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ART. XV.—*The Cambrian Hydroida of the Heathcote and Monegeeta Districts.*

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Introduction.

The following is a systematic account of a remarkable series of hydroid fossils found associated with a fairly rich assemblage of Trilobites of Middle Cambrian age, in the Parish of Knowsley East. At Monegeeta, similar hydroids occur, but Trilobites are absent. The Heathcote rocks are represented by fine-grained shaly mudstones that are dark in colour, weathering in the gullies to a brownish grey, and on the hill-slopes either to a ferruginous rock or a cherty shale. The hydroid-bearing slates of Monegeeta are dark grey or almost black, and are more or less jointed. Some years ago one of us (Chapman, 1919) described certain genera and species of similar hydroids from Monegeeta. These have since been accepted by authorities on the subject as an almost unique occurrence of true fossil hydroids of the order *Calyptoblastea*. The present descriptive account of this fauna from the two localities adds considerably to our knowledge of these ancient forms.

Localities and Stratigraphical Relationship.

The beds with hydroid remains have so far only been found in the central part of the State—along the north-trending Mt. William and Colbinabbin Ranges. These mark one of the most important structural lines of the State, and although the latter range lies a little to the east of the former, they appear to be connected by the north-western south-eastern trending belt of country between Heathcote and Tooboorac. Along these belts Cambrian rocks outcrop with the sequence from predominantly volcanic rocks, to interbedded lavas, ashes, tuffs, agglomerates

and shales, to purely shales. The incoming of bands of sandstones marks the Ordovician rocks, as in the associated shales Lower Ordovician graptolites are found. In general the main development of Lower Ordovician lies to the west of the ranges, while, to the east, Upper Ordovician and Silurian rocks are predominant.

Faulting, especially strike faulting, however, complicates matters, and the detailed stratigraphy is even more complicated than stated above.

(a) HEATHCOTE DISTRICT.—(See Fig. 1.) The fossils which are now being described occur in the Dinesus-Hydroid Beds, which outcrop in the eastern portion of the Parish of Knowsley East, and have been traced northwards to the south-western portion of the Parish of Redcastle, where they have been intruded by a fine-grained granitic rock. The beds outcrop on the western side of Lady's Creek, and are separated by a north-south fault, which has preserved the Pentamerus Beds of the Mt. Ida Sandstone (Upper Silurian). The Dinesus-Hydroid Beds consist of interbedded shales and volcanic ash, tuffs and agglomerates. As these beds are folded, and the exposures are limited, the exact relationship of the various bands has not been worked out, but the associated trilobites, i.e., *Dolichometopus*, *Dorypyge*, *Agnotus*, *Dinesus* and *Notasaphus* fix the horizon as low in the Middle Cambrian. These are overlain by a series of unfossiliferous shales (Goldie Series), which to the west are faulted against beds of Lower Ordovician age (Castlemaine to Bendigonian).

(b) ROMSEY DISTRICT.—(See Fig. 2.) Along the Mt. William Range, east of Romsey and Lancefield, conditions are slightly simpler. The lowest Cambrian rocks consist predominantly of lavas with some interbedded cherts with *Protospongia*, followed by thin ashes and shales of the unfossiliferous Goldie Series, which in turn is followed conformably by the Lower Ordovician rocks. To the east of the Range are faulted strips of Upper Ordovician and Silurian rocks. In the northern portion of the area, no Cambrian fossils apart from *Protospongia* and *Acrotreta* have been found, but immediately south of an oblique fault, which lies east of Romsey, a belt of black mudstones has yielded *Acrotreta antipodum* Chapman, and a rich assemblage of hydroids. North of the fault Lower Ordovician (Lancefieldian) graptolites are found.

The black mudstones show well marked rhomboidal jointing, and are associated with the upper limit of the Cambrian volcanic rocks. As the belt is traced northwards towards the fault, which caused a sudden bending of the strike of beds to N.50°-60° E., they become less fossiliferous, and north of the fault, although lithologically similar beds occur, no trace of the fossils has been found.

Plan of Knowsley East Area, N. of Heathcote.



FIG. 1.

SKETCH PLAN OF MONEGETTA AREA

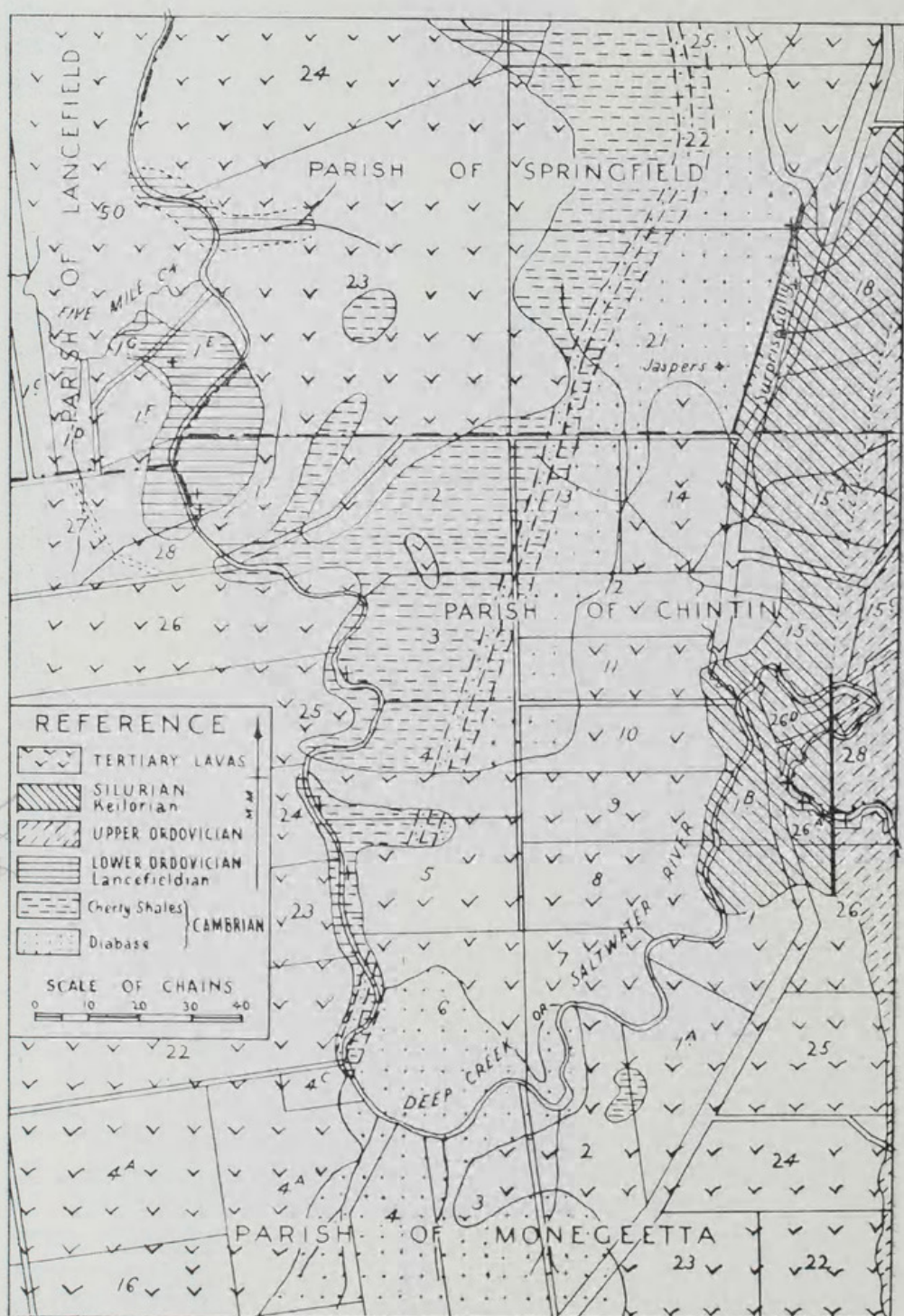


FIG. 2. (N.B.—Legend: The signs for Silurian and Upper Ordovician have been reversed.)

Historical.

The hydroid remains at Monegeeta were first discovered by Professor E. W. Skeats on a University Geological excursion. This collection was described and figured by F. Chapman in 1919 (May), and an excerpt by Chapman and Skeats appeared in the December number of the *Geological Magazine* of that year. Some of these specimens from Monegeeta were submitted by Professor E. W. Skeats, when in England in 1909, to Dr. Ethel M. R. Wood (Dame Shakespear), of Newnham College, Cambridge, and they were also seen by Dr. Chas. Lapworth. Later, in a letter to Professor Skeats, Dr. Wood suggested a relationship of the fossils to the genus *Mastigograptus* Ruedemann.

Hydroid fossils at Knowsley East were first discovered by W. H. Ferguson, of the Victorian Geological Survey, and were examined by T. S. Hall (1900, p. 26), who found "hydrothecae of the *Bryograptus* type." Later, T. S. Hall (1904, p. 218) stated that "One of the forms somewhat distantly resembles *Ptilograptus*, but I am inclined to doubt the graptolite nature of all of them, and to consider them as algae." These specimens were also examined by Professor J. E. Marr, of Cambridge, who determined them as probable algae (Ibid. p. 218, footnote by Professor J. W. Gregory). During the resurvey of these areas, more hydroid remains were found, and the so-called graptolites of the Heathcote district proved to be of similar hydroid affinity to those from Monegeeta. The stratigraphy of the areas being now better understood, together with the evidence of trilobite remains, it is shown beyond doubt that these fossils are of Middle Cambrian age.

Mode of Preservation.

In the Black Shale of Monegeeta.—The fossils in this matrix stand out very clearly as replacements in ?guembelite of the original chitinous zoaria. In some cases, even the most delicate parallel growth-lines of the periderm are apparent on the surface of the shale. The original structure is often so delicate and filmy that, as in certain specimens of *Cactograptus*, it is only decipherable in certain lights, and especially by photography.

In the Grey and Reddish Mudstones of Knowsley East.—In this matrix, the zoaria are replaced by ?guembelite, fairly well preserved, and also by a yellowish fibrous mineral resembling chrysotile, which obliterates the original characters, except as to form. A thin section of this fossiliferous mudstone shows, under high magnification, numerous minute globular bodies suggesting radiolaria or foraminifera.

Systematic Descriptions.

Phylum	COELENTERATA.
Class	HYDROZOA (Hydroida).
Order	CALYPTOBLASTEAE Allman.
Fam.	CAMPANULARIIDAE Allman.
Gen.	Archaeocryptolaria Chapman

Generic Characters (Chapman, 1919, p. 392).—"Hydrocaulus slender, more or less erect or slightly flexuous, length up to about 30 mm. Hydrothecae cylindrical or long-conical, narrowing very slightly towards the base; adnate and attached for some distance along the axis; aperture circular and lip slightly everted. Periderm coarsely wrinkled or scaly. Gonothecae elongately pyriform and incurved to the axis."

The above generic type resembles, in habit and disposition of the thecal cups, the living genus *Cryptolaria*, even to the transverse structural rings. Occasional longitudinal prominences have been noticed on the Cambrian fossils, which may be comparable to the striae and aculeation seen on the living forms.

The recent genus *Cryptolaria* Busk is found living principally in the Pacific and Southern Oceans.

ARCHAEOCRYPTOLARIA RECTA Chapman.

(Pl. XIV., fig. 1.)

Archaeocryptolaria recta Chapman, 1919, p. 392, pl. xix., figs. 4, 4a, pl. xx., Fig. 8. Chapman and Skeats 1919, p. 550, pl. xv., fig. 3.

Dimensions of Holotype:—"Length of axis 32 mm. Approximate width of axis 0.9 mm. Length of hydrothecae 4 mm., length of gonothecae 1.75 mm."

Observations.—*Archaeocryptolaria recta* closely resembles the living *Cryptolaria abyssicola* in form and size, but is not so flexuous. The variety described below as var. *flexilis*, however, has that character. Both *A. recta* and the var. *flexilis* are of approximately the same dimensions. It is a remarkable fact that the recent species is still found living in the Great Bight, south of South Australia, and west of Tasmania in 2,600 fathoms.

Occurrence.—No. 35457, locality 3KE, gully 9 chains from junction with main gully, near south-eastern corner of allotment 3J, Parish of Knowsley East. Holotype from North Monegeeta, in National Museum. Reg. No. 1311.

ARCHAEOCRYPTOLARIA RECTA Chapman var. FLEXILIS var. nov. (Pl. XIV., fig. 2.)

Description of Variety.—Axis flexuous, branching once; thecae not so numerous as in the type species. Pyriform gonothecae present, shorter than the hydrothecae. Length of hydrocaulus 14 mm.; length of hydrothecae 3.4 mm.; length of gonothecae 2.1 mm.

Observations.—Associates on the same slab are:—*Sphenoecium discoidalis* gen. et. sp. nov., and *Archaeolafoea monegettae* (Chapm.).

Occurrence.—No. 35262 (holotype of var.) from the type locality, 2 miles east north-east of North Monegeeta. Nos. 38051, 38052, Loc. 1 Redcastle, near south-eastern corner of parish.

ARCHAEOCRYPTOLARIA SKEATSI Chapman.

(Pl. XIV., fig. 3.)

Archaeocryptolaria skeatsi Chapman 1919, p. 392, pl. xix., fig. 3, pl. xx., fig. 7. Chapman and Skeats, 1919, p. 550, pl. xv., fig. 1.

Observations.—The habit of this species, in being comparatively short-stemmed, irregularly flexuous and with horizontal or backwardly curved hydrothecae, easily distinguishes it from the associated forms in both localities. Good specimens are rather rare and the species often occurs only in small fragments. The reference numbers in the Geological Survey collection here given are those which show clearly determinable characters.

The average length of the hydrosome in the present series is about 9 mm.

Occurrence.—Nos. 35249, 35250 (plesiotype), and 35257, from the type locality, 2 miles east north-east of North Monegeeta. No. 35276, allotment 3L, Parish of Knowsley East. No. 38054, Loc. 1, Redcastle. Holotype from North Monegeeta, in National Museum. Reg. No. 13114.

ARCHAEOCRYPTOLARIA FLABELLOIDES sp. nov.

(Pl. XIV., fig. 4.)

Description of Holotype.—Stem stout, erect and branching off on both sides; the branches bear long and slender hydrothecae. The form and habit closely recall *Cryptolaria flabellum* (Allman 1888, p. 40, pl. xix., figs. 1, 1A).

Dimensions of Holotype.—Length of hydrosome as preserved, 11 mm. The hydrothecae have a length from 2.5 to 3 mm.

Occurrence.—No. 35264 (holotype), from type locality, 2 miles east north-east of North Monegeeta.

Gen. **Archaeolafoea** Chapman 1919.

ARCHAEOLAFOEALONGICORNIS Chapman.

(Pl. XIV., fig. 5.)

Archaeolafoea longicornis Chapman, 1919, p. 390, pl. xix., figs. 1, 1a; pl. xx., fig. 5. Chapman and Skeats 1919, p. 550, pl. xv., fig. 2.

Observations.—The above species appears to be the most abundant of the hydroids of this Middle Cambrian series, the next in order being *Archaeolafoea monegettae*.

In many cases the surface of the hydrosome is remarkably well preserved. The hydrosome has suffered no comminution in the covering process during sedimentation, though the distal portion of the hydrothecae may have been somewhat expanded by compression.

Some of the more complete examples of the hydrosome measure as much as 28 mm. in length and generally show one or two branches on each side.

Occurrence.—Nos. 178, 208, Parish of Knowsley East (Report on Graptolites by T. S. Hall, 27.7.02). Nos. 35276, 35278, allotment 3L; Nos. 35294-5, 35296 (plesiotype), cf. 35298-302, cf. 35304, 36031, Loc. 2 K.E., gully just north of road forming south boundary, allotment 3J; Nos. 35463, 35464, 35466, 35467, ? 35468, ? 35474, ? 35475, 35477, 35481, 35483, Loc. 4 K.E., 1 chain upstream from Loc. 3, allotment 3J; Nos. 35489, 35494, 35498, Loc. 5 K.E., near dam 16 chains from junction of gullies, allotment 3J; all in Parish of Knowsley East. Nos. 35230, 35231, 35234, 35235, 35238, 35247, 35251, 35258, 35259, 35265, 35268-70, 35274, from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta. Nos. 35051, 38052, cf. 38055, 38056, 38057, 38064, 38065, 38072, 38074, Loc. 1, Redcastle. Holotype from North Monegeeta in National Museum. Reg. No. 13112.

ARCHAEOLAFOEIA MONEGETTAE Chapman.

(Pl. XIV., figs. 6-8.)

Mastigograptus monegettae Chapman 1919, p. 391, pl. xix., figs. 2, 2a; pl. xx., fig. 6.

Observations.—After examining an extensive series of the above species the present authors have agreed that the species originally named *Mastigograptus monegettae* should be referred to the genus *Archaeolafoea*. *Mastigograptus*, whilst branching and shrubby in the more complete forms, like *Dendrograptus*, bears capilliform branches, with short denticles; also thecal apertures or pits presumably for the insertion of the thecal cups, as in the genotype of *Mastigograptus*—viz., *M. tenuiramosus*. On the other hand, *Archaeolafoea*, whilst having an arborescent habit, possesses long hydrothecae, which are more or less closely arranged around the stipe.

Occurrence.—Nos. 177, 188, Parish of Knowsley East (Report by T. S. Hall, 27.7.02); ? No. 35297 (associated with trilobites), Loc. 2 K.E., gully north of road forming south boundary, allotment 3J; No. 35276, allotment 3L; Nos. 35480, 35485, Loc. 4 K.E., 1 chain upstream from Loc. 3, allotment 3J; Nos. 35490, 35497, 35500, 35501, Loc. 5 K.E., 16 chains from junction of gullies, allotment 3J; Nos. 35971, Loc. 8 K.E., 5 chains north of gully between allotment 5 and 3J; all in Parish of Knowsley East. Nos. 35232, 35233 (plesiotype), 35246, 35250 (plesiotype), 35251, 35255, 35256, 35261 (plesiotype), 35262, 35270, from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta. Nos. 38051, 38052, 38064, 38065, Loc. 1, Redcastle.

ARCHAEOLAFOEA SERIALIS sp. nov.

(Pl. XIV., figs. 9-11; pl. XV., figs. 12, 12a, 12b.)

Description of Holotype.—Hydrosome consisting of a straight, rigid axis, without branches. The hydrothecae are long, elongately conical, with the majority set almost at right angles to the stem; nine on each side to the space of 10 mm.

Dimensions of Holotype.—Length of hydrosome 20.5 mm.; length of longest hydrotheca 3 mm.

Observations.—At first sight these fossils suggest *Protovirgularia* (McCoy 1853, p. 10, pl. 1B, figs. 11, 11A, 12, 12A); the hydrothecae, however, are not compound as in that genus, but inserted on the axis singly as in the living genus *Lafoea*.

Occurrence.—Nos. 177 (holotype) and 178 (paratype), Parish of Knowsley East (Report by T. S. Hall, 23.7.02). Nos. 35239 (paratype), 35978, and a specimen lent by the Geological Department of the Melbourne University, Reg. No. 1591 (paratype), all from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

ARCHAEOLAFOEA FRUTICOSA sp. nov.

(Pl. XV., figs. 13-16.)

Description of Holotype.—Hydrocaulus seldom branching, with very long cylindrical to conical hydrothecae sessile on main stipe or branches without narrowing at base. Hydrothecae five on one side, seven on other; including a shorter, more conical cup near summit, probably a gonotheca. Thecal margins not expanded. Original periderm finely pustulate and reticulate.

Description of Paratype.—Hydrocaulus bushy—simply branching near middle and summit; the hydrothecae clustered around a long irregularly thickened stipe which is somewhat flexuous.

Dimensions of Holotype.—Length of hydrocaulus 13.5 mm.; length of longest thecae 6.5 mm.; width of stipe at base 0.7 mm.

Dimensions of Paratype.—Length of hydrocaulus 21.5 mm.; length of longest thecae 6 mm.

Observations.—This species is distinguished from *A. longicornis* by the longer and straighter thecae, and their disposition at a more acute angle along the stipe. From *A. monegettae*, it differs in the more regular character and even length of the thecae. In No. 35970 remains of thecae are seen near the base of the hydrocaulus, one of which is elongately pyriform.

Occurrence.—No. 35253 (holotype) from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta. Nos. 35970 (paratype), 35978 (paratype), 35982 (paratype), Loc.

8 K.E., 5 chains north of gully between allotments 5 and 3J, Parish of Knowsley East, cf. No. 191, Parish of Knowsley East. (Report by T. S. Hall, 27.7.02).

Gen. **Mastigograptus** Ruedemann 1908.

MASTIGOGRAPTUS cf. GRACILLIMUS (Lesquereux).

(Pl. XV., fig. 17.)

Psilophyton gracillimus Lesq. 1878, vol. xvii., p. 164, pl. iv., fig. 2.

Dendrograptus (*Psilophyton*) *gracillimus* (Lesq.) Walcott, 1879, p. 21.

Dendrograptus gracillimus (Lesq.), James, 1885, p. 160, pl. ix., fig. 5.

Mastigograptus gracillimus (Lesq.) Ruedemann, 1908, p. 219, pl. x., fig. 2.

Observations.—We have tentatively referred several specimens in this series (including the plesiotype No. 7946) to *M. gracillimus*, which generally agrees with Lesquereux's type figure, a form with a definite stipe, and few branches given off at an acute angle; other of our specimens have a more rigid stipe and shorter branches.

The species is recorded in North America from the Eden and Utica Shales (Llandeilo to Bala).

Occurrence.—No. 7946 (plesiotype), allotment 3J, 3 chains from north-west corner of allotment at bearing of (?) 180°; Nos. 35459, 35461, Loc. 4 K.E., 1 chain upstream from Loc. 3, allotment 3J; Nos. 35492, 35494, 35496, 35498, Loc. 5 K.E., near dam, 16 chains from junction of gullies, allotment 3J; Nos. 35968, 35969, Loc. 8 K.E., about 5 chains north of gully between allotment 5 and 3J; all in Parish of Knowsley East.

MASTIGOGRAPTUS TENUIRAMOSUS (Walcott).

(Pl. XV., fig. 18.)

Dendrograptus tenuiramosus Walcott, 1879, p. 21.

Mastigograptus tenuiramosus (Walcott), Ruedemann, 1908, p. 216, pl. ix., figs. 2, 3; pl. x., fig. 1; pl. xi., figs. 1-4; pl. xii., figs. 1, 2.

Observations.—To this species we refer a form with a hydrocaulus of slender habit, somewhat flaccid, few branches and with several long-conical hydrothecae attached at various angles. These forms show some alliance to the previous species. *M. gracillimus*.

Occurrence.—No. 36458, Loc. 3 K.E., gully 9 chains from junction with main gully near south-eastern corner of allotment 3J; No. 35459, Loc. 4 K.E., 1 chain upstream from Loc. 3, allotment 3J; No. 35491 (plesiotype), 35492, 35496, Loc. 5 K.E., near dam 16 chains from junction of gullies, allotment 3J; No. 35971, Loc. 8 K.E., about 5 chains north of gully between allotments 5 and 3J; all in Parish of Knowsley East. No. 38075, Loc. 1, Redcastle.

MASTIGOGRAPTUS CIRCINALIS Ruedemann.

(Pl. XV., fig. 19; pl. III., fig. 20.)

Dendrograptus sp. Ruedemann 1901, p. 528.

Mastigograptus circinalis Rued. 1908, p. 221, pl. x., fig. 3; pl. xii., figs. 7, 8.

Observations.—The base of the stipe in one of the present specimens is somewhat thickened and immediately gives rise to four branches which are contorted and reverted. The thecae are represented by short cups partly immersed in the branch, and by short spinous structures. A second specimen found in this series is more typical in having thinner branches which are more regularly curved.

The type of this species was described from the Utica Shale, near Albany, New York.

Occurrence.—Nos. 35245 and 35248 (plesiotypes) from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

MASTIGOGRAPTUS ARUNDINACEUS (J. Hall).

(Pl. XVI., fig. 21.)

Graptolithus arundinaceus J. Hall, 1847, vol. 1, pl. lxxiv., figs. 8, 8a.

Dicranograptus arundinaceus J. Hall, 1868, p. 227.

Dendrograptus arundinaceus Gurley, 1896, vol. 4, p. 84.

Mastigograptus arundinaceus (J. Hall) Rued. 1908, p. 221, pl. xii., fig. 6, and woodcut fig. 119.

Observations.—Along with numerous more or less fragmentary specimens there is one very distinct example of the above species, which is here figured. It agrees in all essential particulars of habit, size, and thecal structure, with the form figured by Ruedemann in his Memoir, Pt. II., 1908, pl. xii., fig. 6.

M. arundinaceus was originally described from the Utica Shale, Turin, Lewis Co., New York.

Occurrence.—Nos. 35240, 35241, 35242, 35267 (plesiotype), from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

Gen. **Protohalecium** nov.

Generic Characters.—Hydrocaulus formed of stem having shallow cups (hydrothecae) on stalks. This pedunculated character of the cups shows a structure in common with the living Calyptoblastid, *Halecium* of Oken (1815). The living genus *Halecium* is typical of Southern seas, and rarely found in the North Atlantic.

PROTOHALECIUM HALLIANUM gen. et. sp. nov.

(Pl. XVI., fig. 22.)

Specific Characters.—Hydrocaulus comparatively short, stem repeatedly branches, but not so frequently as in the living genus *Halecium*. The branches are divided at moderately short intervals by internodes with shallow constrictions, and are sometimes sharply deflexed. The terminals of the swollen branches bear hydrothecae with, in some cases, indications of filamentous processes; these may be impressions of tentacles.

Dimensions.—Height of hydrocaulus 5 mm.; greatest width of stem 0.4 mm.; width of branches 0.3 mm.; length of hydrothecae 1.8 mm.

Observations.—The mode of branching bears resemblance both to that of *Halecium flexile* Allman, a living Fuegian and South African form, and to *Halecium telescopicum* Allman, found at Port Jackson, N.S.W. The holotype shows a grouping of from three to five elongate ? hydrothecae at two terminals of the secondary branches. This species is named after the late Dr. T. S. Hall, M.A., who first examined these hydroid remains.

Occurrence.—No. 35972 (holotype), Loc. 8 K.E., 5 chains north of gully between allotments 5 and 3J, Parish of Knowsley East.

Gen. **Chaunograptus** J. Hall 1888.

cf. CHAUNOGRAPTUS GEMMATUS Ruedemann.

(Pl. XVI., fig. 23.)

Chaunograptus gemmatus Ruedemann 1908, pp. 226, 227, pl. x., fig. 11; pl. xi., figs. 6, 7, woodcut p. 227.

Observations.—The specimen here referred to *Chaunograptus* agrees in the habit of the hydrocaulus. In the present example it consists of two branches attached to a short stem. It is beset at fairly wide intervals with short narrow-triangular thecae and an occasional larger broadly triangular or bottle-shaped one, which may be regarded as a gonotheca.

Dimensions.—Length of specimen 23.5 mm.; width of stipe at base of branch 1.3 mm.; average length of thecae 1.5 mm.; length of gonotheca 3 mm.

Occurrence.—No. 35263 (plesiotype) from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta. The type of *Chaunograptus gemmatus* was described from the Utica Shale of Herkimer Co., New York.

Gen. **Sphenoecium** nov.

(Non mut. **Sphenothallus** Chapm. 1917 non J. Hall 1848).

Generic Characters.—Hydrocaulus with short stipe or pedicle with wedge-shaped hydrothecae arranged radially or serially.

(NOTE.—Comparative evidence between the described fossil algae from the Hudson River series referred by J. Hall to *Sphenothallus angustifolius* (Hall 1847, p. 261, pl. lxxvii., fig. 1), and the Heathcote specimens described by Chapman (1917, p. 92, pl. vi., fig. 1), shows them to be distinct in point of size and in the shape of the organism.

The Victorian specimens are here referred to hydroids judging from the thecal character of the attached structures, and not to algaoid organisms. The genus *Sphenoecium* shows affinity to *Cheunograptus* especially in its thecal characters.

SPHENOECIUM FILICOIDES (Chapman).

(Pl. XVI., fig. 24.)

Sphenothallus filicoides Chapman 1917, p. 92, pl. vi., fig. 1.

Original Description.—"Frond (hydrocaulus) thin, with axis slightly differentiated from branches. Branches on leaflets elongated, subovate to wedge-shaped, thickened in median area by a rounded midrib. Length of specimen about 12 mm.; basal leaflets from 4 to 7 mm. in length."

Observations.—This species occurs frequently in the red shales of Knowsley East. It is unknown in the black shales of Monegeeta, where, however, it is replaced by the species next described, *S. discoidalis*. Some of the hydroids referred to *Sphenoecium* are of more extensive growth than shown in the type specimen. The plesiotype now figured shows the stipe to have been flaccid, with the thecae either sessile or attached by slender pedicles. The hydrothecae are conical and outwardly curved. In some cases the aperture is clearly seen as with a circular boundary. Some of the thecae are swollen in the central part of the cup and these probably represent gonothecae. The thecal surface is often covered with a fine reticulum.

Dimensions of Plesiotype.—Length of hydrocaulus 15 mm.; length of thecae 2.8 mm.; width of thecae at aperture 1.3 mm.

Occurrence.—Nos. 174 (plesiotype), 177, 178, 188 (Report by T. S. Hall, 27.7.02), and 36030, Loc. 2 K.E., gully north of road forming south boundary, allotment 3j; No. 35277, allotment 3L; No. 35281, allotment 3q; all in Parish of Knowsley East.

SPHENOECIUM DISCOIDALIS sp. nov.

(Pl. XVI., fig. 25.)

Description of Holotype.—Hydrocaulus composed of short stipes bearing stout conical thecae; these are grouped more or less radially around a central base. The thecae terminate at about

the same distance from the stipes, so that the hydrocaulus has a discoidal appearance. The hydrothecae are elongate, conical, often with a slight twist; others, which may be gonothecae, are short, conical, and with a swollen termination like an attenuated fig. When examined under a moderately high power the base of the hydrocaulus is seen to have a definite polygonal outline with a central circular ring; from this base the stipes emerge somewhat irregularly and rapidly widen. The structure of the base is made distinct by the development of lines of minute pyritous crystals in the fine black shaly matrix, which follow the boundaries of the once chitinous epidermis.

Dimensions of Holotype.—Greatest diameter of hydrocaulus 9.5 mm.; approximate length of stipe to junction of hydrotheca 2.5 mm.; average length of hydrotheca 2 mm.; diameter of theca at mouth 0.88 mm.

Observations.—This form is distinguished from *Sphenoecium filicoides* in the more regularly radial arrangement of the hydrocaulus, the latter having the stipes arranged in a roughly biserial way from near its base. Specimens of *S. discoidalis*, with one exception, are confined to the black shales of Monegeeta where the original epidermal envelope is often well seen as a replacement in ? guembelite and pyrites.

Occurrence.—No. 35971, Loc. 8 K.E., 5 chains north of gully between allotments 5 and 3J, Parish of Knowsley East. Nos. 35236 (holotype), 35247, 35251, 35262, 35266, 35272, 35273, from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

Fam. IDIIDAE.

In this family, the hydrothecae are adnate to the hydrocaulus. The coenosarc is divided into segments, which form two longitudinal series of intercommunicating chambers, each of which corresponds to a hydranth, with the gastral cavity of which it is continuous. (See Allman, G. J., 1888, p. 82.)

Gen. **Cactograptus** Ruedemann 1908.

Ruedemann states of this genus (1908, p. 196) that "the principal difference from both *Acanthograptus* and *Inocaulis* rests in the character of the 'spines,' which, as a comparison of the enlargements of the genotype with those of the genera here adduced will show, are not finger-shaped and bearing apertures on all sides as in *Acanthograptus* and *Inocaulis*, but tubular, bluntly triangular in outline and of the form of large, simple thecae or 'denticles.' The broad middle portion of the branches is as shown by the many parallel thecal walls composed of numerous thecal tubes as in *Inocaulis* and *Acanthograptus*."

CACTOGRAPTUS CRASSUS Ruedemann.

(Pl. XVI., figs. 26-28.)

Cactograptus crassus Ruedemann 1908, pl. viii., fig. 1, text-figs. 99-101.

Observations.—This striking species is abundant in the black shales of Monegeeta. The plesiotype (No. 35222) shows the branching habit of this species more distinctly than in Ruedemann's holotype. In the Monegeeta examples the thickest part of the stem measures 3 mm., and this generally agrees with Ruedemann's types. Occasional circular openings near the spinose part of the thecae also support the evidence for its relationship with the above species. The general structure of the hydrocaulus of *Cactograptus crassus* with its adnate hydrothecae, leaves little doubt that it has a near affinity with *Idia pristis* Lamaroux (cf. Allman, G. J., 1888, p. 85, figs. 1-10), a recent species living in Philippine Seas (20 fathoms), and also dredged from Australian waters from 9 to 27 fathoms (cf. Bale, 1884, p. 114). A close examination of the Victorian fossil here referred to *Cactograptus crassus*, shows traces of urn-shaped gonothecae with longitudinal flutings, as in *Idia pristis* Lamaroux, a structure not shown, however, in Ruedemann's drawings.

Occurrence.—No. 35301, Loc. 2 K.E., gully just north of road forming southern boundary, allotment 3J; Parish of Knowsley East. Nos. 35220 (plesiotype), 35221, 35222 (plesiotype), 35223, 35224 (plesiotype), 35225, and cf. 25252, from *Archaeo-cryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

CACTOGRAPTUS FLEXISPINOSUS sp. nov.

(Pl. XVII., figs. 29-33.)

Description of Holotype.—Hydrocaulus long, somewhat slender compared with *C. crassus*, but with adnate hydrothecae set at a more acute angle than in that species. Spines on edge of hydrothecae much longer and often recurved.

Dimensions of Holotype.—Length of hydrocaulus 42 mm.; width of stipe at base 3.75 mm.

Observations.—The paratype (No. 35247) shows the hydrothecae to be larger, more regularly spaced and wider than in the holotype. In a second paratype (No. 35233) the hydrocaulus is once branched, and much more slender than in the foregoing examples; it may represent a terminal fragment. A third paratype (No. 35254) has a slender hydrocaulus; the hydrothecae are evenly spaced, whilst near the apex they are swollen at their bases, thus suggesting a gonothecal character. The epidermal structure of the hydrocaulus shows it to be areolately marked. This handsome species is generally distinguished by the more flaccid character of the hydrocaulus and the presence of slender spinose terminations of the hydrothecae.

Occurrence.—Nos. 35222, 35226 (holotype), 35227, 35232, 35233 (paratype), 35243, 35246, 35247 (paratype), 35254 (paratype), 35260, 35268, 35271, and 35273, also specimen in University of Melbourne collection (paratype), (Reg. No. 1593) from *Archaeocryptolaria* beds, type locality, 2 miles, east north-east of North Monegeeta. Nos. 35459, 35460, 35461, Loc. 4 K.E., 1 chain upstream from Loc. 3, allotment 3j, Parish of Knowsley East.

CACTOGRAPTUS PLUMIGERUS sp. nov.

(Pl. XVII., fig. 34.)

Description of Holotype.—Hydrocaulus flaccid in appearance, undulate in line of growth. Hydrothecae closely arranged on stipe at a moderately acute angle. Margin of cups truncate, with a short blunt spine, especially in those near the end of the stipe. The hydrothecae are recurved, gradually expanding and much longer than in the previously mentioned species. Gonothecae are represented by shorter and broader cups set at a wider angle on the stipe.

Dimensions of Holotype.—Length of stipe 47 mm.; greatest width 4 mm.

Observations.—At first sight this handsome species might be taken for a closely thecated form of *Mastigograptus monegettae*, but the equal length of the hydrothecae and their evenly curved and adnate character makes its reference to *Cactograptus* certain.

Occurrence.—Nos. 35242, 35243 (holotype), 35253 from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

Gen. **Acanthograptus** Spencer 1884.

This genus is stated to range from the Cambrian (St. Lawrence formation) to the Silurian (Niagaran formation). It appears to be closely related to *Cactograptus* on account of the adnate hydrothecae. Wiman places *Acanthograptus* in the order Dendroidea and finds structure which he regards as dissepimental, although Spencer, the author of *Acanthograptus*, mentions spines or denticles only on one side of the branches. The hydrothecae in the present examples more closely resemble those of *Acanthograptus*, sensu stricto, and *Inocaulis*.

ACANTHOGRAPTUS CANDELABRUM sp. nov.

(Pl. XVII., figs. 35, 36.)

Description of Holotype.—Hydrocaulus with a thickened basal stipe which soon flexuously branches; these are either opposite or alternate. The extended stipe and branches bear short cylindrical and adnate hydrothecae occasionally bispinose and of irregular size; swollen at base, with an occasional larger conical gonotheca. The concave or incurved branches suggest the trivial name.

Dimensions of Holotype.—Length of entire hydrocaulus 28 mm.; width of stipe at base 2.25 mm.; length of hydrothecae circ. 1 mm.

Observations.—The plesiotype, which has an approximate length of 30 mm., only shows traces of the hydrothecae near the base of the stipe, but the general form compares very closely with the holotype.

Occurrence.—No. 35269 (holotype) from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta. No. 184 (paratype), (Report by T. S. Hall, 27.7.02), Parish of Knowsley East.

Fam. DENDROGRAPTIDAE.

Gen. **Thallograptus** Ruedemann 1925.

THALLOGRAPTUS cf. SUCCULENTUS (Ruedemann).

(Pl. XVII., figs. 37, 38.)

Dendograptus ? succulentus Ruedemann 1904, p. 581, pl. iv., figs. 1-4. text-figs. 16, 17.

Thallograptus succulentus (Rued.) 1925, p. 36.

Description of First Plesiotype (No. 35288).—This example is portion of a rhabdosome consisting of a solitary stipe, with fairly regular branchlets numbering 5 to 7, arranged nearly opposite to one another and openly curved upwards. The main stem or branch shows vestiges of thecae at the nodes of the lateral branches. This somewhat incomplete specimen most nearly resembles a portion of the rhabdosome figured by Ruedemann 1904, pl. 4, fig. 3.

Description of Second Plesiotype (No. 35248).—The rhabdosome in this specimen is more flexuous and therefore more typical of the above species. The basal part of the stipe has the characters seen in No. 35228, but soon branches and becomes more irregular. In this way it more closely resembles the figures given by Ruedemann 1904, pl. 4, figs. 1, 2.

Dimensions of First Plesiotype.—Length of rhabdosome 13 mm.; thickness of stipe at base 0.88 mm.; greatest length of lateral branches 3 mm.

Dimensions of Second Plesiotype.—Length of rhabdosome 24 mm.; thickness of stipe at base 0.88 mm.

Observations.—This species has been recorded from the Chazy formation of New York State, zone of *Diplograptus*, equivalent to Lower Llandeilo series, so that if the specific reference is correct, the present occurrence is from a much lower horizon.

Occurrence.—Nos. 35228 (plesiotype). 35229, 35248 (plesiotype), from *Archaeocryptolaria* beds, type locality, 2 miles east north-east of North Monegeeta.

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Explanation of Plates.

PLATE XIV.

- Fig. 1.—*Archacocryptolaria recta* Chapman. N. Monegeeta. Holotype in National Museum, Melbourne. Reg. No. 1311. $\times 5.3$.
- Fig. 2.—*A. recta* Chapman var. *flexilis* var. nov. N. Monegeeta. Holotype of var. in Victorian Mines Dept., N. 35262. $\times 2$.
- Fig. 3.—*A. skeatsi* Chapman. N. Monegeeta. Plesiotype. V.M.D., No. 35250. $\times 1\frac{1}{2}$.
- Fig. 4.—*A. flabelloides* sp. nov. N. Monegeeta. Holotype. V.M.D. No. 35264. $\times 2$.
- Fig. 5.—*Archacolafoea longicornis* Chapman. Parish of Knowsley East, Heathcote. Plesiotype. V.M.D. No. 35296. $\times 2$.
- Fig. 6.—*A. monegettae* (Chapman). N. Monegeeta. Plesiotype. V.M.D. No. 35233. $\times 2$.
- Fig. 7.—*A. monegettae* (Chapman). N. Monegeeta. Plesiotype. V.M.D. No. 35250. $\times 1\frac{1}{2}$.
- Fig. 8.—*A. monegettae* (Chapman). N. Monegeeta. Plesiotype. V.M.D. No. 35261. $\times 5.3$.
- Fig. 9.—*A. serialis* sp. nov. P. of Knowsley East, Heathcote. Holotype. V.M.D. No. 177. $\times 2$.
- Fig. 10.—*A. serialis* sp. nov. P. of Knowsley East, Heathcote. Paratype. V.M.D. No. 178. $\times 1\frac{1}{2}$.
- Fig. 11.—*A. serialis* sp. nov. N. Monegeeta. Paratype. V.M.D. No. 35239. $\times 2$.

PLATE XV.

- Fig. 12.—*A. serialis* sp. nov. N. Monegeeta. Paratype. Specimen in University of Melbourne Collection. Reg. N. 1591. $\times 2$.
- Fig. 12A.—*A. serialis* sp. nov. Same specimen drawn in relief by camera lucida, showing intergrowth of thecal tubes. $\times 8$.
- Fig. 12B.—*A. serialis* sp. nov. Ditto. A microphotograph showing wall of the hydrosome in relief. $\times 25$.
- Fig. 13.—*A. fruticosa* sp. nov. N. Monegeeta. Holotype. V.M.D. No. 35253. $\times 2$.
- Fig. 14.—*A. fruticosa* sp. nov. P. of Knowsley East, Heathcote. Paratype. V.M.D. No. 35970. $\times 2$.
- Fig. 15.—*A. fruticosa* sp. nov. P. of Knowsley East, Heathcote. Paratype. V.M.D. No. 35978. $\times 5.4$.
- Fig. 16.—*A. fruticosa* sp. nov. P. of Knowsley East, Heathcote. Paratype. V.M.D. No. 35982. $\times 2$.
- Fig. 17.—*Mastigograptus* cf. *gracillimus* (Lesquereux). P. of Knowsley East, Heathcote. Plesiotype. V.M.D. No. 7946. $\times 1\frac{1}{2}$.
- Fig. 18.—*M. tenuiramosus* (Walcott). P. of Knowsley East, Heathcote. Plesiotype. V.M.D. No. 35491. $\times 2$.
- Fig. 19.—*M. circinalis* Reudemann. N. Monegeeta. Plesiotype. V.M.D. No. 35245. $\times 2$.

PLATE XVI.

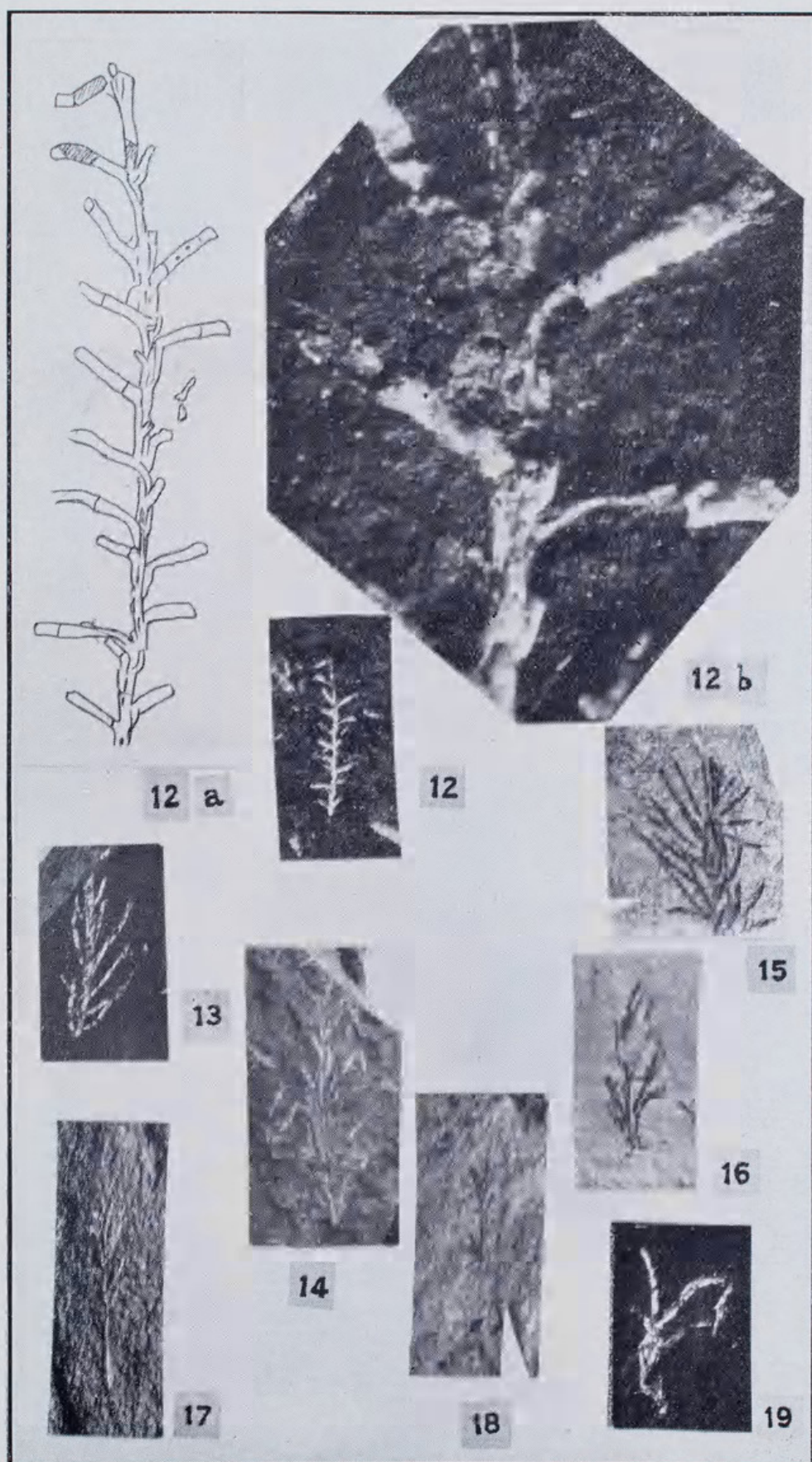
- Fig. 20.—*M. circinalis* Reudemann. N. Monegeeta. Plesiotype. V.M.D. No. 35248. $\times 2$.
- Fig. 21.—*M. arundinaceus* (J. Hall). N. Monegeeta. Plesiotype. V.M.D. No. 35267. $\times 3\frac{1}{2}$.
- Fig. 22.—*Protohalecium hallianum* gen. et. sp. nov. P. of Knowsley East, Heathcote. Holotype. V.M.D. No. 35972. $\times 2$.
- Fig. 23.—cf. *Chaunograptus gemmatus* Ruedemann. N. Monegeeta. Plesiotype. V.M.D. No. 35263. $\times 2$.
- Fig. 24.—*Sphenoecium filicoides* (Chap.). P. of Knowsley East, Heathcote. Plesiotype. V.M.D. No. 174. $\times 2$.
- Fig. 25.—*S. discoidalis* sp. nov. N. Monegeeta. Holotype. V.M.D. No. 35236. $\times 2$.
- Fig. 26.—*Cactograptus crassus* (Ruedemann). N. Monegeeta. Plesiotype. V.M.D. No. 35220. Circ. nat. size.
- Fig. 27.—*C. crassus* (Ruedemann). N. Monegeeta. Plesiotype. V.M.D. No. 35222. $\times 2$.
- Fig. 28.—*C. crassus* (Ruedemann). N. Monegeeta. Plesiotype. V.M.D. No. 35224. Circ. nat. size.

PLATE XVII.

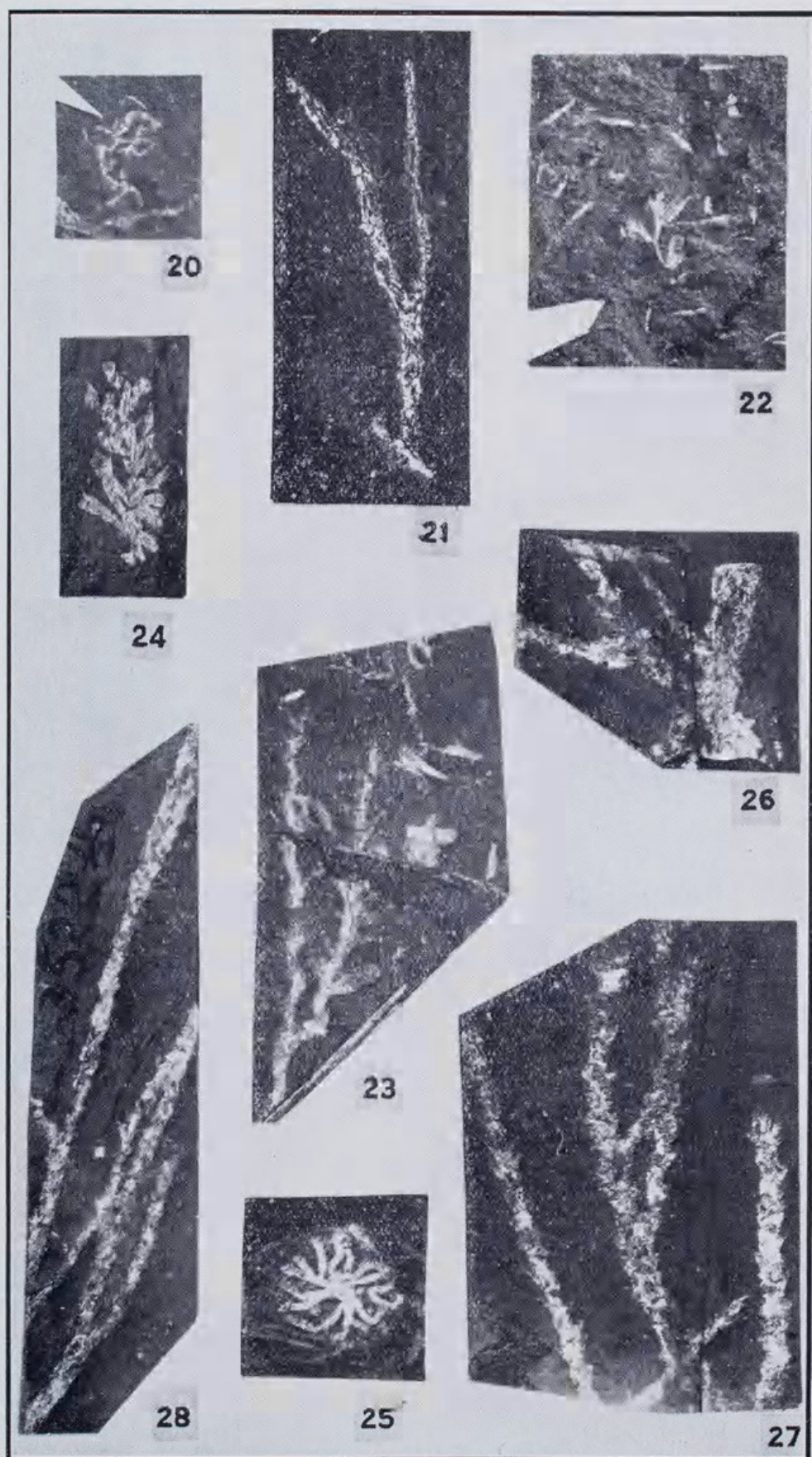
- Fig. 29.—*C. flexispinosus* sp. nov. N. Monegeeta. Holotype. V.M.D. No. 35226. $\times 1\frac{1}{2}$.
- Fig. 30.—*C. flexispinosus* sp. nov. N. Monegeeta. Paratype. V.M.D. No. 35233. $\times 1\frac{1}{2}$.
- Fig. 31.—*C. flexispinosus* sp. nov. N. Monegeeta. Paratype. V.M.D. No. 35247. $\times 2$.
- Fig. 32.—*C. flexispinosus* sp. nov. N. Monegeeta. Paratype. V.M.D. No. 35254. $\times 4$.
- Fig. 33.—*C. flexispinosus* sp. nov. N. Monegeeta. Paratype. Specimen in University of Melbourne Collection. Reg. No. 1593. $\times 1\frac{1}{2}$.
- Fig. 34.—*Cactograptus plumigerus* sp. nov. N. Monegeeta. Holotype. V.M.D. No. 35243. $\times 5-3$.
- Fig. 35.—*Acanthograptus candelabrum* sp. nov. N. Monegeeta. Holotype. V.M.D. No. 35269. $\times 2$.
- Fig. 36.—*A. candelabrum* sp. nov. P. of Knowsley East, Heathcote. Paratype. V.M.D. No. 184. $\times 2$.
- Fig. 37.—*Thallograptus* cf. *succulentus* (Ruedemann). N. Monegeeta. Plesiotype. V.M.D. No. 35228. $\times 2$.
- Fig. 38.—*T.* cf. *succulentus* (Ruedemann). N. Monegeeta. Plesiotype. V.M.D. No. 3 248. $\times 2$.



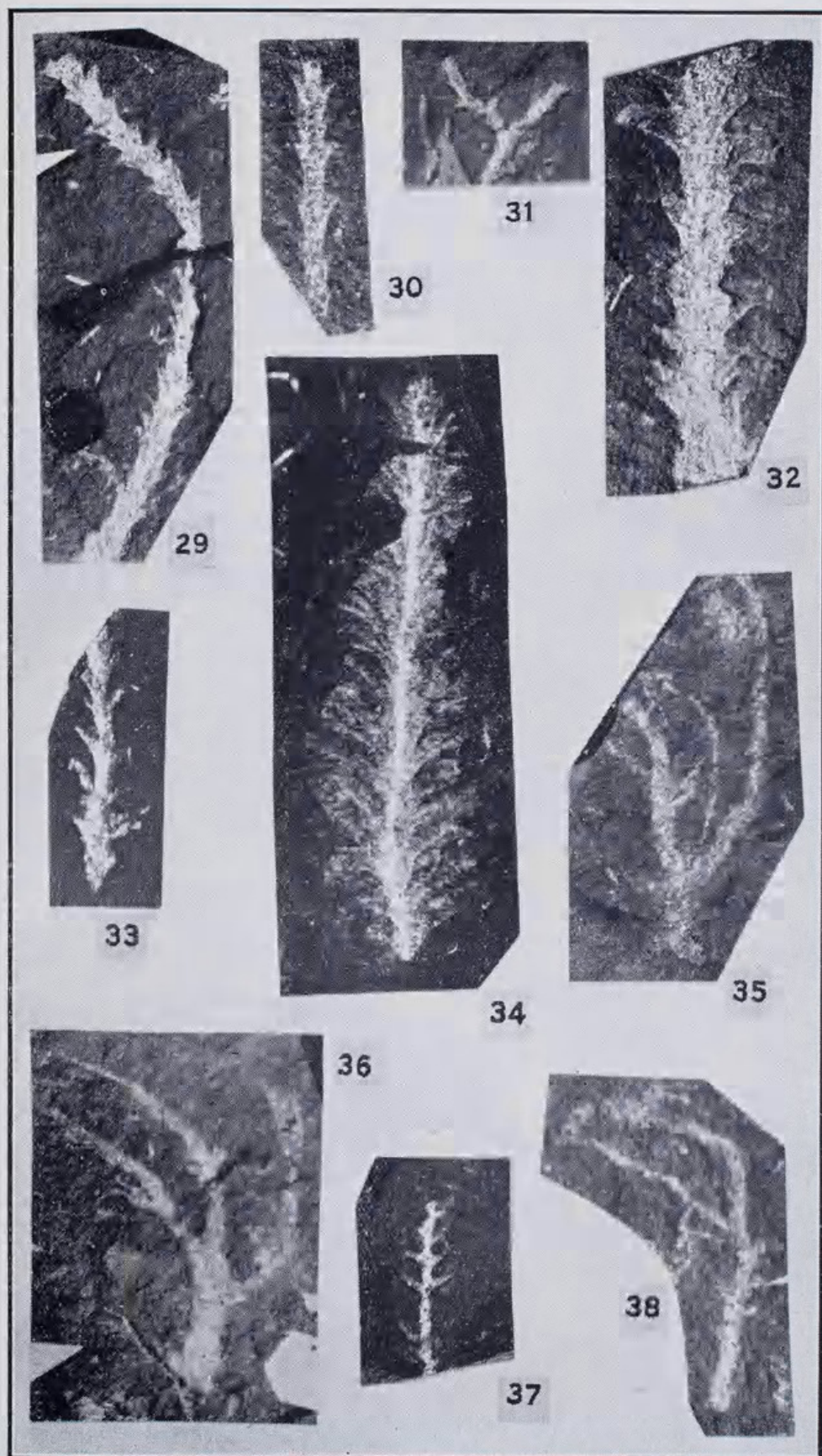
Cambrian Hydroids, Victoria.



Cambrian Hydroids, Victoria.



Cambrian Hydroids, Victoria.



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