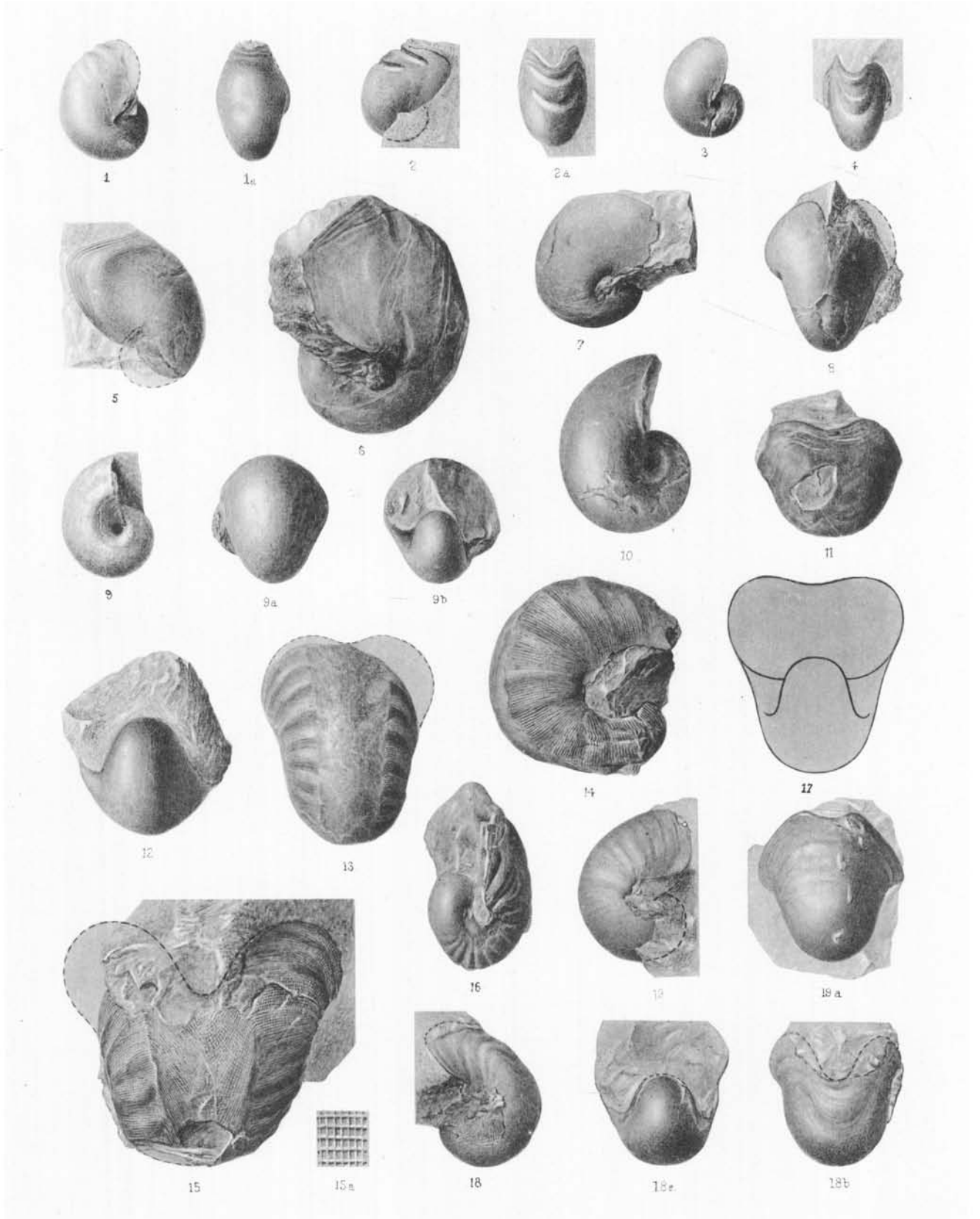


SINUITES.

PLATE II.

Fig.		Page.
1.	*Sinuites maccallumi*, sp. nov. Internal cast. Side view. × 1½. Balclatchie Group, Ardmillan. Mrs. Gray's Coll.	10.
1*a*.	Dorsal view. × 1½.	
2.	Ditto. Internal cast. Side view. × 1½. Same horizon, locality and collection.	10.
2*a*.	Sinus view. × 1½.	
3.	Ditto. Internal cast. Side view. × 1½. Same horizon, locality and collection.	10.
4.	Ditto. Internal cast. Sinus view. × 1½. Same horizon, locality and collection.	10.
5.	Ditto ?. Internal cast. Side view. × 2½. Same horizon, locality and collection.	10.
6.	*Sinuites pseudocompressus*, sp. nov. Internal cast. Side view. × 1¼. Middle Bala. Long Lane Quarry, Craven Arms. Sedgwick Mus.	11.
7.	Ditto. Internal cast. Side view. × 1¼. Same horizon, locality and collection.	11.
8.	Ditto. Internal cast. Sinus view. × 1¼. Same horizon, Horderley. Sedgwick Mus.	11.
9.	*Sinuites pusgillensis*, sp. nov. Internal cast. Side view. × 1½. Corona Beds, Pusgill. British Mus. (G. 22064).	12.
9*a*.	Dorsal view. × 1½. 9*b*. Front view. × 1½.	
10.	Ditto. Internal cast. Side view. × 1¼. Same horizon and locality. Sedgwick Mus.	12.
11.	Ditto. Internal cast. Sinus view. × 1¼. Same horizon, locality and collection.	12.
12.	Ditto. Internal cast. Front view. × 1¼. Same horizon, locality and collection.	12.
13.	*Sinuites semirugosus* (Salter MS.). Dorsal view. × 1½. Bala Series, Tyn y twyl. Mus. Pract. Geol. [28039].	13.
14.	Ditto. Side view. × 2. Same horizon, locality and collection [28040].	13.
15.	Ditto. Sinus view. × 2. Bala Series, Vyrnwy Dam. Sedgwick Mus.	13.
15*a*.	Portion of ornament. × 10.	
16.	Ditto. Internal cast. Three-quarter front view. × 1½. Bala Series, Tyn y twyl. Mus. Pract. Geol. [28041].	13.
17.	Ditto. Restored outline of front view.	
18.	*Sinuites soudleyensis*, sp. nov. Internal cast. Side view, with portion of shell showing ornament. Nat. size. Bala Series, Horderley. Mus. Pract. Geol. [28026].	13.
18*a*.	Front view. Nat. size. 18*b*. Sinus view. Nat. size.	
19.	Ditto. Internal cast. Side view. × 1¼. Bala Series, Soudley. Sedgwick Mus.	13.
19*a*.	Dorsal view. × 1¼.	

Reed, Bellerophontacea. PLATE II

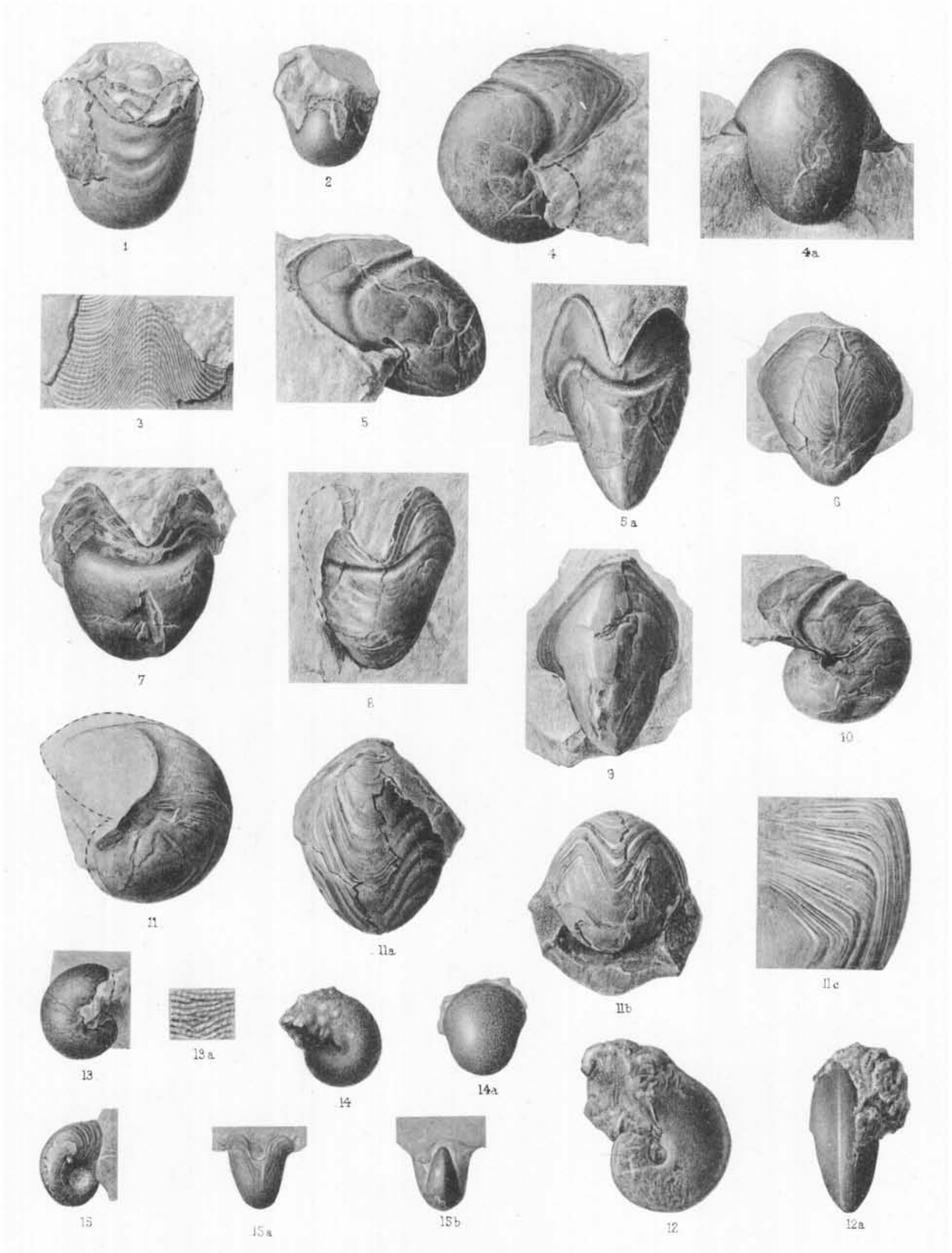


SINUITES.

PLATE III.

Reed, Bellerophontacea.

PLATE III



1-14. SINUITES.

15. SINUITOPSIS.

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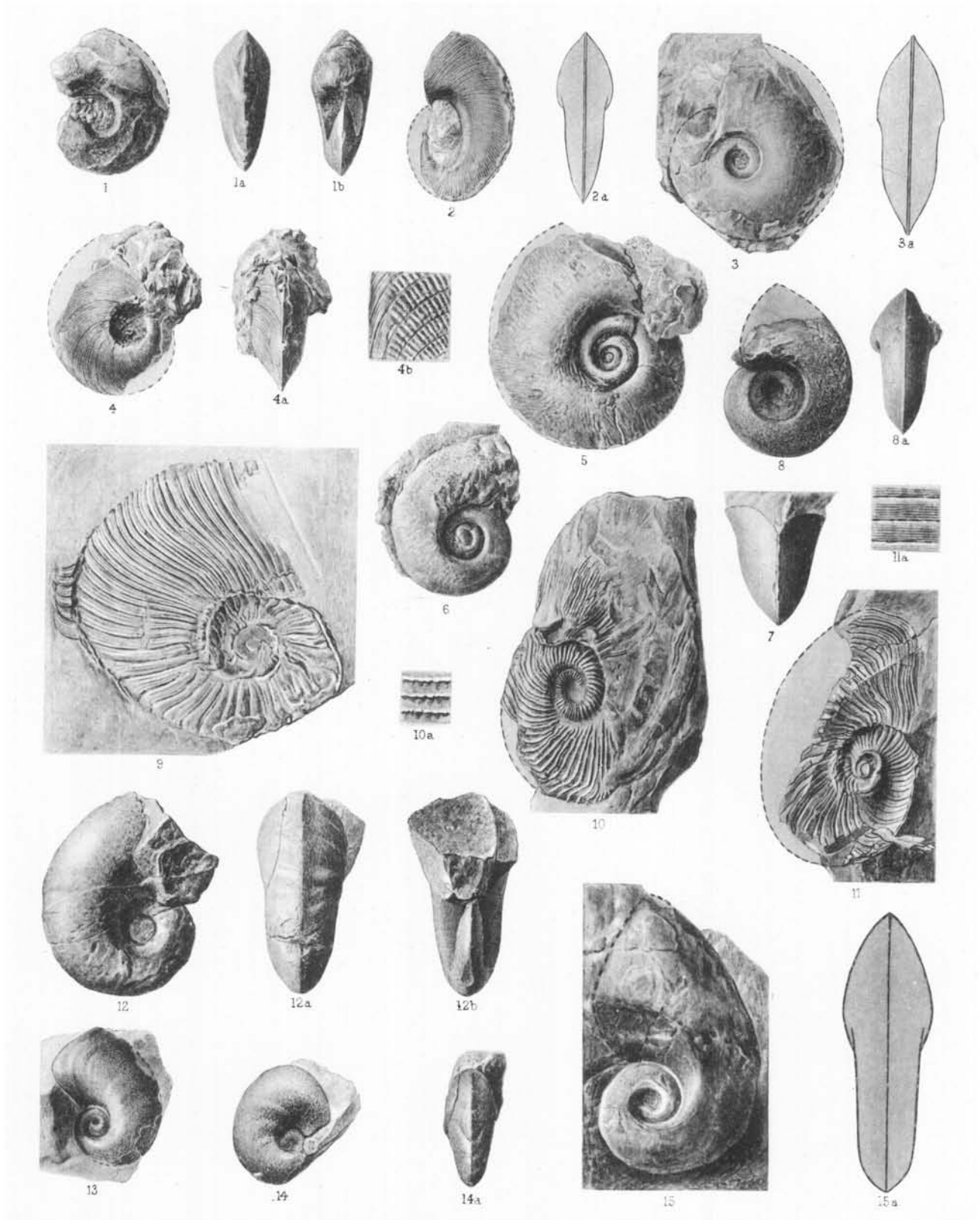
PLATE IV.

Fig.		Page.
1.	*Oxydiscus acutus* (Sow.). Internal cast. Side view of type. × 2. Bala Series, Horderley. Mus. Pract. Geol. [6916].	19.
1*a*.	Dorsal view. × 2. 1*b*. Front view. × 2.	
2.	Ditto. Side view of specimen with shell preserved showing ornament. × 2. Bala Series, Onny River. Mus. Pract. Geol. [28024].	19.
2*a*.	Restored dorsal view. × 2.	
3.	*Oxydiscus bougangensis*, sp. nov. Side view. × 1¼. Stinchar Limestone, Bougang. Mrs. Gray's Coll.	20.
3*a*.	Restored dorsal view. × 1¼.	
4.	*Oxydiscus hunteri*, sp. nov. Side view of specimen with shell preserved. × 1½. Balclatchie Group, Balclatchie. Mrs. Gray's Coll.	20.
4*a*.	Dorsal view. × 1½. 4*b*. Ornament. × 10.	
5.	Ditto. Internal cast. Side view. × 1½. Same horizon, locality and collection.	20.
6.	Ditto. Ditto. × 1½. Same horizon, locality and collection.	20.
7.	Ditto. Sinus view. × 1½. Same horizon, locality and collection.	20.
8.	Ditto. Side view. × 1½. Same horizon, locality and collection.	20.
8*a*.	Dorsal view. × 1½.	
9.	*Oxydiscus ? llanvirnensis* (Hicks). Side view of counterpart of type. Upper Arenig, Llanvirn. Sedgwick Mus.	22.
10.	Ditto. Side view. × 2. Llandeilo Beds, Abereiddy Bay. Mus. Pract. Geol. [28020].	23.
10*a*	Ornament. × 6.	
11.	Ditto. Counterpart of fig. 10. × 2. Mus. Pract. Geol. [28018].	23.
11*a*.	Ornament. × 6.	
12.	*Cyrtolites budleighensis*, sp. nov. Internal cast. Side view. × 1¼. Ordovician Pebble, Budleigh Salterton. British Mus. [G. 15296].	24.
12*a*.	Dorsal view. × 1¼. 12*b*. Front view. × 1¼.	
13.	Ditto. Internal cast. Side view. × 1¼. Same horizon, locality and collection [G. 15298].	24.
14.	Ditto. Internal cast. Side view. × 1½. Same horizon, locality and collection [G. 15299].	24.
14*a*.	Dorsal view. × 1½.	
15.	*Cyrtolites craigensis*, sp. nov. Internal cast. Side view. Nat. size. Stinchar Limestone, Craighead. Mrs. Gray's Coll.	24.
15*a*.	Restored dorsal view. Nat. size.	

Reed, Bellerophontacea.

PLATE IV



1-11. OXYDISCUS. 12-15. CYRTOLITES.

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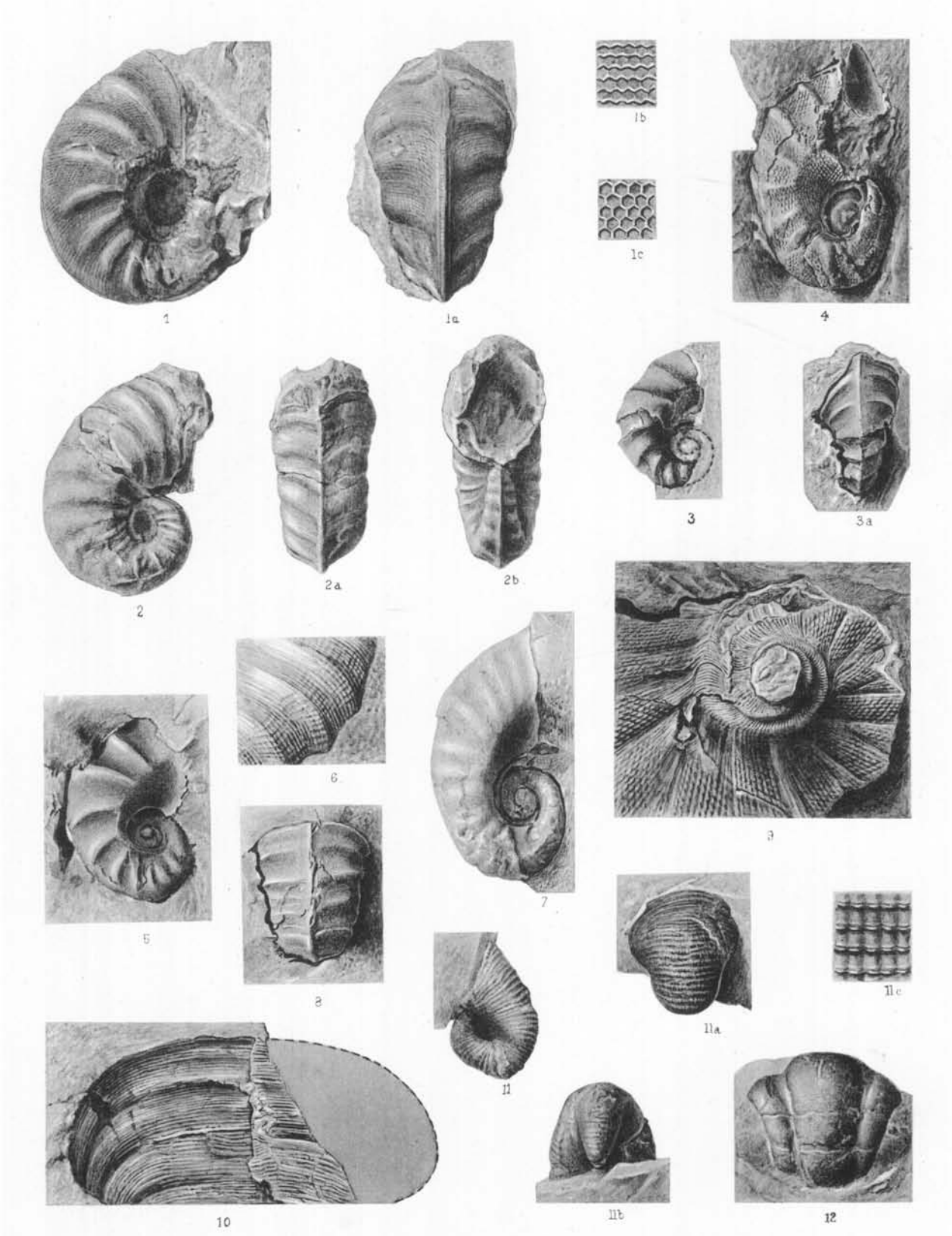
PLATE V.

Fig.		Page.
1.	*Cyrtolites nodosus* (Salter). Side view of type with shell preserved. ×2. Bala Series, Soudley. Mus. Pract. Geol. [28037].	25.
1*a*.	Dorsal view. × 2. 1*b*. Ornament. × 8. 1*c*. Ornament (worn). × 8.	
2.	Ditto. Internal cast. Side view. × 1½. Bala Series, Soudley. Mus. Pract. Geol. [28038].	25.
2*a*.	Sinus view. × 1½. 2*b*. Front view. × 1½.	
3.	*Cyrtolites nodosus* var. *llandoveriana*, nov. Internal cast. Side view. × 2. Lower Llandovery, Blaen y cwm. Mus. Pract. Geol. [28051]	26.
3*a*.	Dorsal view. × 2.	
4.	Ditto. Internal cast. Side view. × 1½. Same horizon, locality and collection. Mus. Pract. Geol. [28050].	26.
5.	Ditto. Internal cast. Side view. × 2. Same horizon and locality. Sedgwick Mus.	26.
6.	Ditto. Portion of dorsal slope, showing ornament. × 3. Lower Llandovery, Sevin Llettyrhyddod. Sedgwick Mus.	26.
7.	*Cyrtolites thraivensis*, sp. nov. Internal cast. Side view. × 1½. Drummuck Group, Thraive Glen. Mrs. Gray's Coll.	26.
8.	Ditto. Internal cast. Sinus view. × 1½. Same horizon, locality and collection.	26.
9.	Ditto. Impression of exterior of umbilical portion of shell, showing ornament. × 4. Same horizon, locality and collection.	26.
10.	Ditto. Impression of portion of shell (fig. 7) near mouth, showing ornament. × 3. Same horizon, locality and collection.	26.
11.	*Isospira huttoni*, sp. nov. Side view. × 2½. Whitehouse Group, Shalloch Mill. Mrs. Gray's Coll.	27.
11*a*.	Dorsal view. × 2½. 11*b*. Inferior view. × 2½. 11*c*. Ornament. × 8.	
12.	*Bucaniella trilobata* (Sow.). Dorsal view of internal cast. × 2. Wenlock Series, Dudley. Sedgwick Mus.	28.

Reed, Bellerophontacea.

PLATE V



1-10. CYRTOLITES. 11. ISOSPIRA.

12. BUCANIELLA.

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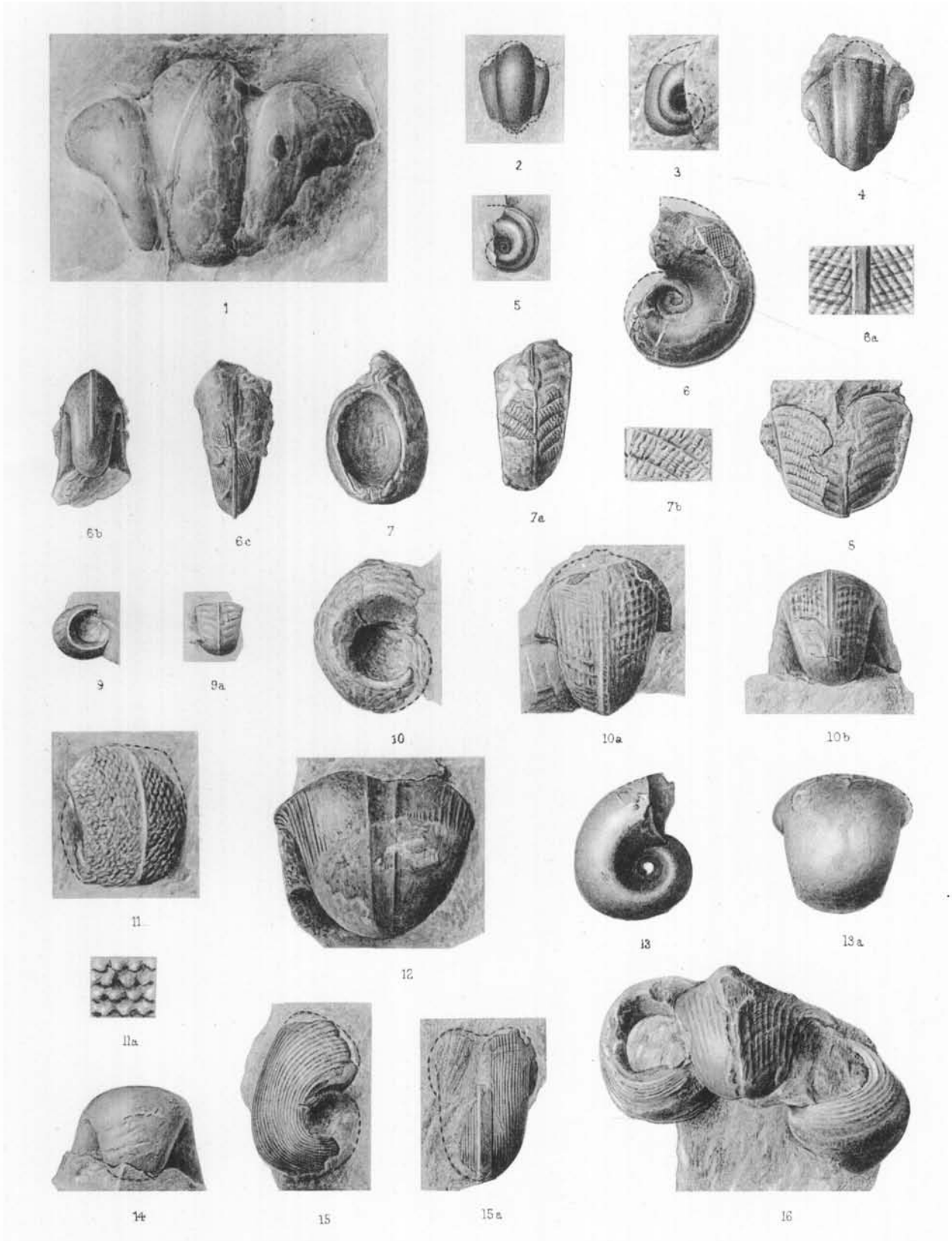
PLATE VI.

Reed, Bellerophontacea. PLATE VI



1-5. BUCANIELLA. 6-11. BUCANIA.

12-16. KOKENOSPIRA.

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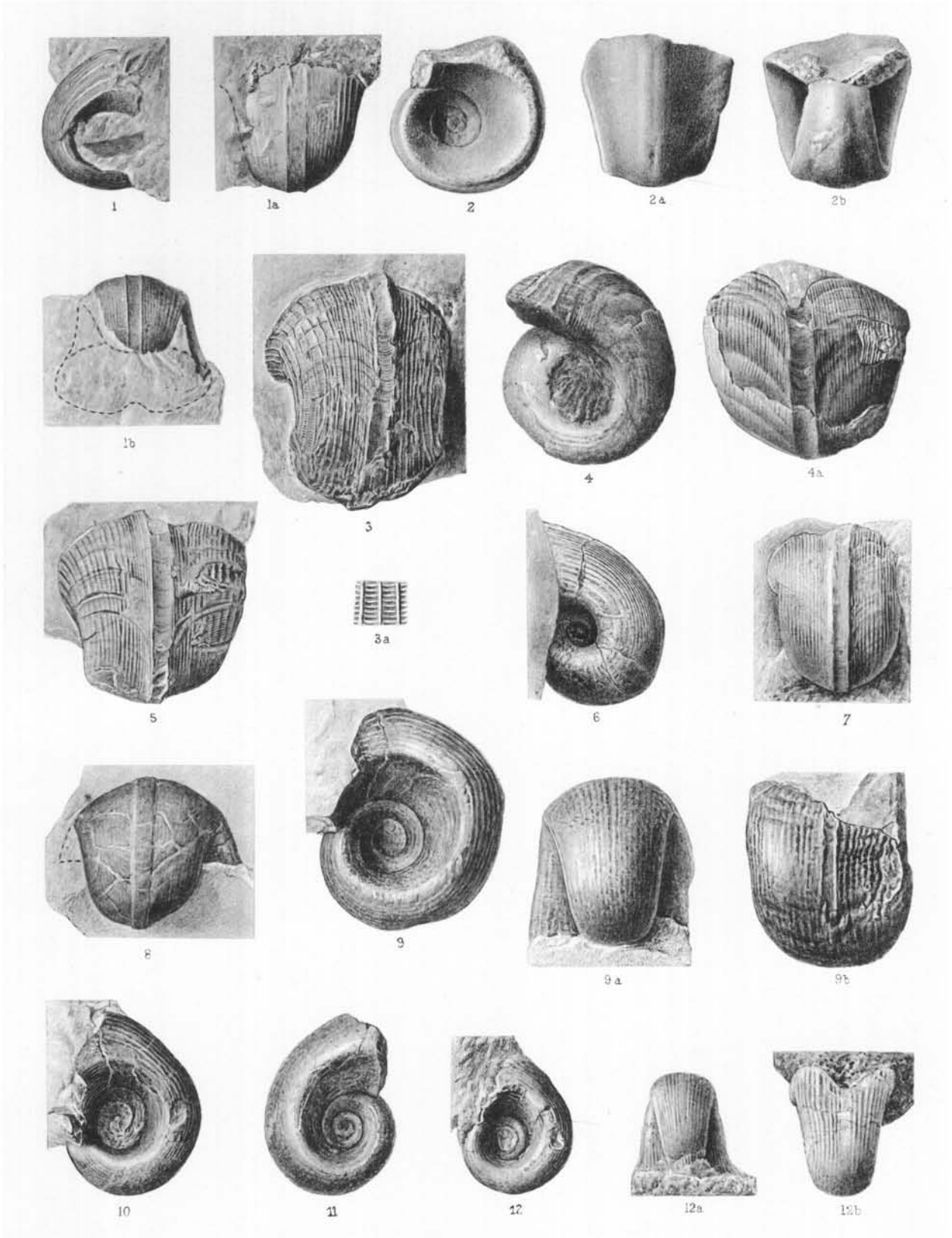
PLATE VII.

Reed, Bellerophontacea.

PLATE VII



KOKENOSPIRA.

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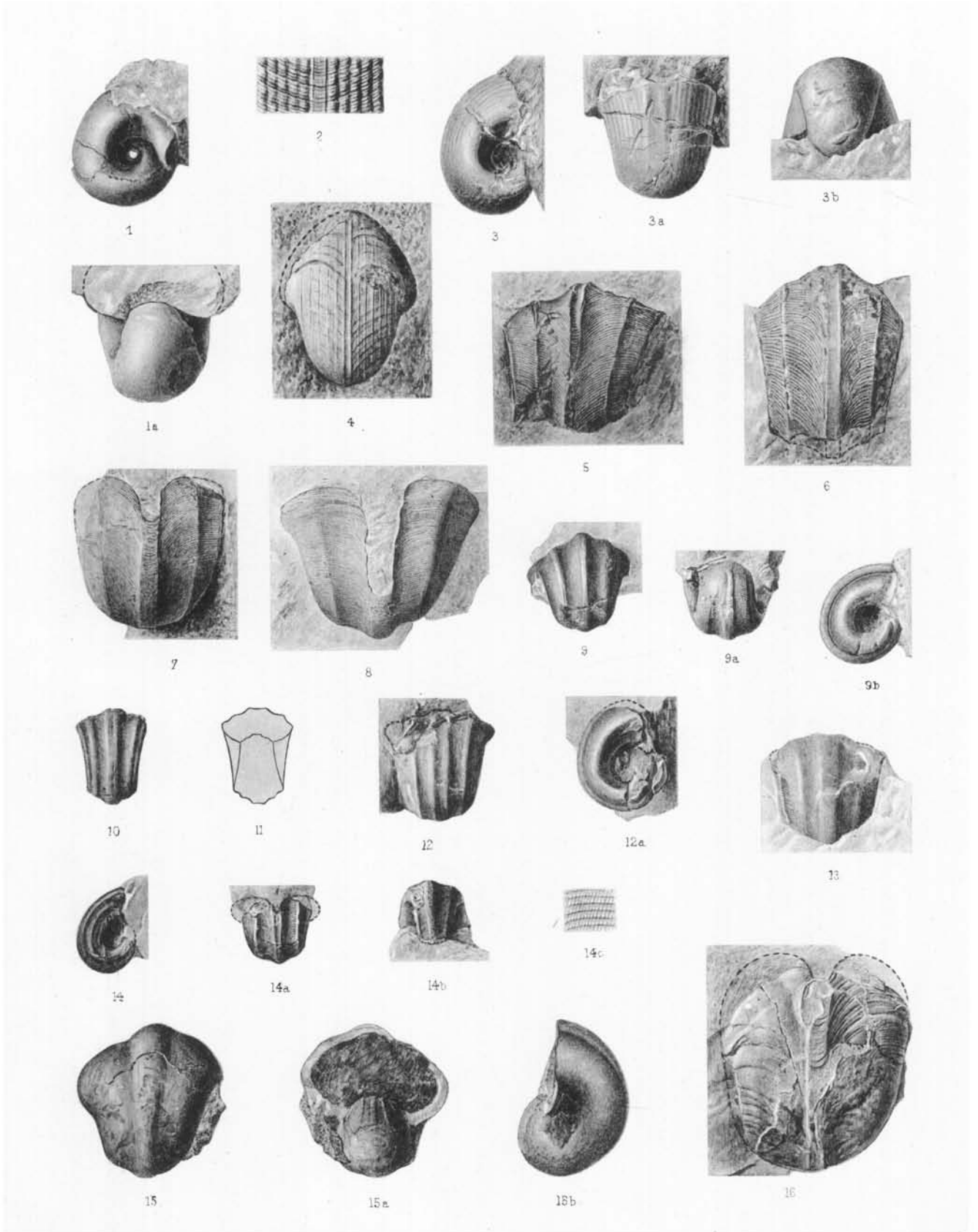
PLATE VIII.

Reed, Bellerophontacea.

PLATE VIII



1-4. KOKENOSPIRA. 5-16. TETRANOTA.