AUSTRALIAN MUSEUM SCIENTIFIC PUBLICATIONS

Fletcher, Harold O., 1938. A revision of the Australian Conulariae. *Records of the Australian Museum* 20(3): 235–255, plates xxiv–xxvi. [31 August 1938].

doi:10.3853/j.0067-1975.20.1938.573

ISSN 0067-1975

Published by the Australian Museum, Sydney

A REVISION OF THE AUSTRALIAN CONULARIAE.

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(Plates xxiv–xxvi.)

Introduction.

THE present paper is a revision of the known species of *Conularia* found in Australian rocks, with descriptions of new species.

The actual position in the animal kingdom which this remarkable genus occupies is still doubtful. It has usually been regarded by authors as having pteropod affinities, although opponents to this theory have assigned the genus to many other groups. Miss Slater, in 1907,[1] revising the British Conulariae, stated that on zoological evidence the inclusion of *Conularia* among the Pteropods must be abandoned. After an exhaustive examination of their characters, Miss Slater concludes that the genus should be regarded as "an extinct group, equivalent to the Cephalopods, and derived with them from the same simple-shelled ancestor".

Members of the genus are found distributed among the European rocks from the Upper Cambrian to the Trias and Lias, with a maximum development in Middle, Upper Ordovician, and Silurian times. In Australian rocks the genus is by no means common. Species have now been recorded from the Cambrian, Upper Silurian, Carboniferous, and Permian rocks. The maximum development is in the Permian horizons, where the shells attained large size, a striking feature common to the Permian fauna of Australia.

The specimens used as a basis for this paper have been collected over a period of many years, and as a result localities and horizons may in occasional instances be in some doubt. It is essential, however, that all the Australian groups of fossils should be revised and new species founded when necessary. It is only in this way that a foundation will be laid for workers on this subject. Palaeontology has been neglected to some extent in the past in Australia, and it is most important that more intensive fossil collecting should be done. Collecting must be carried out scientifically, with complete field data, when possible, of stratigraphical sequence in any particular geological horizon. It is only in this way that the palaeontologist can hope to assist the stratigrapher. Süssmilch[2] stressed this point when he stated: "Our present fossil lists are based largely upon material collected and described many years ago; this material was probably not always localized, while many of the descriptions and determinations now possibly need revision."

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[1] Slater.—"A Monograph of the British Conulariae", Palaeontograph. Soc., 1907, pp. 9-12.
[2] Süssmilch.—Aust. and New Zealand Assoc. Adv. Sci., xxii, p. 116.

History of the Genus in Australia.

For many years very little research has been done on the Australian Conulariae. The first reference to the genus was made by Morris[3] in 1845, when that author described and figured specimens from the Illawarra district and Raymond Terrace as *Conularia levigata*. This name, spelt *laevigata*, was also given by Salter[4] in 1866 to a smooth-shelled species of *Conularia* from North Wales; as the name is pre-occupied, I would suggest that the British species be named *C. salteri*.

In 1847, McCoy[5] recorded *C. levigata* from a fine, grey, micaceous sandstone at Black Creek and from the limestone of Harper's Hill, where it was said to be common. He also described what must be considered a very doubtful species of this genus from Muree, as *C. torta*. A finely ribbed form was also described from the same beds, and named *C. tenuistriata*.

Dana in 1849[6] described a series of fossils collected by the Wilkes United States Exploring Expedition, and refers several of them to *C. laevigata* Morris, and *C. tenuistriata* McCoy. A new species, *C. inornata*, was described from the Permian beds of Glendon in the Maitland district.

De Koninck in 1877[7] recorded with reservation a small fragment of shell from the Silurian beds of Black Rock Creek, near Yass, as *C. sowerbyi* (?) Defrance. This determination was arrived at for two reasons: firstly the ornamentation was very similar, and, secondly, the fragment was collected in association with species identified at that time as forms found associated with *C. sowerbyi* in England. The status of *C. sowerbyi* is discussed under the observations of *C. chapmani*, sp. nov., where it is found that, according to the rules of nomenclature, the name *C. sowerbyi* must be dismissed and become a synonym of *quadrisulcata* Sowerby; *C. sowerbyi* must be renamed. De Koninck also recorded *C. laevigata* Morris, *C. inornata* Dana and the British species *C. quadrisulcata* Miller. *C. tenuistriata* McCoy is again recorded from the Muree beds.

R. M. Johnston in 1886[8] recorded *C. laevigata* from Tasmania, and described a new species from Bridgewater, Tasmania; this was named *C. derwentensis*, and two years later[9] the same author figured a specimen as *C. tasmanica* (allied to *C. inornata*). In a list of species on page 116, a species is listed as *C. derwentensis*, but no mention is made of *C. tasmanica*, so there appears little doubt that *C. tasmanica* was printed in error. The characters and dimensions of the figured specimen agree perfectly with those of *C. derwentensis*. *C. levigata* Morris is recorded and described from the Upper Palaeozoic limestone of the River Styx and Porter's Hill near Hobart. The figure of this species published by Johnston in 1888 is a copy of Morris's original figure.

R. Etheridge, junr., in 1889[10] discussed the structure of *C. inornata*, and in 1901[11] mentioned the upturning of the distal margin of a specimen, *C. levigata*, from the Lower Marine beds of Ravensfield. Several specimens of *Conularia* were exhibited before the Linnean Society of New South Wales in 1902 by Mr. W. S.

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[3] Morris *in* Strzelecki's Phys. Descrip. N. S. Wales, etc., 1845, p. 290, pl. xviii, fig. 9.
[4] Salter *in* Ramsay's Geol. N. Wales; Mem. Geol. Surv., iii, ed. 1, p. 354, woodc. 19 (also ed. 2, 1881, p. 552).
[5] McCoy.—Annals. Mag. Nat. Hist., xx, 1847, pp. 306-8.
[6] Dana.—Wilkes' U.S. Explor. Exped., 1838-42, x, Geology, 1849, p. 709.
[7] De Koninck.—Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 1, p. 43.
[8] Johnston.—Proc. Roy. Soc. Tasmania, 1886 (1887), p. 17.
[9] Johnston.—Syst. Acc. Geol. of Tasmania, 1888, pl. xx, figs. 1, 1*a-b*.
[10] Etheridge, junr.—Proc. Linn. Soc. of N. S. Wales (2), iv, 3, p. 751, pl. xx, fig. 1.
[11] Etheridge, R., junr.—Rec. Austr. Museum, iv, 1, 1901, p. 52.

Dun.[12] These were all from the Lower Marine beds of Harper's Hill and Ravensfield, and included *C. inornata* Dana, *C. levigata* Morris, and *C. tasmaniensis* Johnston (possibly an acute form of *inornata*). Dun mentioned that the genus is but seldom met with in the Upper Marine, but is not rare in the Lower Marine, a distribution which additional specimens prove to be incorrect, as *C. inornata* is more commonly met with in the Upper Marine beds than in the Lower.

In 1904 an additional species was added to the Australian list by Chapman,[13] as *C. ornatissima* from the Silurian beds at South Yarra near Melbourne. *C. sowerbyi* Defrance was recorded from a hard, grey mudstone at the junction of the Woori-Yallock Creek and the Yarra River near Melbourne, and from Wilson's, north of Lilydale. Both these localities are in Victoria and the beds Silurian in age.

Laseron in 1911[14] described and figured a beautifully preserved shell as *Conularia* cf. *laevigata* Morris, complete with apertural lobes. He pointed out that his specimens differed from the typical *C. levigata* in possessing four equal faces.

In 1912 the first Western Australian record of this genus was published by Glauert[15] from three crushed fragments collected at Byro Station. These are described as *Conularia* sp. nov., cf. *C. warthi* of Waagen. Miss L. Hosking in 1931[16] also compares the Western Australian species with *C. warthi*, and in 1933,[17] with additional specimens, was able to prove them identical with the Indian Salt Range species.

Conularia levigata Morris and *C. tenuistriata* have been collected and recorded from the Salt Range and Kashmir beds of India. Diener[18] records the latter species from the Ladukh Valley, Kashmir, while Waagen[19] has quoted it from the boulder beds of the Eastern Salt Range in association with *C. levigata*, according to Waagen a common species. It is strange that no trace of *C. inornata* has been found in the Salt Range beds. In Australia this common species is frequently found associated with *C. levigata* and *C. tenuistriata*, and is distinguished by its strong rectangular cross-section compared with the almost square section of *C. levigata*. Diener points out that there is a slight difference in the shape of the transverse section of the Indian *C. tenuistriata*, and suggests that, if this difference in shape be thought a sufficient reason for distinguishing the Salt Range and Kashmir type from the Australian ones by a varietal denomination, the name *Conularia tenuistriata* var. *indica* might be applied to them.

In 1936, Cowper Reed[20] was of the opinion that the form from Kashmir which Diener referred to *C. tenuistriata* McCoy, is identical with *C. punjabica* from the top of the Talchir boulder bed. In the same paper, Cowper Reed described several new species from localities at the base of the Olive Series above the Talchir boulder bed (Punjabian) of the Salt Range. *Conularia tenuistriata* Morris and *C. warthi* Waagen were also recorded.

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[12] Dun.—Proc. Linn. Soc. of N. S. Wales, 1902, xxvii, 3, p. 495.
[13] Chapman.—Proc. Roy. Soc. of Victoria (N.S.), xvi, 2, 1903, pp. 340-1.
[14] Laseron.—Proc. Roy. Soc. of N. S. Wales, 1911, xlv, p. 247, pl. xi.
[15] Glauert.—Rec. W. Austr. Mus. and Art Gallery, 1912, i, 2, p. 76.
[16] Hosking.—Journ. Roy. Soc. West. Austr., xvii, 1931, p. 36, pl. xi, figs. 3-6.
[17] Hosking.—Journ. Roy. Soc. West. Austr. xix, 1933, p. 57.
[18] Diener.—Mem. Geol. Survey of India (Pal. Indica), 1899 (xv), i, 2, p. 18.
[19] Waagen.—Records Geol. Survey India, 1886, xix, p. 25; Salt Range Fossils (Pal. Indica), 1891, iv, 2, p. 123.
[20] Cowper Reed.—Mem. Geol. Survey of India (Pal. Indica), 1936 (N.S.), xxiii, 1, pp. 29-33.

Grouping of the Species.

The genus *Conularia* has at times been subdivided into groups according to the surface characters of the shell. The most important papers on this subject have been by Lindström (1884), Holm (1893), and Boucek (1928). Lindström[21] proposed three subdivisions of the genus, based on the surface characters of five species. Holm[22] later separated the genus into four sections, following Lindström's plan as a basis for his groupings. Boucek[23] formulated an elaborate subdivision after studying forty-two species, from which he placed three in a new genus, *Conulariella*. These were *C. robusta* Barr., *C. purkneyi* Zel., and *C. sulca* Zel.; the remainder were subdivided into seven groups, following the criteria employed by Holm, but also laying emphasis on additional characters.

The Australian species of *Conularia* fall into two groups, and because of this I propose to follow, for the time being, Holm's grouping, which is as follows:

(1) *Laeves*. Surface smooth, without ridges, but frequently with transverse undulations (growth lines).

(2) *Longitudinales*. Surface ornamented throughout with longitudinal ridges, the segmental line having the form of a carina.

(3) *Moniliferae*. Surface ornamented with transverse ridges or tubercles arranged in transverse rows. A: Internal longitudinal ribs present down the centre of each face. B: Internal longitudinal ribs not present.

(4) *Cancellata*. Surface of the shell covered with strong transverse ridges usually cut by very fine longitudinal ridges (cancellated ornamentation).

List of Australian Species.

	Upper Silurian.	Devonian.	Lower Carboniferous.	Permian.	
				Lower Marine.	Upper Marine.
Section I. *Laeves*	—	—	—	—	—
Section II. *Longitudinales*	—	—	—	—	—
Section III. *Moniliferae*—					
Conularia inornata Dana	—	—	—	×	×
,, *levigata* Morris (*non laevigata* Salter)	—	—	—	×	×
,, *tenuistriata* McCoy	—	—	—	×	×
,, *expansa* sp. nov.	—	—	×	—	—
,, *derwentensis* Johnston	—	—	—	×	—
,, *crenulata* sp. nov.	—	—	—	×	—
,, *acutilirata* sp. nov.	—	—	—	—	×
,, *tuberculata* sp. nov.	—	—	×	×(?)	—
,, *mitchelli* sp. nov.	×	—	—	—	—
,, *torta* McCoy	—	—	—	—	×
Section III. *Cancellata*—					
Conularia ornatissima Chapman	×	—	—	—	—
,, *chapmani* sp. nov.	×	—	—	—	—
,, *warthi* Waagen	—	—	—	×*	×
,, *distincta* sp. nov.	×	—	—	—	—

* Ranges from Lyons to Byro Stage. See Raggatt, *Journal and Proc. Royal Soc. of N.S.W.*, lxx, 1936, pp. 100-17.

[21] Lindström.—On the Silurian Gastropoda and Pteropoda of Gotland. K. Svenska Vet.-Akad., Handb. 49, 1884.

[22] Holm.—Sveriges Kambrisk-siluriska Hyolithidae och Conulariadae. Sver. Geol. Undersokning, No. 112, 1893.

[23] Boucek.—Revise Ceskych Palaeozoickych Konularii. Palaeontographica Bohemiae Nr. xi, 1928.

The groups *Laeves and Longitudinales* are unrepresented in Australian rocks. It has been pointed out by previous workers that this method of grouping is not altogether satisfactory, as some species, closely allied, appear in different sections. In some cases species have been tentatively placed in either of the two groups represented in Australia, until further specimens may produce additional evidence.

Description of Species.

Genus **Conularia** Sowerby, 1821 (*ex* Miller MS.).

Conularia mitchelli, sp. nov.

(Plate xxiv, figs. 4–6.)

Description. Shell of medium size, smooth, tapering uniformly. Cross-section an ellipse (?). Faces unequal, convex. Apical angle small, about 10°. Facial grooves inconspicuous, maybe absent. Aperture and apex unknown. Marginal furrows, shallow, narrow and indistinct. Ornamentation fine; transverse ridges narrow 33–36 in 10 mm.), crossing almost horizontally and without any apparent break in the marginal grooves. Uninterrupted by facial grooves. Furrows smooth.

The fragment of shell described is 55 mm. in length, and the greatest width of face is 24 mm.

Observations. There is only a single example of this delicately and finely ribbed form, but it is well preserved and shows most distinctive characters. This species must have attained a considerable length as the apical angle is extremely small. It is a thin-shelled form and the test is to some extent crumpled and wrinkled. It is difficult to determine the actual cross-section. The three faces preserved on the specimen are convex, and a transverse section appears to be a natural ellipse rather than rectangular.

There is no other Australian species with which this Upper Silurian form can be compared. In the ornamentation of the shell the ridges are not bent up regularly to form a succession of chevrons as is usually the case in this group, but are almost horizontal, and in crossing the faces even show a slight tendency towards a downward curve. The latter feature is no doubt caused by pressure. *C. mitchelli* has some points in common with *C. bohemica* of Barrande,[24] particularly in the shape of the cross-section. It differs in not having the ridges studded with tubercles and in the intervening furrows being smooth. The shell surface in *C. mitchelli* is somewhat weathered, and it is possible that tubercles were present, but there is no indication of any on the single specimen examined.

Collected by the late Mr. John Mitchell, after whom the species has been named.

Locality and Horizon. Bowning, near Yass, New South Wales. Upper Trilobite beds, Bowning Series, Upper Silurian.

Collection. Australian Museum. Holotype (F.27005).

Conularia ornatissima Chapman.

1903. *Conularia ornatissima* Chapman, Proc. Roy. Soc. Victoria (N.S.), xvi, 2, p. 341, pl. xxxi, figs. 13–14.

Observations. This Upper Silurian species, described and figured by Chapman, is characteristic amongst Australian species in its small size, extremely wide

[24] Barrande.—Syst. Sil., 1867, iii, p. 35, pl. i, figs. 1-9.

apical angle of 50°, and outstanding shell ornamentation. The transverse ridges are fine, numerous, and strongly arched. At 10 mm. from the apex of the shell the ridges are 0·2 mm. apart, so that in 10 mm. of shell there would be approximately 60 ridges. On the enlarged portion of the shell (Pl. xxxi, fig. 14) the ridges approximate 60–80 in 10 mm. The intercostal striae are extremely fine, closely packed together, and extend on to the ridges, giving them a tuberculated appearance.

Chapman compares this species with *C. nobilis* Barrande from the Upper Ordovician of Bohemia, but points out that it differs considerably in its type of ornamentation.

The only Australian species with which *C. ornatissima* can be compared is *C. chapmani* mihi, but it is at once distinguished by the much wider apical angle, the fine and sharper longitudinal striae in the furrows, and the closeness of the transverse ridges.

Locality and Horizon. In the blue and yellow mudstones at South Yarra (Yarra Improvements), near Melbourne, Victoria. Melbournian Series, Silurian.

Collection. National Museum, Melbourne, Victoria. (1186, 2361.)

Conularia chapmani, sp. nov.

(Plate xxiv, figs. 1–3.)

1877. *Conularia sowerbyi* (?) De Koninck (*non* Defrance), Foss. Pal. Nouv. Galles du Sud, 3, p. 43.

1903. *Conularia sowerbii* Chapman (*non* Defrance), Proc. Roy. Soc. Victoria (N.S.), xvi, 2, p. 340, pl. xxxi, figs. 10–12.

Description. Shell of small size, delicate and tapering more or less uniformly. Apical angle about 26°. Ornamentation fine; transverse ridges well marked (16 in 10 mm.), becoming more crowded at the apex. Aperture and apex unknown. Facial grooves inconspicuous. Marginal grooves not preserved. Ridges cross the face at an angle of 145° to 150° along the median line, and are uninterrupted. Furrows crossed with prominent stout bars, separated by the width of a bar, and extending on to the ridges to form small rounded tubercles. Tubercles are visible only on a close examination of well-preserved portions of shell; otherwise the ridges appear non-tuberculate.

Length of figured specimen 28 mm. Width of face at apertural end of fragment 17 mm.

Observations. Several specimens have been recorded from the Upper Silurian rocks of Australia as the British species *C. sowerbyi.* These in my opinion are not typical of that species, although possessing many points in common with it. Sufficient variation, however, is shown to allow the Australian species new specific rank. *C. sowerbyi* (?) Defrance was recorded with reservation by De Koninck[25] from the Upper Silurian beds of Black Rock Creek near Yass, but was not figured. The specimen, a single small fragment, was afterwards destroyed in the Garden Palace fire of 1882. De Koninck was unable to say positively that this specimen belonged to *C. sowerbyi*, but believed it to be so for two reasons: first, that the ornamentation was very similar, and, second, that it occurred with other species found in association with *C. sowerbyi* in England. De Koninck's record is now of little value, as the specimen is destroyed, there was no figure,

[25] De Koninck.—Foss. Pal. Nouv. Galles du Sud, 3, 1877, p. 43.

and his description is rather meagre. However, as his specimen was collected from the same beds as, and at no great distance from the locality of, *C. chapmani*, I have presumed that they are identical, and have included his reference as a synonym of *C. chapmani* rather than expunge it from Australian literature.

The single specimen of *C. chapmani*, collected from Bowning in the Yass district, although at first glance similar to *C. sowerbyi*, has many points of difference. In *C. chapmani* the ridges are not as tuberculated as in the British species, even allowing for weathering, while the longitudinal bars in the furrows are not nearly in contact laterally. In *C. sowerbyi* the apical angle is much smaller, and doubtless that species attained a much larger size than the Australian form, which from the appearance of the single fragment would not be a large shell.

Chapman records and figures *C. sowerbii* Defrance from the Upper Silurian beds of Victoria, a comparatively broad form which agrees in some respects with the specimen of *C. chapmani* mihi, but differs from the typical *C. sowerbyi*, as a glance at the ornamentation of both those species shows considerable variation. A close examination reveals that Chapman's species is unlike *C. chapmani* in that the ridges are more crowded, there being twice as many ridges in 10 mm. of shell. It agrees more or less in the non-tuberculated nature of the ridges and in the apical angle. These two forms are closely allied and have been placed together until more specimens from the Silurian beds may produce additional evidence.

Notes on the British Species Conularia sowerbyi de Verneuil.

An interesting point in nomenclature has arisen in regard to the well-known British species *C. sowerbyi*. In 1821 Sowerby[26] described *C. quadrisulcata* from four specimens (pl. cclx., figs. 3–6). These included several species from two different geological horizons. Later, in 1824, the name *C. sowerbyi* attributed by de Blainville to Defrance, with a reference to the "Dictionnaire des Sciences Naturelles", was published. Blainville reproduced all Sowerby's six figures, including his *C. teres*, but gave no description, so that Defrance's right to the species is most doubtful. Sowerby, however, in 1821 definitely mentioned that his description of *C. quadrisulcata* was taken from figure 4, of a very excellent specimen, found by the Rev. R. B. Plumtree, of Gloucester, in transition limestone. This specimen had been given to Miller, who in 1793[27] founded the genus *Conularia* on it, but referred to it as a "curious fossil", the class of which had not been determined. This specimen (fig. 4) is undoubtedly the type specimen of *C. quadrisulcata.*

De Verneuil in 1845[28] would restrict Sowerby's name *C. quadrisulcata* to the Carboniferous species, and adopt Defrance's name *C. sowerbyi* for the Silurian species. Slater[29] points out that, "as this description is accompanied by a clear figure, and since this is the first time that the two forms have been definitely separated and named, the species should be assigned to de Verneuil". This is quite inaccurate as shown above, the name *C. quadrisulcata* being absolutely founded on the specimen (fig. 4), a transition limestone species. The name *C. sowerbyi* must be dismissed entirely, as it was given to the two species intro-

[26] Sowerby.—Min. Conch., iii, 1821, p. 107, pl. 260, figs. 3-6.
[27] Ure.—History of Rutherglen and Kilbride, 1793, pp. 330-331, pl. xx, fig. 7.
[28] De Verneuil *in* Murchison, de Verneuil and Keyserling, Geol. de la Russie d'Europe, 1845, ii, p. 348, pl. xxiv, fig. 5.
[29] Slater.—Monograph of British Conulariae, Palaeon. Soc. ,1907, p. 2.

duced by Sowerby merely as an alternative name, and therefore it should be restricted to fig. 4 also, and become an absolute synonym of *quadrisulcata.*

De Verneuil assigns figures 2*c* and 2*e* of Defrance, or figures 3 and 4 of Sowerby, to *C. sowerbyi*, thereby including the type specimen of *C. quadrisulcata.* In 1855 McCoy[30] points out that the Silurian species should be *C. quadrisulcata*, as the description applied more to the principal specimen (fig. 4) than to any others. He was at first inclined to follow the specific nomenclature of Sandberger, who, in 1847,[31] renounced entirely the name *quadrisulcata* and the still more indefinite *sowerbyi*, and thus on p. 287 used *cancellata.* However, on p. 520, apparently after second thoughts, he used *quadrisulcata*, but unfortunately allotted the name to fig. 5, and then used it for a Carboniferous species.

In Slater's excellent Monograph of the British Conulariae, published in 1907, the type specimen of *C. quadrisulcata* is placed as a synonym of *C. sowerbyi*, while the original figures 5 and 6 of Sowerby are assigned to *Conularia quadrisulcata.* Sowerby's original figure 3 is now a synonym of *C. subtilis* Salter.

Localities and horizons of *Conularia chapmani* are as follows: Junction of the Woori-Yallock and Yarra Rivers, near Melbourne; Wilson's, north of Lilydale, Victoria. Yeringian Series, perhaps younger, Silurian (Chapman). Bowning, near Yass, New South Wales. Upper trilobite beds, Bowning Series, Upper Silurian (Mitchell).

Collection. Australian Museum. (F.28590.) Holotype.

Conularia distincta, sp. nov.

(Plate xxiv, figs. 7–9.)

Description. Shell of medium size, thin, tapering uniformly. Cross section unknown. Faces flat; apical angle about 22°. Marginal grooves not preserved. Facial grooves distinct; aperture and apex unknown. Ornamentation fine; transverse ridges studded with small tubercles, well separated. Ridges arched strongly across the faces (16–18 in 5 mm.), becoming more crowded near the apex and forming an angle of 130°, widening to about 145° towards the apertural end. Ridges undisturbed by facial grooves. Furrows well-marked with longitudinal striations sloping strongly towards the marginal grooves.

Length of fragment 38 mm. Greatest width of face 14 mm.

Observations. This species is represented by a single specimen from the Upper trilobite beds of the Bowning district. The four faces of the shell have been crushed flat and in places are badly wrinkled, but a considerable amount of shell reveals well preserved ornamentation. It is impossible to determine accurately what the cross section was, although the evidence appears to point to its being square. The detailed ornamentation differs from that of *C. chapmani* mihi, the only other Australian species with which it can be compared, in the ridges being placed much closer together, there being almost twice as many in 5 mm. of shell. The striations in the furrows of *C. chapmani* are long, stout, and vertical, whereas in *C. distincta* they are short and slope towards the margins of the shell. The tubercles on the ridges are very minute, and are only preserved on favoured portions of the shell.

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[30] McCoy.—Synops. Brit. Palaeozoic Rocks, 1855, p. 287, 520.
[31] Sandberger.—"Pteropoda der ersten Erdbildungs-Epoche: Conularia und Coleoprion", Neues Jahrb. für Min., etc., 1847, p. 8.

C. distincta is rather an uncommon form so far as the furrow striations are concerned, and there is no other species to my knowledge that it closely resembles. The transverse ridges are very strongly arched near the apex, but the angle becomes less towards the apertural end.

Locality and Horizon. Bowning, near Yass, New South Wales. Upper trilobite beds, Bowning Series, Upper Silurian (Mitchell).

Collection. Australian Museum. Holotype (F.27905).

Conularia warthi Waagen.

(Plate xxiv, figs. 10–11.)

1886. *Conularia* cf. *irregularis* (Kon.) Waagen, Rec. Geol. Surv. of India, xix, p. 26, pl. i, fig. 2 (non *Conularia irregularis* De Koninck).

1891. *Conularia warthi* Waagen, Mem. Geol. Surv. of India (Pal. Indica) (xiii), iv, 2, p. 126, pl. iv, figs. 6*a–d*; pl. v, figs. 1*a–b*.

1912. *Conularia*, sp. nov. (?), cf. *C. warthi*, Glauert, Rec. W. Austr. Mus. and Art Gallery, i, 2, pp. 76–77.

1931. *Conularia* cf. *C. warthi*, Hosking, Journ. Roy. Soc. of W. Austr., xvii, p. 36, pl. xi, figs. 3–6.

1933. *Conularia warthi* Hosking, Journ. Roy. Soc. of W. Austr., xix, p. 57.

Observations. This important Indian species has now been collected from several localities in Western Australia. Described originally from the Lower Speckled Sandstone (Boulder beds) of the Salt Range, its presence has been suspected in Australian rocks for some time, but imperfect material has prevented a definite classification until the last few years.

Glauert in 1912 described three crushed fragments of shell in an ironstone matrix from Byro Station, as *Conularia*, sp. nov (?). He compared his fragments with *C. warthi* Waagen, but refrained from assigning them to that species, as he was unable to find "the fine, somewhat irregular plications that extend transversely over the spaces or valleys between the single ribs", characteristic of the Indian fossil. In 1931 Miss Hosking described and figured some imperfect fragments, identical with those described by Glauert, including specimens showing additional characters. Miss Hosking (p. 37) remarks that: "On one portion where the shelly material is preserved the plications may be seen descending the sides of the ridges, so that it may well be supposed that they are continuous across the valleys between the ridges." In 1933 the same author was able to state definitely that the Western Australian and Indian species are the same. A specimen collected from the Wooramel area showed the rhombic cross section and the typical ornamentation of *C. warthi*, including the row of intercostal tubercles on each side of the lateral furrows.

In the Australian Museum collection is a small suite of fragmentary specimens collected by Mr. H. G. Raggatt from the Gascoyne River. These occur in an ironstone matrix, similar to that described by Glauert, and are associated with crinoid stems. In breaking the ironstone matrix to develop the shell fragments, small portions of beautifully preserved shell were revealed showing delicate ornamentation. The shelly material appears to have been formed of two layers, an outer showing excellent ornamentation, and a thin inner layer revealing distinct granulated ridges, but only indistinct ornamentation in the intercostal areas. On weathered fragments only the studded ridges are shown, the intercostal areas or furrows apparently being quite smooth. The shell is of medium size,

tapering slowly and uniformly, the apical angle being small, about 14°. Cross section rhombic. Facial grooves distinct. Marginal grooves narrow and comparatively deep. The ornamentation consists of transverse ridges, strongly arched across the faces, and varying in number according to the position on the shell. On one specimen (Pl. xxiv, fig. 10) the ridges number 14 within the space of 10 mm. at a distance of 50 mm. from the apex, while 20 mm. from the apex they number 20 in 10 mm. The ridges are interrupted in the centre of the faces by the facial grooves, and on their tops are studded with fine tubercles. These are connected with the fine irregular plications which cross the furrows. In all other characters the fragments agree perfectly with the descriptions given by Waagen and Miss Hosking.

The majority of fragments are of small size, but frequently fragments of shell faces reveal a much larger shell. One fragment measured 20 mm. across the face.

Dimensions of figured specimen: Length 50 mm. Greatest width of face 10 mm.

Localities and Horizon. Western Australia: Byro Station, Murchison district (Glauert); two miles E.S.E. of Survey Station R.20; Bogadi Outcamp, 7 miles south of Survey Station R.18; two miles almost east of Survey Station R.20 in cliff on south bank of Wooramel River (Hosking); Gascoyne Junction, near hotel (Raggatt), Windalia Outcamp, Lynden River (Lyons Stage). Byro Stage, Permian.

Collection. Australian Museum. Figured specimen No. F.36551.

Conularia tuberculata, sp. nov.

(Plate xxv, figs. 1–7.)

Description. Shell of medium size, tapering uniformly. Cross section rectangular, faces unequal. Apical angle 15°–23°. Marginal grooves narrow, of medium depth. Facial grooves distinct. Aperture and apex unknown. Ornamentation fine; transverse ridges average about 14 in 10 mm. of shell, arched across the faces at an angle of about 148°. Ridges studded with minute tubercles tapering upward into small points. In the median line the ridges are disturbed by the facial groove and frequently alternate with one another. Furrows are ornamented with fine longitudinal striations, usually well separated.

Dimensions of fragment (F. 28480, figs. 1–2): Length 32 mm. Approximate complete length 90 mm. Width of wide face, 18 mm.; width of narrow face, 11 mm.

Observations. This delicately ornamented species is represented by a small suite of specimens from the Burindi (Lower Carboniferous) beds of New South Wales. An impression of a small fragment of shell from the Willi Willi (Lower Permian) beds of Kempsey is apparently close to this species. It is a characteristic form and easily distinguished by the very unequal faces, the wide face being almost twice the width of the narrow one. The specimens are in a fairly good state of preservation, except for a slight flattening through pressure. This is well marked in Plate xxv, fig. 1, where it can be seen that the ridges on the apertural end have been distorted into very abrupt curves. After allowing for a certain amount of flattening the faces are markedly unequal, with a distinct rectangular cross section. The average number of ridges in 10 mm. appears to be about 14, although in one specimen (fig. 4), a fragment from the extreme apical region, the ridges approximate 30 within 10 mm. of shell. The ridge crests are

studded with minute tubercles, fairly close-set, which taper upwards to form sharp points, and these occasionally may be slightly hooked. The ridges cross the faces at angles of approximately 148°, although in figure 2 it will be noticed that the straight sides of the chevrons have been replaced by simple curves. This character is not constant, and is probably due to pressure and slight distortion. In well-preserved portions of the shell the longitudinal striations in the furrows are plainly distinguished. These extend right across the furrow and are not in contact laterally. In badly weathered shells the striae in most cases are indistinguishable, or maybe absent altogether, and the furrows appear smooth. In one very small fragment of shell from Kempsey, New South Wales, the striae are particularly noticeable. This fragment is associated in the matrix with *Productus brachythaerus* Sowerby and *Strophalosia gerardi* King, collected from the Willi Willi beds of the Macleay Series. These have been designated recently by Mr. A. H. Voisey as being Permian in age, so that in all probability *Conularia tuberculata*, which is not uncommon in the Carboniferous beds of New South Wales, also extends into the Permian.

There is no other Australian species of *Conularia* that can be compared with *C. tuberculata*. The tuberculated nature of the ridges, the longitudinal striae in the furrows, and the comparatively small size of the shell make it an unmistakable species.

Localities and Horizon. Bramble's Farm, Myall Lakes; Clarencetown; Taree; New South Wales, Lower Carboniferous. Kempsey, New South Wales, Lower Permian.

Collection. Australian Museum. Figured specimens: Pl. xxv, figs. 1–2 (F.28480); fig. 3 (F.29019); fig. 4 (F.25178); fig. 5 (holotype, F.29022); figs. 6–7 (F.36583).

Conularia expansa, sp. nov.

(Plate xxv, figs. 8–9.)

Description. Shell of large size, broad, and tapering uniformly. Apical angle 29°–32°. Cross section square (?). Marginal grooves narrow, shallow. Central facial groove well-marked. Aperture and apex unknown. Ornamentation fine. Ridges prominent, 12–13 in 10 mm., forming a broad curve across the face, uninterrupted by the facial groove and apparently continuous across the marginal groove. Ridges studded on their crests with small tubercles (3–4 in 1 mm.). Furrows about twice the width of the ridges and perfectly smooth.

The total length is estimated to be about 160 mm. Greatest width of face 55 mm.

Observations. The outstanding feature of *Conularia expansa* is the wide apical angle, together with its large size and definite type of ornamentation. There is only one example of this species, but it is exceptionally well preserved and shows an almost complete face. This specimen is from the Lower Carboniferous beds of Clarencetown, New South Wales, and is by far the largest of the Australian Carboniferous Conulariae. There are not many species with which the present form can be compared. Its closest resemblance is with *Conularia quadrisulcata* Sowerby, a British Carboniferous species attaining a length of over 200 mm., and with the same type of ornamentation. De Koninck[32]

[32] De Koninck.—Foss. Pal. Nouv. Galles du Sud, 1877, 3, p. 173.

records *C. quadrisulcata* from Buchan, on the Gloucester, where it was found in a brownish argillaceous limestone, but his specimen was unfortunately lost in the Garden Palace fire of 1882. De Koninck mentions that with a lens one can see irregular transverse striae at the bottom of the furrows; the apical angle is 20°, and there are 24 ridges in 10 mm. of shell. He also states that his single specimen is rhomboidal in cross section. These characters do not entirely agree with the description of the typical *C. quadrisulcata* as defined by Slater,[35] so that there must remain a certain amount of doubt whether the Australian shell was the same as the British species. *Conularia expansa* differs from *C. quadrisulcata* in possessing a far greater apical angle (30°). In the latter it is 12°–14°. The curved ridges are also a distinctive character in the Australian species, as the specimen has received, apparently, very little distortion in its preservation.

The ridges for the most part are uninterrupted by the central facial groove, and are continuous across the marginal grooves, except for a slight upward tendency. *Conularia expansa* is closely allied with *Conularia acutilirata*, from the Middle Permian beds, in shape and size, but differs in the ridges possessing tubercles and in the smooth furrows. In *C. acutilirata* another point of difference is the wide marginal furrows with the interlocking of the ridges.

Locality and Horizon. Clarencetown, New South Wales. Burindi beds, Lower Carboniferous.

Collection. Australian Museum. Holotype (F.36606).

Conularia torta McCoy.

1847. *Conularia torta* McCoy, Ann. Mag. Nat. Hist., xx, p. 306, pl. xvii, figs. 9–10.
1849. *Conularia torta* Dana, Wilkes' U.S. Explor. Exped., Geology, x, p. 710.

McCoy's original description of this species is as follows: "Very elongate-conic, diminishing in diameter at the rate of one line in two inches; section oval; lateral longitudinal channels only two (?), placed with a slight obliquity to the long axis of the shell, giving it a twisted appearance, being placed at the sides (or extremities of the short axis) of the oval section at the base, and being at the ends (or extremities of the long axis) of the oval section near the small end; sides very convex without mesial furrow; transverse sulci coarse (about fifteen in half an inch), continued uninterruptedly across from one side furrow to the opposite."

McCoy records this species as being not uncommon in the Upper Permian sandstone of Muree, New South Wales, but to my knowledge it has not been collected since, although a good deal of collecting has been done in that area. The description given by McCoy of this extraordinary form, from two specimens, shows many modifications from the typical members of the group. Dana remarked on McCoy's description of this species of *Conularia* from Muree, and its having but two longitudinal furrows (articulating sutures). It is quite possible that additional specimens may prove *Conularia torta* to be a true Pteropod shell and distinct from the Conulariae. At present it must be considered a doubtful species of *Conularia.*

Locality and Horizon. Sandstone at Muree, New South Wales. Upper Marine Series, Upper Permian.

[35] Slater.—"A Monograph of the British Conulariae", Palaeon. Soc., 1907, p. 25.

Conularia levigata Morris.

(Plate xxv, figs. 10–13; Plate xxvi, fig. 4.)

1845. *Conularia levigata* Morris *in* Strzelecki's Phys. Desc. of New South Wales, p. 290, pl. xviii, fig. 9*a*, *b*.
1849. *Conularia levigata* Dana, Wilkes' U.S. Explor. Exped., Geology, x, p. 710, pl. x, fig. 9.
1877. *Conularia laevigata* De Koninck, Foss. Pal. Nouv. Galles du Sud, p. 313, pl. xxiii, fig. 1.
1886. *Conularia laevigata* Waagen, Rec. Geol. Survey of India, xix, p. 25, pl. i, fig. 1.
1886. *Conularia laevigata* Johnston, Proc. Roy. Soc. Tasmania (1887), p. 18.
1891. *Conularia laevigata* Waagen, Mem. Geol. Survey of India, Salt Range Fossils, iv, 2, p. 123, pl. iv, figs. 5*a–g*; pl. iii, figs. 1*a–b*, 2*a–b*.
1911. *Conularia* cf. *laevigata* Laseron, Journ. and Proc. Roy. Soc. of N. S. Wales, xlv, p. 247, pl. xi.

The original description given by Morris of this species is as follows: "Shell smooth, elongate, pyramidal, rectangular, gradually decreasing, two of the faces larger than the other two; faces slightly concave, longitudinally sulcated at the lateral angles, ornamented with equal transverse ridges, forming a slightly obtuse angle in the mesial furrow, where they alternate with each other; ridges terminating at the bottom of the lateral channels, curving slightly upwards, and alternating with each other, producing a slightly granulated ridge."

Observations. Salter[34] in 1866 described a species of *Conularia* from North Wales as *C. laevigata*. This name was pre-occupied by Morris in 1845 for the Australian species. In the introduction of this paper it was suggested that the British species be renamed *C. salteri*.

Morris in describing *C. levigata*, stated that the shell was rectangular in cross section, two of the faces being larger than the other two, and the number of ridges within the space of half an inch of shell numbered 16. Dana, in 1849, described this form from Harper's Hill, and stated that the sides are subequal, the larger face in one individual measuring six-tenths of an inch, the smaller face fifty-six-hundredths of an inch. He also adds: "The form of this species in the specimen before us is but slightly convergent, except at the summit. . . . There are 14 to 16 plications in half an inch; and the plicae are smooth, without markings of any kind. No Conulariae were observed in Illawarra, to which region this species is accredited by Strzelecki."

Waagen, in characterizing *C. laevigata* from the boulder- group of the Eastern Salt Range, stresses that the most striking characters, which always hold good in this species, are: first, the rectangular, not quadratic section of the shell; second, the always smooth condition of the ribs, and the very regular distribution of these, so that always ten to twelve can be counted within the distance of 10 mm.

In a large series of specimens, from many localities in New South Wales, the cross section of this species appears to be almost square, with a slight tendency towards rectangularity in some instances. In the type specimen the cross section is rectangular, with faces in proportion of four to five. Dana's figured specimen has almost equal faces, while Laseron's specimen, identified as *Conularia*

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

cf. *laevigata*, which I have assigned to this species, has almost equal faces. The Indian species, according to Waagen, are more inclined to a rectangular cross section and not quadratic.

There is a good deal of variation in the arrangement of ribs. Morris stated in his description that the transverse ribs alternate with each other at the mesial furrow. This feature is not consistent, and it has already been pointed out by Waagen that "sometimes, however, in one and the same specimen, they do not alternate, but unite directly with each other, and then form simply bent lines". This is found in the Australian specimens, where in occasional well-preserved specimens the ribs are uninterrupted across the faces.

Laseron, in 1911, described and figured a specimen from the Lower Permian of the Maitland district as *Conularia* cf. *laevigata* of Morris. After a careful examination I can find no reason to distinguish this specimen from *C. levigata*. Laseron pointed out that the only difference was in the relative proportions of the walls. In his specimen the four sides are practically equal, whereas he considered *C. levigata* as strictly rectangular in cross section.

Conularia levigata is apparently a rather common species in the Lower Marine rocks of the Australian Permian, although several specimens have been recorded from the Upper Marine beds. Morris recorded the species from the Lower Marine of Raymond Terrace and from the Upper Marine of Illawarra. Dana records it as being abundant at Harper's Hill, while De Koninck records the Rev. W. B. Clarke as having found it at Black Creek and in the Muree sandstones.

There cannot be much doubt about the determination of this form. It differs from *C. inornata* of Dana by its almost square cross section, compared with the extreme rectangular cross section of that species. The apical angle is small in *C. levigata*, and it appears that the species must have attained a considerable size. The specimen figured on Plate xxvi, figure 4, has a length of 150 mm. The greatest width of the face is 22 mm. The affinities of *C. levigata* with other species have been dealt with by earlier authors.

Localities and Horizon. New South Wales: Farley; Raymond Terrace; Harper's Hill; Ravensfield; Greta; Jackson Hill, Cessnock; Pokolbin. Tasmania: River Styx; Porter's Hill. Lower Marine Series, Permian. New South Wales: Ulladulla. Upper Marine Series, Permian.

Collection. Australian Museum. Figured specimens: Plate xxv, fig. 10 (F.25779); fig. 12 (F.25780); fig. 13 (F.36590). Plate xxvi, fig. 3 (F.36588).

Conularia inornata Dana.

(Plate xxvi, figs. 2, 5, 8.)

1849. *Conularia inornata* Dana, Wilkes' U.S. Explor. Exped., Geology, x, p. 709, pl. x, fig. 8 (Atlas).

1877. *Conularia inornata* De Koninck, Foss. Pal. Nouv. Galles du Sud, 3, p. 176, pl. xiv, fig. 22.

Description. Shell large, varying considerably in size; tapering slowly and uniformly. Cross section rectangular. Faces unequal; the narrow faces two-thirds the width of the wide ones. Apical angle about 12°–14°. Marginal grooves wide and shallow, a definite groove being formed at the base by the ends of the transverse ridges. Aperture unknown, apex pointed. Ornamentation coarse; transverse ridges finely edged, widely separated (10 to 12 within 10 mm. of

shell), forming an angle of about 150° down the centre of each face. Ridges become more crowded towards the apex of the shell. Facial groove central and distinct, interrupting the transverse ridges so that they occasionally alternate with each other. In the marginal furrows the ridges arch strongly upwards and interlock with each other, forming a distinct raised ridge in the centre of the marginal groove. Furrows smooth.

Length of largest specimen in Australian Museum collection (F.6413), figured on Plate xxvi, figure 2, is about 305 mm. Greatest width of face 32 mm.; small face 24 mm.

Observations. Dana's original description of this species is as follows: "Large, adjoining sides very unequal, smaller three-quarters the breadth of larger. Plicae remote (ten to half an inch), naked, smooth (?); angle of convergence 12°."

The type specimen of this species was collected from the Upper Marine beds of Glendon, New South Wales, and is at present housed in the United States National Museum, Washington, U.S.A. A plaster cast proves it to be nearly three inches in length. The greatest width of the wide face is 28 mm., the narrow face 23 mm. Dana in his description gives the dimensions of the faces at the smaller extremity, three-quarters and nine-tenths of an inch; at the larger extremity, nine-tenths and one inch and two-tenths. The cast shows the specimen to be in a very poor state of preservation. The marginal grooves are poorly preserved, and the faces are badly weathered, almost to the exclusion of any ornamentation. Dana stated that "it is impossible to determine whether the surface of the ridges were quite smooth or crenulated, though it is apparent they could not have been regularly crenulated". The ridges are quite smooth in this species and the furrows are not ornamented.

De Koninck gave a more complete description of *C. inornata* in 1877, when he described a single specimen found by the Rev. W. B. Clarke in a dark grey micaceous sandstone about one and a half miles from Maitland. From one of the fragments De Koninck estimated the length to have been at least 400 mm., although the diameter of the base was only 40 mm. The four faces were depressed in Clarke's specimen (since lost in the Garden Palace fire of 1882), a feature common in most specimens of this species.

Conularia inornata is a not uncommon species in the Upper Marine beds of New South Wales, but is rare in the Lower Marine beds. A good series is represented in the Australian Museum collection, embracing large specimens of over 300 mm. and smaller or juvenile shells measuring about 90 mm.

There has always been a certain amount of confusion over the two species *C. inornata* and *C. levigata.* There is no doubt that they are closely allied and bear a strong resemblance to one another. In both species there is a considerable amount of variation in the number of ridges, which are approximately the same within 10 mm. of shell. The two main points of difference are the extreme rectangular cross section of *C. inornata* and the distinctly raised ridge in the marginal furrows. The apical angle is also wider than in *C. levigata.*

Dana recorded the species from Glendon, while the Rev. W. B. Clarke found it near Maitland in the Newcastle district. Johnston[35] records it doubtfully from the Lower Marine beds of Tasmania. It is strange that this common

[35] Johnston.—Syst. Acc. Geology Tasmania, 1888, p. 116.

Australian species has not been found in the Salt Range beds associated with *C. levigata* and *C. tenuistriata*. It is possible that this species may yet be found in the Indian Permian.

Localities and Horizon. New South Wales: Harper's Hill, Farley, Lower Marine Series, Permian. Shoalhaven, Kiama, Branxton, Capertee, Richmond Vale, Upper Marine Series, Permian.

Collection. Australian Museum. Plate xxvi, fig. 2 (F.6412); fig. 5 (F.36597); fig. 12 (F.36596).

Conularia tenuistriata McCoy.

(Plates xxvi, figs. 7, 8, 10, 11, 14.)

1847. *Conularia tenuistriata* McCoy, Annals and Mag. Nat. Hist., xx, p. 307, pl. xvii, figs. 7–8.

1877. *Conularia tenuistriata* Koninck, Foss. Pal. Nouv. Galles du Sud, ii, p. 310, pl. xxiii, fig. 2.

1886. *Conularia tenuistriata* Waagen, Records Geol. Survey of India, xix, 1, p. 26, pl. i, fig. 3.

1891. *Conularia tenuistriata* Waagen, Mem. Geol. Survey of India (Pal. Indica), iv, 2, p. 125, pl. v, figs. 2–3.

Observations. This species, which is comparatively rare in Australian rocks, is characterized by possessing a rhomboidal cross section and fine transverse ribs; these are closely set together, approximating 27 to 29 within the space of half an inch of shell. It has marked unequal faces, while the furrows are ornamented with longitudinal striae, seen only in well-preserved portions of the shell.

McCoy in 1847 described this species from the Upper Marine micaceous sandstone of Muree, New South Wales, where it was said to be not uncommon, but to my knowledge very few specimens have been collected since that date. In his original description, McCoy stated that the cross section was rhomboidal, with decided unequal faces; two narrow faces flat, or slightly convex, about half of the width of the two wides ones, which are slightly concave. He also stated: "The transverse striae are very fine, twenty-seven to twenty-nine in the space of half an inch, passing uninterruptedly with a slight upward curve, across the broad faces, more nearly straight on the two narrow ones." He gives the dimensions of one specimen, imperfect at both ends, and measuring one and a half inches long, as follows: "Long diameter at base 9 lines, the short diameter at base 4½ lines; long diameter smaller end 6½ lines, short diameter at ditto 3 lines."

This description defines an outstanding type of *Conularia*; one that has a strongly rectangular cross section, or rhomboidal, and with twenty-seven to twenty-nine transverse ribs within half an inch of shell.

De Koninck in 1877 described a further specimen from the type locality which differed from McCoy's specimen in having only nineteen ribs to 10 mm. of shell. The cross section was the same. De Koninck pointed out that the furrows are striated in the direction of the main axis.

Waagen, in recording this species from the Salt Range beds of India, pointed out "the difference of breadth between the two sides of the shell is not quite as strong as in the Australian ones, the narrower side being slightly more than

half the breadth of the broader one". He also stated "the number of ridges are not quite in accordance with McCoy's indications, who counts 27 to 29 within the space of half an inch". Diener in 1899 is doubtful whether the Indian specimens ought to be identified with McCoy's species, because of the difference in shape of the cross-section. In the Salt Range form the narrow sides of the shell are nearly two-thirds the breadth of the broader ones, and seventeen to twenty ribs are counted within the space of 10 mm. As far as the ribs are concerned there is only a slight variation, as in McCoy's specimen, which shows twenty-seven to twenty-nine ribs in half an inch, would possess twenty-two to twenty-three ribs within the space of 10 mm. The variation in the number of ribs is explained by Waagen.

Conularia tenuistriata is uncommon in Australian rocks and the material for examination is poor. In the suite of specimens examined there is a considerable amount of variation both in the shape of the cross section of the shells and in the number of ribs within a given space. The rhomboidal section does not appear to be constant, and I think it quite possible that this character may be caused by deformation of the shell. The majority of specimens have a rectangular cross section.

A single fragment of shell from Kashmir was referred by Diener[36] to *Conularia tenuistriata* McCoy, but Cowper Reed in 1936[37] placed this form as being identical with his new species of *C. punjabica*.

The typical *C. tenuistriata* may be distinguished by the strong rhomboidal or rectangular cross section and a very small apical angle, which gives the specimens an extremely elongated appearance. Faces concave. In the Australian specimens it is difficult to detect longitudinal striae in the furrows, although several specimens reveal a faint indication of them. De Koninck found them on his specimen from Muree.

De Koninck recorded *C. tenuistriata* from the type locality. It has also been recorded with some doubt from the Gympie beds of Queensland by R. Etheridge, junr. Waagen recorded it as being rare in the Salt Range beds, while Cowper Reed described a few specimens from a "*Conularia* zone" one foot thick in the Olive Series, above the Boulder bed and the Eurydesma zone of the Salt Range.

The typical *C. tenuistriata* has been collected from the Lower Marine and Upper Marine beds.

Localities and Horizon. New South Wales: Pokolbin; Ravensfield; Lower Marine Series. Muree; Raymond Terrace; Upper Marine Series.

Collection. Australian Museum. Plate xxvi, figs. 7, 8 (F.25782); figs. 10, 11 (F.26103); fig. 14 (F.20570).

Conularia acutilirata, sp. nov.

(Plate xxvi, fig. 1.)

Description. Shell of large size, moderately thick, tapering uniformly and fairly abruptly. Cross section rhombic. Faces equal, flat; apical angle 23°. Marginal grooves wide, shallow. Ornamentation very distinct; strong bladed

[36] Diener.—Mem. Geol. Survey of India, 1899 (Pal. Indica) (xv), i, 2, p. 18, pl. vii, fig. 6.

[37] Cowper Reed.—Mem. Geol. Survey of India, 1936 (Pal. Indica) (N.S.), xxiii, Mem. 1, p. 31.

transverse ridges (13 in 10 mm. of shell) arch gently across the face, meeting in the centre at an angle of about 157°. Ridges interrupted by a distinct facial groove, and often alternate, otherwise continuous. In the marginal grooves the ridges trend sharply upwards and interlock with those of the adjacent face, tapering away as they pass the median line of the groove. The furrows are wide, usually smooth, although traces of longitudinal striations or wrinkling may be seen near the proximal end.

Length of described specimen 125 mm. Greatest width of face 45 mm. Calculated length approximately 220 mm.

Observations. Two well-preserved examples of this species, both from the Upper Marine beds of the Middle Permian, were collected at Branxton and Maitland, New South Wales. The ridges show little or no distortion from pressure, and it would appear that the rhombic cross section is the natural one. I can find no traces of tubercles on the ridges. Originally the ridges must have terminated in finely bladed edges, slightly overhanging the furrows towards the apex of the shell. The edges have been broken and shattered and at first glance have a somewhat tuberculated appearance. On several parts of the shell, particularly near the apertural end, longitudinal striae are visible on the sloping surface of the ridges, extending well into the furrows. For the most part the furrows are perfectly smooth. In one specimen no traces of longitudinal striae are visible in the furrows. This comparatively large form is an outstanding species amongst the Australian Conulariae and cannot be confused with any existing species. It differs from *C. inornata* Dana, in its wide apical angle and rhombic cross section. It also possesses points of resemblance with *C. expansa* from the Carboniferous rocks, as far as dimensions are concerned, but does not possess the finely tuberculated ridges. The marginal grooves in *C. acutilirata* are much wider than in *C. expansa*, a species in which they are narrow and continuous. The method of the interlocking ridges is similar to that found in *C. quadrisulcata* Sowerby from the Carboniferous of England, but in that species the ridges are strongly tuberculated, the apical angle is smaller and the cross section is square.

Localities and Horizon. Branxton, near Maitland; East Maitland Company's shaft, near Farley, New South Wales. Upper Marine Series, Permian.

Collection. Australian Museum. Figured specimen F.36205.

Conularia crenulata, sp. nov.

(Plate xxvi, fig. 15.)

Description. Shell of medium size, tapering uniformly and slowly. Cross section a rhomb, with equal faces and flat, except for a slight convexity towards the facial grooves. Apical angle 11°–12°. Marginal grooves of medium depth and width, rounded. Facial grooves distinct, not interrupting the transverse ridges. Ornamentation consists of very fine ridges with wide furrows. No trace of any striae on furrows. Ridges moderately close (average 14 within 10 mm. of shell), arched across the face at a fairly wide angle, and crenulated to a marked degree. In the marginal grooves the ridges trend upwards, and although they alternate with the ridges of the adjoining face rarely overlap.

One specimen, approximately 120 mm. in length, has a facial width at the apertural end of 28 mm.

Observations. It is with some hesitation that this specimen is described as a distinct form. The crenulated nature of the ridges appears to be too constant

and regular to have been caused by distortion, while in the same matrix and at no great distance from the specimen in question a fragment of *C. levigata* Morris shows no distortion of the ridges at all. It is distinct from all other Australian species in the crenulated nature of the ridges. In outline this species resembles *C. acutilirata* mihi, but differs in the smaller apical angle; the marginal grooves are deeper and narrower in *C. crenulata.* The specimen is badly weathered, but it appears as if the furrows were ornamented with marked longitudinal striae.

Locality and Horizon. New South Wales: Farley. Lower Marine Series, Permian.

Collection. Australian Museum. Plate xxvi, fig. 15 (F.3137).

Conularia derwentensis Johnston.

(Plate xxvi, fig. 9.)

1886. *Conularia derwentensis* Johnston, Proc. Roy. Soc. Tasmania (1887), p. 17.
1888. *Conularia Tasmanica* Johnston, Syst. Acct. Geol. of Tasmania, pl. xx, fig. 1.

The original description given by Johnston is as follows: "Shell quadrangular, pyramidal; section rectangular; apical angle of larger sides about 25 deg., relation of the two larger sides to the two small ones, nearly as 4 to 3; faces flat or very slightly convex. A strong longitudinal furrow runs down each of the lateral angles, and a faintly marked one longitudinally divides each face into two equal parts; transverse thread-like riblets gently symmetrically arched on each face, sometimes interrupted and alternate at the point where they are intersected by the faint mesial longitudinal furrow, but generally continuous; riblets coarser and more distant than in *C. laevigata*; gradually increasing in density from base to apex; near the latter there are 10 in the space of 10 mm., near the base there are only 5 to 6 in the same space. It is evident that the riblets were minutely granulated as the upper riblets still preserve this character, together with fine vertical striae in the interspaces. In the lateral channels the riblets bend abruptly towards apex, and become interrupted and alternate at junction with the riblets of the succeeding face. Sides gently sloping inwards near basal margins.

"Length of perfect specimen, 5¼ inches; greatest diameter, 49 millimetres by 37 millimetres."

Observations. Johnston prepared the above description apparently from two specimens in the collection of the Tasmanian Museum, but unfortunately did not figure them. The author pointed out that the species is readily distinguished from *C. tenuistriata* and other forms by its much wider apical angle. He also stated that Waagen had recently figured a portion of a similar form from the Olive Series of the Salt Range, India, where it is associated with *C. laevigata* and *C. tenuistriata* as in Tasmania. This Indian form is presumably *Conularia* cf. *irregularis* of Koninck, recorded by Waagen,[38] but later described by him as *Conularia warthi.* In the original description Waagen stated that this form had an apical angle of 25° and possessed granulated ridges with striated furrows, which agreed somewhat with Johnston's *C. derwentensis.* However, with the advent of further specimens, Waagen in 1891, when describing *C. warthi,* included *C.* cf. *irregularis* Waagen as a synonym and revised his description. *C. warthi* has an apical angle of 12°, with 11 to 16 ridges within 10 mm. of shell. The

[38] Waagen.—Rec. Geol. Survey of India, 1886, xix, p. 26, pl. i, fig. 2.

four faces are equal in breadth, so that any relationship with *C. derwentensis* must be dismissed.

Johnston in 1888[39] published a list of species of *Conularia* occurring in Tasmania. These included *C. inornata, C. laevigata, C. tenuistriata, C. torta* and *C. derwentensis*, the latter his own species. *C. inornata* (?) was recorded from the Upper Marine beds, while the other species were recorded from the Lower Marine beds, with the exception of *C. laevigata*, which had been collected from both. On pl. xx of the same publication Johnston figured a specimen (fig. 1) which he called *C. tasmanica* (allied to *C. inornata*). This specimen agrees perfectly with Johnston's description of *C. derwentensis*, is alike in dimensions, and both were collected from the Lower Marine beds of Bridgewater. *C. tasmanica* was not listed on p. 116, and is not mentioned elsewhere, so that it appears evident that *C. tasmanica* was printed in error for *C. derwentensis*.

C. derwentensis differs markedly from *C. inornata* in its very coarse, and sparseness of, transverse ribs within 10 mm. of shell and in its wide apical angle. It has points of resemblance with *C. expansa*, a Lower Carboniferous species, but is distinguished by the longitudinal striae in the furrows of *C. derwentensis* and in the number of ridges. It is an unmistakable species among Australian Conulariae. The figured specimen from Mount Wellington agrees perfectly with Johnston's figured specimen, and agrees similarly with the description of *C. derwentensis*. On well-preserved portions of the shell the granulated ridges and longitudinal striae in the furrows are plainly visible. The dimensions are practically the same as those described by Johnston.

Locality and Horizon. Near Mount Wellington, Tasmania. Lower Marine Series, Permian.

Collection. Australian Museum. (F.36630.)

EXPLANATION OF PLATES.

PLATE XXIV.

Conularia chapmani, sp. nov.

Fig. 1.—Holotype showing one face of shell imbedded in matrix. Bowning, near Yass, N.S.W. Natural size.
Fig. 2.—An enlarged portion of the same shell showing ornamentation.
Fig. 3.—Microphotograph of holotype showing ornamentation.

Conularia mitchelli, sp. nov.

Fig. 4.—Holotype from Bowning, near Yass, N.S.W. Natural size.
Fig. 5.—Transverse section of the same shell at its widest point. Natural size.
Fig. 6.—Microphotograph showing fine ornamentation.

Conularia distincta, sp. nov.

Fig. 7.—Crushed specimen from Bowning, near Yass, N.S.W. Holotype. Natural size.
Fig. 8.—Enlarged portion of face impression, showing longitudinal striae in furrows.
Fig. 9.—Enlarged portion of face showing fine tubercles on the transverse ridges.

Conularia warthi Waagen.

Fig. 10.—Impression of two faces of an imperfect specimen from the Gascoyne River, Western Australia. Natural size.
Fig. 11.—A small fragment of shell showing ornamentation. Enlarged.

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[39] Johnston.—Syst. Acct. Geol. Tasmania, 1888, p. 116.

PLATE XXV.

Conularia tuberculata, sp. nov.

Fig. 1.—An imperfect specimen; wide face showing ornamentation. Natural size.

Fig. 2.—The narrow face of the same specimen. With a lens the tubercles and longitudinal striae are visible. Natural size.

Fig. 3.—A small weathered example of a single face showing tubercles. Natural size.

Fig. 4.—A fragment of shell from the apical end. Ridges very numerous. Ornamentation only visible on impression of inner face. Natural size.

Fig. 5.—Holotype from Bramble's Farm, Myall Lakes, N.S.W. Natural size.

Fig. 6.—A large specimen showing tubercles and striae in furrows. Natural size.

Fig. 7.—A microphotograph of portion of fig. 6, showing tubercles on the transverse ridges. Striae are not shown to advantage.

Conularia expansa, sp. nov.

Fig. 8.—A slightly enlarged impression of a single face, showing wide apical angle and marginal junctions.

Fig. 9.—A small fragment of shell showing tubercles and smooth furrows. Slightly enlarged.

Conularia levigata Morris.

Fig. 10.—Portion of a large specimen, approximately two-thirds natural size.

Fig. 11.—Transverse section of fig. 10. Two-thirds natural size.

Fig. 12.—A well-preserved specimen in matrix, showing typical ornamentation. Two-thirds natural size.

Fig. 13.—Transverse section of a small fragment showing the little difference in the length of the faces.

PLATE XXVI.

Conularia acutilirata, sp. nov.

Fig. 1.—Holotype showing rhombic cross section and wide apical angle.

Conularia inornata Dana.

Fig. 2.—A large almost complete specimen from the Upper Marine beds, Middle Permian. A little under half natural size.

Fig. 3.—Transverse section of fig. 2, slightly distorted. Natural size.

Conularia levigata Morris.

Fig. 4.—A typical specimen from the Lower Marine beds, Lower Permian. The transverse section is square. Two-thirds natural size.

Conularia inornata Dana.

Fig. 5.—A specimen showing typical ornamentation. Two-thirds natural size.

Fig. 6.—Transverse section showing strong rectangular nature of fig. 5.

Conularia tenuistriata McCoy.

Fig. 7.—An enlarged specimen showing 16-20 ridges within 10 mm. of shell. One and a quarter times natural size.

Fig. 8.—Transverse section of fig. 7, showing rhomboidal structure.

Conularia derwentensis Johnston.

Fig. 9.—An exceptionally well-preserved specimen from Mt. Wellington, Tasmania. Natural size.

Conularia tenuistriata McCoy.

Fig. 10.—A small specimen with numerous transverse ridges. Half natural size.

Fig. 11.—Transverse section of fig. 10. Natural size.

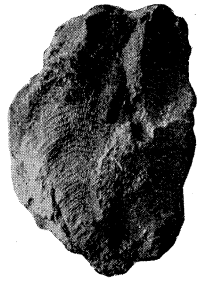
Conularia inornata Dana.

Fig. 12.—Almost complete specimen showing well-preserved ridges. Two-thirds natural size.

Fig. 13.—Transverse section of fig. 12. Half natural size.

Conularia tenuistriata McCoy.

Fig. 14.—Slightly enlarged specimen showing closely-set ridges, but with an almost square cross section.



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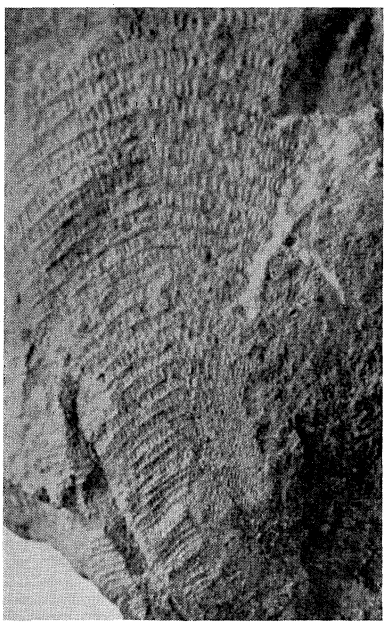

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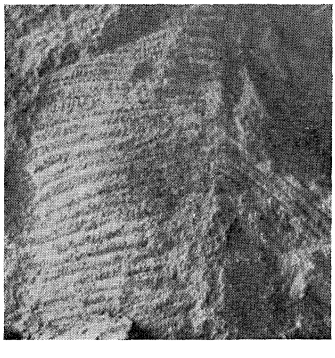

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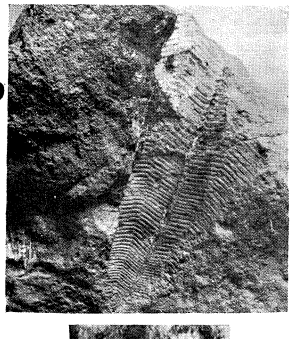

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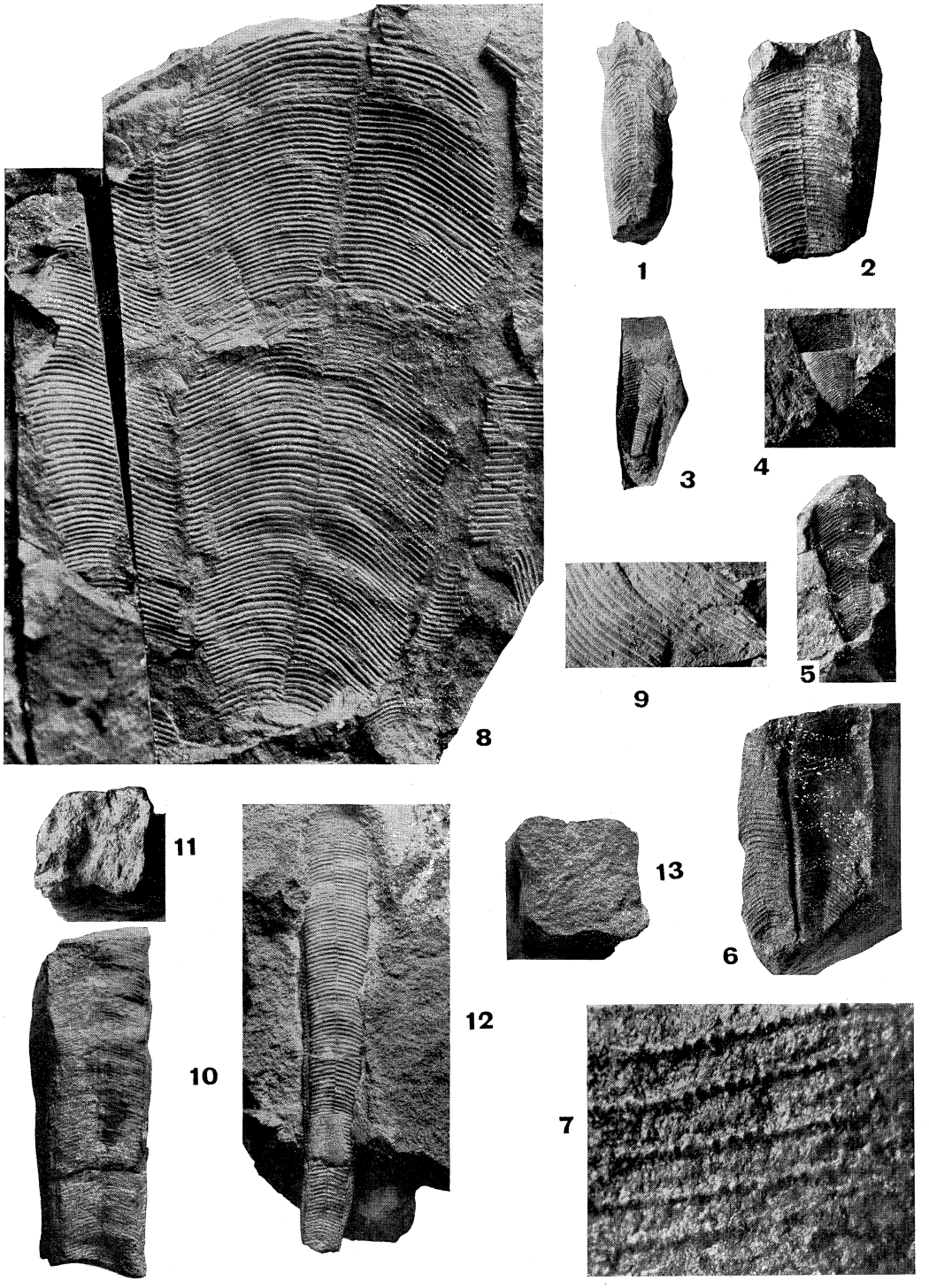

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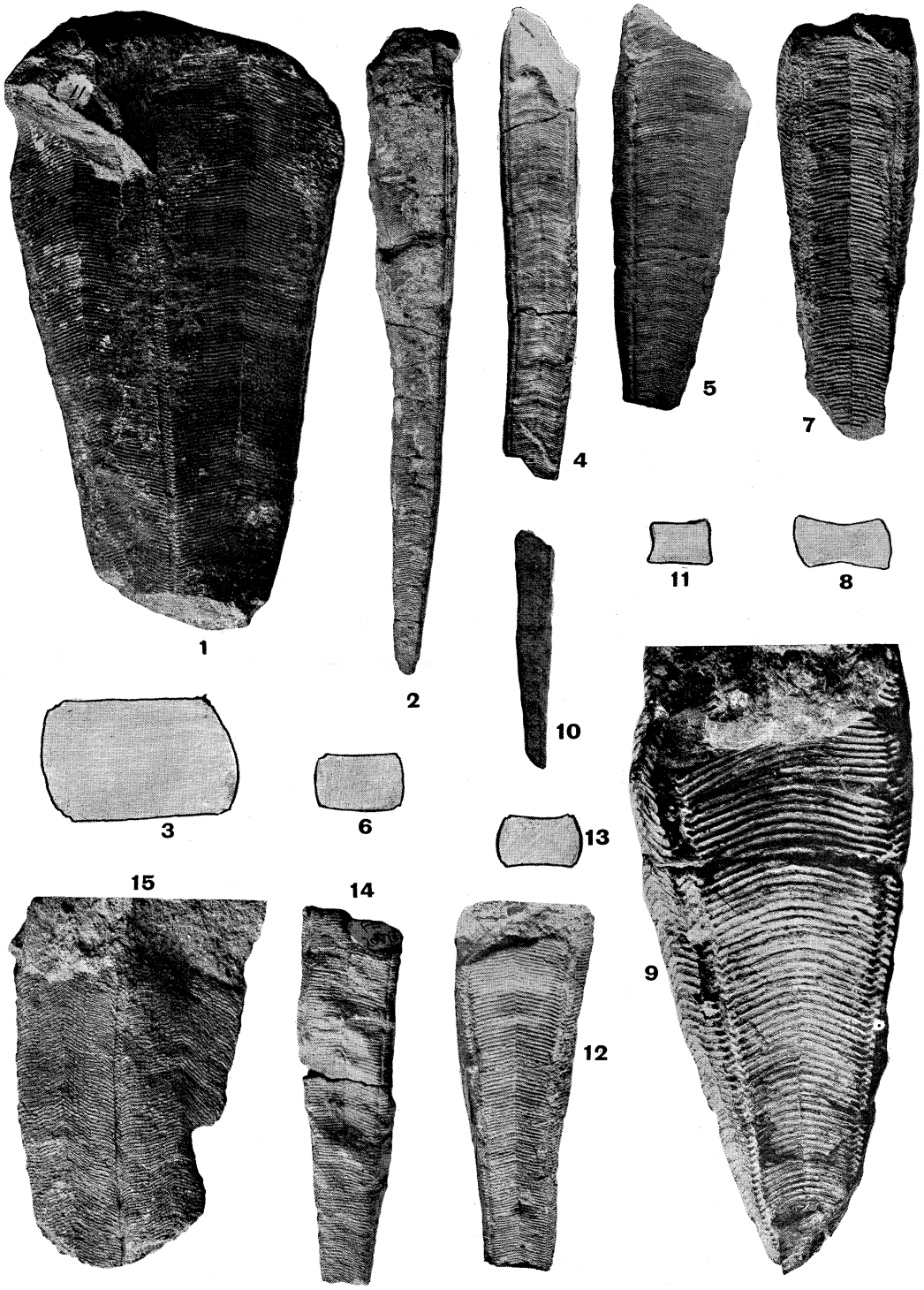

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