A MONOGRAPH

OF

BRITISH CONULARIÆ.

BY

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THE BRITISH CONULARIÆ.

INTRODUCTION.

The interest attaching to the systematic position of the genus *Conularia*, together with the absence of a general account of the British species, induced me to undertake the work for this monograph, which has been carried out during the last two years at the Sedgwick Museum, Cambridge, and the British Museum (Natural History), London. During its progress I have examined specimens from the Geological Survey Collections in London, Edinburgh, and Dublin, from the British Museum (Natural History), from the Sedgwick Museum, Cambridge, from Mrs. Gray's Collection of Girvan Fossils, and from other sources. I also worked at the Vetenskaps-Akademi, Stockholm, where I was enabled, by the kindness of Professor Holm, to inspect a number of Swedish specimens and compare them with the British forms.

In conclusion I should like to express my best thanks to the officials of the museums in which I have worked for their unfailing courtesy and kindness, and especially to Mr. H. Woods, at whose suggestion I undertook the monograph, and who has given me the most valuable help and guidance throughout.

HISTORY.

The first reference to *Conularia* is found in the 'History of Rutherglen and Kilbride,'[1] where the author refers to a "curious fossil," the class of which had not been determined. "The specimens are in casts of ironstone, sometimes found inclosed in ironstone like a nucleus." No locality is given, but the shell is figured. In 1818 Sowerby[2] gave a diagnosis of the genus *Conularia*, which "Mr. Miller, of Bristol, has very properly instituted for the reception of a four-sided fossil,

[1] Ure, 'History of Rutherglen and Kilbride' (1793), pp. 330, 331, pl. xx, fig. 7.

[2] Sowerby, 'Min. Conch.,' vol. iii (1818), p. 107, pl. 260, figs. 1—6.

somewhat resembling an Orthocera, but furnished with imperforate septa, and an inflexion of the lip that nearly closes the mouth." He also described and figured two species, *C. quadrisulcata* and *C. teres*. The former was founded on specimens from "Transition Limestone" (fig. 4), "Bristol Limestone about the Hotwells" (fig. 5), "Transition Limestone that contains mica from near Keswick" (fig. 3), and "Tronlie Bank near Glasgow" (fig. 6), and is now known to include three different species, while the latter was doubted at the first by its author, and was soon afterwards recognised to be an *Orthoceras*.

In 1828 we find the species *C. sowerbyi* attributed by de Blainville[1] to Defrance, with a reference to the 'Dictionnaire des Sciences Naturelles.' De Blainville reproduced all Sowerby's six figures, and gave no description; as all attempts to find any account of *C. sowerbyi* in the 'Dictionnaire' have proved unsuccessful, Defrance's right to the species seems to be very doubtful.

In 1839 Sowerby[2] described and figured a Wenlock Limestone form under the original name, *C. quadrisulcata*, mentioning, however, that it might be found possible to separate this from the Carboniferous Limestone species, in which case Defrance's name should be adopted for the former. The next new species was found in Ireland, co. Tyrone, and was described and figured by Portlock[3] under the name *C. elongata*, together with two other species named respectively "*C. quadrisulcata*, Sow. var. *carb.*" and "*C. quadrisulcata*, Sow. var. *sil.*" The two figured specimens of the latter belong to two distinct species. The next important reference to the genus is in the 'Géologie de la Russie d'Europe,'[4] where de Verneuil, in the Palæontological Section, definitely restricted Sowerby's name, *C. quadrisulcata*, to the Carboniferous species and adopted Defrance's name, *C. sowerbyi*, for the Silurian species, distinguished by its greater size, compressed form and continuous transverse folds. The description is accompanied by a clear figure, and since this is the first time that the two forms are definitely separated and named, the species *C. sowerbyi* should be assigned to de Verneuil.

In 1847 Sandberger[5] published an important monograph on Palæozoic Pteropods, in which he described and figured fourteen species, including among them the three known British forms, but giving to them new and more descriptive names, which, however, have not been adopted. He also gave a general description of the genus, and a list of those characters upon which he based his specific distinctions. In 1855 M'Coy[6] attempted to clear up the confusion in nomencla-

[1] De Blainville, 'Malacol.' (1828), p. 377, pl. xiv, figs. 2 *c*—*e*.

[2] Sowerby in Murchison, 'Silur. Syst.' (1839), p. 627, pl. xii, fig. 22.

[3] Portlock, 'Report, Geol. Londonderry' (1843), p. 393, pl. xxix A.

[4] De Verneuil in Murchison, de Verneuil and de Keyserling, 'Géol. de la Russie d'Europe' (1845), vol. ii, "Paléont.," p. 348, pl. xxiv, fig. 5.

[5] F. Sandberger, "Pteropoda der ersten Erdbildungs-Epoche: Conularia und Coleoprion," 'Neues Jahrb. für Min., etc.,' 1847, p. 8.

[6] F. M'Coy in Sedgwick's 'Synops. Brit. Palæoz. Rocks' (1855), pp. 287, 520.

ture by substituting Sandberger's name, *C. cancellata*, for the *C. sowerbyi* of doubtful origin, and by restricting *C. quadrisulcata* to the Carboniferous species, as had already been done by de Verneuil. In the Appendix[1] to the same work Salter described and figured a new Upper Silurian species, *C. subtilis*, which is also referred to by M'Coy in the text. In 1866 Salter[2] described and figured four species, *C. lævigata*, *C. homfrayi*, *C. margaritifera*, and *C. corium*. In 1867 the most important work upon this genus appeared in Barrande's 'Monograph of Palæozoic Pteropods,'[3] in which he described and figured twenty-seven Bohemian species, giving also a general account of the genus, details of structure, and the horizontal and vertical distribution. In 1873 Salter[4] catalogued, without description or figures, two new species in the Woodwardian Museum, Cambridge, under the names *C. clavus* and *C. bifasciata*. The former, belonging to the Fletcher Collection (reg. no. a. 878) is said to come from the Wenlock Limestone near Dudley, and was described and figured by Cowper Reed[5] in 1902. As, however, both in character and preservation, the fossil is identical with small specimens of *C. quadrisulcata* from the ironstone nodules of the Coal Measures, and is totally unlike any fossil I have seen from the Wenlock Limestone, I am of opinion that a wrong horizon has led to the institution of a false species, which must therefore be abandoned. With regard to *C. bifasciata*, also described and figured by Cowper Reed,[5] the species was unrecognisable from Salter's note, and the same form in Sweden was described and figured eleven years later by Lindström,[6] under the name *C. aspersa*; Lindström's name, and not Salter's, should therefore be adopted for the species. Another new species was added to the list in 1875 by Hicks,[7] who described and figured a somewhat doubtful form from the Lower Ordovician of South Wales under the name *C. llanvirnensis*. Three years later we find a reference by Etheridge[8] to some fragments of a new species from the Lower Carboniferous of Scotland, and these fragments undoubtedly belong to the new species, *C. tenuis*, described subsequently. In 1884, in the important monograph to which reference has already been made, Lindström described and figured five species from Gotland, and in 1893 Holm[9] completed the description of the Swedish members of the family. In addition to the description of nine new

[1] *Loc. cit.*, Appendix A, p. vi, and p. 287, pl. I.L, fig. 24.

[2] J. W. Salter in Ramsay's 'Geol. North Wales,' Mem. Geol. Surv., vol. iii, ed. 1 (1866), pp. 354, 355; ed. 2 (1881), pp. 562, 563, pls. x, xi A.

[3] J. Barrande, 'Syst. Silur. du Centre de la Bohême' (1867), vol. iii.

[4] J. W. Salter, 'Catal. Cambr. and Silur. Foss. Geol. Mus. Cambr.' (1873), pp. 153, 171.

[5] F. R. C. Reed, 'Geol. Mag.' [4], vol. ix (1902), p. 123.

[6] G. Lindström, "Silur. Gastr. and Pterop. Gotland," 'K. Svenska Vet.-Akad. Handl.,' vol. xix, no. 6 (1884), pp. 39—47, pls. i, vii, xix.

[7] H. Hicks, 'Quart. Journ. Geol. Soc.,' vol. xxxi (1875), p. 189, pl. xi, figs. 5, 6.

[8] R. Etheridge, jun., 'Quart. Journ. Geol. Soc.,' vol. xxxiv (1878), p. 19.

[9] G. Holm, "Hyolithidæ och Conulariidæ," 'Sver. Geol. Undersök.' (1893), ser. C, no. 112.

species the author gave a complete list of the species known at the time with tables of vertical distribution in the different countries, and also made the first attempt at a natural classification.

GENERAL MORPHOLOGY.

(1) *Form of the Shell.*—The shell is always in the form of a straight four-sided pyramid. The few cases among British species in which a slight curvature is seen, are probably due to accident. The tapering of the shell is generally uniform, though there are several exceptions in which the sides become nearly parallel towards the aperture while converging more rapidly in the apical portion, *e. g. C. subtilis* (Plate IV, fig. 8).

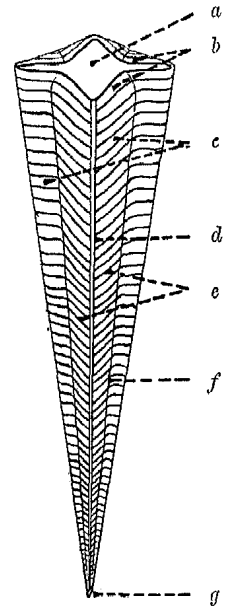


Fig. 1.—Diagram of *Conularia*. *a*. Aperture. *b*. Apertural lobes. *c*. Faces of the pyramid. *d*. Marginal groove. *e*. Transverse ridges. *f*. Facial groove. *g*. Apex.

(2) *Cross-Section.*—The section of the shell at right angles to the long axis varies considerably. Very frequently deformation has taken place, but is not easy to detect, as a square is converted to a rhomb, without any distortion in the shell itself. Hence the observed cross-section is often misleading, though there are certain characters in the ornamentation which throw light upon the natural form (see "Ornamentation," p. 8).

In the majority of cases the transverse section is a square in which the sides are either straight lines as in *C. quadrisulcata* and *C. hispida* (Pl. III, fig. 10), or slightly convex curves as in *C. crassa* and *C. globosa* (Pl. IV, fig. 5, and Pl. III, fig. 7 *b*).

In a considerable number of cases the cross-section is in the form of a more or less flattened rhomb, in which:

(i) The sides are straight or slightly concave throughout the length of the shell, *e. g. C. lævigata.*

(ii) The straight lines are replaced towards the apex by convex curves, while the shorter axis becomes still more diminished, giving rise to a flattened ellipse or figure ∞, *e. g. C. sowerbyi*, *C. vesicularis* (Pl. V, fig. 4 *b*).

(iii) The straight lines are replaced by convex curves throughout, giving rise to an ellipse, *e. g. C. complanata* (Pl. IV, fig. 13).

In one somewhat doubtful case the sides appear to be equal in pairs, giving rise to a rectangle, *e. g. C. punctata* (Pl. I, fig. 10 *b*).

(3) *Faces of the Pyramid.*—Except in the doubtful cases of *C. lævigata* and *C. punctata* among British species, the faces of the pyramids are equal, and similar elongated triangles, with surfaces either plane or with the modifications mentioned above. The apical angle of the face can frequently be measured, even when the specimen is very imperfect. It is usually found to have a fairly constant value for a species, and is therefore of considerable specific importance. It is not readily affected by compression of the shell, as is the case with the apical angle of the pyramid, hence the values given are generally reliable. When the shell tends to become prismatic towards the aperture, the angle of the face becomes correspondingly less.

(4) *Longitudinal Grooves and Ridges.*—The faces are separated from one another in all cases by straight, well-marked, longitudinal grooves, which run down the angles of the pyramid. These "marginal grooves" vary greatly in character, but are very constant for a species. In all the earliest forms they are smooth, deep, and with a tendency for the edges to become prominent, as in *C. coronata* (Pl. III, fig. 1 *a*) and *C. homfrayi*. In the later ornamented types the ornamentation of the faces may be continued across the grooves without change in direction, as in *C. sowerbyi* (Pl. V, fig. 10 *a*); or it may change its direction at the edges, and cease at the base, as in *C. quadrisulcata* (Pl. III, fig. 2); or it may cease abruptly at the edge, leaving a smooth groove, as in *C. breviconventa* (Pl. V, fig. 13).

In shape also there are all stages, from a sharp, well-defined groove, such as is seen in *C. hispida* (Pl. III, fig. 9 *a*); to the wide, shallow undulation seen in *C. crassa* (Pl. IV, fig. 4 *a*).

On the surface of the face itself longitudinal grooves are sometimes seen. In the earlier smooth forms these "facial grooves" are constant, well marked, and frequently resemble the marginal grooves in having prominent, raised edges (*e. g. C. coronata*, Pl. III, fig. 1 *a*); but in most of the later species, if present at all, they appear as narrow depressions, or frequently as fine cracks, marking the line of weakness, along which the transverse ridges are bent. They are always central or

sub-central, according to the position of this bend. In *C. microscopica* (Pl. II, figs. 6, 7), they are unusually deep and constant. Secondary facial grooves, dividing again the half faces, are only seen in the early smooth forms.

In three species the centres of the faces are marked by fine, internal, longitudinal ridges, the internal septa of Lindström.[1] In British forms they are in pairs in *C. punctata* (Pl. I, figs. 10 *a*, 11) and *C. aspersa* (Pl. I, figs. 5, 6 *b*), and single in *C. tenuis* (Pl. II, fig. 2). They appear to be fine, biconvex ridges on the inner surface of the shell. As the result of compression, and owing to the thinness of the shell, in the two latter species they are often seen as raised ridges on the outer surface; in *C. aspersa* these ridges are usually accompanied by a black stain, probably indicating the position of some important anatomical structure (Pl. I, figs. 6 *b*, 9 *c*).

(5) *Aperture and Apex of Shell.*—The aperture of the shell is not commonly preserved, though many perfect examples are known, especially among specimens from ironstone concretions. Each face terminates in a roughly triangular lobe, on which the general ornamentation of the face is continued. Generally these lobes are short and rigid and bent down at right angles to the axis of the shell, partially closing the aperture, as in *C. quadrisulcata* and *C. sowerbyi* (Pl. III, fig. 6; Pl. V, fig. 8); but in *C. aspersa* they are long, and meet, forming an elevated cone (Pl. I, fig. 5); in this species the shell is very thin, and the apertural lobes were probably not rigid.

In the greater number of specimens the delicate apical portion of the shell is not preserved, but examples are found in some species where the pyramid tapers to a fine point. It is generally difficult to make out whether this end was closed or open; but in one species there seems good evidence that the latter state prevailed. *C. tenuis* is found in a good state of preservation in the hard, shaly Calciferous Sandstone of Glencartholm, Dumfriesshire, and on slabs of this rock examples are found in clusters, varying in number from two to as many as sixteen (Pl. II, fig. 1). The size of the individuals of the cluster varies, some being quite small and some full grown. They must have been connected with one another or with some foreign body by their apices, which must therefore have been pierced during some part of the life of the animal. I have found no trace of this fixed condition in any other species, nor have I found any reference to it in published works, except in a short article by Ruedemann,[2] entitled "Note on a Sessile Conularian." He describes this form as a typical Conularian, in which the delicate pyramid base is inserted in a chitinous cup, which by means of suction acted as a temporary organ of attachment. The attachment in the case of *C. tenuis* can hardly have been temporary, and from the size of the individuals must have been an adult character.

In a large number of species, instead of tapering to a fine point the pyramid is

[1] G. Lindström, 'Silur. Gastrop. Gotland,' p. 46.

[2] 'American Geologist,' vol. xvii (1896), p. 158.

found ending in a more or less convex septum, which Sowerby noticed as long ago as 1839 (*loc. cit.*), and which gave rise to the idea that the genus should be placed in the Cephalopods (Pl. V, figs. 12 *a*, 14 *a*). The septum consists of a very thin shell, which appears to be continuous with the inner layer of the test. It is quite unornamented, the striæ which are often seen parallel with the longer axis being probably due to compression (Pl. V. fig. 7 *b*). The position at which it is found varies considerably, for it is sometimes close to the apex, where it only measures about 10 mm. across, while in other cases, in specimens of about the same size, it has a length of 25 mm. or more. Probably, therefore, the apical part of the shell is divided up by a series of septa, of which only the lowest is usually seen. In the Birmingham University Museum, however, there is a specimen which shows a second septum arching away about 6 mm. above the first. The existence of a siphuncle in these septa has been suggested at various times by different writers,[1] but never with any great certainty. The septa are frequently much broken, but I have seen several perfect ones. On only one of these (Pl. V, fig. 1 *b*) have I observed anything like a siphuncle, and here, though the small central tube is very well defined, it appears to be closed, and may be an abortive survival of a once functional structure, or a scar left by the growth of the septum.

In all probability the chambers thus successively cut off at the apex remained quite empty, and the apical ones may even have been lost in the lifetime of the animal; after this had taken place the apical end of the shell must have been closed. But in some species, where the shell is exceptionally thin, septa appear to be unknown. Possibly in all these cases—certainly in *C. tenuis*—the shell remained open at the apex, and was fixed to some foreign body.

(6) *Orientation.*—In total ignorance of the nature of the soft parts of the animal, any distinction between dorsal and ventral sides must be merely an arbitrary one. Salter writes, in 1855[2]: "If we consider, as it seems to me we ought to do, that in this compressed species the two opposite angles of the flatter sides are the dorsal and ventral ones, we shall then, I think, have a character by which we may be able to trace these parts in the squarer species and in some which are probably compressed laterally. For I find that the line where the usual transverse ribs are bent or broken at about the middle of each lobe is not really in the middle in all cases, but is nearer the dorsal and ventral angles than the lateral ones; and again, the two lobes which form the dorsal side are sometimes wider than those two which form the ventral face."

But this attempt at orientation seems to me to be of little value. The "squarer species" are, in all cases which I have observed, symmetrical, and as the

[1] Ruedemann, 'American Geologist,' vol. xviii (1896), p. 65; Sowerby, *loc. cit.* (1839); Hall, 'Palæont. New York,' vol. i (1847), p. 222, pl. lix, fig. 4 *e*.

[2] Sedgwick, 'Synopsis of Brit. Palæoz. Rocks,' Appendix A, p. v.

position of the shell in life was probably upright, it is difficult, without the soft parts, to distinguish dorsal and ventral sides. In describing the compressed forms I have used the terms "central" and "lateral" marginal grooves for the sake of convenience for expressing, respectively, those at the extremities of the short and long diameters of the cross-section.

(7) *Ornamentation.*—A small number of the earlier members of the genus have smooth shells, but the majority show a very delicate and beautiful ornamentation, differing greatly in different species, although usually constant for each species. Among British forms this ornamentation is essentially a transverse one, though in some foreign species a longitudinal direction prevails (*e. g. C. scalaris*, Holm).

Each face is typically crossed by a series of ridges, separated by furrows, and bent up regularly along a central or subcentral line, so as to form a succession of chevrons opening towards the apex. The angle of the chevron varies from 180° to little over 90°. Very usually the angle increases in size from the apex towards the aperture, but in any one species is fairly constant for the central part of the shell. The straight sides of the chevron may be replaced by simple or compound curves. The two sides of the chevron are symmetrical in those species having a square cross-section (Pl. III, fig. 9 *a*), but where a compressed form is the natural one the ridges very frequently fall away more sharply to the lateral than to the central marginal grooves. With this character is often found a shifting of the points of the chevrons towards the central marginal groove (Pl. V, figs. 1 *a*, 7 *a*). These features often afford a clue to the natural cross-section, when the latter cannot be directly observed. The ridges vary in width from coarse bars, nearly 1 mm. wide, as seen in *C. crassa* (Pl. IV, fig. 4 *a*), to the finest striæ, invisible except under the microscope, as in *C. microscopica* (Pl. II, fig. 9). In an individual example the ridges usually become finer and more crowded at the apex, and often again at the aperture, but for the centre of the shell a fairly constant spacing is maintained in any one species.

The details of ornamentation vary enormously. The ridges are sometimes quite smooth, but more frequently the summits are studded with fine tubercles, round, or less commonly elongated, triangular, etc. The tubercles may be prolonged as fine points on to the intervening furrow, as in *C. hispida* (Pl. III, figs. 9 *b*, 11); or may be confined to the ridges, as in *C. globosa* (Pl. III, fig. 7 *a*). In a considerable number of species a well-marked longitudinal striation is seen in the furrows between the ridges; this is usually finer than the main transverse ridging (Pl. V, figs. 2 *a*, 12 *b*).

In a few cases the transverse ridges are represented by rows of tubercles, arranged regularly across the shell, as in *C. aspersa* and *C. punctata* (Pl. I, figs. 7, 8 *b*, 9 *a*, 12 *a*).

(8) *Structure of the Shell.*—The shell in the British species is always very thin, rarely exceeding 1 mm. in thickness, and often very much less. It appears to

have consisted essentially of some chitinous material, impregnated sometimes with a certain amount of lime. In the greater number of species the shell is made up of two distinct layers; the outer is usually dark-coloured, semi-transparent, and highly ornamented; the inner is of a paler colour, more opaque, thinner, and nearly smooth (Plate V, fig. 10 *b*). In such transverse sections as I have been able to obtain this division is not well marked, but the two layers are often clearly seen where the outer is partially flaked off. In some species where the shell is exceptionally thin it is apparently quite homogeneous. The structure of the shell is best seen in some specimens of *C. quadrisulcata* from the ironstone nodules of the Coal Measures.

(9) *Preservation of the Shell.*—The shells are preserved in limestones, sandstones, shales, slates, and ironstone nodules. They are always liable to compression, the result being in some cases actual contact between the upper and under faces. When the specimens are large they are seldom perfect, the apertural part being broken away more often even than the apical portion. Frequently also only one or two faces are preserved. Sometimes the different layers of the shell are seen in an excellent state of preservation, especially in specimens from the ironstone nodules; but more often the outer layer is considerably damaged, and along the summits of the ridges the shell may be entirely gone, little isolated portions remaining in the furrows (Pl. III, fig. 4 *b*). Lastly, in a large number of cases no shell is preserved, and the fossil is in the form of either an external or an internal cast.

DISTRIBUTION OF THE GENUS.

Conularia, though never really common, is found distributed through the British rocks from the Upper Cambrian to the Upper Carboniferous. During this period the maximum development was reached in Middle and Upper Ordovician and Silurian times, when twenty-two out of the thirty British species occurred. Above this horizon the number of species diminishes, five appearing in the Carboniferous rocks, only one of which survives in Upper Carboniferous times. Examples are found in the Budleigh Salterton Pebble Bed, but these are all derived. [See Table on p. 10.]

ZOOLOGICAL AFFINITIES.

The position in the animal kingdom in which the genus *Conularia* should be placed, has been a subject of contention from the time when Sowerby wrote, in 1821, that "it may perhaps belong to that family of Lamarck's order of shelly animals—'Crassipedes'—which inhabit tubes, and contains *Teredo* and some other tubiform shells, whose tubes are sometimes jointed."[1] Very soon after this, and

[1] Sowerby, 'Min. Conch.,' vol. iii (1821), p. 107.

TABLE OF DISTRIBUTION OF BRITISH SPECIES.

Species.	Tremadoc.	Ordovician.			Silurian.			Devonian.	Lower Carboniferous.	Upper Carboniferous.
		Arenig.	Llandeilo.	Bala.	Llandovery.	Wenlock.	Ludlow.			
Conularia homfrayi, Salt.	×	...	...	...	...	...	...	...	...	...
„ *llanvirnensis*, Hicks	...	×	×	...	...	...	...	...	...	...
„ *corium*, Salt.	...	...	×	...	...	...	...	...	...	...
„ *linnarssoni*, Holm.	...	...	×	...	...	...	...	...	...	...
„ sp. (*margaritifera?*)	...	...	×	...	...	...	...	...	...	...
„ *coronata*, n. sp.	...	...	×	...	...	...	...	...	...	...
„ sp.	...	...	×	...	...	...	...	...	...	...
„ sp.	...	...	×	...	...	...	...	...	...	...
„ *elongata*, Portl.	...	...	...	×	...	...	...	...	...	...
„ *lævigata*, Salt.	...	...	...	×	...	...	...	...	...	...
„ *plicata*, n. sp.	...	...	...	×	...	...	...	...	...	...
„ *planiseptata*, n. sp.	...	...	...	×	×	...	...	...	...	...
„ *vesicularis*, n. sp.	...	...	...	×	...	...	...	...	...	...
„ *hispida*, n. sp.	...	...	...	×	...	×	...	...	...	...
„ sp., cf. *aspersa*	...	...	...	×	...	...	...	...	...	...
„ *punctata*, n. sp.	...	...	...	...	×	...	...	...	...	...
„ *sowerbyi*, de Vern.	...	...	...	×	×	×	...	...	...	...
„ *breviconventa*, n. sp.	...	...	...	...	...	×	...	...	...	...
„ *triangularis*, n. sp.	...	...	...	...	...	×	...	...	...	...
„ *crassa*, n. sp.	...	...	...	...	...	×	...	...	...	...
„ *microscopica*, n. sp.	...	...	...	...	...	×	...	...	...	...
„ sp.	...	...	...	...	...	×	...	...	...	...
„ *aspersa*, Lindstr.	...	...	...	...	...	...	×	...	...	...
„ *subtilis*, Salt.	...	...	...	...	...	...	×	...	...	...
„ *hastata*, n. sp.	...	...	...	...	...	...	×	...	...	...
„ *deflexicosta*, Sandb.?	...	...	...	...	...	...	...	×	...	...
„ *quadrisulcata*, Sow.	...	...	...	...	...	...	...	×	×	×
„ *complanata*, n. sp.	...	...	...	...	...	...	...	? ×	×	...
„ *elegans*, n. sp.	...	...	...	...	...	...	...	...	×	...
„ *tenuis*, n. sp.	...	...	...	...	...	...	...	...	×	...
„ *globosa*, n. sp.	...	...	...	...	...	...	...	...	×	...

until 1842, the genus was generally associated with the Cephalopods, but in that year the Pteropodian nature of the shell was suggested by d'Archiac and de Verneuil,[1] although no reasons were given for this opinion. From that time forward we generally find *Conularia* styled a "Palæozoic Pteropod," de Koninck, Sandberger, Bronn, Roemer, d'Orbigny, M'Coy, Eichwald, Barrande, and most other writers adopting this view. A few authors—Portlock, Geinitz, and Dana—still retained *Conularia* among the Cephalopods, Dana considering it to be the shell of a Dibranch Cephalopod. The question was not, however, allowed to rest for long. Opponents to the Pteropodian theory soon appeared: Haeckel[2] considered it most improbable, and Dr. M. Neumayr[3] refuted it in the strongest terms. He expressed the greatest

[1] 'Trans. Geol. Soc.,' [2], vol. vi, p. 325.

[2] E. Haeckel, 'Morphologie,' vol. ii, p. 113.

[3] M. Neumayr, "Zur Kenntniss der Fauna des untersten Lias in den Nordalpen," 'Abhandl. k. k. geol. Reichsanst.,' vol. vii, pt. 5 (1874), p. 18.

surprise that a theory, not possessing even the appearance of probability, should have been accepted as a fact without any kind of proof. He considered the determination of the systematic position of *Conularia* to be a matter of great difficulty, but suggested that it is most probably allied to the Palæozoic Capulidæ.

In 1881 von Ihering[1] placed *Conularia* with the other so-called Palæozoic Pteropods in the class with which it was first associated. He considered that these simple chambered shells constitute the earliest and most primitive group of Cephalopods, allied to the Orthoceratidæ, and named by him, on account of the thinness of the shell, "Leptoceratiten." From this group, according to von Ihering, arise on the one side the Tetrabranchs as a small offshoot, and on the other the Dibranchs (in which he included the Ammonites) as the main branch.

Lindström,[2] in 1884, criticised these conclusions. He stated that in his opinion the external similarity of some species of *Clio* (or *Cliodora*) to a Conularian shell was most striking; that the internal longitudinal septa found in a few species (*e. g. C. aspersa*) were homologous to similar structures found in *Clio*, *Styliola*, etc; that the typical ornamentation of a Conularian was approached in some species of *Clio*; and finally, that among living Pteropods forms differed sufficiently widely to make any discussion of close correspondence unnecessary. He therefore retained the genus with the Pteropods.

In 1889 Pelseneer[3] endeavoured to prove that the "Prétendus Ptéropodes Primaires" had no connection with the modern Pteropods. He based his conclusions on: (1) The form and character of the Conularian shell, and (2) the probable origin of the Pteropods. Although his arguments were answered, each in turn, by C. Wiman[4] in 1894, it appears to me that his deductions as to the affinities of modern Pteropods cannot be refuted.[5]

After prolonged study Pelseneer has come to the conclusion that the Pteropods are not a primitive, but a highly specialised group, derived from two different sources: (1) the Thecosomatous Pteropods (with which *Conularia* was associated) from Bulloidea-like Opisthobranchs, and (2) the Gymnosomatous Pteropods from Aplysioidea-like Opisthobranchs.

The evidence for the highly specialised nature of the Pteropods is seen in their marked asymmetry, and the great concentration of their nervous system; and in their embryology. As the embryo is even more asymmetrical than the adult, they must be derived from ancestors already highly specialised, and the apparent symmetry is acquired by adaptation to natatory habits.

[1] H. von Ihering, 'Neues Jahrb. für Min., etc.' (1881), vol. i, p. 87.

[2] G. Lindström, 'Silur. Gastrop. and Pterop. of Gotland' (1884), pp. 39, 40.

[3] P. Pelseneer, 'Bull. Soc. Belge de Géol., etc.,' vol. iii (1889), Mem., pp. 126—136.

[4] C. Wiman, 'Bull. Geol. Inst. Upsala,' vol. ii (1895), pp. 114—116.

[5] See also Pelseneer, 'Rep. Challenger Expedition,' vol. xxiii, pt. iii (Anatomy), pp. 75—96.

Pelseneer, therefore, has given up entirely the use of the term "Pteropoda"[1] in zoological nomenclature, and has included the three families of "Thecosomatous Pteropods," with a number of other Gastropod families, in his *Tribe* Bullomorpha, *Sub-order* Tectibranchiata, *Order* Opisthobranchiata.

This consignment of the Pteropods to the Opisthobranch Gastropods (themselves highly specialised members of the class) makes it impossible to regard them as a primitive group represented in the earliest Palæozoic rocks. It appears, therefore, that on zoological evidence the inclusion of *Conularia* among the Pteropods must be abandoned.

But the conclusion that *Conularia* is not a Pteropod, does little to facilitate the assignment to its natural position. In considering the question attention may be drawn to the following characters of the shell, which appear to be beyond doubt:

(1) The shell in many cases reached a length of between 100 and 200 mm.

(2) The shell was in most cases very thin, and usually consisted of at least two distinct layers.

(3) In at least one species the apical end of the shell was open, and organic attachment to foreign bodies was thus effected.

(4) In the larger number of species the apical part of the shell was divided up by thin imperforate septa, and the sharply pointed apex was very probably cast during lifetime.

(5) The aperture of the shell was partially closed by infolding lobes.

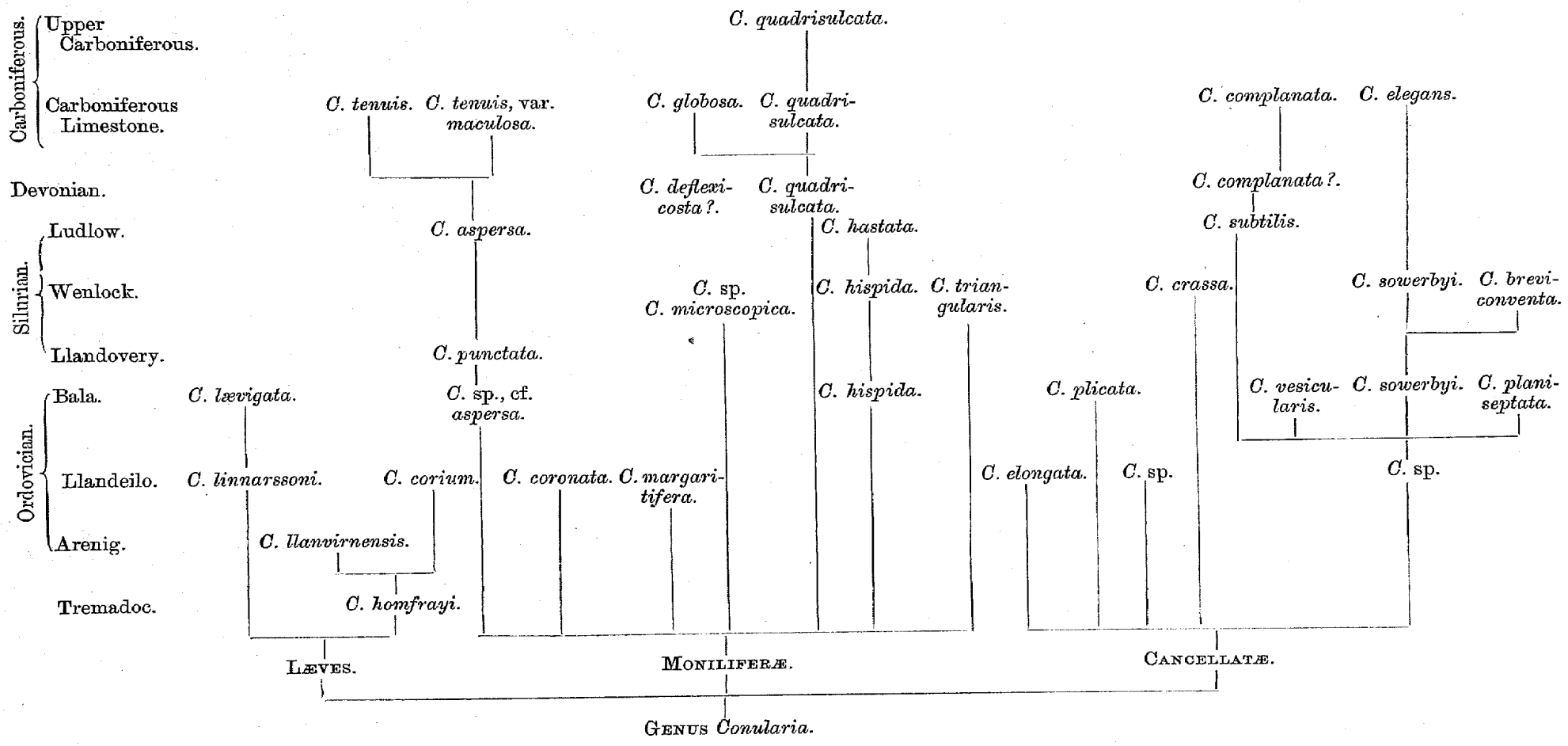
These peculiar and varied characters seem to indicate that *Conularia* is a Mollusc, but do not point to a close relationship with any of the main groups. It appears to resemble the primitive Cephalopods more closely than any other forms, and perhaps we should follow von Ihering in placing the genus in this group. But the differences between it and the earliest Orthoceratidæ are so great that I should prefer to regard *Conularia* as a member of an extinct group, equivalent to the Cephalopods, and derived with them from the same simple shelled ancestor.

CLASSIFICATION.

I have adopted Holm's method of classification as being useful, although perhaps it is not of much value phylogenetically. The method is not altogether satisfactory, as in following it some species which are probably closely allied appear in altogether different sections. For instance, *C. elongata*, in the broad, rounded, and horizontal transverse ridges, resembles *C. linnarssoni*, but by virtue of the sharper definition of these and the fine longitudinal ornamentation it must be placed with the *Cancellatæ*, not with *Læves*. Again, no hard and fast line can be drawn between the *Moniliferæ* and the *Cancellatæ*, *C. crassa*, *C. plicata*, etc., forming a transition beween the two. Holm's section, *Longitudinales*, is unrepresented in British rocks.

[1] E. R. Lankester, 'Treatise on Zoology,' pt. v, Mollusca by Pelseneer (1906).

Table of Distribution of British Species of Conularia arranged according to Holm's Classification.



SYSTEMATIC ACCOUNT OF BRITISH SPECIES.

Family CONULARIIDÆ.

Genus **CONULARIA**, Sowerby 1818 [ex Miller MS.]

Diagnosis.—Shell a four-sided, elongated pyramid—nearly always straight. Cross-section a square, rhomb, rectangle or rhomboid, or the corresponding figures where the straight lines are replaced by curves. Faces of the pyramid flat, convex or concave; all equal or equal only in opposite pairs. Angles of the pyramid marked by straight grooves. Aperture partially closed by infolding lobes, apex sharply tapering; apical part of shell divided up into a few compartments by thin convex, probably imperforate septa. Shell smooth, or ornamented with a series of ridges, sometimes longitudinal, more often transverse. Shell very thin, formed of chitin, more or less impregnated with lime.

Section I.—LÆVES.

Shell without transverse ornamentation, except growth-lines.

(A) Shell large, very thin; marginal and facial grooves well marked; growth-lines irregular and often imperceptible.

(i) Shell smooth, except for a single ridge down the centre of the face. *C. llanvirnensis*, Hicks.

(ii) Shell with a well-marked central facial groove, flanked by two very faint secondary grooves; tapering of shell very gradual. *C. corium*, Salter.

(iii) Marginal and central facial grooves bounded by prominent edges; tapering of shell more rapid. *C. homfrayi*, Salter.

(B) Shell small; growth-lines strongly marked.

(i) Marginal and central facial grooves strongly marked and usually with prominent edges. Growth-lines horizontal. *C. linnarssoni*, Holm.

(ii) Facial grooves absent; growth-lines gently arched across the face. *C. lævigata*, Salter.

Conularia llanvirnensis, Hicks.

1875. *Conularia llanvirnensis*, H. Hicks, Quart. Journ. Geol. Soc., vol. xxxi, p. 189, pl. xi, figs. 5, 6.

Diagnosis.—Shell large, very thin, tapering uniformly; cross-section unknown. Faces flat, apical angle of face 5°—6°. Marginal groove unknown; strong central

ridge (?). Aperture unknown; apex pointed; apical septa unknown. Ornamentation absent; lines of growth indistinct.

Dimensions.—Length 150—180 mm. Width of face 30 mm.

Description.—This shell is found in a bad state of preservation in the Upper Arenig and Lower Llandeilo rocks of South Wales. It seems to be of a somewhat doubtful nature. The "strong central ridge," mentioned by Hicks, is only occasionally seen, and then appears to be merely a line of weakness, along which the shell has yielded. There seem, indeed, to be few characters in proof of its generic position, and those features by which it is distinguished from *C. corium* are of a negative kind. However, until better specimens are obtained, which may prove or disprove its right to specific distinction, I have retained *C. llanvirnensis* as a separate species.

Horizon and Locality.—Upper Arenig: Llanvirn.

Type.—Sedgwick Museum, Cambridge (reg. nos. 19, 20).

Conularia corium, Salter.

1866. *Conularia corium,* J. W. Salter, in Ramsay's Geol. N. Wales, Mem. Geol. Surv., vol. iii, ed. 1, p. 355, pl. xi A, fig. 11 (also ed. 2, 1881, p. 563).

Diagnosis.—Shell large, very thin, tapering uniformly; cross-section unknown. Faces equal, slightly convex apically, concave aperturally; apical angle 4°—5°. Marginal grooves narrow and straight, tending to become prominent towards the aperture. Central facial grooves well marked; secondary grooves on either side faint, converging slowly. Aperture, apex, and apical septa unknown. Ornamentation absent.

Dimensions.—Length about 250 mm. (?) Width of face over 30 mm.

Description.—This species was described by Salter in 1866, and still at the present time very few examples are known. Hence little can be added to his description. No specimen that I have seen, is nearly perfect, and all are badly preserved. The secondary facial grooves, about 7 mm. apart at the apertural end, slowly approach one another towards the apex. They are very faint along their whole course, and die away before reaching the apex.

Affinities.—Salter compared this species with *C. pyramidata* of the May Sandstone (Ordovician), but it differs from this in having the faces equal, a smaller apical angle, and a smooth shell. Of British species, it is undoubtedly closely allied to *C. homfrayi,* from which it is distinguished by the slow rate of tapering and the simple nature of the marginal and central grooves.

Horizon and Locality.—Lower Llandeilo; Tyobry, Penrhyn.

Type.—Museum of Practical Geology (reg. nos. 16173, 16174).

Conularia homfrayi, Salter.

1866. *Conularia homfrayi,* J. W. Salter, in Ramsay's Geol. N. Wales, Mem. Geol. Surv., vol. iii, ed. 1, p. 354, pl. x, figs. 11—13 (also ed. 2, 1881, p. 562).

Diagnosis.—Shell large, thin, tapering uniformly; cross-section unknown. Faces flat, apical angle 7°—10° (?). Marginal grooves well marked, edges prominent. Central facial grooves strong, with prominent edges, and flanked by faint secondary grooves. Aperture imperfectly preserved, lobes apparently blunt and not inflected; apex sharply pointed; septa unknown. Ornamentation absent.

Dimensions.—Length 110 mm. Width of face 25 mm.

Description.—This species is represented by fairly numerous examples, but most are fragmentary and imperfectly preserved. The rocks in which they occur have usually undergone cleavage, and the fossils are sometimes broadened and sometimes greatly drawn out, so that the apical angle of the face cannot be relied on as representing the true angle. The facial ridges and grooves are also difficult to make out for the same reason. The central groove is quite definite, and there appears to be a faint groove close to it on each side.

Affinities.—This, the earliest of British *Conulariæ,* is most nearly allied to *C. corium,* which is found at a slightly higher horizon. It is distinguished from the latter by its smaller size, more rapid tapering, and by the raised edges of the marginal and central grooves.

Horizon and Localities.—Upper Tremadoc: Garth Hill; Tu-hwnt-yr-bwlch; etc.

Type.—Sedgwick Museum, Cambridge (reg. no. 7).

Conularia linnarssoni, Holm. Plate I, figs. 1—4.

1843. *Conularia quadrisulcata,* var. Silurian, J. Portlock, Rept. Geol. Londonderry, p. 393, pl. xxix A, fig. 3.

1893. *Conularia linnarssoni,* G. Holm, Hyolithidæ och Conulariidæ, p. 130, pl. iv, figs. 38—40.

Diagnosis.—Shell small, tapering uniformly; cross section-square. Faces equal, flat, apical angle 16°—20°. Marginal grooves well marked, base rounded, edges smooth and prominent. Facial grooves strong, central; edges sometimes prominent. Aperture unknown; apex sharply pointed; apical septa unknown. Ornamentation absent. Growth-lines strongly marked, regular, horizontal, ending abruptly on either side of the marginal groove, leaving a smooth edge; at the central grooves replaced by fine striæ, bent down towards the apex, and meeting at an angle at base of the groove. Occasionally the growth-lines are hardly visible, and the shell is then quite smooth.

Dimensions.—Length, 50—60 mm. Width of face, 15 mm.

Description.—This species was instituted by Holm for the reception of a small specimen from the Chasmopskalk (= Llandeilo) of Ålleberg, Vestergötland. Its existence in Britain has not, until now, been recorded, but there are nearly thirty examples in Mrs. Gray's Girvan Collection. Portlock's *C. quadrisulcata*, var. Silurian (Mus. Pract. Geol., reg. no. 12645), is also, undoubtedly, an example of this species, which is therefore represented in both Scotland and Ireland.

Some of the Scottish specimens are quite well preserved; most are flattened, but one (Pl. I, fig. 1), shows approximately a square cross-section, and this is probably the natural form, though Holm's type from Ålleberg is slightly compressed. In the latter specimen also there appears to be a slight inequality between the pairs of faces, but this is not noticeable in the British forms. In close juxtaposition with the examples from Craighead there occur, in more than one case, rods covered with a shell exactly similar to that of the *Conulariæ*, and tapering from a width of 3 mm. to that of 1 mm. I have seen none actually attached to the *Conularia*, but I think it highly probable that they constitute the apical end of the shell, which was drawn out to a considerable length, and was probably attached to some foreign substance. The longest has a length of 25 mm.

Affinities.—This species is quite different from any other British form. It resembles, in some characters, the Swedish *C. lævis* (Lindström), but is readily distinguished by the horizontal growth-lines.

Horizon and Locality.—Llandeilo: Craighead, Ardmillan, and Balcletchie, Girvan. Lower Silurian: Desertcreat, Co. Tyrone.

Type.—Geological Survey Collection, Stockholm.

Conularia lævigata, Salter.

1866. *Conularia lævigata*, J. W. Salter, in Ramsay's Geol. N. Wales, Mem. Geol. Surv., vol. iii, ed. 1, p. 354, woodc. 19 (also ed. 2, 1881, p. 562).

Diagnosis.—Shell small, tapering uniformly; cross-section rhombic (?). The faces meeting at one acute angle slightly smaller than the other pair; slightly convex apically and concave aperturally; apical angle 7°—8°. Marginal grooves shallow, rounded; facial grooves absent. Aperture, apex, and apical septa unknown. Ornamentation absent, except for gently curved irregular lines of growth.

Dimensions.—Length 40—50 mm. Width of face 14—15 mm.

Description.—Only the type specimen of this species is known. It is somewhat doubtful whether the inequality of the sides referred to by Salter is not due to accident, and the course of the growth-lines (*i. e.* rising to a maximum at the angle where the smaller sides meet) may also be a secondary character.

Affinities.—This species differs from the other smooth types in the absence of

facial grooves and in the course of the growth-lines. It is possible, in the absence of any other examples, that the specimen should be regarded as an ornamented shell, which is smooth as the result of bad preservation.

Horizon and Locality.—Caradoc: Llwyn-yr-hwch, Beddgelert, N. Wales.

Type.—Museum of Practical Geology (reg. no. 12657).

Section II.—MONILIFERÆ.

Ornamentation consisting exclusively of transverse ridges or of tubercles arranged in transverse rows, without finer longitudinal ridges.

(A) Internal raised longitudinal ribs ("septa" of Lindström, *loc. cit.*) present down the centre of each face.

(*a*) Ornamentation extremely fine; hardly visible without a lens.

(i) Septa in pairs down the centre of each face. Faces equal. Tubercles round and distinct. *C. aspersa*, Lindström.

(ii) Septa in pairs down the centre of each face. Faces equal in opposite pairs. Tubercles more or less confluent in longitudinal rows. *C. punctata*, sp. nov.

(iii) Septa in pairs down the centre of each face, and also singly at the angles of the pyramid (?). *C.* sp. cf. *aspersa*.

(*b*) Ornamentation coarse. Septa singly down the centre of each face.

(i) Transverse ridges quite smooth. *C. tenuis*, sp. nov.

(ii) Ridges finely tuberculated. *C. tenuis*, var. *maculosa*.

(B) No internal longitudinal ribs present.

(*a*) Ornamentation very fine, just visible to the naked eye or only visible with a lens.

(†) Marginal and facial grooves with prominent edges.

(i) Shell large; ridges fine and regular, festooned across each half face. *C. coronata*, sp. nov.

(ii) Shell small; ridges form a sigmoidal curve from the facial groove down to the marginal groove. *C.* sp. (*margaritifera ?*).

(††) Marginal and facial grooves simple.

(i) Shell small; ornamentation only seen under microscope. *C. microscopica*, sp. nov.

(ii) Shell small; ornamentation just visible to naked eye. *C.* sp.

(*b*) Ornamentation visible to naked eye.

(†) Tubercles round; confined to the ridges.

(i) Ridges coarse, turning up at an angle in the marginal grooves; faces flat. *C. quadrisulcata*, Sowerby.

(ii) Ridges fine, turning up at an angle in the marginal groove, and curving across the face. *C. deflexicosta*, Sandberger.

(iii) Ridges fine and closely packed; faces convex. *C. globosa*, sp. nov.

(††) Tubercles prolonged as sharp projections on to the furrow above.

(i) Tubercles oval; projections fine, curving, hair-like, and irregular in length. *C. hispida*, sp. nov.

(ii) Tubercles short, blunt, triangular. Ridges fine, and closely packed. *C. triangularis*, sp. nov.

(iii) Tubercles prolonged upwards as sharp, straight lamellæ, extending nearly across the furrow. *C. hastata*, sp. nov.

Conularia aspersa, Lindström. Plate I, figs. 5—9.

1873. *Conularia bifasciata*, J. W. Salter, Catal. Cambr. Silur. Foss. Woodw. Mus., p. 171 (*a*. 926).
1884. *Conularia aspersa*, G. Lindström, Silur. Gastrop. Gotland, p. 46.
1902. *Conularia bifasciata*, F. R. C. Reed, Geol. Mag. [4], vol. ix, p. 123.

Diagnosis.—Shell large, very thin; tapering uniformly. Cross-section probably square. Faces equal, flat; apical angle about 20°. Marginal grooves shallow, inconspicuous; central facial groove faint and inconstant, flanked by a pair of fine internal ribs, converging from 3 mm. to less than ·25 mm. at the apex, marked on the exterior by fine black lines. Aperture nearly closed by four triangular lobes, forming an elevated cone; apex sharply pointed; apical septa unknown. Ornamentation inconspicuous; ridges fine, closely packed (40—100 in 5 mm.); arched gently across each face, meeting at a wide angle and without break in the marginal grooves and undisturbed by the central ribs; studded with small round tubercles. Furrows smooth. Growth-lines follow the course of the ridges.

Dimensions.—Length at least 120 mm. Width of face, 35 mm.

Description.—The British species, which is common in the Lower Ludlow Flags of Shropshire, is undoubtedly the same as the species from Gotland described by Lindström (Pl. I. fig. 8 *a*). I have examined a large number of the Swedish forms, and find that they are quite indistinguishable from the British specimens, except for the fact that as a rule the ornamentation is better preserved. Salter's name, *bifasciata*, is the earlier, but in the 'Catal. Cambr. and Silur. Foss.' no description or figure is given, so that it can only be regarded as a MS. name and Lindström's name, *aspersa*, must be adopted.

The "internal septa" of Lindström are well seen in almost every example,

appearing either as black lines, flush with the surface, or as shelly ridges, rendered prominent on the outside by the compression of the shell. Often the shell is entirely flattened, so that the "septa" from the under faces are seen through the shell of the upper face (Pl. I, fig. 6 *a*).

The ornamentation varies considerably, both in coarseness and in the arrangement of the tubercles. The transverse ridges may be only about 40 per 5 mm., or may be as many as 100. Again the same variety in arrangement is seen as is described by Lindström for *C. bilineata*—*i. e.* the tubercles are sometimes close together, forming a very definite tuberculated ridge (Pl. I, fig. 6 *c*), while in other cases they are about equally spaced, laterally and vertically, and the actual ridges are hardly seen (Pl. I, fig. 7); again, in the same specimen the tubercles are sometimes round, sometimes distinctly elongated (Pl. I, fig. 9 *c*).

Affinities.—This species, together with *C. punctata* and *C.* sp. cf. *aspersa*, form a well-defined group, characterised by the presence of the paired "septa." They are readily distinguished by this from all other forms, and are possibly related to *C. tenuis* from the Carboniferous rocks, which shows the single central "septum." The type of ornamentation is that seen in *C. exquisita*, Barrande.

Horizon and Locality.—Lower Ludlow Shales: Church Hill, Leintwardine; Bow Bridge, etc. Silurian: Gotland.

Type.—Vetenskaps Akademi, Stockholm.

Conularia punctata, sp. nov. Plate I, figs. 10—12.

Diagnosis.—Shell of medium size, moderately thick, tapering uniformly. Cross-section oblong, with the shorter diameter four-fifths of the longer. Faces equal in pairs, flat; apical angles about 14° and 10° respectively (?). Marginal grooves wide and shallow; centre of face marked by a pair of internal ribs converging towards the apex. Aperture, apex, and apical septa unknown. Ornamentation inconspicuous; ridges fine, closely packed (40 in 5 mm. in adult shell), arched across the face, and undisturbed by the central ribs; studded with small tubercles which tend to blend with those above and below, giving rise to vertical as well as transverse striation. Furrows very narrow.

Dimensions.—Length of one incomplete portion, 50 mm. Width of face, 32 mm.

Description.—There are only four examples of this species, all in Mrs. Gray's collection of Girvan fossils, and none are perfect. One small example (Pl. I, fig. 10 *a*) shows four faces at right angles to one another, and one pair appear to be distinctly shorter than the other pair (Pl. I, fig. 10 *b*). This is the only specimen in which the cross-section can be directly ascertained, and this may be misleading, as the preservation is not good. The longitudinal "septa" are well seen, both as black lines on the exterior (Pl. I, fig. 10 *a*), and as projecting ribs on the inner face (Pl. I, fig. 11). They appear to be solid cores between the two

layers of the shell, ridging up the inner layer only (Pl. I, fig. 11). The ornamentation appears to be almost intermediate between that of *C. aspersa*, Lindström, and that of *C. curta*, Sandberger. In the young shell the longitudinal ridges are almost stronger than the transverse (Pl. I, fig. 10 *c*), but in the adult both are equally strong (Pl. I, figs. 12 *a*, 12 *b*). The furrows are only fine grooves between neighbouring ridges. The shell is fairly thick, and consists of two distinct layers.

Affinities.—This species is closely related to *C.* sp. cf. *aspersa* from the Bala, and to *C. aspersa* from the Ludlow. It is distinguished from both by the form of the transverse section, by the small angles of the faces, and by the ornamentation.

Horizon and Locality.—Middle and Upper Llandovery: Woodland Point and Penkill, Girvan.

Type.—Mrs. Gray's Collection.

Conularia sp. cf. **aspersa**, Lindström. Plate I, figs. 13—14.

In the highest Bala rocks of Thraive Glen, Girvan, and at the same horizon at Horderley, incomplete fragments of a Conularian are found. Although specimens are fairly numerous, only one (Pl. I, fig. 13) gives any detail of the form of the shell. This specimen, so far as can be ascertained, is the external cast of one face, which tapers uniformly at an angle of about 25°. The internal longitudinal "septa," so characteristic of *C. aspersa*, are also found here, and from the figured specimen appear to be present, not only in pairs down the centres of the faces, but also at the angles of the pyramid (Pl. I, fig. 13 *a*). This appearance may, however, be misleading, and cannot be confirmed from other specimens, as these, though showing the septa, are all very incomplete and broken. No shell is preserved, but the ornamentation is well seen in the casts, and closely resembles that of *C. aspersa* (Pl. I, fig. 13 *b*). It varies much in coarseness with the size of the shell (*cf.* Pl. I, figs. 13 *b* and 14 *a*). This species is closely allied to *C. punctata* and to *C. aspersa*, from both of which it may provisionally be distinguished by the presence of the "septa" at the angles of the pyramid.

The figured specimen is in Mrs. Gray's Collection, and comes from the Starfish Bed, Girvan.

Conularia tenuis, sp. nov. Plate II, figs. 1—3.

1878. *Conularia*, sp. ind., R. Etheridge, jun., Quart. Journ. Geol. Soc., vol. xxxiv, p. 19.

Diagnosis.—Shell large, very thin, tapering uniformly; cross-section square. Faces equal, flat; apical angle 10°—14°. Marginal grooves shallow and incon-

spicuous; centre of face marked by a conspicuous longitudinal internal "septum." Aperture slightly contracted; lobes broad and rounded; apex tapers to a sharp point; apical septa unknown. Ornamentation highly characteristic. Ridges fine, perfectly smooth, well spaced (5—6 in 5 mm.), forming an average angle of 132° along the central rib. Furrows smooth or irregularly wrinkled.

Dimensions.—Length at least 180 mm. Greatest width of face seen, 20 mm.

Description.—It is certainly this species to which R. Etheridge refers, *loc. cit.*, but his specimens seem to have been very fragmentary, and he therefore gave no name and no figure. Over seventy specimens have come under my notice, and the species seems to be one of the best marked as well as one of the most interesting known. At present it has only been found in the dark grey cement stone in the Lower Carboniferous of Scotland, where it is always completely flattened. From the equality of the faces, and the symmetry between the halves of each face, it may be inferred that the cross-section was square. The most characteristic feature of the shell is the strong median rib which is seen down the centre of each face. This rib is of the same nature as the internal "septum" seen in *C. aspersa*, but as the shells are always flattened, the rib becomes conspicuous upon the outer surface. More often than not a complicated network is seen, for owing to the thinness of the shell and the compression which has occurred, the transverse and longitudinal ridges of the two under faces are also prominent upon the outer surface (Pl. II, fig. 2). The ridges are smooth, glossy, and rounded, and are generally well preserved. In the furrows the very thin shell is often seen to be wrinkled (Pl. II, fig. 3).

The most remarkable feature of this species is the close association of several individuals, which has not, to my knowledge, been recorded for any other species. Pl. II, fig. 1, shows at least sixteen specimens of varying sizes, attached at their apices, and radiating from a centre. This is the most nearly perfect, though not the only example, I have seen. In the British Museum (Nat. Hist.) is a slab with three large specimens and a fourth fragment radiating from a centre (no. G. 17662) and another with at least seven small individuals showing radial arrangement (no. 17664). There is no sign of specialisation among the individuals, and the arrangement was, therefore, probably not of the nature of a true colony, but merely an association of separate individuals.

Affinities.—This species is quite unlike any other, owing to the thinness of the shell, the central internal longitudinal rib, and the smoothness of the transverse ridges. It is possibly allied to *C. aspersa.*

Horizon and Localities.—Calciferous Sandstone: Glencartholm, Eskdale; Water of Leith; Woodhall Mill.

Type.—Geological Survey Museum, Edinburgh.

Conularia tenuis, var. **maculosa**, nov. Plate II, fig. 4.

Five specimens of the seventy-two which I have examined differ from the majority in having the ridges slightly wider, and their summits ornamented with a row of small round tubercles (Pl. II, fig. 4). The latter are exceedingly well marked over the whole of the shell in the specimens in which they occur, and as in the common type there is not the least trace of tuberculation, these few examples constitute a well-marked variety. In all other characters they agree with the normal type, except, perhaps, that the ridges form a curve across the face rather than a sharp angle along the central ridge; but this difference is not strongly marked.

Conularia coronata, sp. nov. Plate III, fig. 1.

Diagnosis.—Shell large, very thin, non-calcareous; tapering uniformly; cross-section a flattened rhomb (?); faces equal, flat; apical angle about 15°. Marginal grooves well defined; edges becoming prominent towards the aperture. Similar grooves with raised edges marking the centres of the faces; half-faces again subdivided by fine secondary grooves. Aperture unknown; apex pointed; apical septa not seen. Ornamentation inconspicuous—only seen with a lens. Ridges very fine, regular (75 in 5 mm.), forming a series of festoons across the face, rising irregularly at the marginal and central grooves, and falling in shallow arcs between; growth-lines following the course of the ridges. Ridges broken up by vertical striations; furrows smooth.

Dimensions.—Length of largest specimen (incomplete), 107 mm. Greatest width of face, 32 mm.

Description.—Only two examples of this species are known, and each shows a greatly crumpled and wrinkled surface, pointing to a very thin, probably non-calcareous test. Plate III, fig. 1, shows the more nearly perfect of the two, but this also has only three faces preserved, is greatly compressed, and slightly deformed, so that the cross-section is doubtful. The prominent raised edges of the marginal and central grooves, so well seen in this species, are of frequent occurrence among the earlier Conulariæ, but are never seen in the later forms. The fine and beautifully regular ornamentation is best seen on the raised edges of the grooves (Plate III, fig. 1 *b*), where the test is less wrinkled, but can be traced across the crumpled surface of each face. The course of the ridges is somewhat irregular; they rise at each marginal and central groove, but the height to which they rise and the sharpness of the curves formed vary considerably on the different faces. The ridges appear to be broken up by a very fine cross-striation, of which there is no trace in the furrows.

Affinities.—This species resembles the early smooth types superficially, but is

readily distinguished from them by the large angle and the fine and regular ornamentation. It comes very close to a Bohemian species, *C. insignis*, Barrande, from which it differs in having (1) a smaller apical angle, (2) a finer ornamentation, (3) more prominent marginal and facial grooves. It is also very like *C. sosia*, Barrande, but here again all the grooves are simple, and the course of the ridges is different.

Horizon and Localities.—Lower Llandeilo: Ritton Castle, Salop; Llandrindod, Radnorshire.

Type.—British Museum (Nat. Hist.) (reg. no. G. 17660).

Conularia sp. (*margaritifera*, Salter ?). Plate II, fig. 5.

(?) 1866. *Conularia margaritifera*, J. W. Salter, in Ramsay's Geol. N. Wales, Mem. Geol. Surv., vol. iii, ed. 1, p. 355, pl. xi *a*, fig. 12, and ed. 2 (1881), p. 563.

1906. *Conularia doveri*, J. Postlethwaite, Geol. English Lake District, ed. 2, p. 27, pl. v, fig. 16.

Diagnosis.—Shell small, tapering more rapidly towards the apex. Cross-section probably rhombic. Faces equal, flat; apical angle about 20°, nearer the aperture 14°. Marginal grooves well defined, of medium depth; facial grooves central, fine apically, broader and more prominent towards the aperture. Aperture unknown; apex sharply pointed; apical septa unknown. Ornamentation inconspicuous; ridges fine (30—50 in 5 mm.), tuberculated, forming a strongly sigmoidal curve across each half face; angle 120°—130°.

Dimensions.—Length probably about 40 mm. Width of face about 9 mm (?).

Description.—The specimen upon which Salter based the species *margaritifera* was described by him as "only a fragment of one segment." If, as I am inclined to believe, this fragment is only half the face, and the "sub-central sulcus" is the result of accident, the specimen from the Skiddaw Slates probably belongs to the same species; but more material is needed to prove the point. The latter is imperfect, but fairly well preserved, and shows well the fine sigmoidal ridges (Pl. II, fig. 5 *b*), and the marginal and facial grooves.

Affinities.—The species has, in common with *C. coronata*, the prominent grooves and fine curved ridges, but is readily distinguished by the smaller size, coarser ornamentation, and the direction of the ridges.

Horizons and Localities.—Skiddaw Slates: Brunstock Scar. (?) Llandeilo: Dow Hill, Girvan. Lower Llandeilo: Ty Obry.

Type.—Sedgwick Museum, Cambridge, and Museum of Practical Geology (reg. nos. 16175, 16176 ?).

Conularia microscopica, sp. nov. Plate II, figs. 6—9.

Diagnosis.—Shell very small, non-calcareous; tapering uniformly; cross-section square. Faces equal, flat; apical angle 10°—12°. Marginal grooves deep, well

defined; edges sharp and base rounded. Facial grooves deep, straight, central. Aperture unknown; apex sharply pointed; apical septa unknown. Ornamentation only seen under microscope. Ridges very fine and closely tuberculated (250—300 in 5 mm.), forming an angle of 145°—150° along the facial grooves, ceasing abruptly at the marginal grooves. Growth-lines following the same course as the ridges, and visible to the naked eye.

Dimensions.—Length, 20—30 mm. Greatest width of one face, 5 mm.

Description.—This small shell appears perfectly smooth when seen with the naked eye, but under high magnification the very fine, and often well preserved, ornamentation is well seen (Pl. II, fig. 9). The vertical striation, seen on the ridges, does not appear to extend to the furrows. The marginal and central grooves are quite smooth.

Affinities.—Some specimens of this shell might be mistaken for the smoother examples of *C. linnarssoni*, but under the microscope the ornamentation distinguishes it from that and all other forms. It is probably allied to *C. coronata*.

Horizon and Locality.—Wenlock Shale: Buildwas.

Type.—Museum of Practical Geology (reg. no. 12628).

Conularia sp. Plate II, fig. 10.

Diagnosis.—Shell small, tapering uniformly; cross-section square. Faces equal, flat; apical angle 15°. Marginal grooves well defined, rounded, fairly deep. Facial grooves central, fine. Aperture, apex, and apical septa unknown. Ornamentation inconspicuous; ridges fine and close (25 in 5 mm.) forming an angle of 130° along the facial groove. Ridges nearly as wide as the furrows; tuberculated; furrows smooth.

Dimensions.—Length, 25 mm.? Width of face, 7 mm.

Description.—There is only one example of this small form, and as the preservation is not very good, and only one complete face is seen, I have not named it as a separate species. The most marked characters are the square cross-section, rounded marginal grooves (Pl. II, fig. 10 *b*), and fine ridges symmetrically disposed along the facial grooves. The finer ornamentation is almost obliterated, but the ridges appear to be tuberculated (Pl. II, fig. 10 *c*).

Affinities.—This species is nearly allied to *C. microscopica*, from which it is distinguished by the much coarser ornamentation.

Horizon and Locality.—Wenlock Limestone: Ledbury.

Type.—British Museum (Nat. Hist.) (reg. no. G. 11798).

Conularia quadrisulcata, Sowerby. Plate III, figs. 2—6.

1821. *Conularia quadrisulcata*, Sowerby, Min. Conch., vol. iii, p. 107, pl. 260, figs. 5, 6.

1840. *Conularia quadrisulcata*, J. Prestwich, Trans. Geol. Soc. [2], vol. v, p. 442, pl. xl, fig. 2.

1843. *Conularia quadrisulcata*, J. Portlock, Rept. Geol. Londonderry, p. 393, pl. xxix A, figs. 4, 5.
1847. *Conularia tubericosta*, F. Sandberger, Neues Jahrb. für Mineral. etc., p. 21, pl. i, fig. 12.
1855. *Conularia quadrisulcata*, F. M'Coy in Sedgwick's Synops. Brit. Palæoz. Rocks, p. 520.
1873. *Conularia clavus*, J. W. Salter, Catal. Cambr. Silur. Foss. Woodw. Mus., p. 153.
1902. *Conularia clavus*, F. R. C. Reed, Geol. Mag. [4], vol. ix, p. 122.

Diagnosis.—Shell varies much in size and tapers uniformly; cross-section square. Faces equal, flat; apical angle about 14°. Marginal grooves well marked, with angular base and edges; facial grooves inconstant. Aperture partially closed by four short lobes bent down at right angles to the axis; apex sharply pointed; apical septa rarely seen, gently convex. Ornamentation increasing in coarseness with the increase in the size of the specimen. Ridges well defined; in medium-sized specimen (Pl. III, fig. 2) 8—10 in 5 mm.; forming an average angle of 140° across the face; studded with small round tubercles. Furrows smooth.

Dimensions.—The largest specimen is calculated to be over 200 mm. in length. Greatest width of face, 36 mm.

Description.—The name *quadrisulcata* was the first specific name given by Sowerby, and is generally recognised to have included more than one form from more than one horizon. In 1845 the name was restricted by de Verneuil to the Carboniferous form, and since that time it has been applied indiscriminately to most Carboniferous species; but even when restricted the species is a very variable one. The Coal Measure forms, from their state of preservation and general appearance, would seem to be quite distinct from the larger limestone specimens, but when details are preserved on the latter they are found to shade quite insensibly into the former. The size varies immensely; probably the smallest shells are not full grown. On the whole the Coal Measure examples are small, few exceeding a length of 60—70 mm., and none reaching the large size of the Carboniferous Limestone forms. The appearance of the ornamentation varies greatly according to the state of preservation. In specimens from a coarse limestone no shell is seen, and the ridges appear broad and rough, with only a faint indication of tuberculation (Pl. III, fig. 2), while specimens from the ironstone nodules of the Coal Measures show a delicate ornamentation beautifully preserved. In the latter two distinct layers of shell may be seen. The innermost is very thin, light-coloured, opaque, and little ornamented (Pl. III, fig. 4 *b*). Outside this is the thicker layer, which is most often seen, and which in the ironstone specimens is dark brown to black, semi-transparent, and with a resinous lustre. This, when perfectly preserved, shows beautiful rounded tubercles on the summits of the ridges, with tiny projections passing from them to the base of the ridge in the direction of the aperture; the furrows are quite smooth (Pl. III, fig. 5). Occasionally, as the result of secondary action, the furrows are thrown into a series of irregular interlocking folds or corrugations, which at times assume a more or less regular arrangement, giving the effect of a normal longitudinal striation

(observed in other species, but not so frequently). The arrangement of the ridges in the marginal groove is very characteristic; on the edges they turn up abruptly towards the aperture, and meet, or alternate, with those of the adjacent face at the base (Pl. III, fig. 2). Sometimes the ridges bifurcate on the edge.

Affinities.—This species is quite unlike any other British form. The coarser specimens from the limestone sometimes slightly resemble specimens of *C. crassa*, but they are readily distinguished by the ornamentation of the marginal grooves.

Horizons and Localities.—Upper Devonian: Frankmarsh, N. Devon (rare). Carboniferous Limestone: Yorkshire, Derbyshire, Staffordshire, Dublin, Glasgow, etc. Coal Measures: Coalbrookdale, etc.

Conularia deflexicosta, Sandberger (?).

1847. *Conularia deflexicosta*, F. Sandberger, Neues Jahrb. für Min., etc., p. 16, pl. i, fig. 6.
1896. *Conularia deflexicosta*, G. F. Whidborne, Devon. Fauna S. England, vol. iii, p. 35, pl. iv, fig. 13.

Remarks.—In the monograph referred to above Whidborne described a very imperfect specimen of a Conularian from Pilton, and referred it, "presumptively," to Sandberger's species, *C. deflexicosta*. I have not seen any other similar specimens, so that the occurrence of this species in Britain remains doubtful. The ridges appear to be tuberculated and the furrows smooth, so that the species must be placed in the section Moniliferæ.

Conularia globosa, sp. nov. Pl. III, figs. 7, 8.

Diagnosis.—Shell of medium size, tapering uniformly; cross-section a square with the sides convex. Faces equal, gently convex; apical angle 7°—8°. Marginal grooves of medium depth and with rounded base. Facial grooves central, faint, only seen in young specimens. Aperture unknown. Apical septum deeply convex, with circular transverse section. Ornamentation fine. Ridges prominent, crowded (25—35 in 5 mm.), forming a very wide angle or broad curve across the face, and continuous across the marginal groove, making an angle of about 140° in its base; closely studded with small round tubercles. Furrows smooth.

Dimensions—Length about 100 mm. Greatest width of face, 19 mm.

Description.—Of the two specimens known, one (Pl. III, fig. 8) appears to be quite a young form. Each shows the true cross-section, and the characteristic deeply convex septum. The ridges are very close together, especially towards the aperture; they are for the most part regular, but in places anastomose, and vary their course. The tubercles are well preserved over the whole shell, and no sign of ornamentation is seen in the furrows (Pl. III, fig. 7 *d*).

Affinities.—This species is most nearly allied to *C. quadrisulcata*, from which it is distinguished by the convex faces, the deeply convex septum, and the fine ornamentation.

Horizon and Localities.—Carboniferous Limestone: Avon Gorge and Tortworth.

Type.—Museum of Practical Geology (reg. no. 11909).

Conularia hispida, sp. nov. Plate III, figs. 9—11.

Diagnosis.—Shell of medium size, thin; tapering uniformly; cross-section square. Faces equal, flat; apical angle 10°—12°. Marginal grooves deep and narrow; base and sides rounded. Facial groove fine, central. Aperture, apex, and apical septa unknown. Ornamentation fine; transverse ridges (8—24 in 5 mm.), forming an angle of 130°—145° along the central groove; closely studded with small pear-shaped tubercles, which are prolonged upwards as fine projections about half way across the furrow; the other half quite smooth.

Dimensions.—Length about 140 mm. Greatest width of face, 25 mm.

Description.—This shell is usually found somewhat compressed, but one specimen from Ledbury gives a truly square cross-section (Pl. III, fig. 10). The state of preservation is good and the characteristic ornamentation is well seen. The ridges (average, 14 in 5 mm.) are more closely packed near the apex, and pass without a break across the marginal grooves. Down the centre of each face the shell is puckered into little short folds, which follow the course of the ridges, and die out before reaching the marginal grooves. The little pear-shaped tubercles (45—50 in 5 mm.) are often much worn down and nearly obliterated, but when well preserved are seen slightly clasping the ridge, and tapering upwards into fine points (Pl. III, fig. 11). The upper half of each furrow is quite smooth.

Affinities.—This species is readily distinguished from any other by its unique ornamentation.

Horizon and Localities.—Wenlock Limestone: Dudley; Ledbury. Highest Bala: Thraive Glen, Girvan.

Type.—British Museum (Nat. Hist.) (reg. no. G. 10041).

Conularia triangularis, sp. nov. Plate III, fig. 12.

Diagnosis.—Shell of medium size; tapering uniformly; cross-section square. Faces equal, flat; apical angle 12°. Marginal grooves of medium depth and with rounded base. Facial groove fine, central. Aperture, apex, and apical septa unknown. Ornamentation inconspicuous; transverse ridges fine, closely packed (50 in 5 mm.), forming an angle of 135°—145° along the central groove, studded with small, closely-packed, triangular tubercles.

Dimensions.—Length at least 60 mm. Greatest width of face, 14 mm.

Description.—Only one example of this species is known, but its characters are so well marked as to justify its separation as a new species. The shell is well preserved, and has undergone only very slight deformation. This has resulted in three of the faces being slightly ridged down their centres, but the fourth shows a fine groove, which is probably the natural condition. The marginal grooves are also probably a trifle deepened, but in places show a gentle, rounded base with the ornamentation continuing across undisturbed (Pl. III, fig. 12 *c*). The transverse ridges are so crowded as to be hardly visible to the naked eye. They are studded with close-set tubercles, rounded below, but on the upper side prolonged into blunt points, which cross the furrow above (Pl. III, fig. 12 *d*). The tubercles are for the most part reduced to small triangular hollows.

Affinities.—This species is readily distinguished from all others by the fine, close-set ridges and the triangular tubercles.

Horizon and Locality.—Wenlock Limestone: Dudley.

Type.—British Museum (Nat. Hist.) (reg. no. 866).

Conularia hastata, sp. nov. Plate IV, fig. 1.

Diagnosis.—Shell of medium size, tapering uniformly; cross-section probably square. Faces equal (?), flat; apical angle about 18°. Marginal grooves slight; base angular; facial groove fine and central. Aperture, apex, and apical septa unknown. Ornamentation fine; ridges prominent, closely packed (20—25 in 5 mm.), forming a broad curve across the face, flat in the centre, and falling to the marginal grooves, where they meet the ridges of the adjacent side at an angle of nearly 90°. Studded with very small, round, distant tubercles, from which fine, sharp lamellæ extend upwards across the furrow.

Dimensions.—Length, 60—70 mm. Greatest width of face, 17 mm.

Description.—There are six specimens of this species in the Survey Collection at Edinburgh, all from the same locality. None are at all perfect, and no cross-section can therefore be obtained directly. The only evidence as to its form is that afforded by the course of the ridges. The latter are, in most cases, very nearly symmetrical upon each half of the face, which is usually only the case with square specimens. However, this is not a certain test, and the natural form may have been flattened. The ornamentation is very constant for all the specimens. The ridges vary very little in distribution from apex to aperture, and down the whole length of the shell they are fine, closely packed and very well defined, and the little vertical striæ are usually clearly seen, especially in the external casts (Pl. IV, fig. 1 *d*).

Affinities.—This shell slightly resembles *C. hispida* and *C. triangularis*, but is easily distinguished from both.

Horizon and Locality.—Upper Ludlow: River Esk below Henshaw Burn.
Type.—Geological Survey Museum, Edinburgh (reg. no. 4623).

Section III.—CANCELLATÆ.

Ornamentation cancellated, with coarser transverse main ridges, forming obtuse angles across the faces, and finer and lower longitudinal ridges connecting the former. Ornamentation visible to naked eye.

(A) Transverse section square. Longitudinal ridges feeble and inconstant.

(i) Ridges coarse, irregular, almost horizontal. Central facial groove strong. *C. elongata*, Portlock.

(ii) Shell small; ridges and tubercles fine; longitudinal ridges chiefly marked on either side of the marginal grooves. *C. plicata*, sp. nov.

(iii) Shell large; ridges and tubercles very coarse; marginal grooves very wide and shallow. *C. crassa*, sp. nov.

(iv) Marginal grooves with rounded base and prominent, smooth, rounded edges. *C.* sp.

(B) Transverse section rhombic or elliptical.

(*a*) Longitudinal ridges faint and inconstant; tapering more rapid at the apex.

(i) Facial groove well marked, often sub-central; average angle of ridges 130°. Ridges fall more sharply to the "lateral" than to the "central" marginal grooves. *C. subtilis*, Salter.

(ii) Sides nearly parallel towards the aperture; cross-section elliptical; facial groove absent; average angle of ridges 150°. *C. complanata*, sp. nov.

(*b*) Longitudinal ridges strongly marked over the whole shell.

(i) Shell small; apical angle of face 17°—20°; apical septa flat; ridges nearly horizontal across the "central" marginal groove, bent down sharply to the "lateral" grooves; longitudinal bars separated. *C. planiseptata*, sp. nov.

(ii) Shell of medium size; apical angle of face 10°—11°; apical septa convex; ridges meet at an angle in the marginal grooves; transverse and longitudinal bars prominent, and equally spaced. *C. vesicularis*, sp. nov.

(iii) Shell large; apical angle of face 10°—12°; apical septa convex; ridges nearly horizontal across the central marginal groove; the longitudinal ridges twice as numerous as the transverse, rounded and in contact laterally. *C. sowerbyi*, de Verneuil.

(iv) Shell large; apical angle of face 16°—20°; apical septa convex; ridges cease at the edges of the marginal grooves, which are smooth and narrow. Ornamentation as in *C. sowerbyi*, but coarser. *C. breviconventa*, sp. nov.

(v) Shell small; apical angle of face 8°—10°; apical septa convex; ridges nearly horizontal across the central marginal groove; ornamentation fine; longitudinal ridges numerous, sharply defined, not in contact laterally. *C. elegans*, sp. nov.

Conularia elongata, Portlock.

1843. *Conularia elongata*, J. Portlock, Rept. Geol. Londonderry, p. 393, pl. xxix A, fig. 2.
1847. *Conularia pectini-costata*, F. Sandberger, Neues Jahrb. für Min., etc., p. 17, pl. i, fig. 7.

Diagnosis.—Shell small, tapering uniformly; cross-section square. Faces equal, slightly concave; apical angle about 10°. Marginal grooves wide and very shallow. Facial groove strong, central. Aperture, apex, and apical septa unknown. Ornamentation coarse; transverse ridges irregular (8 in 5 mm.), passing horizontally across the face; interrupted by the facial groove, but continuous across the marginal groove, in which they arch down towards the apex. Furrows crossed by fine, regular, longitudinal striæ (20—30 in 5 mm).

Dimensions.—Length about 40 mm. Greatest width of face, 10 mm.

Description.—The type specimen still remains the only known example of this species. The shell is not preserved, but the ornamentation is fairly well seen. The ridges are irregular and thickened by friction, so that they appear over most of the shell more like the rounded growth-lines of *C. linnarssoni*, but towards the aperture they are finer, and as many as 15 in 5 mm., and the longitudinal striation of the furrows is seen to extend to the ridges.

Affinities.—This species resembles *C. linnarssoni* in the strongly marked central facial groove and the horizontal transverse folds, but is readily distinguished by the cancellated ornamentation and the small angle of the face.

Horizon and Locality.—Caradoc (?): Desertcreat.

Type.—Museum of Practical Geology (reg. no. 12642).

Conularia plicata, sp. nov. Plate IV, figs. 2, 3.

Diagnosis.—Shell of medium size, tapering uniformly; cross-section square. Faces equal, flat; apical angle 16°—17°. Marginal grooves of medium depth and width; facial grooves absent. Aperture partially closed by short blunt triangular lobes, at right angles to the main axis. Apex sharply pointed; apical septa unknown. Ornamentation fine; ridges far apart (9—12 in 5 mm.), forming broad,

simple curves across the face, continuous across the marginal groove, studded with small, round, well-spaced tubercles. Furrows marked by secondary transverse ridges and faint longitudinal striations—the latter especially marked close to the marginal grooves.

Dimensions.—Length sometimes as much as 70 mm., usually 20—30 mm. Greatest width of face, 20 mm.

Description.—This is a well-marked species, of which there are several examples in Mrs. Gray's Collection. The most characteristic features are the broad sweeping curves which the ridges make across the face, the secondary transverse ridges, and the small distant tubercles.

Affinities.—This species is easily distinguished from other cancellate forms by the square cross-section and fine curved ridges. With *C. crassa* it forms a transition between the Moniliferæ and the Cancellatæ.

Horizon and Locality.—Upper Bala (Starfish Bed): Girvan.

Type.—Mrs. Gray's Collection.

Conularia crassa, sp. nov. Plate IV, figs. 4—6.

Diagnosis.—Shell large, tapering uniformly; cross-section a square, with the sides gently convex. Faces equal, convex; apical angle about 16°. Marginal grooves very shallow, wide; facial groove hardly perceptible. Aperture, apex, and apical septa unknown. Ornamentation coarse; transverse ridges strong, widely separated (5—6 in 5 mm.), forming an angle of about 140° down the centre of the face, studded with large rounded, distant tubercles (8 in 5 mm.).

Dimensions.—Length at least 120 mm. Greatest width of face, 24 mm.

Description.—Examples of this species are found in a fairly good state of preservation, often retaining a considerable portion of the shell. They have usually undergone flattening, so that the cross-section is obscure, but one specimen (Pl. IV, fig. 5) shows a broad ellipse, which appears to have been derived from a square, the sides of which are replaced by gently convex curves. The most marked character of the species is the exceedingly wide and shallow marginal grooves, which are of the nature of gentle undulations, without any well-marked boundaries. The ornamentation is continued across them without any break. The appearance of the ridges varies with the state of preservation. Sometimes the blunt, rounded tubercles are clearly seen; but more often they appear flattened and pierced in the centre (Pl. IV, fig. 6 *b*); or, again, only a raised, wavy ridge may be seen (Pl. IV, fig. 4 *b*); or, lastly, the tubercles may be worn away and represented by hollows, between which little portions of the shell still remain. The furrows are crossed by very slight, inconspicuous and inconstant vertical undulations.

The specimen seen in Pl. IV, fig. 4 *a* shows a curious smooth portion of shell just below the fracture. On each side it appears to be quite continuous with the inner less-decorated layer of the shell. In this character, and in its texture, it is quite similar to the apical septa found in so many species. On each side the transverse ridges appear undisturbed, but above their course is very irregular for over 20 mm. The probable explanation of this is, that the shell was injured during the life of the animal, and the injury was repaired by the growth of the inner layer.

Affinities.—This species is readily distinguished from other British forms by the very coarse ornamentation and the wide, shallow, marginal grooves. In general characters it resembles *C. œlandica*, Holm, but the ornamentation is much coarser, the angle of the face larger, and that of the ridges smaller than in the Swedish species.

Horizon and Locality.—Wenlock Limestone: Dudley.

Type.—British Museum (Nat. Hist.) (reg. no. G. 6271).

Conularia sp.

Description.—Several fragmentary specimens occur in the Llandeilo rocks of Balcletchie and Dowhill, which should probably be placed in a distinct species, but as there is no example which is at all complete I merely note the characteristic features: Marginal grooves well marked with rounded base, and prominent rounded edges; facial grooves absent. Faces equal, flat; apical angle 10°—11°. Apex sharply pointed. Ornamentation fairly coarse; ridges (10—12 in 5 mm.), forming a sharp curve (= angle of 135°) across the face, bending up again and ceasing abruptly at the prominent edges of the marginal grooves; smooth near the apex, but finely tuberculated higher up. Furrows slightly striated.

Dimensions.—Length, 30 mm. Greatest width, 7 mm.

All specimens are in Mrs. Gray's Collection.

Conularia subtilis, Salter. Plate IV, figs. 7—11.

1821. *Conularia quadrisulcata*, Sowerby, Min. Conch., vol. iii, pl. 260, fig. 3.
1855. *Conularia subtilis*, J. W. Salter, Appendix A to Sedgwick's Synops. Brit. Palæoz. Rocks, p. vi.
1855. *Conularia subtilis*, F. M'Coy, in Sedgwick's *op. cit.*, p. 288, pl. i, L, fig. 24.

Diagnosis.—Shell of medium size, tapering slightly more rapidly at the apex. Cross-section rhombic; diagonals often nearly equal. Faces equal, slightly convex apically and concave aperturally; average apical angle 13°. Marginal grooves narrow, inconspicuous; facial groove fine; central or slightly nearer the "central"

marginal groove. Aperture, apex, and apical septa unknown. Ornamentation fine; ridges narrow (10—40 in 5 mm.), forming an average angle of 130° along the facial groove, and falling more sharply to the "lateral" than to the "central" marginal grooves; studded with small, close-set, rounded or slightly elongated tubercles, which tend to be prolonged upwards and downwards into little points (Pl. IV, fig. 10 *b*). Striation of furrows slight or absent.

Dimensions.—Length about 80 mm. Greatest width of face 17 mm.

Description.—Salter's type specimen of *Conularia subtilis* comes from the Kirby Moor flags of the Kendal district, and its preservation is as bad as that of most of the other fossils from this locality. No shell is seen, and the ornamentation is blurred or almost obliterated. From finer grained rocks at the same horizon other specimens, which I believe to be of the same species, are found in a much better state of preservation, although these naturally do not agree in every way with Salter's description. Fig. 7 shows a specimen from Monmouthshire, on the lower half of which the ornamentation closely resembles that of the Benson Knot specimens, while on the upper half the fine and delicate ornamentation, characteristic of well-preserved examples, is well seen. The examination of a number of specimens shows that the inequality of the faces, noted by Salter, is not of general occurrence, and I believe that the shell, in its natural condition, was equal sided. The cross-section is sometimes nearly square, and then the want of symmetry between the two halves of each face is less marked. The ornamentation varies greatly, even on the same specimen. In places the little tubercles appear elongated, and clasp the raised ridge, giving the appearance of little rings threaded upon it (Pl. IV, fig. 10 *a*). In another part of the same shell they are prolonged up and down into the furrows as little short, pointed projections (Pl. IV, fig. 10 *b*), while sometimes, again, they appear as little, simple, round tubercles (Pl. IV, fig. 9 *b*). Usually there is no definite longitudinal ridging of the furrows, but sometimes it is slightly, sometimes even strongly, developed. One specimen from Deerhope, Pentland Hills, shows distinct ornamentation. The tubercles are much smaller, and are prolonged downwards towards the apex, as long, fine points extending across the furrow (Pl. IV, fig. 11). The Scottish specimen represented in the last-mentioned figure should perhaps be placed apart as a definite variety, as, together with the difference in ornamentation, the apical angle of the face is large, about 20°, and the tapering appears uniform. The ridges also on adjacent half faces are almost horizontal across the "central" marginal groove, falling sharply to the "lateral" grooves.

Affinities.—This species in some ways resembles *C. hispida* and *C. hastata*, from which it is distinguished by the rhombic cross-section and sub-central facial groove. Other specimens resemble more closely *C. sowerbyi*, and coarse specimens are sometimes hard to distinguish, but the form of the pyramid and the course of the ridges are generally sufficiently characteristic.

Horizon and Localities.—Upper Ludlow: Brigsteer; Benson Knot; Underbarrow; Usk, Monmouthshire; Whitcliff, Ludlow; etc.

Type.—Sedgwick Museum, Cambridge (reg. no. *b* 59).

Conularia complanata, sp. nov. Plate IV, figs. 12—14.

Diagnosis.—Shell large, tapering more rapidly near the apex. Cross-section an ellipse. Faces equal, gently convex; apical angle about 15°, but the sides nearly parallel, except towards the apex. Marginal grooves shallow, with angular base; facial grooves absent. Aperture unknown; apical septum convex, shallow. Ornamentation fine; ridges low (17 in 5 mm.), forming an angle of about 160° towards the aperture, diminishing to 140° towards the apex; studded with small, round, prominent tubercles. Furrows smooth, or more often slightly striated.

Dimensions.—Length about 150 mm. Greatest width of face, 25 mm.

Description.—In Carboniferous rocks the species is comparatively abundant, but its preservation is nearly always bad. The shell often reaches a large size, and the prismatic form towards the aperture is well seen. The spacing of the ridges is very uniform for the greater part of the shell, but near to the aperture the ridges become very crowded. There is an imperfect specimen from the Devonian of Padstow, Cornwall, which may belong to this species (British Museum [Nat. Hist.], G. 8229).

Affinities.—This species resembles most closely *C. subtilis*, from which it is distinguished by the large size, the absence of the facial groove, and the wide angle of the transverse ridges.

There is a specimen in the British Museum (Nat. Hist.), reg. no. G. 9030, from the Carboniferous Limestone of Stonyhurst, Lancashire, which differs from the foregoing in some important points, but the preservation is so bad and the specimen so imperfect that no satisfactory diagnosis can be given. The characters which can be determined are: Marginal grooves very shallow. Ornamentation fine; ridges very narrow, evenly spaced (14 in 5 mm.), forming at the aperture broad curves, which give place towards the apex to perfectly straight horizontal lines. Ridges appear to be tuberculated with widely separated round tubercles; furrows smooth. Length of portion, 82 mm.

Horizons and Localities.—Devonian: Padstow, Cornwall (?). Carboniferous Limestone: Bristol; Oreton and Farlow, Salop, etc.

Type.—British Museum (Nat. Hist.) (reg. no. G. 17666).

Conularia planiseptata, sp. nov. Plate V, figs. 1, 2.

Diagnosis.—Shell small, tapering uniformly, or slightly more rapidly near the apex. Cross-section rhombic or elliptical, with the longer diameter more than

double the shorter. Faces equal, slightly convex; apical angle 17° — 20°. Marginal groove of medium depth, base rounded; facial grooves absent. Apical septum flat. Ornamentation fine; ridges fairly close (average 18 in 5 mm.), forming an angle of 145° across the face; point of angulation nearer to the "central" than to the "lateral" marginal groove; ridges continuous across the grooves, at the base of which they form an angle of almost 180°; studded with small, rounded, widely separated tubercles. Furrows crossed by narrow, well-defined vertical bars.

Dimensions.—Length, 40—50 mm. Greatest width of face, 16 mm.

Description.—Well-preserved examples of this small species are obtained from Thraive Glen, but those from Woodland Point are all somewhat fragmentary. The figured specimen shows a nearly perfect apical septum, which, unlike the septa of most species, is quite flat; and since the surface is quite unwrinkled, this must be the natural form. The small oblong projection in the centre is very suggestive of some sort of siphuncle (Pl. V, fig. 1*b*). I have not seen anything resembling this in any other example, even where the septa are nearly perfect. In this specimen the central tube appears to be closed, and may very likely be only a scar left by the final completion of the septum.

Affinities.—This species resembles most closely *C. vesicularis*, from which it is distinguished by the large angle of the face, the flat apical septum, and slight differences in the ornamentation.

Horizons and Localities.—Upper Bala and Middle Llandovery: Thraive Glen and Woodland Point, Girvan.

Type.—Mrs. Gray's Collection.

Conularia vesicularis, sp. nov. Plate V, figs. 3—6.

Diagnosis.—Shell of medium size, tapering uniformly. Cross-section at the aperture a rhomb with diameters nearly equal, at the apex an ellipse or the figure ∞. Faces equal, flat, convex, or gently concave near the aperture; apical angle 10°—11°. Marginal grooves of medium depth; facial grooves absent. Apical septa convex. Ornamentation fine; ridges moderately close (average 17 in 5 mm.), forming an angle of 140° across the face; the point of angulation slightly nearer to the "central" than to the "lateral" marginal groove; ridges continuous across the marginal grooves and forming an angle at the base of about 150°. Ridges studded with rounded tubercles; furrows crossed by prominent bars.

Dimensions.—Length about 90 mm. Greatest width of face, 14 mm.

Description.—This species is of widespread occurrence in the uppermost Ordovician rocks. Specimens are not usually well preserved and no aperture is known. The "central" marginal groove is usually deeply sunken towards the

apex, and the faces strongly convex, thus giving an ∞-shaped cross-section (Pl. V, fig. 4 *b*). Towards the aperture the "central" marginal grooves become much more prominent, the faces become slightly concave, and the cross-section approaches a square (Pl. V, fig. 4 *a*).

The ridges are generally fine and well-marked. The tubercles are very often worn down, and the circular hollows in the furrows are then strongly marked (Pl. V, fig. 6 *b*). Frequently the shell is removed entirely, and a very characteristic appearance is then obtained. Ridges and vertical bars are replaced by grooves, and the furrows appear to be filled with rows of gently hollowed tubercles (Pl. V, fig. 6 *c*). I have not observed this appearance in any other species.

Affinities.—This species is closely allied to *C. sowerbyi* and to *C. planiseptata*. It is distinguished from the latter by the slow rate of tapering, and from the former by the smaller size, and by the characteristic ornamentation.

Horizon and Localities.—Caradoc: Acton Scott; Tynwyd; Cardington; etc.

Type.—Museum of Practical Geology (reg. no. 12647).

Conularia sowerbyi, de Verneuil. Plate V, figs. 7—11.

1821. *Conularia quadrisulcata*, Sowerby, Min. Conch., vol. iii, pl. 260, fig. 4.
1828. *Conularia sowerbyi*, Defrance, MS.
1839. *Conularia quadrisulcata*, Sowerby, in Murchison's Silur. Syst., pl. xii, fig. 22.
1845. *Conularia sowerbyi*, de Verneuil, in Murchison, de Verneuil, and de Keyserling, Géol. de la Russie d'Europe, vol. ii, p. 348, pl. xxiv, fig. 5.
1847. *Conularia cancellata*, F. Sandberger, Neues Jahrb. für Min., etc., p. 20, pl. i, fig. 11.
1855. *Conularia cancellata*, F. M'Coy, in Sedgwick's Synops. Brit. Palæoz. Rocks, p. 287.
1859. *Conularia sowerbyi*, Sowerby, in Murchison's Siluria, ed. 3, p. 550, pl. xxv, fig. 10.

Diagnosis.—Shell large, tapering uniformly; cross-section rhombic near the aperture, elliptical near the apex. Faces equal, gently convex, apical angle 10°—12°. Marginal grooves shallow, broad; facial grooves inconstant. Lobes of the aperture short and triangular; apex closed by a convex septum. Ornamentation fairly coarse; transverse ridges well marked (average 12 in 5 mm., more crowded at the apex and the aperture), forming an average angle of 147°. Ridges closely set with rounded tubercles. Longitudinal bars in the furrows twice as numerous as the transverse ridges, rounded, and in contact laterally. Ornamentation continuous across the marginal grooves.

Dimensions.—Length about 120 mm. Greatest width of face, 33 mm.

Description.—This species is the commonest of British Conulariæ. It is found usually preserved in limestone, and has, therefore, undergone less crushing than many. At the aperture the cross-section is a rhomb with the longer diameter

rather less than twice the shorter (about 5 : 3), but at the apex the shell almost invariably appears more flattened, and the cross-section takes the form of an ellipse with the longer diameter more than twice the shorter. The apical angles of the faces vary in different specimens, but the measurements are not always trustworthy, and the greater number give values between 10°—12°.

The apertural lobes are not usually seen, though there are several specimens known which show them in a more or less nearly complete state. They are short, with gently rounded apices, and bend down at right angles to the axis of the shell (Pl. V, fig. 8). In almost all cases the shell is closed at the apical end by a gently convex septum (Pl. V, figs. 7 *b* and 9), and rarely, if ever, does it taper to a sharp point. The septum occurs at varying distances from the aperture, and this fact points to the probability of the existence of more than one such partition in the length of the shell. Indeed, in one specimen, from the Museum of Birmingham University, 6 mm. above the terminal septum the shell is broken away, and another and quite similar septum is seen, passing inwards parallel to the other, and apparently continuous with the thin inner layer of the shell. The ornamentation is of the typical cancellate type. The point of angulation of the transverse folds is perceptibly nearer to the "central" than to the "lateral" marginal grooves, and the ridges meeting in the "central" groove from adjacent faces form an angle approaching 180°. In the apical half of the shell the ridges form straight-sided chevrons across the face, but towards the aperture there is a marked increase in the size of the angle, and the straight lines are replaced by broad, compound curves, at first concave, then convex to the aperture as they pass down from the point of angulation to the marginal groove.

The tubercles on the ridges are sometimes well preserved, but more often are reduced by friction to small rounded hollows; still more frequently the ridges are worn down to coarse, rough projections, and in the furrows between these the shell is well preserved, and the close and regular vertical striation is clearly seen. If the outer layer of the shell is removed, the thin yellowish under-layer is exposed, ornamented in the same way as the outer, but much less strongly (Pl. V, fig. 10 *b*).

Affinities.—This shell is the commonest British representative of a type that is widely spread all over the globe. It is very similar to the Bohemian species, *C. proteica*, Barrande, and to the Swedish *C. cancellata*, Lindström, but it is doubtful whether it is identical with either of these. Species with strongly cancellated ornamentation appear to have flourished in highest Ordovician and Silurian times, and during this period gave rise to local types (*C. planiseptata*, *vesicularis*, *breviconventa*), which cannot be identified with species of other countries. Lindström's species, *C. cancellata*, ranging from the Brachiopodskiffer to the highest Silurian of Gotland, may possibly in the same way include more than one local species, but I was not able to identify any with the British forms.

Horizons and Localities.—Wenlock Limestone: Malvern; Ledbury; Dudley; etc. Upper Ludlow: Underbarrow; etc.

Type.—Unknown.

Conularia breviconventa, sp. nov. Plate V, figs. 12, 13.

Diagnosis.—Shell of medium size, tapering uniformly; cross-section a flattened rhomb. Faces equal, flat. Apical angle 16°—20°. Marginal grooves narrow, of medium depth; facial grooves inconstant. Aperture unknown; apex closed by a convex septum. Ornamentation coarse; ridges, on an average, 6 in 5 mm. for the centre of the shell, closer at the aperture and the apex, forming an average angle of 130°. Ornamentation of the typical cancellate type with close-set tubercles, ceasing at the edge of the marginal groove.

Dimensions.—Length about 70 mm.; greatest width of face, 20 mm.

Description.—This species is not nearly so common as the preceding one, but occurs with it at Dudley and other places. The shell generally appears to be compressed, as is seen by the fine wrinkles along the septum; hence the observed transverse section may not be the true one. The angle of the face is always considerably larger than in *C. sowerbyi*. The marginal grooves are markedly different, being narrow, well-defined, and apparently with smooth base. The detailed ornamentation is the same as in *C. sowerbyi*, but is, on the whole, much coarser; the angle of the ridges is smaller, and increases very little towards the aperture, the ridges themselves are more sharply defined, and, if curved at all, form simple arcs concave to the aperture.

Affinities.—This species closely resembles the commoner form, *C. sowerbyi*, but is distinguished by the coarser ornamentation, by the much larger facial angle, and by the smooth, narrow, marginal grooves, in which the ornamentation of the rest of the shell is absent. It very closely resembles *C. trentonensis*, Hall, in the wide facial angle and coarse ornamentation.

Horizon and Locality.—Wenlock Limestone: Mayhill; Dudley; etc.

Type.—British Museum (Nat. Hist.) (reg. no. G. 17667).

Conularia elegans, sp. nov. Plate V, fig. 14.

Diagnosis.—Shell small, tapering uniformly; cross-section rhombic. Faces equal, slightly convex; apical angle 8°—10°. Marginal grooves narrow, sharply defined; facial grooves absent. Aperture unknown; apical septum slightly convex. Ornamentation fine; ridges regular, narrow, crowded (20—25 in 5 mm.) forming an angle of about 140° across the face. Furrows crossed by fine, regular, well-marked striations, which in places are seen to extend to the ridges.

Dimensions.—Length about 60 mm. Greatest width of face, 12 mm.

Description.—The figured specimen, although very imperfect, shows a considerable amount of shell in a good state of preservation. The septum is finely wrinkled parallel to its long axis, which indicates that the specimen is compressed; but the ridges, meeting at a broad angle in the "central" marginal groove, and falling away more sharply towards the sides, indicate that the natural form is a rhomb, and not a square. The ridges are very regularly spaced through the whole length of shell, and are for the most part smooth. However, in a few places, the striations of the furrows appear to extend to the ridges, forming slight tubercles, which have probably been worn down over the rest of the shell.

Affinities.—This small species is quite distinct from the other cancellate types. It resembles *C. planiseptata* more closely than any other form, but is readily distinguished by the slow rate of tapering, the fine ornamentation, and the nearly smooth ridges.

Horizon and Locality.—Carboniferous Limestone: Farlow, Salop.

Type.—British Museum (Nat. Hist.) (reg. no. G. 17665).

Conularia, sp.

Remarks.—In the Llandeilo rocks of Craighead and Ardmillan fragments of a cancellate *Conularia* are found, which probably belong to a separate species, but on account of the very imperfect condition of the shells it is impossible to give a definite diagnosis. The transverse section is probably a very much flattened rhomb, for the faces show a great want of symmetry, the ridges forming a straight line across the "central" marginal groove. The marginal grooves are wide, but well-defined, and the ornamentation, which is markedly cancellate, is continuous across the grooves. The longitudinal bars in the furrows are well separated, as in *C. planiseptata.*

INDEX OF SPECIES OF CONULARIA.

The names printed in italics either refer to foreign species or are synonyms. The numeral in black type indicates the page on which the specific diagnosis occurs.

EXPLANATION OF THE PLATES.

All the figures are of natural size unless the amount of enlargement is stated. Owing to the very great difference between the coarse and fine species I have found it impossible to make all magnifications of details the same. The magnifications are all 2, 5, 10, or multiples of 10, and when possible a 10 magnification is given for comparison.

PLATE I.

FIGS. PAGE

1—4. *Conularia linnarssoni*, Holm Mrs. Gray's Collection . . 16

1. Specimen from Llandeilo Beds, Balcletchie. Uncrushed, showing a square cross-section. × 2.
2. Small flattened specimen from the same locality. Shell almost smooth. × 2.
3. Marginal groove. × 20.
4. Facial groove showing striations. × 20.

5—9. *Conularia aspersa*, Lindström 19

5. Specimen from the Lower Ludlow of Church Hill, showing the apertural cone. British Museum (Nat. Hist.), no. 5373.

6 *a*. Large imperfect specimen from the same locality, compressed so as to show the "septa" from the under faces. 6 *b*. Portion of shell with "septa." × 5. 6 *c*. Ornamentation. × 40. British Museum (Nat. Hist.), no. G. 4603.

7. Ornamentation of another specimen from the same locality. × 40. British Museum (Nat. Hist.), no. G. 4604.

8 *a*. Specimen from the Silurian of Gotland. 8 *b*. Ornamentation. × 40. Vetenskaps Akademi, Stockholm.

9 *a*, *b*, *c*. Ornamentation of other Swedish specimens. × 40.

10—12. *Conularia punctata*, sp. nov. Mrs. Gray's Collection . . 20

10 *a*. Small specimen from the Upper Llandovery of Penkill, uncrushed. 10 *b*. Cross-section of shell. 10 *c*. Ornamentation above fracture. × 20.

11. Portion of the inner surface of the shell of another specimen, showing the septa projecting inwards only. × 10.

12 *a*. Ornamentation of a larger specimen. × 20. 12 *b*. External cast of the same. × 20.

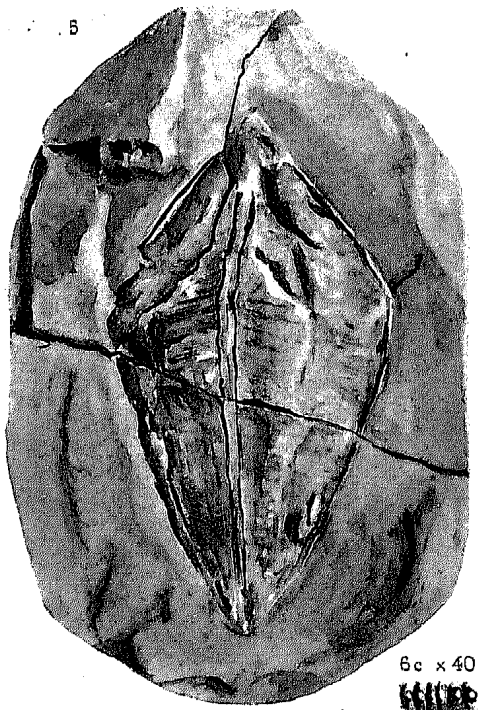
13, 14. *Conularia* sp., cf. *aspersa*, Lindström Mrs. Gray's Collection . 21

13 *a*. External cast of large specimen from the Starfish Bed (Upper Bala), Girvan, showing one face. 13 *b*. Ornamentation. × 20.

14 *a*. Ornamentation of a small specimen from the same locality. × 20. 14 *b*. The same. × 40.

Slater, British Conulariæ.

PLATE 1.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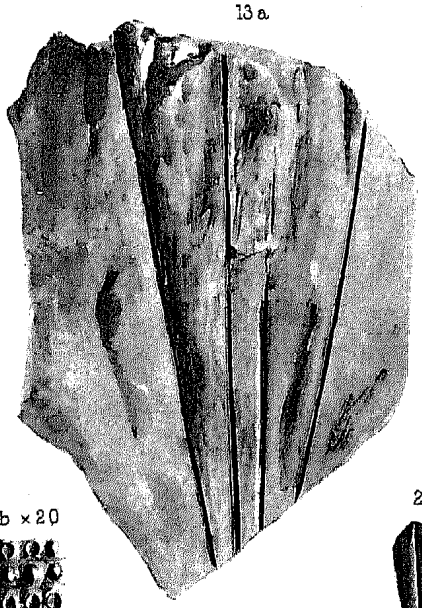
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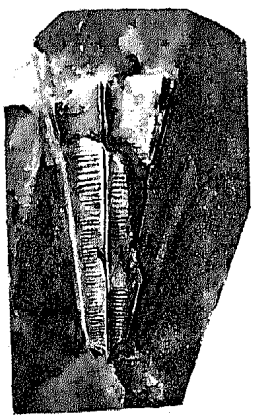
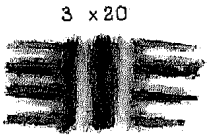

1 x 2


13b x 20


2 x 2


4 x 20


9b x 40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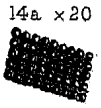
6c x 40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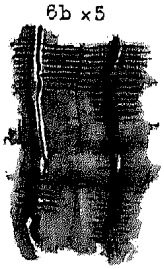
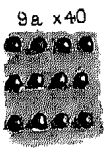
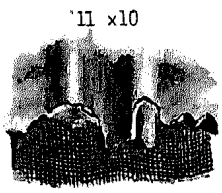

6b x 5


8b x 40


14b x 40


9a x 40

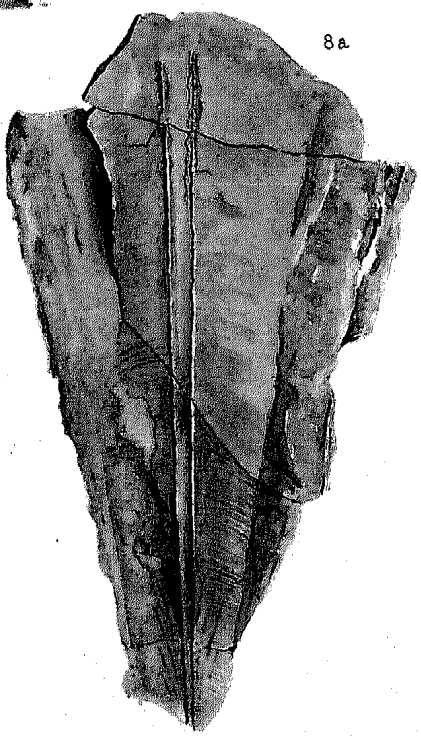

7 x 40


11 x10


9c x40


10c x20


6a.


8a.


12a x 20


12b x 20


10b


10a

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PLATE II.

FIGS. PAGE

1—3. *Conularia tenuis*, sp. nov. 21

1. Slab of Calciferous Sandstone from Glencartholm, showing numerous specimens attached by their apices. Geological Survey Museum, Edinburgh, no. 1.

2. Compressed specimen from the same locality, showing the thinness of the shell. × 2. British Museum (Nat. Hist.), no. G. 17661.

3. Ornamentation of another specimen. × 10.

4. *Conularia tenuis*, var. *maculosa*, nov. British Museum (Nat. Hist.), no. G. 17663. Ornamentation. × 10 . . . 23

5. *Conularia*, sp. (*margaritifera* Salter ?). Sedgwick Museum, Cambridge 24

5 *a*. Small specimen from the Skiddaw Slates, Brunstock Scar. × 2. 5 *b*. Small portion of the shell by the central facial groove, showing the fine ornamentation. × 5. 5 *c*. Ornamentation. × 20.

6—9. *Conularia microscopica*, sp. nov. 24

6. Specimen nearly complete and uncrushed from the Wenlock Shale of Buildwas. × 2. Museum of Practical Geology, no. 12628.

7. Imperfect flattened specimen from the same locality, showing the crumpled shell. × 2. British Museum (Nat. Hist.), no. G. 17668.

8. Cross-section near apex of another specimen. × 2.

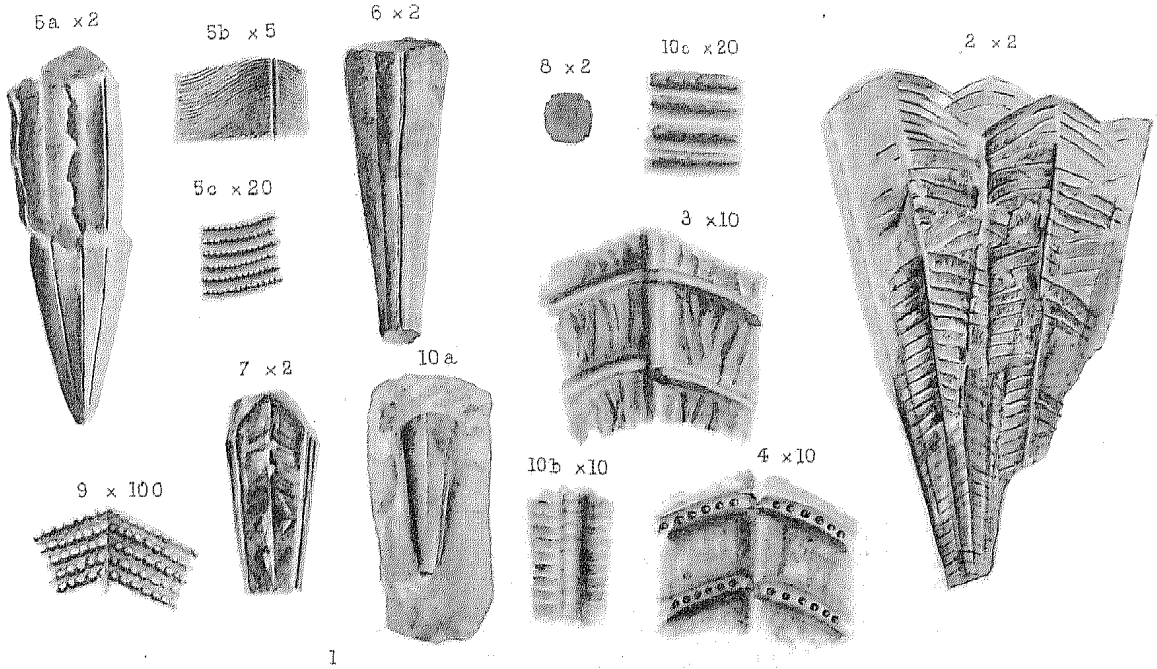
9. Ornamentation. × 100.

10. *Conularia*, sp. British Museum (Nat. Hist.), no. G. 11798 . 25

10 *a*. Specimen from the Wenlock Limestone of Ledbury showing one face. 10 *b*. Marginal groove. × 10. 10 *c*. Ornamentation. × 20.

Slater, British Conulariæ

PLATE II



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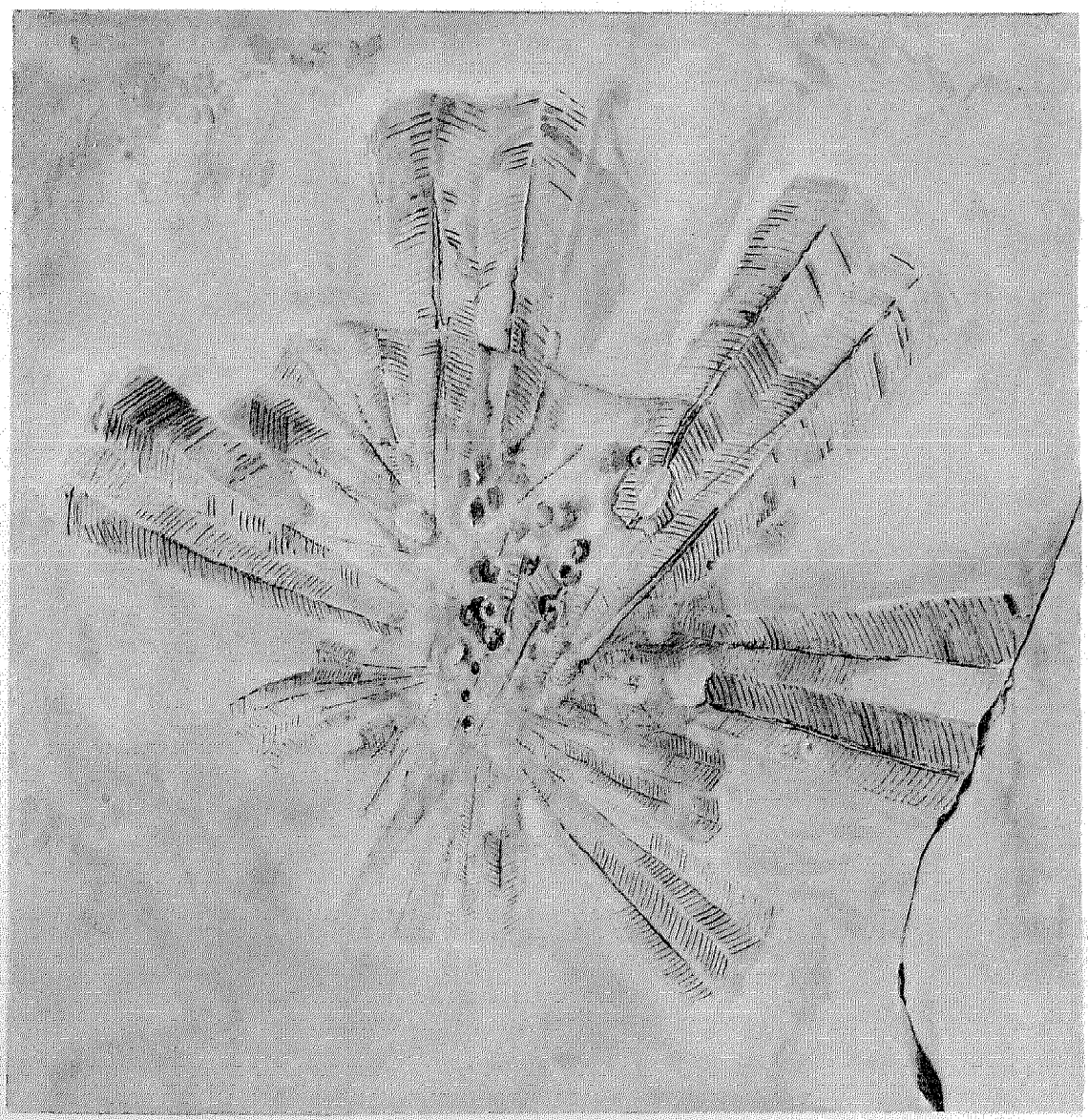

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PLATE III.

FIGS. PAGE

1. *Conularia coronata*, sp. nov. British Museum (Nat. Hist.), no. G. 17660 23

1 *a*. Compressed specimen from the Lower Llandeilo Rocks of Ritton Castle, showing one nearly complete face and one half face. 1 *b*. Marginal groove. × 5. 1 *c*. Ornamentation. × 20.

2—6. *Conularia quadrisulcata*, Sowerby 25

2. Specimen from the Carboniferous Limestone of Staffordshire in the private collection of Sir Thomas Wardle.

3. Flattened specimen from the Coal Measures, Salop. British Museum (Nat. Hist.), no. 3448.

4 *a*. Specimen from Carluke, Glasgow. Museum of Practical Geology, no. 11903. 4 *b*. Ornamentation near the apex. × 20.

5. Ornamentation of a specimen from the Coal Measures, Coalbrookdale. × 20.

6. Aperture of a small specimen from Coalbrookdale. × 2.

7, 8. *Conularia globosa*, sp. nov. Museum of Practical Geology . 27

7 *a*. Specimen from the Carboniferous Limestone of Avon Gorge. 7 *b*. Cross-section just below fracture. 7 *c*. Cross-section of septum. 7 *d*. Ornamentation. × 20. (No. 11909.)

8. Young specimen from the same horizon at Tortworth. (No. 11911.)

9—11. *Conularia hispida*, sp. nov. 28

9 *a*. Specimen from the Wenlock Limestone near Dudley. 9 *b*. Ornamentation. × 10. British Museum (Nat. Hist.), no. G. 10041.

10. Cross-section of another specimen from Ledbury. British Museum (Nat. Hist.), no. G. 11796.

11. Ornamentation of a specimen from the Upper Bala of Thraive Glen, Girvan, showing the pear-shaped tubercles. × 20. Mrs. Gray's Collection.

12. *Conularia triangularis*, sp. nov. British Museum (Nat. Hist.), no. 866 28

12 *a*. Imperfect specimen from the Wenlock Limestone of Dudley. 12 *b*. Cross-section. 12 *c*. Marginal groove. × 10. 12 *d*. Ornamentation. × 20.

Slater, British Conulariæ.

PLATE III

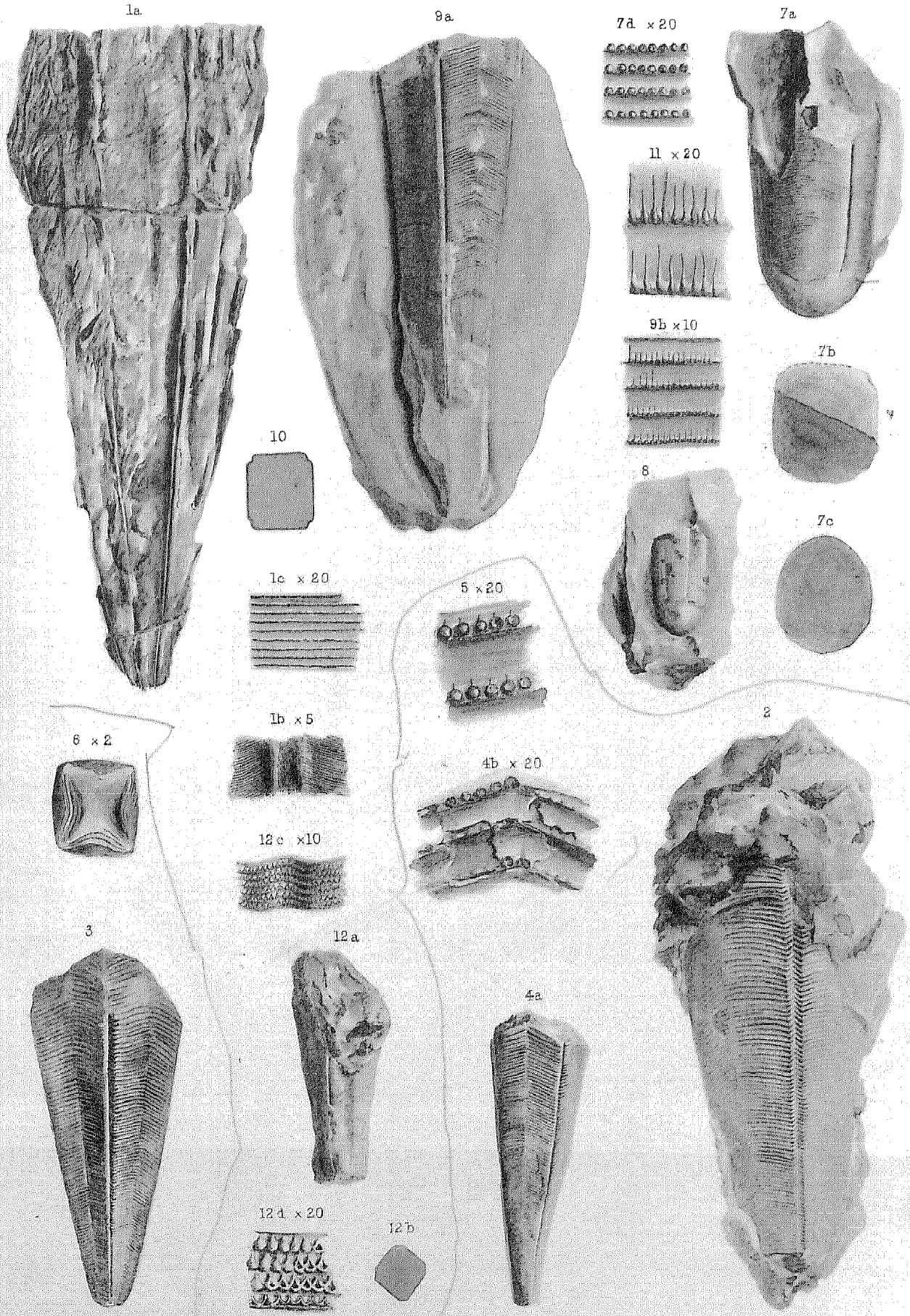

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PLATE IV.

FIGS. PAGE

1. *Conularia hastata*, sp. nov. Geological Survey Museum, Edinburgh 29

1 *a*. Specimen showing one face, from the Upper Ludlow, R. Esk below Henshaw Burn. (Reg. no. 4623.) 1 *b*. Ornamentation. × 10. 1 *c*. Ornamentation. × 20. 1 *d*. External cast of ornamentation. × 20.

2, 3. *Conularia plicata*, sp. nov. Mrs. Gray's Collection . . 31

2 *a*. Uncrushed specimen with square cross-section from the Starfish Bed (Upper Bala), Girvan. 2 *b*. Marginal groove. × 10.

3 *a*. Flattened specimen from the same locality. 3 *b*. Ornamentation. × 10.

4—6. *Conularia crassa*, sp. nov. 32

4 *a*. Large specimen from the Wenlock Limestone of Dudley. British Museum (Nat. Hist.), no. G. 6271. 4 *b*. Ornamentation. × 5.

5. Cross-section of a slightly compressed specimen from the same locality. Museum of Practical Geology, no. 12510.

6 *a*. Small specimen from the same locality. British Museum (Nat. Hist.), no. 47832. 6 *b*. Ornamentation. × 5.

7—11. *Conularia subtilis*, Salter 33

7 *a*. Specimen from the Upper Ludlow, Usk, Monmouthshire. 7 *b*. Ornamentation above the fracture. × 10. 7 *c*. The same. × 20. British Museum (Nat. Hist.), no. G. 4602.

8. Specimen from the same horizon at Benson Knot. Sedgwick Museum, Cambridge, reg. no. G. 14.

9 *a*. Flattened specimen from the same horizon at Bradnor Hill, Kington. 9 *b*. Ornamentation. × 20. Museum of Practical Geology, no. 12497.

10 *a*, *b*. Ornamentation of different parts of the same shell from the Whitcliff, Ludlow. × 20.

11. Ornamentation of specimen from Deerhope, Pentland Hills. × 20. British Museum (Nat. Hist.), no. G. 8744.

12—14. *Conularia complanata*, sp. nov. 35

12. Imperfect specimen from the Carboniferous Limestone of Farlow, Salop. British Museum (Nat. Hist.), no. G. 17666.

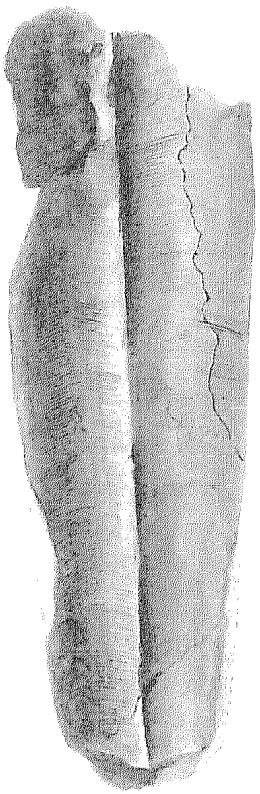
13. Cross-section of another specimen from the same horizon.

14 *a*. Ornamentation of another specimen. × 10. 14 *b*. The same. × 20.

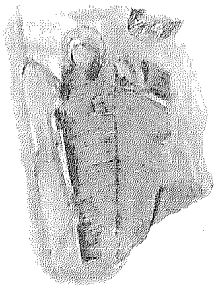
Slater, British Conulariæ.

PLATE IV

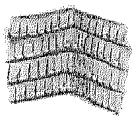
12



1a



1b ×10



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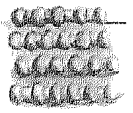

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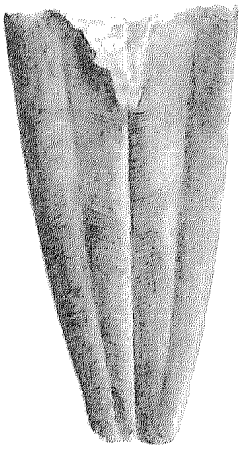

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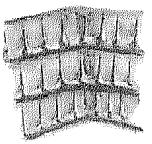
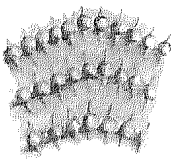


10b ×20



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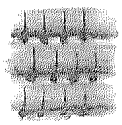
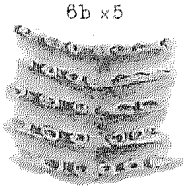


6b ×5



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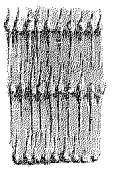

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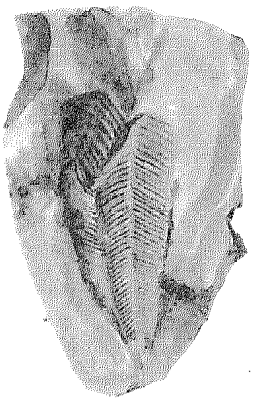

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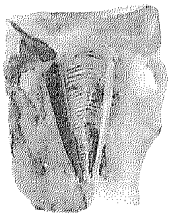
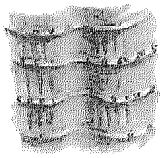
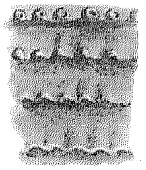


2b ×10



4b ×5



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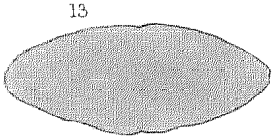
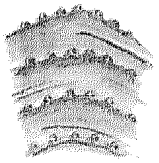
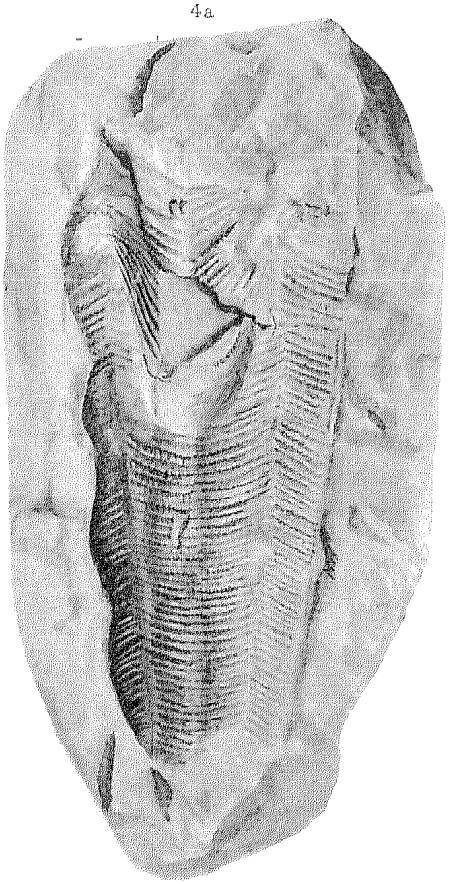


3b ×10

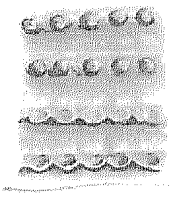


3a

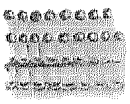
4a



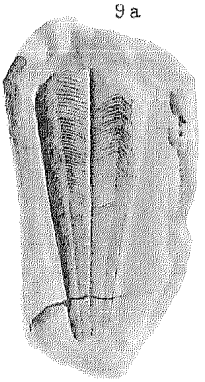
14b × 20



14a ×10

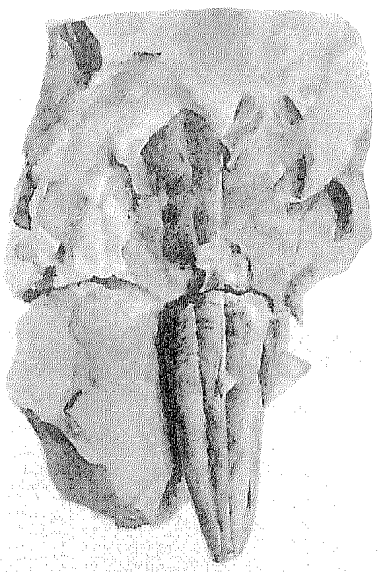


9a

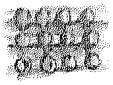


7b ×10

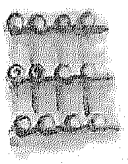
7a



7c ×20



9b ×20



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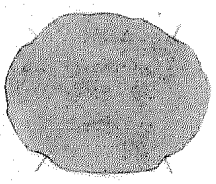

PLATE V.

FIGS. PAGE

1, 2. *Conularia planiseptata*, sp. nov. Mrs. Gray's Collection . 35

1 *a*. Specimen from the Upper Bala of Thraive Glen. 1 *b*. Apical septum, showing siphuncle (?). × 2.

2 *a*. Ornamentation of another specimen from the same locality. × 10. 2 *b*. The same. × 20.

3—6. *Conularia vesicularis*, sp. nov. 36

3. Imperfect specimen from the Bala of Acton Scott. Museum of Practical Geology, no. 12647.

4 *a*. Cross-section of another specimen at the aperture. × 2. 4 *b*. The same at the apex. × 2.

5. Ornamentation. × 10.

6. Different appearances of ornamentation. × 20. 6 *a*. Ridges well preserved. 6 *b*. Ridges worn, and rounded hollows prominent. 6 *c*. Shell all removed, and internal cast left.

7—11. *Conularia sowerbyi*, de Verneuil 37

7 *a*. Specimen from the Wenlock Limestone of Dudley, ending in a broken apical septum. 7 *b*. Portion of broken apical septum. × 5. British Museum (Nat. Hist.), no. 6327.

8. Imperfect aperture of another specimen. Museum of Practical Geology, no. 12504.

9. Complete apical septum of another specimen. Museum of Practical Geology, no. 11799.

10 *a*. Marginal groove. × 5. 10 *b*. Portion showing inner layer of shell. × 5.

11. Ornamentation. × 10.

12, 13. *Conularia breviconventa*, sp. nov. 39

12 *a*. Specimen from the Wenlock Limestone of Dudley. 12 *b*. Ornamentation. × 5. 12 *c*. The same. × 10. British Museum (Nat. Hist.), no. G. 17667.

13. Marginal groove of another specimen. × 5.

14. *Conularia elegans*, sp. nov. British Museum (Nat. Hist.), no. G. 17665 39

14 *a*. Small specimen from the Carboniferous Limestone of Farlow, Salop. 14 *b*. Ornamentation. × 10. 14 *c*. The same. × 20.

Slater, British Conulariæ.

PLATE V