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III.

## Palæontological Contributions TO The Geology of Western Australia.

BY

Dr. GEORGE J. HINDE, F.R.S.,

E. A. NEWELL ARBER, M.A., F.L.S., F.G.S.,  
University Demonstrator in Palæobotany, Cambridge,

R. ETHERIDGE, Esq., The Curator of The Australian  
Museum, Sydney, N.S.W.

AND

LUDWIG GLAUERT, F.G.S., Field Geologist.

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WITH 12 PLATES AND 5 FIGURES.



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## PREFATORY NOTE.

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The eight contributions to which the Geological Survey is indebted to the authors have been received since the publication of the last palæontological Bulletin, No. 27, in the year 1907.

The first contribution, from the pen of Dr. Geo. J. Hinde, F.R.S., throws considerable light on the conditions prevailing in the Norseman District.

The second, by Mr. Newell Arber, M.A., F.G.S., is an important addition to our knowledge of the Jurassic Flora of Western Australia; whilst that of Mr. Etheridge, the Curator of the Australian Museum, to whom the Survey is under a debt of gratitude, which it is difficult to repay, adds considerably to our knowledge of the organic remains of the Oolitic Beds of the Greenough River.

The description of *Sthenurus Occidentalis*, from the Mammoth Cave on the Margaret River, was prepared by Mr. L. Glauert, F.G.S., Field Geologist, for the information of the Caves Board.

The list of Western Australian Fossils, stratigraphically and zoologically arranged, which Mr. Glauert has drawn up to facilitate the work of the Geological Survey, will meet a much felt want at the hands of all workers in, and students of, Australian Geology.

The account of the New Fossils from the Barker Gorge, Napier Range, in the Kimberley Division, seems to point conclusively to the occurrence of undoubted Devonian Beds in this portion of the State.

The Notes on the Geological Age and Organic Remains of the Gingin Chalk contain evidence which points strongly to its being Cretaceous and not Tertiary, to which horizon it had previously been assigned.

A. GIBB MAITLAND,

GOVERNMENT GEOLOGIST.

Geological Survey Office,  
Perth, 21st March, 1910.

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*1.—On the Fossil Sponge Spicules in a Rock from the Deep Lead (?) at Princess Royal Township, Norseman District, Western Australia.*

BY

Dr. GEORGE J. HINDE, F.R.S.

Some months since Mr. A. Gibb Maitland, F.G.S., Government Geologist of Western Australia, forwarded to me for examination a sample of an earthy siliceous rock [8131] from the Deep Lead (?), known as the "Princess Royal," situated on the townsite of the same name at the eastern margin of Lake Cowan. Brief references to this deep lead (?) are given in Bulletin No. 21 (1906), of the Geological Survey of Western Australia, where it is stated that it was discovered in February, 1901, in carrying out alluvial workings for gold, mostly in the main street. The depth was 88ft. in kaolin.

Above the "wash" there is a white pug showing the usual slickensides and crush faces and above this ironstone gravel patches. The wash itself is mullocky, with concretions of a magnesian nature, and with quartz particles, etc. This wash is said to have been 30 to 40 feet wide, and about 6ft. in thickness on the west side, and below it there is a gritty brown material, evidently decomposed hornblendic rock.

At the Princess Royal townsite there is a strip of kaolinized ground about a mile long and a quarter of a mile wide, which may be either a remnant of a wider covering or be due to the felsite dykes in this locality being very susceptible to decomposition. At the south end of this patch the deep lead was found. No particular age can be assigned to this kaolin; it is probably mostly decomposed rock *in situ* and has been increasing in depth as long as this has been dry land (pp. 20, 36).

The reports from the Bulletin quoted above respecting the character of the deposits in this deep lead (?) do not make mention of any rock at all comparable with the sample which has been sent to me, and it may be hoped that further investigation will furnish some detailed information as to the thickness of the deposit from which the sample was taken, its position in the series exposed in the lead, and the character of the beds above and below it.

## GENERAL CHARACTERISTICS OF THE ROCK.

The sample of rock examined consists of three small irregular lumps of a very light, whitish, finely granular, and powdery material, which is so incoherent, tender, and friable that it readily breaks up into dusty powder between the fingers, and when treated in water with a soft brush it passes into a greyish mud. It may be said to be an aggregation of fine particles without any cementing material to bind them together. There is no indication of bedding to be seen in the lumps. Treated with dilute hydrochloric acid, the rock shows no reaction whatever.

When the powdered rock is examined dry with a strong lens or by reflected light under a microscope, it is seen to be composed mainly of minute glassy rods and granules, and occasionally of entire sponge spicules. In addition to these remains of organic origin there are some minute grains of a dark mineral, and also more numerous clear granules, mostly of quartz. The larger part of the latter are angular or sub-angular, some are rounded, and others seem to be small crystals. †

The spicules of siliceous sponges are the only fossils recognised so far, in the rock sample, no remains of other siliceous organisms, usually associated in marine deposits of this character, such as radiolaria and diatoms, have been met with.

## CONDITION OF PRESERVATION OF THE SPONGE SPICULES.

The chemical constitution of the spicules of which this rock is mainly composed is closely similar to that of recent siliceous sponges. The silica is in the colloid condition and presents the same clear glassy aspect so characteristic of recent spicules and, as in these latter, it is negative in polarized light between crossed Nicols.

Exceptionally some of the spicules are of a milky tint with a porcellaneous appearance, similar to spicules in the Lower and Upper Greensand of the South of England (1) and in the Cretaceous Sponge-beds of Westphalia, and in a few cases also the spicular walls are traversed in all directions by very minute curved lines as in fossil spicules from Wiltshire (2). But the change from the normal glassy condition does not seem to have reached any further stage, and in no instance have I seen a spicule of chalcidonic silica in the material.

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† "In my report on the Norseman material I mentioned that some of the quartz grains probably were partially formed in the rock, but I have since had an opportunity of showing these grains to Dr. J. S. Flett of the Geological Survey of Great Britain, and he considers that they have not been enlarged by a secondary deposition of silica, and that they have rather the appearance of having been derived from vein quartz. He further thinks that some of the fine portions of the rock in which the sponge spicules are embedded may be kaolin." G. J. H., 10th September, 1909.

(1.) Hinde. *Sponge Remains in the Lower and Upper Greensand of the South of England.* Phil. Trans. Roy. Soc., Vol. CLXXV. (1885), p. 426.

(2.) Ibid pl. XL., fig. 8.



The axial canals in these fossil spicules are considerably enlarged, and they contrast strongly with the very fine, oftentimes scarcely visible, axial canals in the spicules of recent sponges. In some instances the silica of the interior of the spicules has been dissolved away to such an extent that only a thin outer sheath of the original wall remains. The enlarged canals have usually smooth and even walls, but not infrequently they are eroded irregularly and have a nodose appearance. The outer surface of the spicules is very commonly covered with small circular pittings and their walls are bored at right angles with neat cylindrical holes which often penetrate to the axial canal of the spicule. Similar borings and enlarged canals are found in detached sponge spicules dredged up from considerable depths and they have been attributed to the action of boring algæ (1).

Comparatively few of the larger spicules in this soft rock are preserved intact; a large proportion are broken up into small fragments. The larger and more robust monaxon spicules, together with the trifids and calthrops have suffered most from fracture, and uninjured specimens are difficult to find, whilst many of the smaller fusiform, cylindrical, pinshaped, and styliform spicules and the delicate dermal spicules of lithistid sponges, remain in a perfect condition. The skeletal spicules of lithistids have, as a rule, lost their distal ends, by which they are interlocked together. The robust meshwork of dictyonine hexactinellids, which might have been supposed strong enough to resist fracture, is in the material, now reduced to microscopic fragments.

On the whole the preservation of the sponge spicules in this Norseman material is very similar to that of other fossil sponge deposits of Tertiary Age, and it does not markedly differ from that of the detached spicules found at the present time of the sea floor.

#### DESCRIPTION OF THE SPONGE SPICULES.

With the view of correlating the spicules in this Norseman material with these in similar fossil deposits in other regions, and also with those of recent siliceous sponges, the various forms commingled together in the rock sample are described and figured below. The similar forms of Monaxonid spicules are first considered and afterwards those of Tetractinellid, Lithistid and Hexactinellid Sponges.

##### MONAXONID SPICULES.

The fusiform acerate, cylindrical, styliform, dumb-bell or tibiella and pin-shaped spicules with a single axis are very numerous. With the exception that a few of the larger acerate spicules belong to the Tetractinellida, the rest are the skeleton spicules of the Monaxonida. The very minute so-called flesh spicules are poorly

(1.) Duncan, Journ. Roy. Micros. Soc., ser. 2, Vol. I. (1881), p. 557, pls. VII., VIII.

represented in the deposit by a few forms of chessman or sceptrella spicules belonging to the genus *Latrunculia*.

No anchorate flesh spicules have been observed in the deposit.

*Acerate Skeleton Spicules of various genera.*

Pl. I., fig. 1.—Fusiform acerate, robust, smooth, slightly curved, greatest thickness in the centre; tapering gradually to each end. Length 1.5 mm., thickness (1) 0.07. Probably belongs to a species of *Geodia*.

Pl. I., fig. 2.—Fusiform acerate with tapering drawn out ends, smooth. Length 0.43 by 0.05. Common. An axial canal is not shown in these spicules. A spicule very similar in form and proportions occurs in *Desmacidon* (*Homæodictya*) *grandis*, from Simon's Bay, Cape of Good Hope. Ridley and Dendy (Chall. Rep., vol. 20, p. iii, pl. XXIX., fig. 7).

Pl. I., fig. 3.—Fusiform acerate, slightly curved, gradually tapering to both ends which are acutely pointed. It is very similar to the spicules of a variety of *Petrosia variabilis*, Ridley. (Chall. Rep., vol. XX., p. 13, pl. II., fig. 12). Length 0.43 by 0.03.

Pl. I., fig. 4.—Fusiform acerate, very evenly curved, the ends blunted, smooth. An axial canal is not recognizable in the specimen figured. Length 0.38 by 0.03. Common.

Pl. I., fig. 5.—Robust fusiform acerate, bent near the centre, tapering towards the ends, which are slightly blunted, smooth. Length 0.33 by 0.035.

Pl. I., fig. 6.—Robust vermiculate spicule, curved and undulating; surface smooth. The axial canal opens at both ends, which are blunted. Length 0.68, thickness 0.064. Rare.

Pl. I., fig. 7.—Acerate, straight or slightly curved, tapering near the ends, which are blunted; the surface is covered with minute conical spines. Length 0.22 by 0.03. Smaller but similarly spined spicules are present in the sponge deposits at Oamaru, New Zealand (Linn. Soc. Jour. Zool., vol. XXIV., p. 184, pl. VII., fig. 15), and in the recent *Halichondria infrequens*. Carter, from the Gulf of Manaar (Ann. and Mag. Nat. His. s. 5, vol. VII., 1881, p. 369, pl. XVIII., fig. 9a.)

*Cylindrical Spicules of various genera.*

Pl. I., figs. 8, 9.—Slightly curved cylindrical spicules, smooth, with ends evenly rounded. As a rule no axial canals are shown in these forms; they vary greatly in size, the larger range to 0.46 by 0.06, the smaller are nearly reniform and about 0.08 by 0.03. The specimens are numerous and well preserved. Similar spicules are present in the Oamaru deposit (*op. cit.*, p. 184, pl. VII., figs. 31, 36), and also in the material dredged by the "Egeria" from a depth

(1.) The dimensions of the spicules are in all cases given in millimeters and decimal parts thereof, it is proposed therefore to omit "mm." after each measurement.

of 3,001 fathoms off the South-West coast of Australia. *Strongylophora durissima*, Dendy, from the Gulf of Manaar, is built up of similar spicules of various sizes. (Supp. Rep. Pearl Oyster Fisheries, Gulf of Manaar, p. 141, pl. IX., fig. 1.)

Pl. I., fig. 10.—Curved cylindrical spicule, with evenly rounded non-inflated ends, the surface with slightly raised whorls or rings with the edges minutely spined. Length 0.29 by 0.025. Smaller spicules similarly spined occur in the Oamaru material (*op. cit.*, pl. VII., figs. 29, 30), and Mr. Carter has figured a detached spicule of the same kind from the Gulf of Manaar (Ann. and Mag. N.H., ser. 5, vol. VI., 1880, pl. V., fig. 29). The sponge to which these belong is unknown.

Pl. I., fig. 11.—Robust, straight, cylindrical, spicule with round, spined ends, the lateral surface with stout blunt spines disposed in whorls. Length 0.25 by 0.085. Approximately similar spicules, but with the spines not so regularly arranged, are present in the Oamaru material (*op. cit.*, p. 187, pl. VII., figs. 42, 43).

Pl. I., fig. 12.—Subcylindrical spicule with a prominent acute spine at each end, and the lateral surfaces armed with whorls of alternate larger and smaller spines. Length 0.2 by 0.09 in width, spines included. Similar spicules are present in material dredged by the "Egeria," lat. 36° 53' S., long. 115° 48' E., depth 3,001 fathoms. Sponge unknown.

Pl. I., fig. 13.—Subcylindrical, slightly curved, with a prominent spine at each end, lateral surface with whorls of subequal spines. Length 0.28 by 0.08.

#### *Tibiella or Dumb-bell Spicules.*

Pl. I., fig. 14.—Slightly curved tibiella, shaft fusiform with sub-spherical ends, smooth. Length 0.17 by 0.015.

Pl. I., fig. 15.—Tibiella nearly straight, the shaft cylindrical with a round knob at each end, smooth. Length 0.37, thickness of shaft 0.02, of terminals 0.03. Similar but somewhat smaller spicules are described by Carter in *Forcepia crassanchorata* from Port Elliot, South Australia (Ann. & Mag. N.H., s. 5, vol. XV., 1885, p. 111, pl. IV., fig. 3b).

Pl. I., fig. 16.—Tibiella, slender, curved, shaft cylindrical with spherical ends, smooth. Length 0.1 by 0.005, terminals 0.007. Rare.

#### *Sceptrella or Chessman Flesh Spicules of LATRUNCULIA, Bocage.*

Pl. I., fig. 17.—Sceptrella with a relatively stout axis, the base expanded with small divergent spines, a median disc armed with short spines and a cupolar summit, also spined. Height, 0.07, thickness of shaft 0.017, width of median disc 0.05. Rare.

Pl. I., fig. 18.—Sceptrella small, with stout axis, base expanded with a thin spined edge supported on a fringe of acute spines

extending obliquely downwards; a thin median disc with sharp edge; the summit convex, smooth, with a sharp margin. Height 0.055, breadth of base and summit 0.045.

Pl. I., fig. 19.—Sceptrella with a slightly expanded and arched base with downward projecting spines; in the middle of the shaft a whorl of horizontal spines; the summit with a marginal fringe of spines and a prominent vertical spine. Height 0.066, width of axis 0.066; of the central whorl 0.026. Rare.

Pl. I., fig. 20.—Sceptrella with a stout axis and an arched and spined base, a medium sharp edged disc; the summit convex with vertical spines. Height 0.063, width of shaft 0.02, of the median disc and summit 0.036. Rare.

Pl. I., fig. 21.—Sceptrella relatively small, the basal portion and median disc similar to the preceding in form, the summit like truncated cone with minute spines. Height 0.04, width of shaft 0.011, of median disc 0.026. Rare.

Pl. I., fig. 22.—Sceptrella with slender cylindrical shaft and a small median disc with smooth margin, the summit slightly expanded with the margin notched. Length 0.05, width of shaft 0.006, of median disc 0.02.

Four of the forms of Sceptrella described above (pl. I., figs. 17, 18, 20, 21) are modifications of a common type which has an expanded base with divergent spines, a median disc and a convex summit: in fig. 19 there is a median whorl of spines and at the summit a prominent spike, whilst in fig. 22, there is no distinctive base, a small median disc and a notched summit. Each of these forms may represent a distinct species of *Latrunculia*. Similar variations of form-details are shown in the Sceptrella spicules of the Oamaru deposit (op. cit. p. 215, pl. XI., figs. 15-39).

#### *Style or Acuate Spicules.*

Pl. I., fig. 23.—Part of an elongated tapering spicule, probably a style similar to those in the genus *Tethya*, Lam. The part preserved is 1.64 in length by 0.04 in thickness at the fractured end.

Pl. I., fig. 24.—Style, robust, smooth, slightly curved at the proximal end, and tapering in the lower third of the spicule. Length 0.72 by 0.04. Similar skeleton spicules are present in the recent *Myxilla hastata*, Ridley and Dendy, from off the mouth of the Rio de la Plata at 600 fathoms. (Chall. Rep. vol. 20, p. 134, pl. XXVII., fig. 1). Common.

Pl. I., fig. 25.—Style slender, slightly curved, nearly of an even thickness throughout. Imperfect at the distal end. Length 0.73 by 0.02. Rare.

Pl. I., fig. 26.—Style slender, elongate, smooth, the summit evenly rounded and curved nearly at right angles to the straight,

gradually tapering shaft. Length 0.37 by 0.017. A similar but somewhat more robust spicule occurs in the Oamaru material (*op. cit.*, p. 191, pl. VIII., fig. 30).

Pl. I., fig. 29.—Nearly straight, robust style, the upper third stout, then somewhat rapidly tapering to the apex. The upper portion of the spicule is covered with minute conical spines, the lower two-thirds is quite smooth. Length 0.39, maximum thickness 0.06. Rare.

*Spinulate or Pin-shaped Spicules.*

Pl. I., fig. 27.—Robust spinulate slightly curved, head spherical, constricted at the neck, shaft slightly increasing in thickness towards the middle, the lower portion of the spicule is wanting. Length (incomplete) 0.57 by 0.05.

Pl. I., fig. 28.—Straight, smooth spinulate, head spherical, neck slightly constricted, very gradually tapering to the apex. Axial canal normal. Length 0.42 by 0.02. A similar spicule is present in the Oamaru material (*op. cit.*, p. 193, pl. IX., fig. 6).

SPINES OF TETRACTINELLID SPONGES.

*Calthrops Spicules.*

Pl. I., fig. 30.—Robust calthrops, the rays sub-equal, smooth, gradually tapering. Length 0.28 by 0.06.

Calthrops spicules of various sizes are fairly common in the Norseman deposit, some are larger, others smaller than the specimen figured. They have in all cases, smooth, simple rays. Similar spicules are present in the Oamaru deposit (*op. cit.*, p. 231, pl. XIII., figs. 35–40) and in fossil sponge deposits generally.

*Trifid Spicules of Geodia and other genera.*

Pl. I., fig. 31.—Trifid with straight tapering shaft and simple head rays directed obliquely forwards. Length of shaft (incomplete) 0.34 by 0.05; head rays 0.16 by 0.04. It may be compared with the smaller trifid spicules of the Oamaru material (*op. cit.*, p. 234, pl. XIII., figs. 14, 15).

Pl. I., fig. 32.—Trifid with simple slightly curved and nearly horizontal head rays. The shaft is broken away just below the head, it is 0.035 in thickness: the rays are 0.08 in length. This spicule corresponds in form and size with the zone spicules of the recent *Stelletta reticulata*, Carter, from off the South coast of Australia (Ann. & Mag. N.H., ser. 5, vol. XI., 1883, p. 352, pl. XIV., fig. 46).

Pl. I., fig. 32.—Trifid, with simple, strongly curved head rays. Shaft (imperfect) 0.03 in thickness, head rays about 0.1 in length. It probably belongs to a species of *Geodia*. Similar spicules are found in the Oamaru material (*op. cit.*, p. 235, pl. XII., fig. 24),

and in deposit brought up by the "Egeria" off S.W. of Australia, lat.  $36^{\circ}08' S.$ , long.  $117^{\circ}10' E.$ , from a depth of 2,479 fathoms.

Pl. II., fig. 1.—Spicule with a tapering shaft and a single, slightly recurved head ray; the base of a second ray is shown, but there is no indication of a third. The shaft is 0.23 by 0.02, the head ray 0.037 in length. It appears to be an abnormal development of a trifid spicule.

Pl. II., fig. 2.—Trifid with straight elongate shaft and with each of the head rays bifurcated and horizontally extended. The tips of the rays are broken away, and the axial canal in the shaft is considerably enlarged. Shaft 0.36 by 0.03: width across the head rays 0.13. Similar spicules are present in the genus *Erylus*. Gray.

Pl. II., fig. 3.—Trifid with simple head rays directed upwards. The shaft (imperfect) is 0.04 in thickness, the head rays 0.12 by 0.02. Similar spicules occur in the recent genus *Craniella*, O. Schmidt and in *Stelletta* they are also present detached in the Oamaru material (op. cit. p. 234, pl. XIII., figs. 16, 17).

Pl. II., fig. 4.—Trifid spicule with a stout, straight shaft, and bifurcated head rays. The shaft is 0.05 in length. It may belong to *Erylus*. Gray. A form nearly similar is figured from Oamaru (op. cit. p. 234, pl. XIII., fig. 12).

Pl. II., fig. 5.—Trifid with curved tapering shaft and trifurcate head rays directed obliquely forwards. The head rays are partly broken, but in one the trifurcate character is distinctly shown by the axial canals. Shaft 0.37 by 0.05. The head rays are 0.14 in length.

Pl. II., fig. 6.—Trifid with slender shaft and simple head rays directed backwards. The shaft is 0.006 in thickness, the head rays are 0.05 in length and about the same thickness as the shaft. It may be compared with the grapnel spicules of *Cydonium Mülleri*, Fleming—*Geodia Zetlandica*, Johnston (see Bowerbank, Mon. Brit. Spong. vol. III., pl. VII., fig. 7). Similar forms are common in the Oamaru material (op. cit., p. 235, pl. XII., figs. 18–24).

#### LITHISTID SPICULES.

*Body Spicules of* RAGADINIA, Zittel, and DISCODERMIA, Bocage.

Pl. II., figs. 7, 8.—Spicules with four arms or rays; one is frequently truncated or reduced to a rounded knob; the fully developed arms have a prominent ring-like inflation a short distance from the spicular centre; beyond the ring the arms bifurcate and terminate in twig-like extensions which interlock with those of adjoining spicules. The delicate twig-like extremities are broken off the detached spicules. In one specimen (fig. 7), the axial canal is seen as a delicate straight line extending from the centre to about two-thirds the length of each arm; in the other (fig. 8), the canals are widened and reach to the ends of the arms, which are, however,

incomplete. The arms are about 0.17 in length, and 0.04 thick near the centre. The spicules belong to *Ragadinia*, Zitt. of which several species are known from the upper Cretaceous (*Bel. mucronata* Zone) of Germany and the South-West of England. Detached spicules closely resembling those from Norseman are known from Coesfeld in Westphalia, the Upper Chalk of Norfolk (1): also in the Upper Greensand near Warminster, Wiltshire, and in the Lower Greensand of Haslemere and Tilburstow Hill, Surrey (2).

Pl. II., figs. 9, 10.—Both the spicules figured are imperfect: in one (figure 9) an arm is wanting, and in the other (fig. 10) two are broken away, so that their original tetractadine character can hardly be recognised. Small extensions are given off from the arms; their ends are frequently furcate and they are covered with tubercles. In one (fig. 9), a delicate straight line in the principal arm may represent an axial canal whilst in the other (fig. 10), two short canals are shown near the broken margin. These spicules may belong to *Discodermia*, Bocage. Fragments of similar spicules are very common in the Norseman material.

*Reniform and Globostellate Spicules of Tetractinellid Sponges.*

Pl. II., figs. 12, 13.—Reniform spicules, similar to those forming the dermal crust of *Geodia* sponges, are very numerous in the deposit. Generally the hilum can be distinguished, but the minute rods with prominent heads of recent forms are not shown in these fossil specimens. Not infrequently they are perforated by boring algæ (?) as in the specimen figured (fig. 13). Small specimens measure 0.07 by 0.037, the larger 0.09 by 0.062.

Pl. II., fig. 14.—Globostellate spicules, apparently solid, their surfaces covered with short, stout, conical spines, which in some cases seem to be regularly disposed in lines. Diameter 0.1. Fairly numerous.

Pl. II., fig. 15.—Globostellate similar to the preceding, but much smaller. Diameter 0.04—0.05. Very common. Similar forms are present in the recent genus *Cydonium*, Muller.

Pl. II., figs. 16, 17.—Globostellate spicules with solid centra from which extend a number of stout cylindrical rays with expanded lobate summits. No canals are visible either in the rays or in the centra. Diameter 0.1. Similar spicules are present in the recent *Cydonium Müllerii* Fleming. They occur detached at Oamaru (op. cit. p. 237, pl. XIV., figs. 28, 29, 30, and also in the dredgings by the "Egeria" off the S.W. of Australia, from a depth of 2.479 fathoms.

*Globostellate Spicules of TETHYA, Lamarck.*

Pl. II., fig. 18.—Globostellate with numerous rays which originate in the centre of the spicule and for about one-third their length

(1.) Hinde. Fossil Sponge Spicules from the Upper Chalk of Horstead, 1880, p. 58, pl. 5, figs. 1-4.

(2.) Phil. Trans. Roy. Soc., vol. CLXXV., part II., 1885, p. 444, pl. XLV., figs. 5, 5a, 5b.

extend beyond the centrum. The rays are straight and the free portions gradually taper. In each there is a well-marked, now enlarged, canal, which begins at the origin of the ray and opens at its free distal end. The figured specimen is 0·13 in diameter: smaller forms are about 0·08, including the rays. These spicules are closely related to those of *Tethya robusta*, Bowerbank (Proc. Zool. Soc. Lond., 1873, p. 10. pl. II., fig. 15) now living in Australian seas. They are very common in the Norseman material, but as a rule the free portions of the rays are broken off. Similar detached forms are present in the Upper Cretaceous (Zone of *Bel. mucronata*) of Westphalia, and in the same zone of the Chalk of Norfolk.

Pl. II., fig. 19.—Small globostellate with 12–14 acutely pointed rays extending for about half their length beyond the centrum. No canals visible. Diameter, including rays, 0·05. This form may be one of the smaller stellates of the crust of a species of *Tethya*.

#### DERMAL SPICULES OF LITHISTID SPONGES,

Pl. II., figs. 20, 21.—Spicules consisting of a thin, flattened siliceous plate with very irregular lobate margins. In the centre of the plate is a short, acutely pointed shaft which projects at right angles from the inner or lower surface. Three short canals radiate from the junction of the shaft with the plate and in the central point is a small circle representing the axial canal of the shaft. The shaft in these spicules is usually broken off the horizontal plate. The plate or head of these spicules is about 0·3 in breadth. The sponge to which they belonged cannot be known with certainty; they may have formed the dermal layer of a species of *Ragadinia* whose skeleton spicules have been described above.

#### *Dermal Spicules of DISCODERMIA*, Bocage.

Pl. II., fig. 22.—The spicule figured has the margins rounded, but in other specimens of the same form they are irregularly lobate. The outer surface has numerous minute spines or papillæ, as Carter terms them, and these are connected with each other by delicate raised lines which give the appearance under the microscope of a fine network with polygonal meshes. Three short axial canals are shown in the centre of the spicule. The spicular heads are 0·3–0·38 in breadth. The shafts are wanting. The late Mr. Carter has described dermal spicules with a similar surface network in the recent *Discodermia aspera* from the Gulf of Manaar (Ann. & Mag. N.H., ser. 5, vol. VI., 1880, p. 501, pl. VIII., fig. 49g), but in a microscopic slide of the spicules of this sponge, mounted by himself and presented to me, there is no net-work shown on the dermal spicules, nor does Prof. Sollas mention this character in describing *D. aspera* though he studied the spicules in a slide also supplied to him by Mr. Carter (Chall. Rep. vol. XXV., p. 327). It is probable therefore that the dermal spicules with this peculiar and distinctly marked surface ornamentation may belong to some other species than



*D. aspera*. The detached forms in the Norseman material are very common, and well preserved as a rule.

Pl. II., figs. 26–26.—Dermal spicules with an elongate slender shaft and a saucer-shaped or vasiform expansion at its summit. The expanded head is approximately circular in outline, the margins are smooth, even and slightly elevated (fig. 25); in the centre is a small boss or knob which in some cases may project above the level of the margins (fig. 23), in others it is hardly perceptible (fig. 24). Viewed from below, the under surface of the spicule shows one or more concentric growth lines and faint traces of radiating folds reaching a short distance above the edge; the fractured summit of the shaft and its axial canal are shown in the centre (fig. 26). The axial canal of the shaft is closed at or just below the junction of the shaft and the head, it extends the length of the shaft and opens at its distal apex. There is no indication of canals radiating from the centre in any of these spicular heads. In one specimen the shaft is embraced by a portion of a skeleton spicule of the sponge to which the dermal spicule belonged. The shaft is about 0.2 in length: the expanded heads are 0.075–0.11 in breadth. They belong to a species of *Discodermia* not improbably to the same form as the skeleton spicules described above (pl. II., figs. 9, 10).

Nearly similar dermal spicules are figured by O. Schmidt (1) in *D. dissoluta* from off Barbados at a depth of 56 fathoms: by Carter (2) in *D. levidiscus* from the Gulf of Manaar, and by Sollas (3) in *D. ornata* a recent sponge of unknown locality. As the Norseman spicules differ in smaller details from those in the species just mentioned, it is probable that they belong to a sponge yet undescribed.

*Dermal Spicules of CORALLISTES, O. Schmidt, and other genera.*

Pl. III., fig. 1.—Dermal spicule with a short shaft and at its summit six horizontally extended rays. The rays are sub-equal when complete and they are traversed by axial canals which extend to the distal ends of the rays. The rays are about 0.18 in length by 0.05 wide. The head of the specimen is 0.39 across. These spicules are common in the Norseman material but generally in fragments. Similar detached spicules are found in the Oamaru deposit, also in the material dredged by the “Egeria” off the S.W. of Australia from a depth of 2,479 fathoms. They also form the dermal layer in several genera of Megamarine and Tetracladine Sponges from the Upper Cretaceous of the South of England and of Germany, and in the recent genus *Corallistes*, O. Schmidt.

Pl. III., fig. 2.—Dermal spicule with a short shaft and five horizontally extended rays at its summit. In this form one of the head rays of the normal trifold remains simple, and the other two

(1.) Die Spongien des Meerbusen von Mexico, Heft. II., 1880, p. 87, pl. V., fig. 2c.

(2.) Ann. & Mag., N. H., ser. 5, vol. VI., 1880, p. 503, pl. VIII., figs. 51c, d.

(3.) Chall. Rep. vol. XXV., p. 297, pl. XXXI., figs. 5, 5a, 5d.

are bifurcate. The rays are nearly straight, slender, and they terminate distally with a small foot-like expansion. The axial canals extend but a short distance from the centre of the spicule. The rays are 0.13-0.22 in length by 0.02 in thickness. In the character of the rays this form resembles the dermal spicules of *Theonella Swinhoei* Gray, as figured by Sollas (Chall. Rep., vol. XXV., p. 284, pl. XXIX., figs. 4, 4a, 4b).

Pl. III., fig. 3.—Dermal spicule in which one of the head rays is larger and inequally developed in comparison with the others. The axial canals are short and nearly equal in size. Diameter of the head rays 0.4. Rare.

*Skeleton Spicule of VETULINA, O. Schmidt.*

Pl. II., fig. 11.—Spicule with four or five rays extending in different directions from a definitely thickened centre. Some of the rays are single, others furcate, their distal ends are slightly expanded where they have been attached to adjoining spicules. In the centre of the spicule is a shield shaped prominence. Axial canals are not present. The spicule is 0.14 in breadth. Similar spicules are present at Oamaru, they have been referred to the recent genus *Vetulina* (op. cit., p. 240, pl. XIII., figs. 31-33). Rare.

*Spicules of unknown Sponge.*

Pl. III., figs. 6, 7.—Minute spicules, with a short central axis or shaft from either end of which three or four acutely pointed rays extend obliquely. Each ray has two whorls of small spines. Canals are not visible. Diameter of the spicule, including the rays, 0.15: length of the terminal rays 0.075. I have not met with any description of this form in connection with either fossil or recent sponges.

*Dermal (?) Spicules, DACTYLOCALYCITES, Carter: PLACOLITHIS, pars. EHRENBURG.*

Pl. III., figs. 4, 5.—Thin siliceous plates of oval elliptical outlines with smooth surfaces and a series of straight or slightly curved canals radiating from the central area to the circumference. The margins in all the specimens in this deposit are imperfect, either from having been worn away or from not having reached full development: they now show the free distal ends of the radiating canals, with tongue-like extensions and deep alternating large and small notches between... In the centre of the spicules the canals are disposed so as to form a double arch, with their apices nearly meeting, from this point the canals radiate fan-like towards each end. When the spicules are complete their margins are even and continuous all round, the distal ends of the canals are closed, and the notches now form oval or hour-glass shaped apertures ranged round and just within the margins of the plate. The canals vary

in number in different specimens from 17 to 24. The spicules are 0.25-0.3 in length, by 0.12-0.18 in breadth.

These detached spicules are widely distributed. As fossils they have been found in the Jurassic radiolarian marls of Hanover (1), in the Upper Greensand of (2) Devonshire, and (3) Wiltshire, the Upper Cretaceous of (4) Westphalia (zone of *Bel. mucronata*) and in the same zone at (5) Horstead, Norfolk: in the Tertiary radiolarin deposits of (6) Barbados, and in similar deposits at (7) Oamaru, New Zealand. They have also been dredged up from a depth of over 13,000 feet in the (8) Indian Ocean and from off the S.W. coast of Australia at a depth of 3,000 fathoms. In the Norseman material they are fairly common. They are supposed to be the dermal spicules of a sponge, which is as yet, unknown.

#### SPICULES OF HEXACTINELLIDA.

Pl. III., fig. 8.—A small fragment of the skeleton of a dictyo-nine hexactinellid. The spicular frame is robust, its surface smooth, the nodes are simple, *i.e.*, not octahedral, and the axial canals are considerably enlarged. The spicular framework is 0.035 in thickness and the distance from node to node 0.11. Minute fragments of a similar character are common in the Norseman material.

Pl. III., fig. 9.—A detached five-rayed spicule, the rays robust, tapering, and blunt at their distal ends. The axial canals are enlarged and open at the end of the rays. Length of rays, 0.14: thickness 0.045.

Pl. III., fig. 10.—Spicule similar to the preceding, the rays are short and tapering slightly, with rounded ends; the canals are well shown, and in this specimen they terminate within the rays. Length of rays 0.085: thickness 0.04.

Pl. III., fig. 11.—A detached five-rayed spicule with smooth, slightly tapering rays; the axial canals are much enlarged and open at the ends of the rays. Length 0.14 by 0.025.

#### *Dermal Spicules of ROSSELLA, Carter.*

Pl. III., figs. 12, 13, 14.—Spicules consisting of an elongate straight shaft, with four straight or slightly curved rays extending at right angles from its summit. They have been compared to a

- 
- (1) Palæontographica, Bd. XXXI., pl. XX., fig. 42.
  - (2) Carter. On Fossil Sponge Spicules of the Greensand, etc., Ann. & Mag., N. H., S. 4, vol. VII., p. 123, pl. IX., fig. 40.
  - (3) Hinde. Sponge Remains in the Lower and Upper Greensand. Phil. Trans. Roy. Soc., vol. CLXXV., part II., 1885, p. 442, pl. XLIII., fig. 3.
  - (4) V. Zittel. Ueber Coeloptychium. Abh. d. k. Akad. d. Wiss. XII., Bd. III., Abth., p. 47, pl. V., figs. 32-35.
  - (5) Hinde. Fossil Sponge Spicules from the Upper Chalk., 1880, p. 40, pl. I., fig. 23.
  - (6) Bury. Polycystines in the Barbados Chalk deposit, 1862, pl. VII., figs. 1, 2.
  - (7) Hinde & Holmes. Sponge Remains in the Lower Tertiary Strata of Oamaru, New Zealand. Linn. Soc. Journ. Zool., vol. XXIV., 1892, p. 236, pl. XIV., figs. 35, 36, 37.
  - (8) Ehrenberg. Microgeol. Studien, 1873, p. 147, pl. 36, fig. 9.

section of an umbrella, the shaft representing the handle, and the four rays as so many ribs. For a short distance from the shaft the horizontal rays are connected together by a siliceous membrane, beyond this the rays are quite independent of each other. The angle included by the four rays varies in different specimens from  $105^{\circ}$  to  $120^{\circ}$ . Canals, now considerably enlarged are shown both in the shaft and in the rays. These spicules are fairly common in the Norseman material, but they are all very imperfect so that it is not possible to ascertain their dimensions when complete. The longest fragment of a shaft (fig. 12) is 0.27 in length by 0.035 in thickness, and of a ray 0.25 by 0.02. This form of spicule detached was first noticed in the \* Upper Chalk of the North of Ireland, and it was considered by the late Dr. Bowerbank to belong to the dermal system of a siliceo-fibrous sponge. Afterwards it was found on the same horizon (Zone of *Bel. mucronata*) in (1) Westphalia, (2) Norfolk, and in siliceous rock occurring as an erratic in the Boulder Clay of the Roode Klif, Friesland. In (3), a paper on this rock, the resemblance of these forms to the spicules of the surface of the recent hexactinellid, *Rossella antarctica*, Carter, is pointed out. The Norseman specimens are considerably smaller than those in the (4), recent sponge from South of the Kerguelen Islands and from the South Atlantic, east of Buenos Ayres, and they further differ in having a siliceous membrane or patagium connecting the rays near their junction with the shaft, and in the absence of spines on the rays. In both these features the Norseman umbrella spicules correspond with the fossil forms in the Upper Cretaceous rocks of Germany, the East of England, and the North of Ireland.

#### SUMMARY.

The sample of soft, white siliceous rock from the Deep Lead (?) at Princess Royal, in the Norseman District, was found, on microscopic examination, to consist almost entirely of the spicular remains of siliceous sponges; a large proportion of the spicules are now reduced to minute fragments and detritus, but here and there some fairly perfect or but slightly injured forms have been preserved, and the various kinds of these have been described and figured in the report. No other organic remains beyond those of siliceous sponges have been found in the rock sample, and not a single specimen of radiolaria or diatoms, which are usually associated with sponge spicules in deposits of a similar character has been noticed. There is but a small proportion of inorganic constituents in the rock; these consist of minute dark grains which have not been

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\* J. Wright. Proc. Belfast Nat. Field Club, 1873-4, ser. 2, vol. I., p. 138, pl. III., fig. 1.

(1.) Zittel. op. cit., p. 46, pl. V., figs. 47-50.

(2.) Hinde. op. cit., 1880, p. 62, pl. I., figs. 29, 30.

(3.) Hinde. Bull. Soc. Belge de Geol. Paléon., etc., vol. III., 1889, p. 257, pl. VIII., figs. 105, 106.

(4.) See Chall. Rep. Zool., vol. XXI., p. 139, pl. LV., figs. 9, 13.

determined, microscopic particles of quartz, and a few larger granules of the same mineral which appear to have been partly formed in the rock.

The silica of the spicules is in the same colloidal condition as in recent sponges; in only a few instances are there indications of incipient change. The spicules are all detached and the various kinds are indiscriminately mingled together in the rock. They are nearly all skeleton spicules: very few of the smaller flesh spicules have been found. With hardly an exception they are well known forms, belonging to Monaxonid, Tetractinellid, Lithistid, and Hexactinellid sponges: the three first mentioned groups appear to be represented in about equal proportions, but the spicules of hexactinellid sponges in the material are comparatively few.

Besides spicules which resemble those of existing sponges, there are many in the deposit closely similar to detached spicules in material dredged from a depth of 3,000 fathoms off the South-West coast of Australia, and also to the spicules in the fossil sponge deposit at Oamaru, New Zealand, which is considered to be Upper Eocene in age.

Some of the spicules of the Norseman material are also present in the Cretaceous rocks of England, Ireland, and Germany. Amongst these are three characteristic and somewhat rare forms: the skeleton spicules of a lithistid sponge (1) *Ragadimia*, sp.: the (2) dermal spicules of a sponge as yet unknown, but probably a Tetractinellid: and the umbrella spicules of the Hexactinellid genus (3), *Rossella*, sp. I found and (4) described these three kinds of spicules many years since in the siliceous material enclosed within a single hollow flint nodule from the Upper Chalk of Horstead, Norfolk. It is worthy of note that the three species of sponge to which these spicules belong should have existed together in the Cretaceous seas of the Northern hemisphere, and should have been found again associated together in Tertiary or Post-Tertiary deposits in the Southern hemisphere.

It seems to me that this Norseman sponge-rock is not a merely local deposit, but that it was formed in the open ocean, at some distance from a coast-line, so as to be away from sediment-bearing currents, and probably at a considerable depth. The sponges which furnished the materials of the deposit may have lived, died, and been disintegrated in the same area. As regards the geological age of the rock, I should judge that it is newer than the Cretaceous, but there are no data to indicate the particular periods of the Tertiary or Post-Tertiary in which it may have been formed.

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(1.) Pl. II., figs. 7, 8.

(2.) Pl. III., figs. 4, 5.

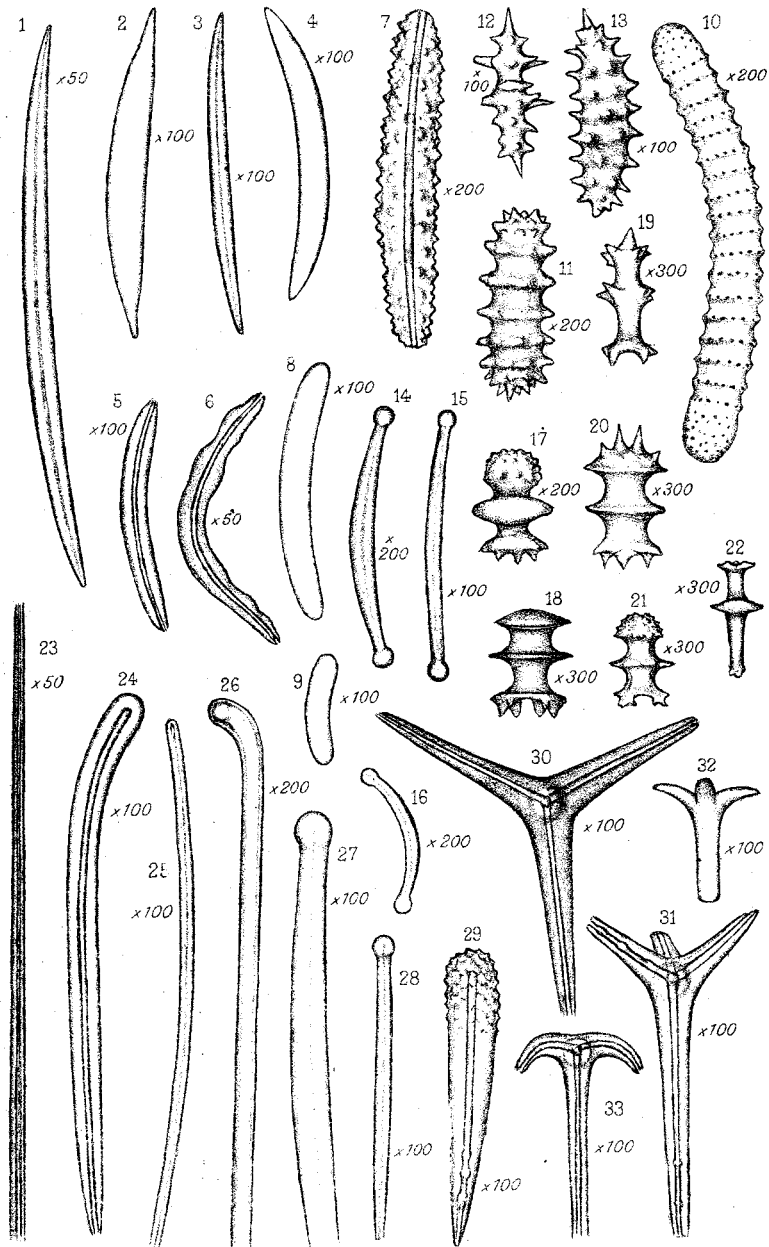
(3.) Pl. IV., figs. 12, 13, 14.

(4.) Fossil Sponge Spicules from the Upper Chalk of Horstead, 1880, p. 58, pl. V., figs. 1-4; p. 40, pl. I., fig. 23; p. 62, pl. I., figs. 29, 30.

## EXPLANATION OF PLATES.

## PLATE I.

- Fig. 1.—Acerate spicule. Probably of *Geodia*— $\times 50$ .  
 „ 2.—Acerate spicule of *Desmacidon* (?)— $\times 100$ .  
 „ 3.—Acerate spicule of *Petrosia* (?)— $\times 100$ .  
 Figs. 4, 5.—Fusiform acerate spicules— $\times 100$ .  
 Fig. 6.—Vermiculate spicule— $\times 50$ .  
 „ 7.—Spined acerate of *Halichondria* (?)  $\times 200$ .  
 Figs 8, 9.—Smooth cylindrical spicules of *Strongylophora* (?)— $\times 100$ .  
 Fig. 10.—Curved cylindrical spicule with spined whorls— $\times 200$ .  
 „ 11.—Straight cylindrical spicule with whorls of spines— $\times 200$ .  
 „ 12.—Subcylindrical spicule with whorls of spines— $\times 100$ .  
 „ 13.—Curved cylindrical spicule with whorls of spines— $\times 100$ .  
 „ 14.—Curved tibiella or dumb-bell spicule— $\times 200$ .  
 „ 15.—Straight tibiella of *Forcepia* (?)— $\times 100$ .  
 „ 16.—Curved tibiella spicule— $\times 200$ .  
 „ 17.—Sceptrella spicule of *Latrunculia* sp.— $\times 200$ .  
 „ 18.—Sceptrella spicule with smooth convex summit, *Latrunculia*— $\times 300$ .  
 „ 19.—Sceptrella spicule with median whorl of spines, *Latrunculia* sp.— $\times 300$ .  
 „ 20.—Sceptrella spicule with convex spined summit, *Latrunculia* sp.— $\times 300$ .  
 „ 21.—Sceptrella spicule of *Latrunculia* sp.— $\times 300$ .  
 „ 22.—Sceptrella spicule with cylindrical axis, *Latrunculia* sp.— $\times 300$ .  
 „ 23.—Style spicule of *Tethya* (?) distal portion— $\times 50$ .  
 „ 24.—Style spicule of *Myrilla* (?) sp.— $\times 100$ .  
 „ 25.—Style spicule (imperfect)— $\times 100$ .  
 „ 26.—Style spicule with curved summit— $\times 200$ .  
 „ 27.—Spinulate spicule (imperfect at the distal end)— $\times 100$ .  
 „ 28.—Pin-shaped spicule— $\times 100$ .  
 „ 29.—Style with the upper portion spined, the lower smooth— $\times 100$ .  
 „ 30.—Calthrops spicule with subequal rays— $\times 100$ .  
 „ 31.—Trifid spicule with simple head-rays— $\times 100$ .  
 „ 32.—Trifid spicule (upper portion) of *Stelletta* sp.— $\times 100$ .  
 „ 33.—Trifid spicule of *Geodia* (?) with recurved head-rays— $\times 100$ .



G. J. Hande del.  
G. M. Woodward lith.

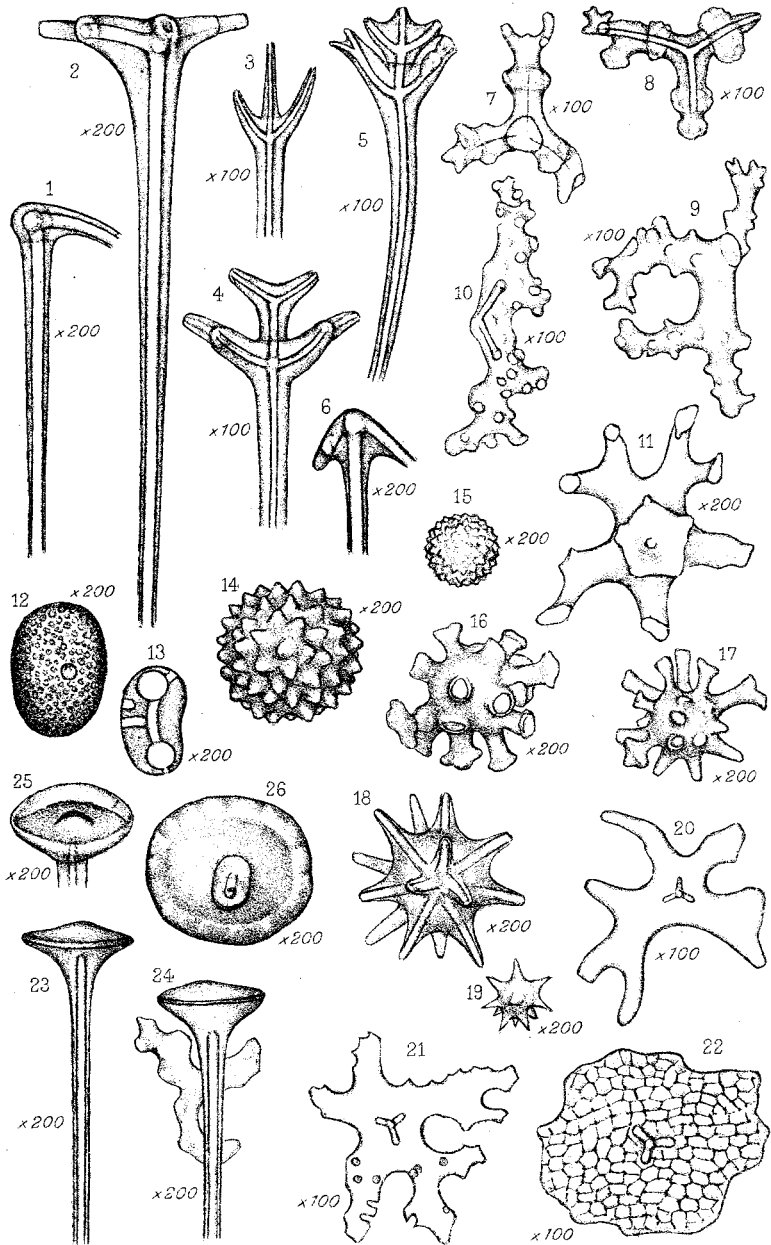
West, Newman imp.

FOSSIL SPONGE SPICULES. NORSEMAN, W. AUSTRALIA.

## PLATE II.

- Fig. 1.—Trifid spicule, abnormal, with only two head-rays— $\times 200$ .  
 „ 2.—Trifid spicule with bifurcated head-rays— $\times 200$ .  
 „ 3.—Trifid spicule of *Craniella* (?) sp. (upper portion)— $\times 100$ .  
 „ 4.—Trifid spicule of *Erylus* (?) sp. (shaft imperfect)— $\times 100$ .  
 „ 5.—Trifid spicule with head rays trifurcate— $\times 100$ .  
 „ 6.—Trifid spicule of *Cydonium* (?)— $\times 200$ .  
 Figs. 7, 8.—Skeleton spicules of *Ragadinia* sp.— $\times 100$ .  
 „ 9, 10.—Skeleton spicules, imperfect, of *Discodermia* sp.— $\times 100$ .  
 Fig. 11.—Skeleton spicules of *Vetulina* sp.— $\times 200$ .  
 Figs. 12, 13.—Reniform spicules of *Geodia*. Fig. 13 shows perforations of boring alga— $\times 200$ .  
 Fig. 14.—Globostellate spicule— $\times 200$ .  
 „ 15.—Globostellate spicule of *Cydonium*— $\times 200$ .  
 Figs. 16, 17.—Globostellate spicule of *Cydonium* sp.— $\times 200$ .  
 Fig. 18.—Globostellate spicule of *Tethya* sp.— $\times 200$ .  
 „ 19.—Globostellate spicule of *Tethya* sp.— $\times 200$ .  
 Figs. 20, 21.—Dermal spicules of *Ragadinia* sp.— $\times 100$ .  
 Fig. 22.—Dermal spicules of *Discodermia* showing surface network.— $\times 100$ .  
 Figs. 23–26.—Dermal spicules of *Discodermia* sp. Fig. 23 is a lateral view, showing the shaft and a prominent boss in the centre of the head plate. Fig. 24 is a specimen with a portion of a skeleton spicule entangled round the shaft. Fig. 25 shows the upper surface of the head plate, and Fig. 26 shows the under surface with the broken stump of the shaft—all  $\times 200$ .





G. J. Hinde del.  
G. M. Woodward lith.

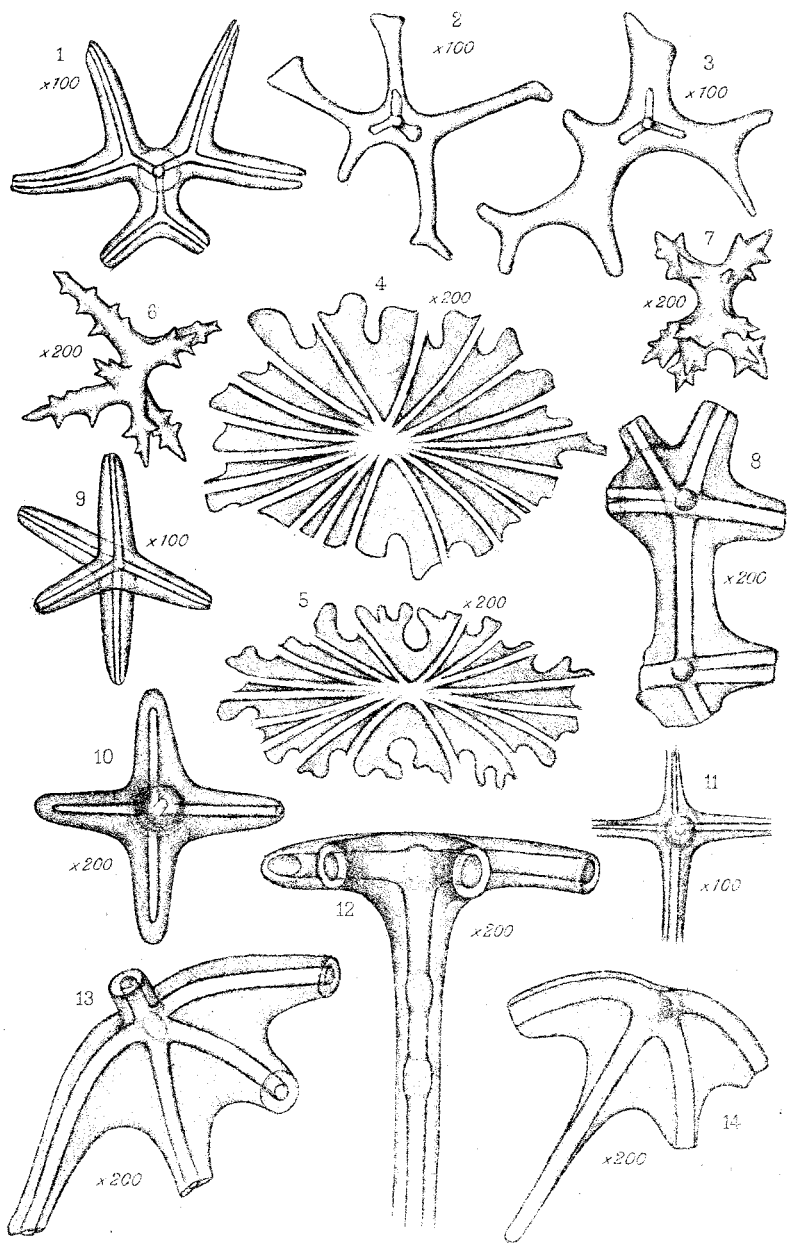
West, Newman imp.

FOSSIL SPONGE SPICULES. NORSEMAN, W AUSTRALIA.

## PLATE III.

- Fig. 1.—Dermal spicule of *Corallistes* (?)— $\times 100$ .  
 „ 2.—Dermal spicule showing the head-rays (?) *Theonella*— $\times 100$ .  
 „ 3.—Dermal spicule with the head-rays unequally developed— $\times 100$ .  
 Figs. 4, 5.—Dermal (?) spicules of unknown sponge. *Dactylocalycites* Carter.  
 The lower margin of Fig. 4 is partly broken away— $\times 200$ .  
 „ 6, 7.—Spicules with spinous rays. Sponge unknown— $\times 200$ .  
 Fig. 8.—Fragment of spicular framework of dictyonine hexactinellid— $\times 200$ .  
 Figs. 9, 10, 11.—Detached five-rayed spicules of hexactinellid sponges.  
 Figs. 9 and 11— $\times 100$ ; Fig. 10— $\times 200$ .  
 „ 12, 13, 14.—Umbrella spicules of the dermal surface of *Rossella* sp. all fragmentary. Fig. 12 gives a lateral view of the upper portion of the vertical shaft and of the basal portion of the four horizontal rays which radiate from its summit. Figs. 13 and 14 represent the proximal portion of the four horizontal rays with their canals and the patagium connecting the rays; also the broken summit of the vertical shaft— $\times 200$ .

The spicules figured on the plates were all derived from a specimen of siliceous rock from the Deep Lead (?) at Princess Royal, Norseman District, Western Australia.



G. J. Hinde del.  
G. M. Woodward lith.

West, Newman imp.

FOSSIL SPONGE SPICULES. NORSEMAN, W. AUSTRALIA.

## II.—Some Fossil Plants from Western Australia.

BY

E. A. NEWELL ARBER, M.A., F.L.S., F.G.S.,

*Trinity College, Cambridge, University Demonstrator in Palaeobotany.*

The specimens submitted to me were derived from two localities.

The first of these was Mt. Hill (second hill about half mile from Trig. Station) and is represented by two specimens numbered [8050] and [8054] respectively.

Specimen [8050] (3 pieces) is a portion of a coniferous trunk, in which the structure is in part preserved. A transverse section has been made of the specimen, but the preservation of the wood, on microscopic examination, proved to be far too imperfect to permit even of generic determination. It is impossible to determine the age of the beds from which it was derived.

Specimen [8054] (2 pieces) has been cut across, and appears to be an arenaceous (?) rock containing a number of thin, eroded fragments or chips of wood, the structure of which is, for the most part, not preserved. Here and there, however, fragments of the wood appear to be petrified, but not sufficiently to permit of determination. The specimen affords no indication of the age of the beds from which it was derived. It is, however, probably *not* Palaeozoic.

The second locality was the main road on West boundary of M. 299, 28 chains South of the North-West corner, about three miles South of Mingenew. Altitude about 500 feet above Mingenew. 25 specimens, numbered [8104 A-Y], were forwarded to me from this locality.

### OTOZAMITES FEISTMANTELI, *Zigno.*

- 1881—*Otozamites Feistmanteli*, Zigno, *Flora. Foss. Oolit.* Vol. II., p. 90, pl. 34, figs. 6-8.  
 1900—*Otozamites Feistmanteli*, Seward, *Jurassic Flora* (Brit. Mus. Catal.) Vol. I., p. 221.  
 1907—*Otozamites Feistmanteli*, Salfeld, *Palaeontogr.*, Vol. 54, p. 182, pl. XIX., fig. 14.

This fossil frond is represented by 15 specimens [8104, A-O], each exhibiting one or more examples.

The fronds vary considerably in detail, both as regards the shape of the leaflets and the degree of imbrication. There is, however, every reason to believe that they all belong to the same species.

[8104, D.] is a good example of one type, in which the pinnules are short and overlap one another. The shape and nervation of the pinnules is well seen. They are attached to the upper surface of the rachis by a broad base, the upper angle of the base being auriculate. This frond appears to be quite identical with that figured by Zigno (*see* above) on fig. 8 of plate 34, from the Lower Jurassic of Italy. This species has also been determined from the Lower Oolite of Britain.

The fronds seen on specimens [8104 A, B, C, G, I, J, and K], are similar to [8104 D]; the nervation being well seen in [8104 C].

In [8104 F], also [8104 E and L], the pinnules are more elongate, their length being about 2 c.m. as compared with 1.3–1.4 c.m., in the case of [8104 D].

In [8104 M] the base of a small frond is seen where some of the pinnules do not exceed 3 m.m. in length, and are more oval in shape.

In [8104 H], the pinnules are less imbricated, and this feature is also seen in [8104 L], which shows two fronds, one with short, imbricated pinnules similar to [8104 D], and another larger frond with longer pinnules, more distant from each other.

In [8104 N–O] the pinnules are also less imbricated.

A comparison of the typical specimen [8104 D] with the figure given by Kurr of his *Zamites Mandelslohi* (Beitr. foss. Flora Jura format., Württembergs, 1845, p. 10, pl. I., fig. 3), would appear to indicate that the Australian frond may be identical with that occurring in the Lower Oolite of Germany. On the other hand, this matter remains in doubt, for the specimens recently figured under this name, from the Lias of Holzmaden, Württemberg, by Salfeld (Palæontogr., Vol. LIV., 1907, p. 182, pl. XVI., figs. 1a, 1b, 1c) do not appear to be specifically identical with the Australian leaves.

Feistmantel (Mem. Geol. Surv. New South Wales, Pal. No. 3, 1890, p. 147, pl. 28, figs. 9, 9a; refigured by Salfeld, *ibid.*, pl. XIX, fig. 14; *see* also Jack and Etheridge Geol. and Palæontol. of Queensland 1892, p. 381) has also compared a Queensland fossil, from the Talgai coalfield on the Condamine River, with *Otozamites Mandelslohi* (Kurr). Feistmantel's figure, however, appears to be rather carelessly drawn, or else the specimen is not very well preserved.

There would appear to be a distinct possibility that his frond from Queensland may be identical with the fossils under discussion here, but until his figured specimen (in the Min. and Geol. Mus., Sydney) has been compared with the West Australian leaves, it will be difficult to form any opinion on this point.

So far as I am aware Feistmantel's record is the only species of *Otozamites* as yet found in Australia, though Tenison-Woods

(Proc. Linn. Soc. New South Wales, 1883, vol. VIII., p. 151) has described the same species from another locality in Queensland, *i.e.*, the Darling Downs near Toowoomba.

Thus while there may be some uncertainty as to the identity of the Australian fossils with Kurr's species *Otozamites Mandeslohi*, there is every reason to regard them as specifically identical with the *O. Feistmanteli*, Zigno, of the lower Jurassic of Italy and England. Professor Seward (*ibid.* p. 221) has diagnosed this species as follows:—"Frond narrow, linear; pinnæ short and broad, attached to the upper face of the rachis by a broad base, of which the upper corner is slightly auriculate; the apex is bluntly rounded, the tip being directed upwards. Venation of the *Otozamites* type."

*cf.* PAGIOPHYLLUM. *sp.*

[8104 X-Y]. A portion of a Gymnospermous twig occurs on this specimen associated with a frond of *Otozamites Feistmanteli*, Zigno. The preservation is unfortunately very poor, and it is not possible to determine even the genus with certainty. It appears to stand nearest to the genus *Pagiophyllum*, and with it may be compared the *Pagiophyllum Kurri* of Schimper from the Lias of Germany (see Salfeld, *ante*, p. 186, pl. XIX., fig. 1: also the *Araucaria peregrina* of Kurr, *ante*, p. 9, pl. I., fig. 1). Tenison-Woods has figured (*ante* p. 165, pl. 4, fig. 1) an obscure specimen under the name *Cunninghamites Australis*, *sp. nov.*, which may also be compared with this fossil. Tennison-Wood's specimen was obtained from the Mesozoic beds of Rosewood, Ipswich, Queensland.

#### FOSSIL WOODS,

[8104 P, Q, S, T, U.] Fragments and casts of fossil stems, in which the structure is not preserved. They are indeterminable, and of no value. The ribbed specimen [8104 U] has been cut across, but it is obviously not petrified, and consequently no sections were made of it. It is probably not the pith cast of an Equisetaceous genus, but of Coniferous origin. [8104 T] shows what may possibly be a ribbed pith cast, and part of the wood lying more externally. It is, however, impossible to determine its position in the Vegetable Kingdom. [8104 R] is a poor cast of a branching or leafy twig, and is also indeterminable.

#### INDETERMINABLE.

[8104 V-W]. A minute fragment of what appears to be the apical portion of the pinna of a frond. Each pinnule appears to possess a well marked mid-rib, but otherwise the nervation is not seen. The specimen is far too fragmentary and badly preserved to be determinable.

[8104 W] also shows two small seed-like bodies, which are indeterminable.

CONCLUSIONS AS TO THE AGE OF THE BEDS IN THE SECOND  
LOCALITY.

Of the specimens examined, the fronds of *Otozamites Feistmanteli*, Zigno, and the specimen compared with *Pagiophyllum*, alone afford any evidence as to the age of the beds.

These plants occur in the Jurassic of Europe, and possibly also in (?) Jurassic beds in Queensland. So far as a comparison with the European fossils is concerned, the age would appear to be *earlier* rather than *later* Jurassic. *O. Feistmanteli*, Zigno, occurs in the Lower Jurassic of England and Italy, and possibly also in Germany. *Pagiophyllum Kurri*, with which [8104 X-Y] may be compared, is a Lower Jurassic fossil from Germany. As regards the plant bearing beds elsewhere in Australia, the flora of beds, probably of Jurassic age, in Queensland at Talgai (Condamine River), the Darling Downs, and Rosewood, West of Rockhampton, affords the closest comparison with the specimens from Western Australia.

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### III.—Oolitic Fossils of the Greenough River District, Western Australia,

BY

R. ETHERIDGE,

*Curator of the Australian Museum, Sydney, N.S.W.*

#### I.—INTRODUCTION.

Through the kindness of Mr. A. Gibb Maitland, Government Geologist, I have lately had the pleasure of examining a collection of the Oolitic fossils of the Greenough River District.

The principal, and really only important, paper dealing with West Australian Mesozoic fossils, up to a comparatively recent date, was that of the late Charles Moore \* of Bath, England. He enumerated a large number of species occurring in that State and of these he described or figured eleven; nine were described as new, and twenty were believed to be identical with European species. I am now in a position to figure some of these exotic forms mentioned by Moore. In 1904, Mr. F. Chapman published a paper dealing with West Australian Jurassic fossils in the National Museum, Melbourne, † but no new forms were described.

#### II.—DESCRIPTION OF THE SPECIES.

##### CLASS ANNELIDA.

GENUS SERPULA, *Linnaeus*, 1758.

(*Systema*, Ed. X., p. 786).

SERPULA CONFORMIS, *Goldfuss*.

(Plate IV., Fig. 1.)

*Serpula conformis*, Goldfuss, *Petrefacta Germaniæ*, 2nd Edit., 1862, I., p. 212, pl. 67, f. 13, *a* and *b*.

*Obs.*—A few small *Serpulæ* are attached to the surfaces of Mollusca. There is no feature to distinguish them from the above carinate Oolitic species.

Moore enumerated *Serpulæ* but without attaching specific names.

*Loc.*—Tibraddon Station, Greenough River.

\* Moore—*Quart. Journ. Geol. Soc.*, 1870, XXVI., pp. 228-261, pls.

† Chapman—*Proc. R. Soc., Vict.*, 1904, XVI., (n.s.), p. 327.



## CLASS BRACHIOPODA.

GENUS RHYCHONELLA, *Fischer*, 1809.

(Notice Foss. Gouv. Moscou, p. 35.)

RHYCHONELLA VARIABILIS, *Schlotheim*.

(Plate IX., Figs. 3 and 6).

*Rhychonella variabilis* (Schlotheim), Davidson, Mon. Brit. Oolitic and Liassic Brach., 1852, pt. 3, p. 78 (for synonymy), pl. 15, f. 8-10, pl. 16, f. 1-6.

*Obs.*—This species was first recorded by Mr. Moore.\* In the present collection are biplicate and triplicate individuals, answering to the varieties *bidens* and *triplicata* of Phillips.

*Loc.*—Snake Farm, Greenough River.

## CLASS PELECYPODA.

GENUS OSTREA, *Linnaeus*, 1758.

(Systema, Ed. X., p. 696).

OSTREA THOLIFORMIS, † *sp. nov.*

(Plate VII., Figs. 2-7.)

*Sp. Chars.*—Lower valve obtusely conical, irregularly low-dome or cupola-shaped, with a large concave scar of attachment; test very thick. Upper valve flat, a little concave, or the surface rolling. Cardinal margin in both valves well developed, extending the entire width of the upper valve; chondrophore comparatively large; resilium furrows both in the chondrophore and on cardinal margin are strong. Adductor scar in the upper valve oblique and transversely ovate, with exsert lower margin. Well developed latilaminæ on the exterior of both valves.

*Obs.*—There are ten examples of this oyster in the collection. It is a solid and substantial, although not large form; one specimen is sub-lobate, the others irregularly round, or oval, in marginal outline. It may possibly belong to one of Bayle's sections of the Genus *Pycnodonta* or *Rhynchostreon*. In the works and collections at my command I am unable to find any species precisely like it but the nearest is *O. akkabensis*, Krumbeck, ‡ from the Syrian "Glandarienkalk."

A second species of oyster is possibly present (Pl. IX., fig. 2). It is an upper valve, flat and deltoid in outline, not unlike the same valve of the Kimmeridgian *O. deltoidea*, Sby., but rather less deltoid.

*Loc.*—Tibraddon and Sandspring Stations, Snake Farm, Greenough River; Fossil Hill, two miles East of Moonyuccneeka Railway Station.

\* Moore—Quart. Journ. Geol. Soc., 1870, XXVI., pp. 231, 232, pl. 10, f. 11 and 12.

† *Tholus*—a dome or cupola.

‡ Krumbeck—Beitrag Pal. Geol. Oster.—Ung. Orients, 1905, XVIII., Heft 1 and 2, pl. 12, f. 1 and 2.

GENUS *ALECTRYONIA*, *Fischer*, 1806.

(Bull. Soc. Imp. Nat. Moscou, VIII.)

*ALECTRYONIA MARSHII*, *J. Sby.*, *sp.*

(Plate IV., Figs. 5-7; Pl. V., Fig. 4).

*Ostrea diluviana*, Parkinson, Organic Remains, etc., 1811, III., p. 217, pl. 15, f. 1.*Ostrea Marshii*, J. Sowerby, Min. Conchol., 1816, I., p. 103, pl. 48.*Ostrea Marshii*, Goldfuss, Petrefacta Germanice, 1833, II., lief. 4, pl. 73.*Ostrea Marshii*, Morris and Lycett, Mon. Moll. Gt. Oolite, 1854, pt. 3, p. 126, pl. 14, f. 2, 2a.*Ostrea Marshii*, Moore, Quart. Journ. Geol. Soc., 1870, XXVI., p. 232.*Alectryonia Marshii*, Fischer, Man. Conch. et Pal. Conch., 1886, fas. X., p. 926, f. 690.*Ostrea Marshii*, Muller in Bernhardt's Deutsch-Ost-Afrika, 1900, VII., p. 16, f. 1, 1a.

*Obs.*—There are several specimens, and all may pass as varieties of this well known and widely spread shell, "very variable in form," as James Sowerby said, and shown in Goldfuss' beautiful figures. Both the ovately oblong and fan-shaped varieties are present, and the zig-zag frontal edges are also strongly in evidence. Our specimens accord best with Goldfuss' figures *a*, *b*, *f*, and perhaps *k*. The elevated adductor is also very apparent in one. The area, as in foreign examples, is triangular and shell-like and vertically divided by a central wide chandrophore.

*Locs.*—Tibraddon and Sandspring Stations, Greenough River.

GENUS *CTENOSTREON*, *Eichwald*, 1868.

(Lethæa Rossica, 1868, II., p. 455.)

*CTENOSTREON PECTINIFORMIS*, *Schl.*, *sp.**Ostracites pectiniformis*, Schlotheim, Petrefactenkunde, 1820, I., p. 231.*Ctenostreon pectiniformis*, Eth., fil., Rec. Austr. Mus., 1901, IV., No. 1, p. 14, pl. 3 (for synonymy).*Ctenostreon pectiniformis*, Chapman, Proc. R. Soc. Viet., 1904, XIV., (n.s.), pt. 2, p. 329, pl. 30, f. 1.

*Obs.*—Five examples in a poor state of preservation add little to our previous knowledge of Australian form of this species. One has the fistulous spines produced into regular elongate tubes, as shown in one of Lycett's figures.\*

*Locs.*—Tibraddon and Sandspring Stations, Greenough River; Fossil Hill, two miles East of Moonyoonooka Railway Station.

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\* Lycett—Suppl. Mon. Moll. Gt. Oolite, 1863, pl. 29, f. 1.

GENUS PECTEN, O. F. Müller, 1776.

(Zool. Donicæ Prod., p. XXXI.)

PECTEN (?) CINCTUS, J. Sowerby.

(Plate IX., Fig. 1).

*Pecten cinctus*, J. Sowerby, Min. Conchol., IV., p. 96, pl. 371.

*Pecten cinctus*, Moore, Quart. Journ. Geol. Soc., 1870, XXVI., pp. 230, 231, and 232.

*Pecten cinctus*, Chapman, Proc. R. Soc. Vict., 1904, XVI. (n.s.), pt. 2. p. 328.

*Obs.*—The name *P. cinctus*, J. Sby. appeared in Moore's list of West Australian Oolitic fossils, but no complete description of either the British shell, or its supposed Australian analogue has, so far as I am aware, appeared. The original figure displays a shell defective in the region of the auricles and cardinal margin, whilst all the West Australian specimens within my knowledge are in a poor or incomplete state of preservation. In all I have nine specimens before me, seven forming a portion of the present collection and two in the Australian Museum; the largest of these measures seventeen centimeters by sixteen and a half.

I do not by any means feel satisfied our Australian shells are Sowerby's species. Sowerby said the valves of the British shell were of nearly equal convexity, but in the present instance the valves are very far from being nearly equally convex; indeed five are actually plano-convex.

The shell is sub-orbicular, more or less plano-convex, one valve moderately convex, the other flat, or nearly so; the test is thick, but as a rule much exfoliated. In the convex valve, one of the auricles (? anterior) is flat and wing-like, undivided from the body of the shell, and possibly slightly falcate along the outer margin. On the flat valve one auricle (? anterior) is triangular with a strongly falcate, or even segmoidal outer margin. The other ear of the same valve, of which a portion is still visible on one specimen, is, judging from the direction of the ornamenting laminae, rectangular; one of the flat valves is ornamented with fine concentric lines. It may be pointed out that Sowerby's figure corresponds to the flat valve of our shells.

*Locs.*—Tibraddon Station; a quarter of a mile North-West, and half a mile North of Woolanooka; Sandspring Station, Greenough River; Snake River, Greenough River District.

PECTEN (?), *sp.*

(Plate VIII., Figs. 5 and 6.)

*Obs.*—I previously refer to *Pecten* two small slightly oblique valves, almost round in outline, very moderately convex and with small flat ill-defined triangular auricles. A very large number of strong costæ decorate the surfaces, either all of one size or alter-

nately larger and smaller, the latter interpolated, the former sometimes bifurcate. The umbo was acute and overhung the cardinal margin.

I believe this to be one of those unsatisfactory forms oscillating between *Pecten* and *Radula* and in all probability in want of a particular generic designation.

*Loc.*—Sandspring Station, Greenough River.

GENUS RADULA, *Klein*, 1753.

(Tent. Meth. Ostrac., p. 135).

RADULA DUPLICATA, *J. de C. Sowerby*.

(Plate VIII., Figs. 7 and 8).

*Plagiostoma duplicata*, *J. de C. Sby.*, Min. Conchol., 1827, V., p. 114, pl. 559, f. 3.

*Lima duplicata*, *Morris and Lycett*, Mon. Moll. Gt. Oolite, 1853, pt. II., p. 26, pl. 3, f. 6 and 6a.

*Obs.*—Of rather common occurrence throughout the hand specimens of matrix are portions of a small *Radula*. The auricles always either hidden or defective, and all that can be said of the specimens is that the size is small, the outline oblique, and the surface covered with many radiating, direct, strong, angular costæ; between these are very much finer ribs, occupying the centres of the valleys or inter-costal spaces, and not reaching to the umbos.

In their present condition it is impossible to distinguish these fossils from the corresponding portions of *R. duplicata*.

*Locs.*—Sandspring Station, and a quarter of a mile South of Tibraddon Station, Greenough River.

GENUS MODIOLA, *Lamarck*, 1799.

(Min. Soc. Hist. Nat. Paris, 1799, p. 87).

MODIOLA MAITLANDI, *sp. nov.*

(Plate V., Fig. 1 and 2).

*Sp. Chars.*—Shell large, bold, gibbous, oblique, strongly medio-liform, and transversely elongate. Cardinal margins straight, about three-quarters the length of the shell; valves convex along the obtuse diagonal ridges, which are at first nearly parallel to the cardinal margins, and then curve outwards and downwards, the valves steep on the fore side, flat on the hind surface. Anterior ends very small, almost undeveloped, the margin bluntly rounded. Ventral margins long, concave in the centre, convex at both ends. Sculpture of fine concentric lines and broad latilaminæ of growth.

*Obs.*—This fine shell, of which the interior is unknown, appears to be an addition to the West Australian list. For an Oolitic *Modiola* its size appears to be unusual, and quite vies with that of

*M. alatus*, Krumbeck, \* of the Glandarienkalk of Syria ; it differs from this, however, in the possession of pronounced diagonal ridges and insinuated ventral margins.

*M. Maillandi* is not unlike some *Myoconchæ*, particularly Cretaceous species. Even amongst *Modiola*, the size is more akin to that of the recent species *Modiola vagina*, Lamk, than it is to most fossil forms. It is named in honour of Mr. A. Gibb Maitland, Government Geologist.

*Locs.*—Tibraddon and Sandspring Stations, Greenough River.

#### GENUS CUCULLÆA, Lamarck, 1801.

(Système, p. 116).

##### CUCULLÆA SEMISTRIATA, Moore.

(Plate VI., Figs. 1 and 2 ; Pl. VIII., fig. 3).

*Cucullæa semistriata*, Moore, Quart. Journ. Geol. Soc., 1870, XXVI., 250, pl. 14, f. 3.

*Cucullæa semistriata*, Eth. fil., Ann. Rept. Dept. Mines, N. S. Wales for 1889 (1890), p. 239.

*Sp. Chars.*—Shell obliquely oblong, quadrate, robust, inflated. Cardinal margins considerably less than the width of the shell ; umbonal regions high, prominent ; umbos depressed, flattened above, the apices curving over the area ; the latter wide, with sharp margins, and deeply excavated, the ligamentary grooves widely V-shaped, about fourteen on each moiety of the area. Anterior ends obtuse, the margins very slightly rounded or almost truncate ; anterior slopes slightly flattened but steep. Posterior ends obliquely produced, obtusely pointed ; margins above oblique, below obtusely rounded ; posterior slopes forming scalene triangles, long, slightly concave ; diagonal ridges prominent above. Articuli strong ; medium denticles numerous and oblique ; lateral teeth three on each side, large and strong, the upper one practically horizontal, the median slightly oblique, the lower decidedly oblique. Sculpture of deep latilaminar grooves with between them finer concentric lines, crossed on the anterior slopes by fine radii producing a cancellated surface.

*Obs.*—Moore speaks of the “hinge-area bounded by a lanceolate straight space,” which does not appear on the specimens before me. This species very closely resembles Goldfuss’ illustration† of *C. oblonga*, J. Sby. So far as I have been able to isolate the articulus, the shell appears to be a true *Cucullæa*, at the same time the muscular scars have not been seen. *C. semistriata* is represented by the greatest number of individuals, and it may be distinguished generally by its oblong-quadrate robust form.

\* Krumbeck—Beitrage Pal. Geol. Osterr.—Ung. Orient, 1905, XVIII., left 1 and 2, pl. 11, f. 4 and 5.

† Goldfuss—Petrefacta Germaniæ, Thiel 2, pl. 123, f. 2.

*Locs.*—Tibraddon and Sandspring Stations and half a mile North of Woolanooka, Greenough River; Fossil Hill, two miles East of Moonyoonooka Railway Station, Greenough River District.

*CUCULLÆA TIBRADDONENSIS, sp. nov.*

(Plate V., Fig. 3 and 4).

(?) *Cucullæa, sp.* Moore, Quart. Jour., Geol. Soc., 1870, XXVI., p. 250.

*Sp. Chars.*—Transverse obliquely oblong, produced posteriorly only moderately inflated in the umbonal region. Cardinal margins about two-thirds the length of the shell; umbos depressed, flattened above. Area narrow, deep; ligamentary grooves five on each area half. Anterior ends rather obtuse, the margins almost vertical above, rounded below, the antero-cardinal junctions forming a right angle; anterior slopes obtuse. Posterior ends long, produced, narrow, wedge-shaped, the margins all rounded, and without postero-cardinal angles; diagonal ridges sharp umbonally becoming obtuse in their downward course and dying out; posterior slopes slightly concave. Sculpture of latilaminæ, which are strong and corrugated on the posterior extremities, with intermediate finer concentric lines, and umbonal radii.

*Obs.*—Moore recorded four species of *Cucullæa* from West Australia, viz., *C. oblonga*, J. Sby., *C. inflata*, Moore, *C. semistriata*, Moore, and a fourth, to which no name was given, this last "distinguished by its being much narrower or transversely elongated." There is a strong probability of this being the shell in question. It may be at once distinguished from the others by its wedge-like produced posterior end.

*Locs.*—Tibraddon and Sandspring Stations, Greenough River.

*CUCULLÆA, sp.*

(Plate VII., Fig. 1; Pl. VIII., Figs. 1 and 2).

*Obs.*—The collection contains four single valves that may be Moore's first species of West Australian *Cucullæa* (*C. inflata*), although neither of them appear to be sufficiently inflated to answer to his figures. The shells before me possess an outline quite dissimilar to those referred to *C. semistriata*. It is quadrate, somewhat obliquely so, longer than broad. The cardinal margins, as Moore says of his *C. inflata*, are shorter than the width of the shell, and the umbos median and much elevated. The largest specimen is by no means perfect, but the anterior and posterior ends appear to be truncate, and there is certainly a strong posterior diagonal ridge, again as described by Moore, and a wide posterior slope. The area is wide and very high, with many ligamental furrows (more than fifteen). The entire valve is sculptured with fine concentric lines on wide latilaminæ, and anterior radii.

Moore recorded\*, but neither described nor figured, the European *C. oblonga*, J. Sby.† as a West Australian species. He said "*C. oblonga* is the most frequent [species] of this genus." Sowerby's figure is drawn from a point of view very difficult for determinative purposes, but notwithstanding this, I have not seen a *Cucullæa* from West Australia I could refer to it, although the present form approaches nearest.

*Loc.*—Fossil Hill, two miles East of Moonyoonooka; Sand-spring Station, Greenough River.

GENUS TRIGONIA, *Bruguère*, 1789.

(Encycl. Méthod. I., pl. 14).

TRIGONIA MOOREI, *Lycett*. ‡

(Plate IV).

*Trigonia Moorei*, Lycett. Brit. Fos. Trigonæ, No. 4, 1878, p. 151, fig.

*Trigonia Moorei*, Moore, Quart. Jour. Geol. Soc., 1870, XXVI., p. 254, pl. 14, f. 9 and 10.

*Trigonia Moorei*, Eth. fil., Rec. Austr. Mus., 1904, No. 4, pl. 27, f. 3 and 4.

*Sp. Chars.*—Shell irregularly quadrate, posteriorly oblique; valves generally compressed, in advanced age becoming inflated; anterior cardinal margins short, steep; posterior cardinal margins moderately long; umbonal regions high; umbos much more anterior than posterior, fine, very slightly opisthogyrate; escutcheon elongately cordate, almost reaching to the posterior cardinal angles, bounded by fairly well pronounced carinæ; ligamentary aperture heart-shaped, short. Anterior ends small comparatively, entirely confined between the upper parts of the cinctures and the anterior margins which are rounded; posterior ends much compressed, the margins short and oblique; cinctures on leaving the umbos at first nearly vertical, then sweeping down so as to just miss the postero-ventral angles, broad and shallow; diagonal ridges prominent; posterior slopes flattened, each traversed by a median radial groove. Ventral margins well rounded on the anterior side, and nearly straight medianally to the postero-ventral angles. Sculpture anterior to the cinctures of 20–23 sharp, outstanding, concentric lyræ, separated by wide, flat valleys, the former almost vertical along the anterior margins; on arriving at the cinctures the lyræ rise into flat transverse nodes, but pass over the former as faint flat laminae, terminating at the diagonal ridges as prominent transverse echinating nodes; posterior slopes bear fine curved radii and transverse ridges giving rise to a scabrous surface, the points of intersection nodose; on the escutcheon this scabrous sculpture occurs at its very apex immediately under the umbos, the remainder

\* Moore—Quart. Journ. Geol. Soc., 1870, XXVI., pp. 231, 250.

† Sowerby—Min. Conchol., 1818, III., p. 7, pl. 206, f. 1 and 2.

‡ Non *T. Moorei*, Garich.

of the surface bearing lines. Articles much arched, strong ; hinge plates thick ; nymphæ small, erect ; triangular cardinal callosity of the left valve well developed and projecting horizontally above, but distinctly hollowed below ; posterior tooth of the right valve long, fitting into a correspondingly long and deep socket of the left valve ; posterior tooth of the left valve also large and projecting.

*Obs.*—This, to us well-known, shell has not been described before in detail. It is one of the most characteristic West Australian Mesozoic fossils and occurs at certain localities in great profusion. The original notes published by Mr. Moore were furnished by Dr. J. Lycett, who compared *T. Moorei* with *T. costata*. J. Sby., of the European Lower Oolite and found it to differ as follows :—(1) generally more compressed ; (2) escutcheon narrower and longer (3) posterior slopes (Lycett's area) larger, more convex, more expanded, and bipartite, the median carinæ replaced by grooves ; (4) inner carinæ (bounding the escutcheon) slightly nodular and inconspicuous ; (5) anteally the lyræ approach the valve margins almost perpendicularly ; (6) no distinct anterior truncation ; (7) diagonal ridge of the right valve stronger than that of the left. Of these characters the last does not appear to hold good when a number of specimens are examined.

Mr. F. L. Kitchin considers *T. Moorei* to be of "essentially similar aspect" to his *T. dhoensis*\* of the Cutch Jurassic fauna, but on a close examination the two shells need not for a moment be mistaken for one another.

There is a much higher degree of gibbosity, or inflation, in the united valves of old shells, than in those of young and median growth. In old individuals also the scabrous surface of the posterior slopes is much accentuated. Other than these points the species appear to maintain its character free of variation. The largest example to come under my notice measured two and a half inches along the cinctures from umbos to ventral margins. In absolutely unworn specimens, the interlyrate concentric striæ on crossing the cinctures rise into delicate frills.

*Locs.*—Tibraddon and Sandspring Stations, Greenough River ; Fossil Hill, two miles East of Moonyoonooka Railway Station ; quarter mile North-West and half mile North of Woolanooka, Greenough River and Snake Farm, Greenough River.

GENUS ASTARTE, *J. Sowerby*, 1816.

(Min. Conchol., II., p. 85).

ASTARTE CLIFTONI, *Moore*.

(Plate V., Figs. 5-8 ; Pl. VI., Fig. 3).

*Astarte Cliftoni*, Moore, Quart. Journ. Geol. Soc., 1870, XXVI., p. 249, pl. 13, f. 10.

*Sp. Chars.*—Shell ovately-trigonal, inequilateral in the extreme, compressed ; cardinal margins highly arched, strongly re-

\* Kitchin—Jurassic Fauna of Cutch (Pal. Ind.), III., pt. 2, No. 1, 1903, p. 29, pl. 3, f. 1 and 2.



versed V-shaped, short on the anterior sides, and very long posteriorly. Umbos quite anterior, fine, sharp, and depressed; lunule large, deep, ovate cordiform; escutcheon very long, deep and narrow; ligamentary aperture less than half the length of the escutcheon, ligament stout. Anterior ends merely fractional from the advanced position of the umbos, their brief margin quite rounded; anterior diagonal ridges short, curved very sharp, bounding the lunule. Posterior ends consisting of what is tantamount to the entire valves, flattened, the margins rounded, forming by their junctions with the oblique cardinal margins approximate angles of  $15^{\circ}$ ; posterior slopes quite inconspicuous. Sculpture of very numerous, sharp, close, regular, concentric lyræ.

*Obs.*—The ovately-trigonal outline, long obliquely arched cardinal compressor margins, and compressed valves, render this an easily recognised shell. It is only to be distinguished from *A. subtrigona*, Münster,\* of the Wurtemberg Inferior Oolite, by possessing a rather more oblique outline and more compressed valves. I have seen the articulus of the left valve, and it is characteristically astartiform; the central socket for the reception of the right central cardinal is remarkably large.

*Loc.*—Tibraddon Station, Greenough River.

## CLASS GASTEROPODA.

GENUS PLEUROTOMARIA, *Defrance*†, 1824.

(Tableau, p. 114).

PLEUROTOMARIA GREENOUGHENSIS, *sp. nov.*

(Plate VIII., Figs. 9 and 10).

*Sp. Chars.*—Shell conical, gradate; whorls six, step-like, lower portion the larger moiety and slightly oblique, the upper half nearly horizontal; band probably represented by a slight groove around the middle of each whorl. Sculpture spiral.

*Obs.*—A very unsatisfactory specimen, but as univalves appear to be so scarce in collection of West Australian Mesozoic fossils, it was thought advisable to notice it. The base is incomplete, but the mouth was probably transversely oval and oblique. The finer details of sculpture also are not preserved.

*Loc.*—Sandspring Station, Greenough River.

## CLASS CEPHALOPODA.

GENUS DORSETENSIA, *S. S. Buckman*, 1892.

(Mon. Inf. Oolite Ammonites, pt. VI., p. 302).

DORSETENSIA CLARKEI, *Crick*.

(Plate VI., Fig. 4; Plate IX., Fig. 7).

*Ammonites radians*, Moore (non Schlotheim), Quart. Journ. Geol. Sec., 1870, XXVI., pp. 230, 231, 232; pl. 15, f. 2.

*Ammonites (Dorsetensia) Clarkei*, Crick, Geol. Mag., 1894, I., (4), p. 388, pl. 12, f. 2, a-c.

*Obs.*—Seven examples of this species are before me in varying states of preservation, the largest with a diameter of three and a

\* Münster.—In Goldfuss, Petrefacta Germaniæ, Ed. 2, 1862, II., p. 183, pl. 134, f. 17, a and b.

† Restricted, Fischer.

quarter inches. Two of the specimens exhibit five and a half whorls and still incomplete. In casts the costæ disappear on the flanks at about the sixth whorl.

*Locs.*—Tibraddon Station and Snake Farm, Greenough River ; Fossil Hill, two miles East of Moonyoonooka Railway Station.

GENUS PERISPHINCTES, *Waagen*, 1869.

(Benecke's Geogn-pal. Beiträge, 1869, II., p. 248).\*

PERISPHINCTES CHAMPIONENSIS, *Crick* ?

*Ammonites* (*Perisphinctes*) *championensis*, *Crick*, Geol., Mag., 1894, I., (4), p. 436, pl. 13, f. 2 *a* and *c*.

*Ammonites* (*Perisphinctes*) *championensis*, *Chapman*, Proc. R. Soc. Vict., 1904, XVI. (n.s.), p. 331, pl. 30, f. 2.

*Obs.*—Two imperfect specimens are referred to this species one with a diameter of five and a half inches. Both exhibit the superumbilical nodes and fasciculate costæ of this and *P. robiginosus*, *Crick*, † indeed, it is very difficult to distinguish the one from the other.

*Loc.*—Tibraddon Station, Greenough River.

GENUS SPHÆROCERAS, *Bayle*.

SPHÆROCERAS SEMIORNATUS, *Crick* ?

(Plate IX., Fig. 8).

*Ammonites Brocchi*, *Moore* (non *J. Sby.*), Quart. Journ. Geol. Soc., 1870, XXVI., pp. 231, 232, pl. 15, f. 4.

*Ammonites* (*Sphæroceras*) *semiornatus*, *Crick*, Geol. Mag., 1894, I. (4), p. 434, pl. 13, f. 1, *a* and *b*.

*Obs.*—A single impression or mould in limonite may represent this species judging by the remains of the sculpture ; the superumbilical or dorsal tubercle-ribs passing into more numerous median or ventral costæ are quite apparent.

*Loc.*—Tibraddon Station, Greenough River.

GENUS NAUTILUS, *Breynius*, 1732.

(Dissert. de Polythal).

NAUTILUS PERORNATUS, *Crick*.

*Nautilus semistriatus*, *Moore* (non *D'Orb.*), Quart. Journ. Geol. Soc., 1870, XXVI., pp. 230, 231, 232.

*Nautilus perornatus*, *Crick*, Geol. Mag. 1894, I. (4), p. 386, pl. 12, f. 1 *a* and *c*.

*Obs.*—In the present collection are three examples imperfect and poorly preserved, but still showing that the shell attained a

\* *Fide* Neumayr.

† *Crick*—Geol. Mag., 1894, I. (4), p. 438, pl. 13, f. 3, *a*, and *b*.

large size. The largest consists of a portion of the venter and one flank, the former bearing revolving costæ, and the latter coarse lines of growth. This specimen measures round the venter sixteen inches, and across the same, four and a half inches. The second example is similar but smaller, whilst the third is part of a flank and half a venter again exhibiting the revolving costæ, but in this instance on both, with septal sutures and camerae. The third example is a much smaller specimen, about double the size of Mr. Crick's figure.

*Loc.*—Tibraddon Station, Greenough River and Fossil Hill, two miles East of Moonyoonooka Railway Station.

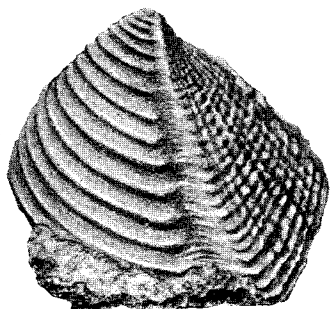
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#### EXPLANATION OF PLATE IV.

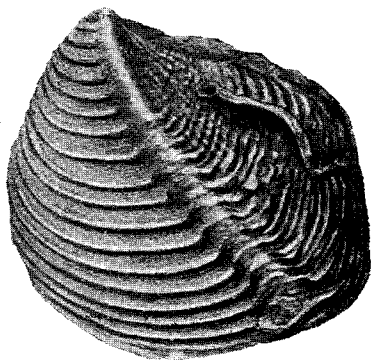
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##### TRIGONIA MOOREI, *Lycett.*

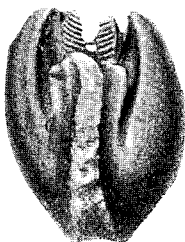
- Fig. 1.—A full grown specimen of a left valve showing the lyræ passing across the cincture as frills.
- „ 2.—A similar valve the lyræ terminating in tubercles before passing over the cincture; the posterior slope with semi-concentric lyræ and median shallow radial groove.
- „ 3.—Slightly smaller example with the eschinated sculpture of the posterior slope and well developed nodes along both sides of the cincture.
- „ 4.—A similar specimen to Fig. 3.
- „ 5.—Articulus of a left valve showing the projecting cardinal socket-like callosity and teeth.
- „ 6.—Internal cast of the right valve.
- „ 7.—Internal cast of the united valves seen from above.
- „ 8.—The same seen from the anterior.
-



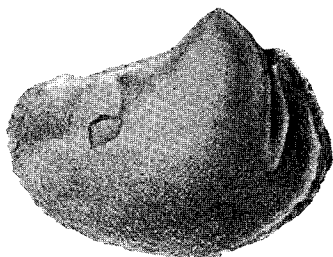
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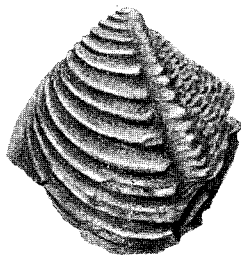
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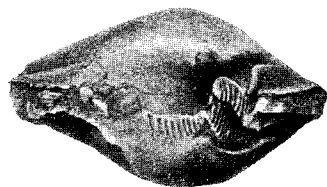
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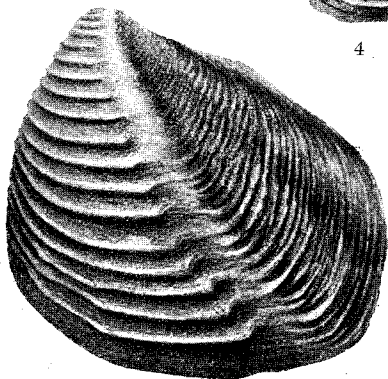
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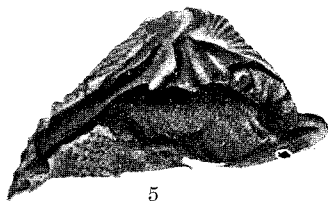
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## EXPLANATION OF PLATE V.

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MODIOLA MAITLANDI, *Eth. fil.*

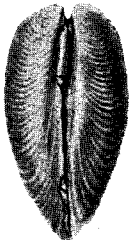
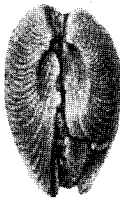
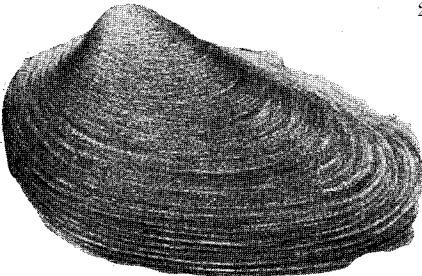
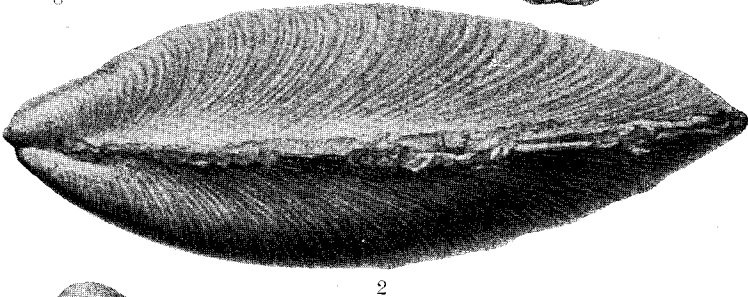
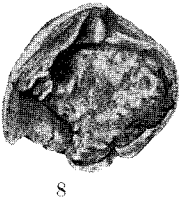
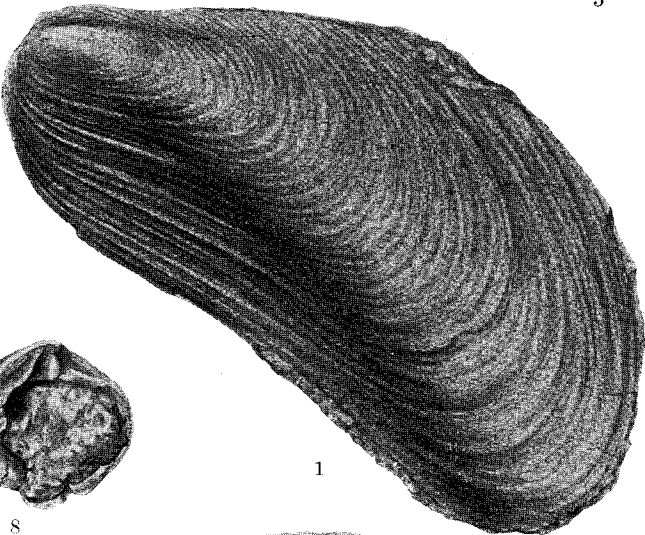
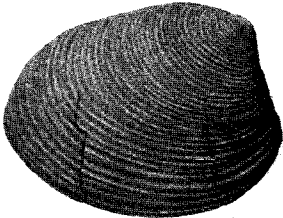
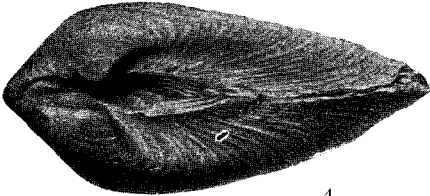
- Fig. 1.—Left valve of a well preserved example.  
 „ 2.—The united valves seen from above.

CUCULLÆA TIBRADDONENSIS, *Eth. fil.*

- „ 3.—Left valve slightly imperfect.  
 „ 4.—The united valves seen from above, exhibiting the area.

ASTARTE CLIFTONI, *Moore.*

- „ 5.—Right valve showing the general outline and close regular concentric lyræ.  
 „ 6.—United valves seen from above with the escutcheon and ligament.  
 „ 7.—Anterior end of the united valves with the lunule.  
 „ 8.—Articulus of the left valve.
-



## EXPLANATION OF PLATE VI.

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CUCULLÆA SEMISTRIATA, *Moore*.

- Fig. 1.—Left valves nearly complete.  
 „ 2.—United valves seen from above, exhibiting the area.

ASTARTE CLIFTONI, *Moore*.

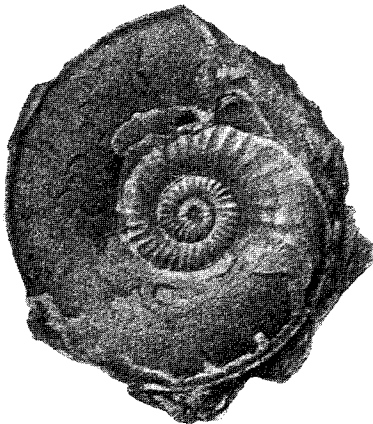
- „ 3.—Right valve of an individual with fine lyræ.

DORSETENSIA CLARKEL, *Crick*.

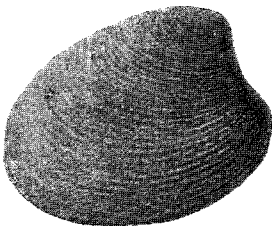
- „ 4.—An imperfect shell exhibiting costæ on the inner whorls, also sutures and keel of the venter.

ALECTRYONIA MARSHI, *J. Sowerby*.

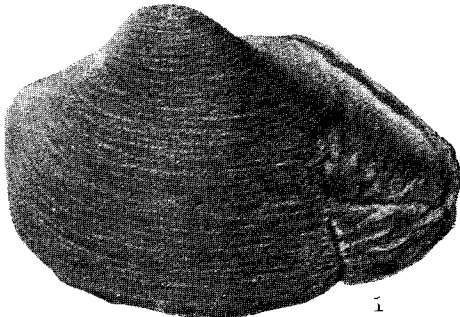
- „ 5.—Interior of portion of a fan-shaped (?) valve with the elevated adductor scar.  
 „ 6.—Exterior with subradiating costæ and partial view of the zig-zag frontal edge.  
 „ 7.—Interior of a subtriangular valve with the elevated adductor scar, and large triangular area and its wide chondrophore.
-



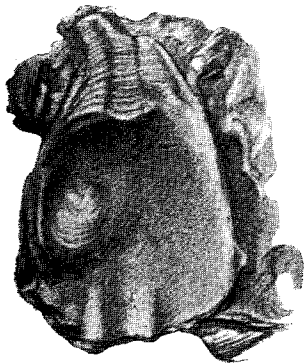
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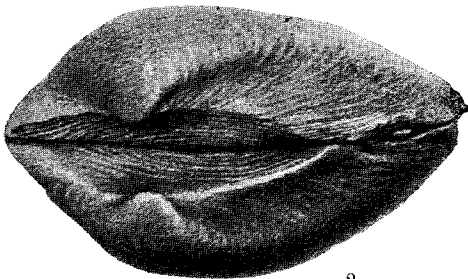
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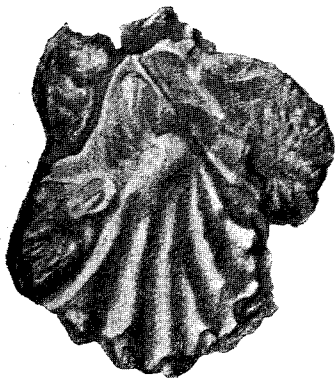
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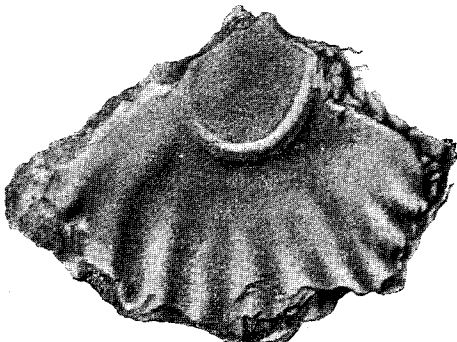
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5



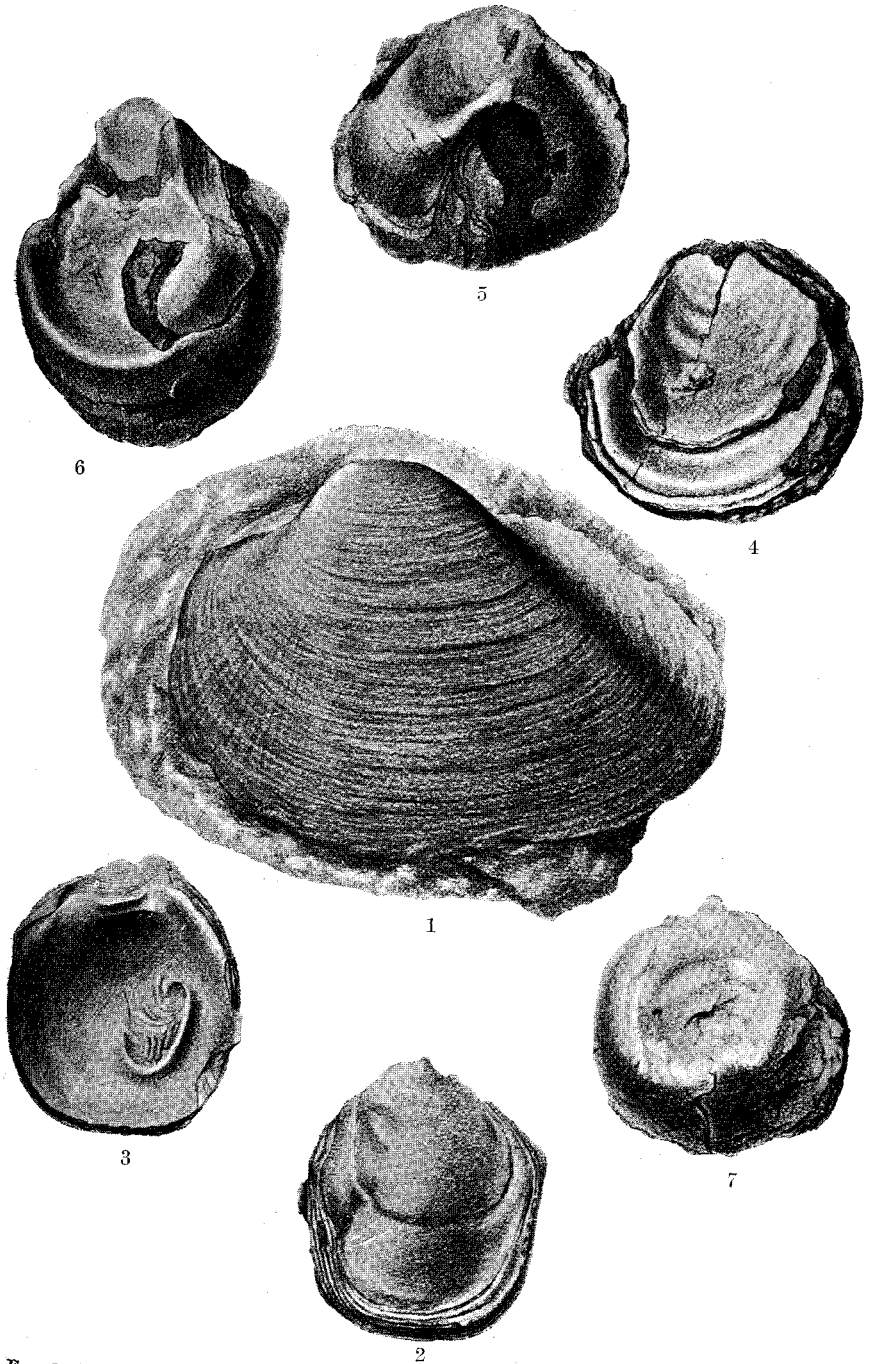
## EXPLANATION OF PLATE VII.

CUCULLÆA, *sp.*

Fig. 1.—Left valve nearly complete with latelaminæ bearing subordinate concentric lines, crossed at the anterior end by fine radii. (This may be *C. inflata*, Moore.)

OSTREA THOLIFORMIS, *Eth. fil.*

- „ 2.—Exterior of flat valve.
- „ 3.—Interior of the same valve with the elevated adductor scar rim and *Serpulæ*.
- „ 4.—Another example of a flat valve.
- „ 5.—The attached dome-shaped valve more or less exfoliated.
- „ 6.—A much exfoliated attached valve.
- „ 7.—Another similar valve, but less dome-shaped than Fig. 5, and with a larger area of attachment.



Frank R. Leggatt, Del.

## EXPLANATION OF PLATE VIII.

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CUCULLÆA, *sp.*

- Fig. 1.—Imperfect Right valve, possibly referable to *C. inflata*, Moore.  
 „ 2.—Umbonal elevation and partial area of the same specimen.

CUCULLÆA SEMISTRIATA, *Moore.*

- „ 3.—Umbo, area, and teeth of the articulus.

ALECTRYONIA MARSHI, *J. Sby.*

- „ 4.—An imperfect specimen exhibiting the strong subradiating costæ, and undulating or zig-zag front.

PECTEN (?), *sp.*

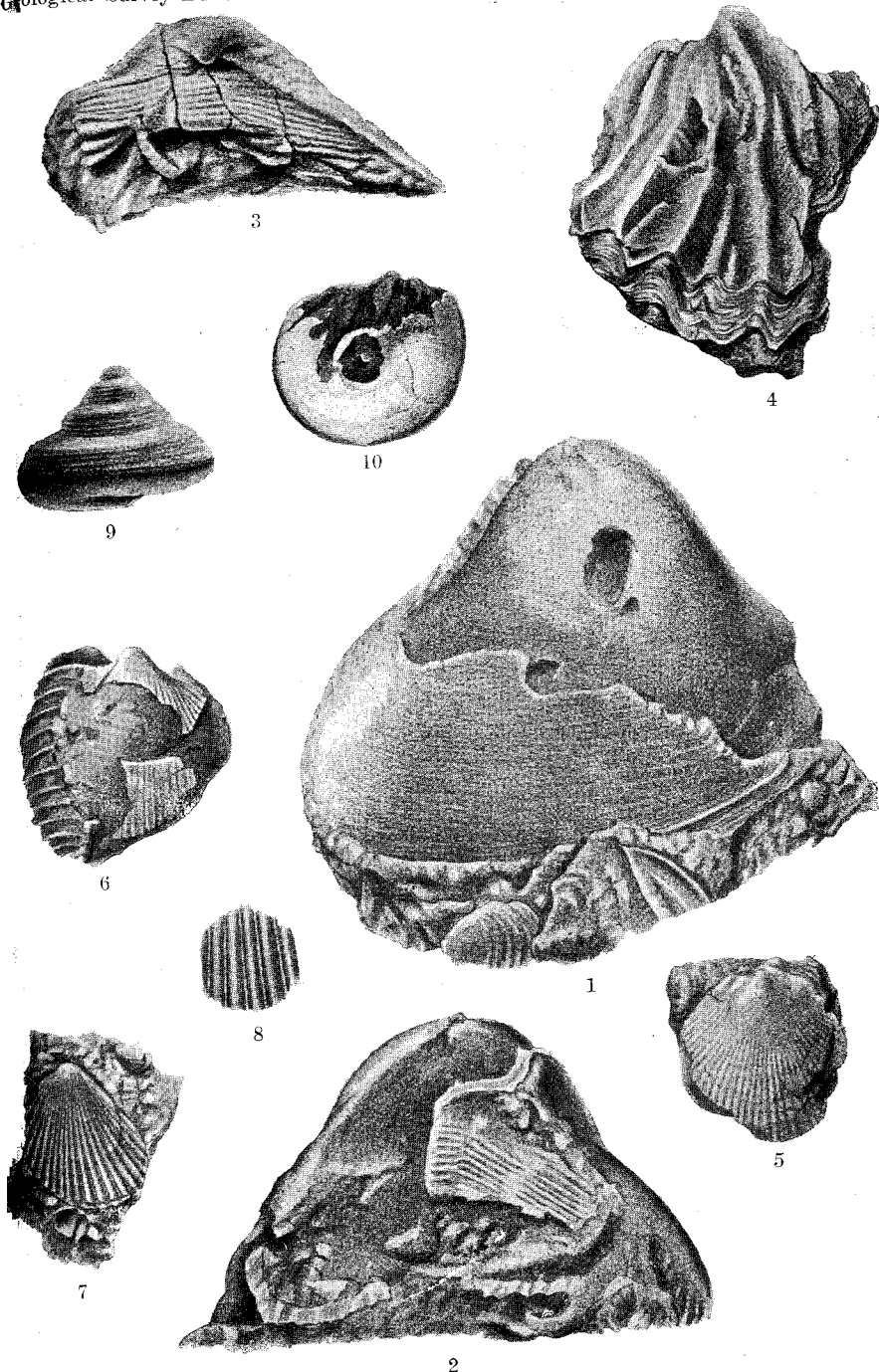
- „ 5.—A small valve provisionally referred to *Pecten* with strong costæ.  
 „ 6.—Another valve, probably the opposite to that represented in Fig. 5.

RADULA DUPLICATA, *J. de C. Sby.*

- „ 7.—Portion of a valve, less the auricles.  
 „ 8.—The costæ, primary and secondary, much enlarged.

PLEUROTOMARIA GREENOUGHENSIS, *Eth. fil.*

- „ 9.—The shell seen in elevation.  
 „ 10.—The base.
-



## EXPLANATION OF PLATE IX.

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 PECTEN (?) CINCTUS, *J. Sby.*

Fig. 1.—Flat valve much exfoliated, with remains of the auricles.

OSTREA, *sp.*

„ 2.—Interior of an upper or flat valve exhibiting area above, test laminae at the sides, and the adductor scar.

RHYNCHONELLA VARIABILIS, *Schlotheim.*

„ 3.—Umbo of the pedical valve, and the brachial valve with the fold occupied by three costae.

„ 4.—Lateral view of the specimen represented in Fig. 3— $\times 3$ .

„ 5.—Pedicel valve of the specimen represented in Figs. 3 and 4; the sinus occupied by two costae— $\times 3$ .

„ 6.—A second specimen, the fold of the brachial valve bearing two costae— $\times 3$ .

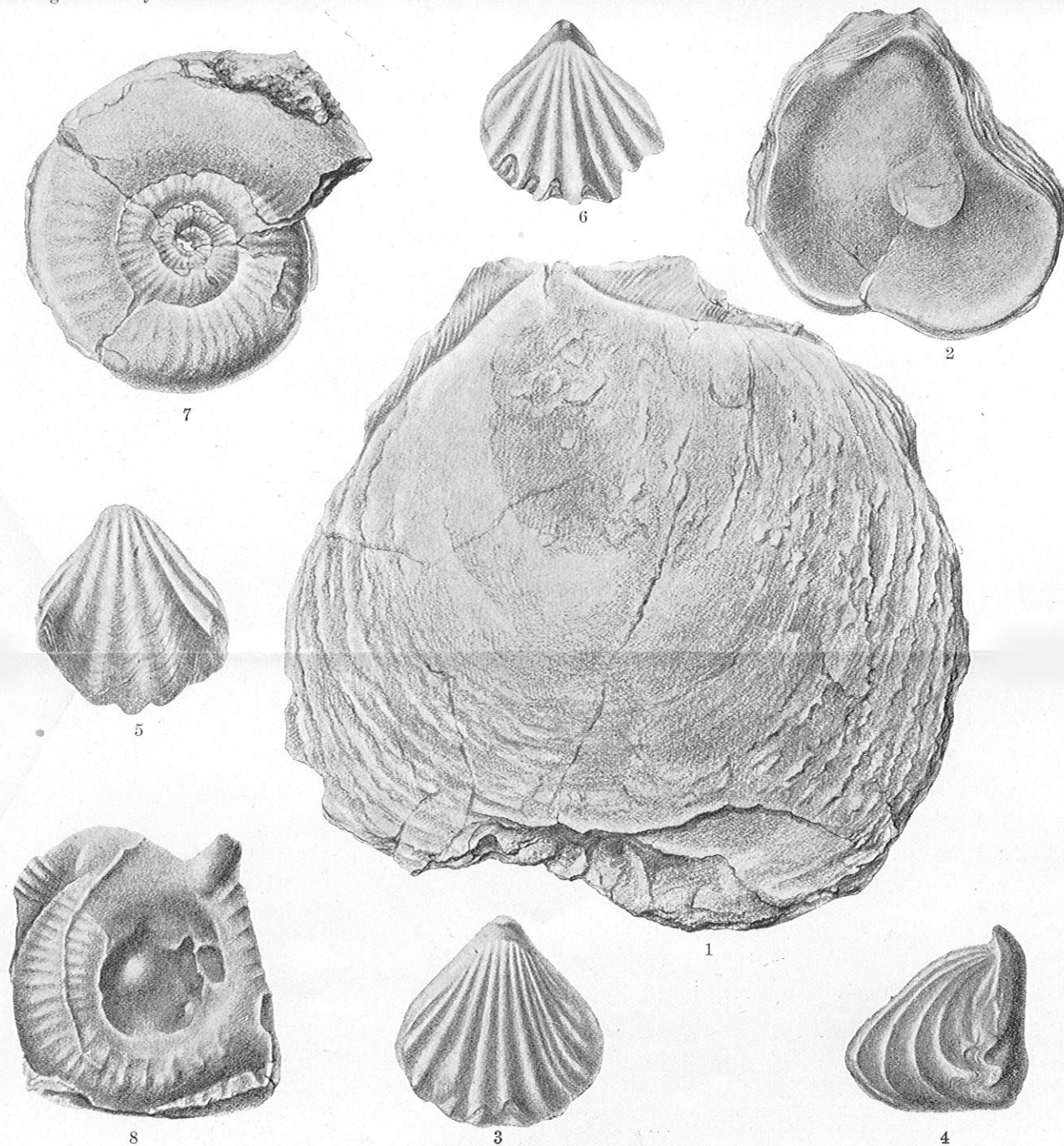
DORSETENSIA CLARKEI, *Crick.*

„ 7.—A large example exhibiting the costae and keel of the venter.

SPHEROCERAS SEMIORNATUS, *Crick (?)*.

„ 8.—Cast from a natural mould in limonite displaying a very imperfect specimen.

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Frank R. Leggatt, Del.

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# IV.—*Sthenurus Occidentalis* (Glauert).

BY

LUDWIG GLAUERT, F.G.S.

*Field Geologist.*


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## INTRODUCTION.

In the course of a construction of a pathway in the Mammoth Cave, Margaret River, 1904, the workmen found it necessary to break into a large boss of Stalagmitic material. As soon as the external layer had been removed, bones, mostly in a fragmentary condition, were encountered. Many of these were laid on one side, but, owing to the true significance of the discovery not being evident to those engaged upon the work, many valuable portions were doubtlessly destroyed or lost, while those to hand have suffered considerably from the rough usage to which they have been subjected.

Mr. E. A. LeSouef, the Director of the Zoological Gardens, collected numerous specimens, which he had conveyed to Perth, where, in due course he handed over the majority to the Secretary of the Caves Board of Western Australia, the authority controlling the cave where the bones were found. In November, 1908, Mr. LeSouef, made a further delivery of fossil remains, obtained with those previously handed over, including a lower jaw which he had recognised as belonging to *Sthenurus*, an extinct genus of the Macropodidæ not previously recorded from this State.

The Caves Board, aware of the great importance of the find, submitted the specimens for examination and description. The report, dated January 26th, 1909, was submitted to the Board at the meeting held on Friday, January 29th.

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## ORDER MARSUPIALIA.

### SUB-ORDER DIPROTODONTIA.

Family Macropodidæ.

Sub Family Macropodinae.

GENUS *STHENURUS*, Owen 1873.

*Sthenurus* (1) Owen Proc. Roy. Soc. London XXI., No. 141, p. 128—1873.

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(1.) Synonymy *Fide*. Trouessart's "Catalogus Mammalium" Tom. II., 1900.



- Owen Phil. Trans. Roy. Soc. London, CLXIV., pt. I., p. 265—1874.
- Lydekker Cat. Foss. Mam. Brit. Mus. (N.H.) pt. V., p. 232—1887.
- Lydekker Handb. Marsup. p. 253—1894.
- DeVis. Proc. Lin. Soc. N.S.W., 2nd Series, Vol. X., p. 83—1895.
- Protemnodon* (partim) Owen Proc. Roy. Soc. London, XXI., No. 141, p. 128—1873.
- Owen Phil. Trans. Roy. Soc. London, CLXIV. pt. I., p. 274—1874.
- Procoptodon* Owen Proc. Roy. Soc. London, XXI., No. 145, p. 387—1873.
- Owen, Phil. Trans. Roy. Soc. London, CLXIV., pt. II., p. 786—1874.
- Pachysiagon* (n.n.) Owen Proc. Roy. Soc. London, XXI., No. 145, p. 386—1873.
- Owen Phil. Trans. Roy. Soc. London, CLXIV., pt. II., p. 784—1874.
- Macropus* (partim) (1) Owen Mitchell's 3 Exped. East Austr., Vol. II., p. 359—1838.
- Owen Descr. Cat. Mam. Aves. Roy. Coll. Sur. London, p. 325—1845.
- Macropus* (*Sthenurus*) *atlas* (type) Wellington Valley, N.S.W.

STHENURUS OCCIDENTALIS, GLAUERT.

- Sthenurus* sp. nov. Glauert Proc. Geol. Soc. London, No. 881, p. 120—1909.
- Quart. Journal Geol. Soc. London, Vol. LXV., p. 462—1909.
- Sthenurus occidentalis* sp. nov. Records W.A. Museum, Vol. I., pt. 1, p. 31, etc., 1910.

Prof. Owen's description of *Sthenurus atlas*, which is the type of the genus, is published in the Philosophical Transactions of the Royal Society of London, CLXIV, Part I., 1874, pp. 265—274, with figures (2) and is rather too lengthy to quote here, particularly as much abbreviated accounts of the generic characters are given by later authors.

Mr. R. Lydekker, the author of the Catalogue of the Fossils Mammalia in the British Museum (N.H.), suggests radical alter-

(1.) See also Owen "The Extinct Mammals of Australia" 1877, a work which contains the results of Prof. Owens' researches on the extinct Marsupials of Australia united in book form.

(2.) This description is repeated in Owen's "Extinct Mammals of Australia," 1877, pp. 416—424, etc.

ations in part V. of that work. He restricts the Genus of *Sthenurus* to one species only *S. atlas*, and places all the other species under *Macropus*. Further he states (1) "It will be shown in the sequel that all the upper jaws described by Owen under the name of *Sthenurus* and the lower ones as *Protemnodon*, indicate large Wallabies belonging to the present genus: (*Macropus*), although the genus *Sthenurus* as defined below, is a valid one."

On page 231 of the same volume we find the description of *Sthenurus*. "The fourth upper premolar develops a complete inner, and the lower one a corresponding outer lobe, so that the worn crown of these teeth present oval, flat surfaces, and have no secant edge. The true molars have no vertical enamel folds, and are short and wide: the longitudinal bridge connecting the ridges being very imperfect, and the anterior talon of the upper molars unconnected by such a bridge with the first ridge. The mandibular symphysis is not ankylosed, and the lower incisors are of the macropine type. The Genus connects *Macropus* with *Procoptodon*. This latter genus was described as follows (2) by Mr. Lydekker: "Genus *Procoptodon* (Owen). The mandibular symphysis is ankylosed in the adult, and the ramus of the mandible short and deep, the diastema being also short. The premolars resemble those of *Sthenurus* in structure, but the true molars are elongated and usually have their enamel thrown into a series of vertical folds. There are large palatal vacuities: and the lower incisors are subcylindrical."

There being a large stock of material in the Queensland Museum. the curator, Mr. C. W. DeVis, examined the specimens in that collection with a view of adopting the new classification. He found, however, that he could not separate *Sthenurus* and *Procoptodon* on account of the numerous intermediate-forms, and therefore wrote (3). "An amalgamation of *Procoptodon* with *Sthenurus* is demanded by their verisimilitude of tooth sculpture, and by the occurrence of forms of transition between the two. Owen's reference of the maxilla of *Protemnodon anak* to *S. atlas* has been accounted for by Mr. Lydekker."

The enlarged Genus *Sthenurus* is defined by Mr. deVis in these terms:—

"Lower permanent premolar with an obliquely disrupted lobe forming the posterior moiety of the outer side, the cleft occupied by sinuous and papillary folds. Upper permanent premolar with a broad ledge on the inner side its cavity traversed by erect folds. Molars short, with ascending, tapering, spreading folds incumbent on their surfaces; posterior, basal, margins tumid, but rarely forming distinct talons, mandibular symphysis generally ankylosed: lower incisors generally small, laterally compressed and much less incumbent than in other Macropods. A vascular foramen on the outer side of the mandible beneath one of the posterior molars. Posterior orifice of dental canal generally above the level of the teeth. Palate with large vacuities."

(1.) *op. cit.*, p. 207.

(2.) *op. cit.*, p. 233.

(3.) *Proc. Lin. Soc. N.S.W.*, 2nd series, Vol. X., p. 88—1895.

As the specimen under consideration possesses characteristics associated by Mr. R. Lydekker with *Procoptodon* and *Sthenurus* as distinctive features and also disagrees with both of them in several important points (×) it has been considered advisable to adopt the name of *Sthenurus* in the wider sense suggested by Mr. C. W. deVis.

#### DESCRIPTION.

The specimen consists of the major portion of the left mandibular ramus, embracing the incisor, the diastema, all the cheek teeth and the lower part of the coronoid united in the position of nature to the right ramus which is perfect up to and including the third cheek tooth (m2) (1). The state of the teeth show that the last molar (m4) has been in use for some time before the death of the animal, the individual would therefore be classed as *aged* by Mr. Oldfield Thomas (2) and as *adult* by Mr. C. W. deVis (3). All the milk teeth have been shed, and of the permanent dentition every member shows signs of wear.

It is possible to take the following measurements, chiefly on the left side.

*Incisor* (i) length from base of enamel to the extremity of the worn crown 22 m/m : length of cutting edge of crown 13 (1) thickness of crown 6·5 ; vertical diameter at base of enamel 11 ; transverse diameter 7.

*Diastema*.—Length, from posterior base of enamel of incisor to anterior edge of socket of premolar (p4) 22·5.

*Cheek teeth*.—Length of entire series, *in situ*, from anterior edge of p4 to hind edge of m4 61.

*Premolar* (p4) antero-posterior dimension 17, summit of crown 12·5, greatest width of anterior moiety 7, of posterior 9.

*First Molar* (m1) (5) length 10·5, width fore lobe (6) 8·5, hind lobe 8·5.

*Second Molar* (m2) length 11·5, width fore lobe 8·5, hind lobe 9·5.

*Third Molar* (m3) length 12·5, width, fore lobe 10, hind lobe 10.

*Fourth Molar* (m4) length, 11·5, width, fore lobe 9·5, hind lobe 9.

*The Mandible*.—Length of jaw from the tip of the incisor to the hind margin of the coronoid 160 : greatest depth in front of

(×.) This specimen has the ankylosed symphysis, the short and deep ramus, the short diastema and the vertical folds in the enamel of the molars of *Procoptodon* associated with the short and wide molars of *Sthenurus*, the longitudinal links are but faint.

(1.) At the time of the preparation of this Report, I was permitted by the Director of the W. A. Museum to examine several boxes of specimens presented to that Institution by the Caves Board, and I had the good fortune to find the remainder of the right ramus so that the specimen is practically a complete lower jaw. This description simply deals with those portions submitted by the Caves Board in December, 1908.

(2.) Catalogue of Marsupialia and Monotremata in the collection of the British Museum (NH.) p. 7, 1888.

(3.) "A Review of the Fossil Jaws of the Macropodidæ in the Queensland Museum." Proc. Linn. Soc. N.S.W., 2nd series, Vol. X., p. 79—1895.

(4.) As all the measurements are given in millimeters it is proposed to omit the m.m. in this section.

(5.) This corresponds to the d4 of Professor Owen. The m1 of this authority agrees with the m2 of later writers.

(6.) In this list of measurements, the width of the lobes of the molars is the extent of the cutting edges of the lobes.

p4—34, greatest depth at m4, 35: depth behind p4, 31. Thickness under p4—15, behind m3—18, anterior dental (vascular) (1) foramen  $7\frac{1}{2}$ —8, below the diastemal border and slightly in advance of p4. A second, smaller foramen 15 below the base of the posterior lobe of m1.

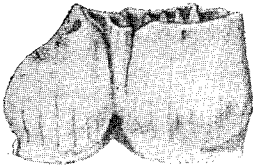
### *The Teeth.*

#### *The Incisors. (i).*

These teeth are shorter, but vertically longer, than in *Macropus*, they gradually taper from the base to the extremity and have an outline very similar to the corresponding teeth of *S. atlas*, as figured by Owen (2) though their working surface is relatively longer, a feature which is no doubt due to the greater age of the individual. The inner surfaces of the tooth are covered with enamel, whilst even on the former there is an inverted V-shaped sinus caused by the encroachment of the radical cement.

At the socket the teeth have an oval or elliptical section, and an ovate, almost lozenge-shaped one at the base of the enamel.

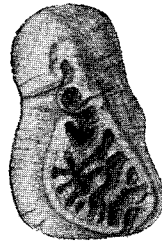
Fig. 1.



L.G., del. p4  $\times$  2.

The left lower premolar (p4) outer aspect, twice the natural size

Fig. 2.



L.G., del. p4  $\times$  2.

The same, seen from above, twice the natural size.

#### *The Premolar (p4). Figs. 1 and 2.*

This tooth is elongately oval in horizontal section, possessing a marked constriction at a point 7 m/m from the anterior basal edge, chiefly on the outer aspect, which almost divides the tooth into a fore and a hind lobe: the constriction passes upwards and backwards to the cleft which proceeds obliquely along the crown of this tooth so that the lobe forming the anterior portion of the outer surface of the crown occupies the whole of the inner face. At the anterior extremity of this cleft there is a notch in the crown of the tooth. The posterior part of the crown is shorter than the

(x.) This specimen has the ankylosed symphysis, the short and deep ramus, the short diastema and the vertical folds in the enamel of the molars of *Procoptodon* associated with the short and wide molars of *Sthenurus*, the longitudinal links are but faint.

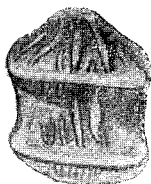
(1.) Later authorities term this the mental foramen.

(2.) Phil. Trans. Royal Soc. 1874, Plate XXII., figs. 5 and 6, and Extinct Mammals of Australia, Plate LXXXII., figs. 5 and 6.

crown of the succeeding molar, it was evidently used for crushing or pounding as it has a broad working surface with complex transverse ridging between the inner and the outer edges. Of the complex folds or ridges one is of much greater size and prominence than the rest.

The outer and inner faces of the fore part of the tooth each possess three more or less distinct folds which pass upwards from the prebasal ridge: the apices of the first and second form the well-marked anterior prominence of the tooth, the third reaches up to the ridge that passes backwards from the prominence to the hind part of the crown. This ridge after having been traversed by the notch of the point of the constriction passes uninterruptedly to the intero-posterior angle, here it is broken by a distinct vertical fold, then it sweeps round to form the curved trenchant edge of the postero-external lobe and to join the fore and aft ridge at the point of constriction. A faint prebasal ridge can be traced on the fore, inner and outer aspects of the tooth but is entirely absent from the hind face, which is perfectly smooth and plain from side to side, and base to crown.

Fig. 3.



L. D., del.  $m2 \times 2$ .

The second right  
lower molar ( $m2$ )  
seen from above,  
twice the natural  
size.

*The Molars* ( $m1$ — $m4$ ). Fig. 3.

These teeth are short and wide, the lobes are thin and almost straight, being slightly convex backwards. The crests of the lobes are slightly concave, angles sharp, forming a sharp point on the inner edge, but on the outer one resembling a somewhat thickened protuberance from which a marginal fold proceeds downwards and forwards almost closing—in the case of the one from the hind lobe—the mid-valley, the fold from the fore lobe fringing the outer edge of the fold that forms the anterior ledge, or talon, of the lobe. Similar marginal folds, but branching are to be seen on the anterior surface of the inner angle of the fore lobe, and are represented by a simple marginal fold on the anterior surface of the inner angle of the hind lobe. External incumbent fold on the fore lobe large and

prominent sweeping round to form a sharp ridge along the anterior ledge or talon of the tooth. The second fold is very short and almost rudimentary, the third slightly less prominent than the first, branching, the branches reaching to the base of the anterior ridge, three or four additional folds are more or less indistinct. In a worn tooth most of these folds are very difficult to distinguish.

Several vertical folds on the hind surface of the fore lobe, only two of which can be seen distinctly, the outer one forming the longitudinal link and the second giving rise to a subsidiary link. A third very subordinate vertical fold forms a faint line reaching to the inner angle of the hind lobe. Two or three additional markings are present, evidently corresponding to the insignificant folds on the fore surface of the hind lobe. Hind surface of the hind lobe ornamented with numerous, about nine, rudimentary vertical folds which pass down to the slight post basal swelling that can hardly be termed a ridge.

#### *The Ramus.* (Plates X., XI., XII.)

The lower jaw is strong and powerful, it differs considerably from that of *Macropus*, firstly it is much more solidly built, which, together with the shape and size of the teeth, suggests that the animal's food consisted of hard vegetable matter; secondly, the diastema being short and straight and not long and curved, the contour of the upper border of the ramus differs to a marked extent from that of *Macropus*.

As in Owen's figure of *S. atlas* (1) we find a large foramen present on the outer side of the mandible below the diastema and slightly in front of p4, as well as a second smaller one which is placed under m1 instead of beneath one of the posterior molars. The rear portion of our specimen shows the fenestral vacuity in the form of a pouch having its opening slightly below the level of the alveolar platform, it communicates with a pouch on the inner surface of the jaw by means of a fenestral foramen. The posterior opening of the dental canal is also distinctly to be seen in the pouch.

The post-alveolar platform has a sharp inner border and a most distinct angle. The outer face of the ramus bears a platform under and round the base of p4 and a short groove commencing 15 m/m below the crown of p4 and extending as far as the hind edge of m1.

Immediately below this channel the outer surface of the ramus swells considerably so that the section is fairly convex in a vertical direction though almost straight horizontally.

On the inner face of the ramus the ramus thins rapidly below a well-marked ridge that runs obtusely along the ramus, connecting the posterior extremity of the alveolar platform with the lower end of the symphysis. The symphysis is ankylosed and large in extent; above it there is the postsymphyseal depression which

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(1.) Phil. Trans. Royal Soc. London, 1874, Plate XXII., fig. 5.

is present in both rami and consists of a channel communicating with a foramen (?)

Little of the coronoid process is to be seen, still it is evident that the anterior border of the ascending process ran at right angles to the line of the molars.

The lower border of the mandibles shows a distinct upward arch rising abruptly at the posterior end of the symphysis.

Compared with *S. atlas*, as figured by Owen, the ramus is seen to be considerably deeper and thicker in proportion to its longitudinal extent, the diastema is markedly shorter,  $12\frac{1}{2}$  m/m—and the incisors much more inclined.

#### STHENURUS OCCIDENTALIS.

*Specific Characters.*—Longitudinal links continuous, with the outermost of the incumbent folds, low, but distinct; a second link, lower and very indistinct in a worn tooth, present in the mid-valley of all the molars. Posterior basal ridge absent in m1 and but faintly in the other molars.

Mandible thick, symphysis anchylosed. Incisor inclined, posterior dental foramen below the lower of the teeth, level with the alveolar groove. Anterior edge of the coronoid process rising at right angles to the line of the teeth; under surface of the mandible arched upwards. Diastema short. Ramus thinner than in *S. oreas* (DeVis), and deeper than in *S. atlas*. (Owen).

*Note.*—The subsequent examination of several additional specimens shows that "the external incumbent fold on the fore lobe which sweeps round to form the sharp ridge along the anterior talon of the tooth" is ornamented with two or three vertical folds on its outer aspect. (1.)

#### *Differences and Resemblances.*

*S. goliath*, Owen. *S. rapha*, Owen, and *S. pusio*, Owen.

These forms are much larger in size and have differently shaped rami and teeth. The ornamentation is also of a different pattern.

*S. pales*. Owen.

This form is much larger in size but resembles *S. occidentalis* in the arrangement of the incumbent folds on the anterior aspect of the fore lobes of the molars and in the sculpturing of the posterior surfaces of both the fore and hind lobes.

*S. otuel*. Owen.

This species is of much greater size than the specimen under review, and has teeth which are differently shaped but which bear ornamentations very similar to those found on *S. occidentalis*.

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(1.) *Vide also sequel.*

*S. oreas*. DeVis.

Our form has the same general outline as this species and the same depth of ramus as well as an anchylosed symphysis. On the other hand, the teeth are of different dimensions, as will be seen from the table below. The ramus is also considerably thinner than that of *S. oreas*, so that there can be no hesitation in looking upon our form as distinct from this Queensland species—we must bear in mind that ours is the jaw of an “aged” or adult animal in whose skeleton no further developments are to be expected.

	<i>S. oreas</i> (†).	<i>S. occidentalis</i> .
Cheek series .. ..	.. 62·2 m/m	.. 60-61 over all
m1-m4 .. ..	.. 58 ..	.. 45 ..
m1-m3 .. ..	.. 41·5 ..	.. 32-33 ..
p4 .. ..	.. 11·9 ..	.. 12·5 (17) ..
m3 (length of) ..	.. 14·6 ..	.. 12·5 ..
m3 (width of) ..	.. 12·1-13·2 ..	.. 10 ..
Thickness of mandible ..	.. 22·5-25·8 ..	.. 15 x 17 or 18 ..
Anterior depth of mandible	34·2 ..	.. 34
Posterior depth of mandible	35·5 ..	.. 35

*S. atlas*. Owen.

This species (according to DeVis, *loc. cit.*) is distinguished from *S. oreas* by having a much more slender ramus and by the fact that the symphysis is not anchylosed. In shape too, the ramus is flat exteriorly, increasing in depth posteriorly. Lower contour lines straight or arched upwards.

Against this, our form is thick, the exterior surface slightly convex longitudinally (horizontally), much more so vertically. Lower contour line arched upwards. Symphysis anchylosed.

Owen's figure of *S. atlas* (1) shows a ramus which differs from *S. occidentalis* in one or two other points; for instance, it has a longer diastema and shows very little if any trace of the inverted ridge or projection which is so evident on the inner side of the ramus of our form of *Sthenurus*.

As regards measurements we find the following relations:—

	<i>S. atlas</i> (2).	<i>S. occidentalis</i> .
Cheek series .. ..	.. 55·8-58·6	60-61 over all
m1-m3 .. ..	.. 30·1-31·6	32-33 ..
p4 .. ..	.. 12·1 x 6·8-12·8 x 7	12·5 x 6 (17 x 7 x 9) over all
m3 (width of) ..	.. 8·9-10·5	10 over all
Thickness of mandible	14·8-15·6	15-17 or 18
Anterior depth of mandible	26·1-28·5	34
Posterior depth of mandible	29-32·7	35

(†.) *Op. cit.*, p. 96.

(1.) Owen, *Phil. Trans.*, 1874, pl. XXII., figs. 5, 6, 7 and 8.

(2.) De Vis., *op. cit.* p. 98.



There is evidently a close relationship between our form and these last two species.

Since the above description was written I was engaged by the Western Australian Museum Committee and the Caves Board of W.A. to undertake further explorations in the Mammoth Cave. Amongst 2,000 specimens, several mandibular rami of *S. occidentalis* were obtained which, upon examination, confirmed the description and measurements given in my report to the Caves Board. All the specimens obtained were presented to the Western Australian Museum by the Board in March 1909.

*Note.*—Amongst the specimens transferred to the Department by the Western Australian Museum authorities in 1908 were four large fragments of rock with a label "Gypsum from Cliffy Head, Dongara."

Upon these being examined by Mr. E. S. Simpson and myself at that time, traces of animals remains were observed, and the material in which the bones were embedded identified as Limestone and Stalagmite, not Gypsum. The specimens were therefore laid on one side for further examination. Subsequently I was instructed to examine the material, and as a result I have been able to extract a portion of the left lower jaw of a *Sthenurus*. The state of preservation of the fossil, the nature of the matrix, and the numerous inclusions of fragments of charred wood, twigs, and branches of trees, snail shells, together with the casts of leaves of Eucalypts, and the fact that the fossil is a *Sthenurus occidentalis*, cause me to state with every confidence that the specimens must have come from the Mammoth Cave, Margaret River, S.W.

Most likely they are a portion of the collection made by the Director of the Museum, Mr. B. H. Woodward, during his visit to the Cave in August, 1905. (1).

The specimen [10087] is somewhat damaged, but still it bears the socket and root of the incisor, the premolar p4 (2) and the first, together with the anterior half of the second molar m1 and m2.

#### MEASUREMENTS.

The following measurements are possible :—

<i>The Teeth.</i> —p4 length (crown 12·5 m/m) 14·5 m/m over all			
Width of fore lobe cutting			
edge	..	..	7·5
Width of hind lobe cutting			
edge	..	..	9
m1. length of crown	..		10·5
Width of fore lobe cutting			
edge	..	..	8·5
Width of hind lobe cutting			
edge	..	..	9
m2, length	..	..	..
Width of fore lobe, cutting			
edge	..	..	9

(1.) Records of the W.A. Museum, Vol. I., part 1, p. 10—1910.

(2.) The dental formula in use in the British Museum (N.H.) is adopted, the manner in which it differs from that proposed by Prof. Owen has already been referred to.

*The Mandible—*

Depth of mandible in front of p4 about	..	36	m/m
Depth of mandible behind p4	..	31.5	
Thickness under p4	..	15	

The anterior dental foramen (1),  $3\frac{1}{2}$ m/m in diameter, is situated about 8m/m below the diastemal edge, and slightly in advance of p4. The length of the diastema, which is imperfect, would be about 22m/m.

*Description.*—The premolar (p4) differs somewhat from the corresponding tooth of the type of the species; the most important feature is the presence of a small cusp or tubercle on the inner half of the anterior aspect of the tooth. The suggestion of a similar process is seen on the premolars of some of the mandibles in the W.A. Museum Collection.

The foldings of the complex transverse ridging on the broad working surfaces, which occupies the posterior portion of the crown, is rather more complicated, perhaps due to the state of wear of the tooth, but more likely an individual feature, for the examination of all the premolars of *S. occidentalis* which I have been able to examine shows slight variations in the arrangement of these folds. The vertical fold in the enamel at the intero-posterior angle is so worn that all but the base of the conical pit has been removed.

The outer aspect of the tooth is very similar to that of the type, but the inner one bears traces of two or three rudimentary vertical folds, just beneath the posterior portion of the crown, which are not to be seen on the type.

*The Molars.*—The first molar (m1) is very much worn, the summits of the outer extremity of both fore and hind lobe are so worn that in each case the dentine is exposed. The ornamentation of the teeth is as in the type, with the addition that the vertical folds on the hind surface of the hind lobe of m1 rise from an arched post-basal ridge which, though slight, is quite distinct (†), and that though this animal was considerably older than the type at the time it met its death, the vertical folds on the outer aspect of the “external incumbent fold on the fore lobe, which sweeps round to form a sharp ridge along the anterior talon of the tooth” can be seen with the aid of a lens. These folds are not very prominent in some specimens, and seem to be soon worn away—they are exceptionally distinct on the second molar of the specimen in the departmental collection, and have been recognised on the type specimen (2) since it was described.

*The Ramus* is very strong, that portion which is preserved has the same thickness as the type, but the depth is somewhat greater, both before and behind p4 due, no doubt, to the greater age of the animal (3). The exposed root of the incisor enables

(†) In my examination of the type specimen I could find no trace of any post-basal ridge on m1.

(1.) Prof. Flower has designated this foramen the mental foramen, *see* Osteology of the Mammalia.

(2.) *See ante* p. . . . and Records of the W.A. Museum, Vol. I., part 1, p. 36—1910.

(3.) This increase in depth of the ramus as the animal ages is a common feature with the Macropodidae.

one to guess the length of the diastema which, had it been perfect, would have had the same extent as in the type. The state of the fractured inner surface at the root of the incisor proves that the symphysis was anchylosed.

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The discovery of this specimen is interesting, as it helps to prove that the features seen and recognised upon the type of the species as points of difference are not merely individual variations, but characteristics of a group of animals—a distinct species of *Sthenurus*. The presence of the vertical folds on the outer aspect of the external incumbent fold on the anterior lobe of every molar of this species yet examined is an important additional feature peculiar to *S. occidentalis*.

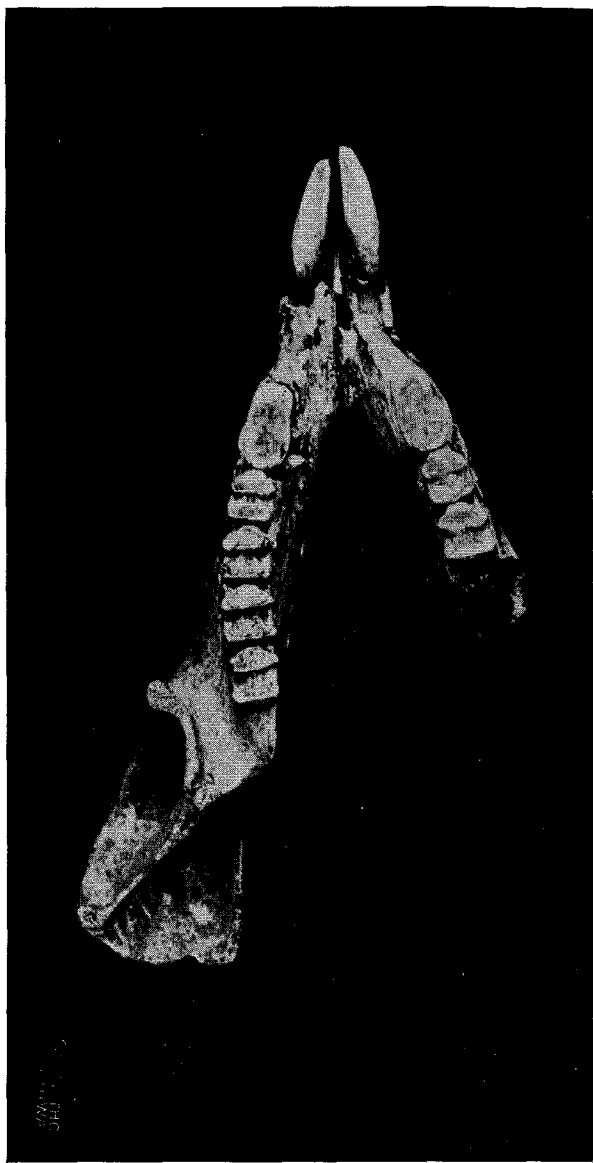
#### EXPLANATION OF PLATES.

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Plate X.—The united rami seen from above.

Plate XI.—Exterior aspect of left ramus.

Plate XII.—Interior aspect of same.



*Sthenurus occidentalis* (Glauert)  $\times \frac{3}{4}$ .

The united rami seen from above.

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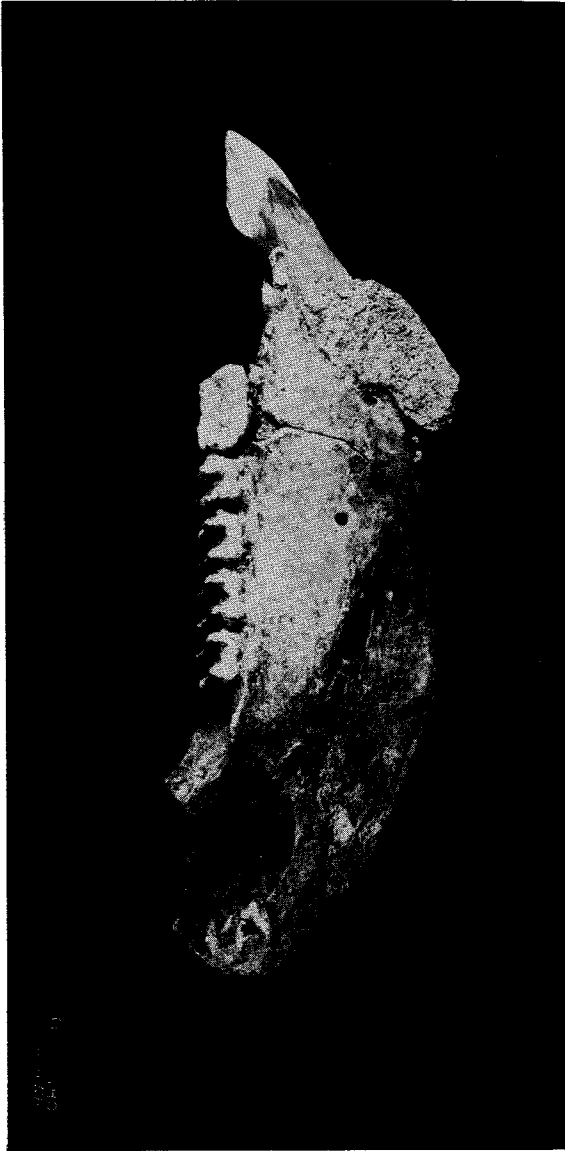


*Sthenurus occidentalis* (Glauert)  $\times \frac{3}{4}$ .

Exterior aspect of left ramus.

B. 36-3.

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*Sthenurus occidentalis* (Glauert)  $\times \frac{3}{4}$ .

Interior aspect of left ramus.



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*V.—A List of Western Australian Fossils  
(systematically arranged),*

BY

LUDWIG GLAUERT, F.G.S.,

*Field Geologist.*

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GENERAL INTRODUCTION.

This list is an attempt to catalogue all the Western Australian Fossils that have been collected in the State up to the end of 1908.

Whilst every care has been taken to make it as complete as possible, it is felt to be far from perfect owing to the vagueness of some of the localities, the uncertainty of various names, and the disappearance of many of the specimens.

Although Western Australian Palæontology is still in its infancy several attempts have been made to catalogue the forms then known.

In 1870 Chas. Moore compiled a list of the Mesozoic Fossils (*vide* Q. J. G. S., Vol. XXVI., 1870, p. 232), which was the authority for Mr. Etheridge's "Catalogue of Australian Fossils" of 1878—as far as the Western Australian Fauna was concerned. Some five years later W. H. Hudleston gave a list of the Palæozoic Fossils that had been submitted to him for examination and description (*vide* Q. J. G. S., Vol. XXXIX., 1883, p. 590). The next list compiled was that published in the Annual General Report for 1890, by Mr. H. Page Woodward, at that time Government Geologist. This was the first attempt to classify all the Western Australian Fossils, and is the most comprehensive Catalogue that is known to this Department at the present time. In order to show the advances made in Western Australian Palæontology since that date, all the species then recorded are prefixed with the letter "W" in the following pages. Since 1891, untabulated lists have appeared in the following Government publications and in the presidential address, Section "C," Geology, at the Adelaide meeting of the Australasian Association for the Advancement of Science, 1907, all over the signature of Mr. A. Gibb Maitland, the present Government Geologist of this State. Although up to date, they do not claim to be complete or systematically arranged, and so do not fill the place that this present catalogue is intended to occupy.

Bulletin No. 4.—The Mineral Wealth of Western Australia, Chapter I, 1900.

Bulletin No. 26, part 7.—Recent Advances in the Knowledge of the Geology of Western Australia, 1907.

Year Book.—Western Australian Year Book (article "Salient Geological Features"), from Bulletin No. 4, 1902-4.

It was the original intention to include all the Western Australian Fossils in this present list, but more careful investigation of the specimens and their labels show that almost all the Cainozoic examples were badly preserved casts, which did not permit an exact determination. As it would be useless to include such very doubtful records, it was thought more advisable to confine the list to the Palæozoic and Mesozoic Times only, and to leave the Cainozoic and more recent examples till better preserved specimens came to hand, or circumstances permitted more time being spent upon them, so that some definite result might be obtained.

Again, the known fossil flora of Western Australia is so small and insignificant that it was considered the wiser plan to confine it to a separate article.

The plan adopted is to a great extent similar to that of Mr. Etheridge: the animal remains are in zoological order (after Zittel), and occupy the first longitudinal subdivision; in the second subdivision the localities are placed in geographical sequence from North to South; the third column is reserved for references to publications, which are indicated by letters of the alphabet, *see* page 73 (when the letters represent works containing figures or illustrations of the species they are printed in capitals); then follows the subdivision containing the names of the Museums known to contain Western Australian Fossils, here the presence of a species is recorded by means of a  $\times$ . As this list is designed chiefly for use in this State it was considered an advantage to distinguish species represented in the Geological Gallery of the Western Australian Museum by printing the names in a **heavier type**. Species exhibited in other Museums, and not in the National Collection, have their names printed in ordinary type, whilst the name of specimens that are recorded but cannot be traced to any collection are printed in *italics*.

In compiling this work the first Bulletin issued by the Department, The Bibliography of the Geology of Western Australia, by A. Gibb Maitland, 1898, was freely used, and all its references consulted wherever possible.

For articles of later date, manuscript notes made by the Government Geologist were found of great assistance. The Assistant Keeper of the Geological Department of the British Museum (Natural History), the Assistant Secretary of the Geological Society of London; the Directors of the Western Australian Museum; the Australian Museum, Sydney; the National Museum, Mel

bourne ; the Public Library, Museum, and Art Gallery, Adelaide ; the Museum of the Geological Survey of New South Wales, Sydney ; the Curator of the Bath Museum (England), and the Department of Agriculture and Technical Instruction, Dublin, have given useful and valuable information which is gratefully acknowledged.

The task has proved most interesting and instructive to me, and has suggested many problems and possibilities, so that it is hoped that in the near future it may be possible to amplify the present list.

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- (r.) **Maitland, A. Gibb.** "Recent Advances in the Knowledge of the Geology of Western Australia." *Austr. Assoc. Adv. Sci. (Adelaide)*, 1907, and *Bulletin No. 26*.—1907.
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- (v.) **Campbell, W. D.** The Irwin River Coalfield, *Bulletin 38*.

NOTE.—Figured specimens are indicated by capital letters in the column of References throughout the Tables.

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## PART I.

### PALÆOZOIC FOSSILS.

The greater portion of Western Australia consists of Igneous or Metamorphic rocks of great antiquity, but in the "Kimberleys," the "North-West" to the "Gascoyne," large stretches of country consist of Palæozoic Rocks which have been recognised by most competent authorities as being chiefly of Carboniferous Age. A strip, running down between the Darling Ranges and the coast, is met with in the Victoria District, and may possibly be exposed at Bullsbrook, near Midland Junction, and further South along the

base of the Darling Ranges, but of this no definite Palæontologica evidence has yet been discovered. Still further South the Collie Coal Basin is the extreme outpost of the beds of this coal-bearing age so far as is yet known.

As regards Devonian Rocks, there is but very scanty information. Hardman (1) recognised Devonian strata in the Kimberley area and obtained fossils which are true Devonian types.

In 1906, Mr. H. P. Woodward, in the course of an extended trip in the West Kimberley District, collected a number of specimens from the Barker Gorge in the Napier Range, which London authorities have classified as of undoubted Devonian age.

Some of the older writers, Hudleston, etc., determined possible Devonian forms from the "Gascoyne" and the "Irwin" localities, which the latter researches of this Department have failed to verify.

Rocks of greater antiquity are present in Western Australia, for Hardman obtained undoubted Cambrian fossils from Kimberley, but our knowledge is very restricted as it is not even definitely known where Hardman collected his specimens. It is also supposed that the Stirling Ranges in the extreme South of the State are Silurian and, according to Hardman, that Lower Silurian, or Cambro-Silurian strata, are exposed in the country he examined in the North. It is needless to enter more fully into the matter here as all information can be obtained from Bulletin 26, part 7, of 1907, where the Government Geologist goes into the Geology of the State in detail.

The lithological character of the Palæozoic rocks is not striking, the Carboniferous representations are mainly grey crystalline limestone with occasional ironstained areas, but associated with these are carbonaceous and micaceous shales, sandstones and conglomerates, as well as Glacial beds and series of volcanic lavas and ashes. The Nullagine Beds may be either Cambrian or Devonian: they are not Carboniferous. The Devonian Beds are mostly grey limestones, whilst the older Palæozoic strata consist chiefly of more or less altered sedimentary rocks and crystalline limestones. For further information in this connection reference may be made to the publication of this Department, to which attention has just been drawn.

In the following portion of the list the pages have been divided into four main columns, as explained in the Introduction.

*Locality.*—Roughly speaking there are four chief districts, Kimberley, Gascoyne, Irwin and Collie. Of these, the second is subdivided into the Valleys of the Lyons, Wyndham, Gascoyne,

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(1.) Hardman: "Report on the Geology of the Kimberley District" (two reports, dated 1884 and 1885.

and Wooramel Rivers ; whilst the third is split up into Irwin River Coal seam and Mingenew.

It has been thought advisable to consider Mingenew as one of the more important sections, as it is chiefly there that fossils homotaxial with the Permo-Carboniferous of the Eastern States have been obtained. (1.)

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(1.) *Vide* G.S., W.A., Bulletin No. 27, page 19.

PALÆOZOIC.

CAMBRIAN.

	Genus and Species.	Locality.				Reference.	Exhibited.					
	Sub-Kingdom MOLLUSCA. Class Gastropoda. Sub-Class Euthyneura. Order Opisthobranchia. Sub-Order Conularida.	Kimberley.					Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
W	<b>Salterella Hardmani</b> (Eth. fil.) .. .. .	×	..	..	..	L.o.r. ..	×	×	..	..	×	..
	Sub-Kingdom ARTHROPODA Class Crustacea. Sub-Class Trilobita. Order Opisthoparia.											
W	<b>Olenellus (?) Forresti</b> (Eth. fil.) .. .. .	×	..	..	..	L.o.r. ..	..	..	..	..	×	..



PALÆOZOIC—continued.

DEVONIAN.

	Genus and Species.	Locality.				Reference.		Exhibited.					
		Kimberley.	Barker Gorge, Napier Range.	Gascoyne River.				Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
	Sub-Kingdom COELENTERATA. Sub-Branch Cnidaria. Class Hydrozoa. Stromatoporoidea.												
(?)	Actinostroma clathratum (Nich.) .. .. .	×	..	×	..	I.o.	..	..	..	..	..	×	..
	Stromatoporella Eifeliensis (Nich.) .. .. .	×	..	×	..	I.o.	..	..	..	..	..	×	..
	Class Anthozoa. Sub-class Tetracoralla.												
(?)	Cyathophyllum depressum (Hinde) .. .. .	×	..	×	..	I.o.	..	×	..	..	..	×	..
	„ virgatum (Hinde) .. .. .	×	..	×	..	I.o.	..	×	..	..	..	×	..
(?)	Phillipsastræa (Smithia) sp. .. .. .	..	×	..	..	t.	..	×	..	..	..	..	..
	Sub-Class Hexacoralla. Order Madreporaria. Sub-Order Tabulata.												
	Aulopora repens (Knorr & Walch) .. .. .	×	..	..	..	I.o.	..	×	..	..	..	×	..
	Favosites Goldfussi (Edw. & Haime) (1) .. .. .	×	..	×	..	..	..	×	..	..	..	×	..
	Pachypora tumida (Hinde) .. .. .	×	..	..	..	I.o.	..	×	..	..	..	×	..
	„ sp. .. .. .	..	×	..	..	t.	..	×	..	..	..	×	..
(?)	Syringopora reticulata var. patula (Hinde) .. .. .	..	..	×	..	..	..	×	..	..	..	×	..

Sub-Kingdom ECHINODERMATA. Sub-Branch Palmatozoa. Class Crinoidea.																			
	Stems and arms of Crinoids .. .. .	×	..	×	..	i.	..	×	..	..	..	..	..	..	..	..	..	..	..
Sub-Kingdom VERMES. Sub-Order Tubicoia (Sedentaria.)																			
(?)	<i>Spirorbis omphalodes</i> (Goldf.) .. .. .	×	..	×	..	i.o.	..	..	..	..	..	..	..	..	..	..	..	..	..
Sub-Kingdom MOLLUSCOIDEA. Class Brachiopoda. Order Protremata.																			
	<i>Productus</i> sp. .. .. .	×	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..
Order Telotrema.																			
W	<i>Atrypa reticularis</i> (Linn.) .. .. .	×	..	..	..	..	..	l.o.r.	..	×	..	..	..	..	..	×	..	..	..
	<i>Rhynchonella cuboides</i> (J. de C. Sowerby) .. .. .	×	..	..	..	..	..	l.o.	..	×	..	..	..	..	..	×	..	..	..
W	„ ( <i>Hypothyris</i> ) <i>pugnis</i> (Martin) .. .. .	×	..	..	..	..	..	l.o.r.	..	×	..	..	..	..	..	×	..	..	..
	„ ( <i>Uncinulus</i> ) <i>c.f. Timorensis</i> (Beyr.) .. .. .	×	×	..	..	..	..	t.	..	×	..	..	..	..	..	..	..	..	..
	<i>Spirifera Musakheyensis</i> var. <i>Australis</i> (Ford) .. .. .	×	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..
(?)	„ <i>c.f. Verneuli</i> (Murch) .. .. .	×	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..
	„ sp. .. .. .	×	..	..	..	..	..	l.o.r.	..	..	..	..	..	..	..	×	..	..	..
Sub-Kingdom MOLLUSCA. Class Pelecypoda. Order Prionodesmacea.																			
(?)	<i>Aviculopecten limæformis</i> (Morris) (2) .. .. .	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..
	„ <i>multiradiatus</i> (Eth. Sen.) (3) .. .. .	..	..	×	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..

(1.) *Favosites gothlandica* (Lamarck) *vide* Eth. fil Geol. and Pal., Queensland, p. 50. (2.) In a list of Fossils identified by the British Museum authorities and returned to Perth, 11th March, 1892, this shell is reported from Dandaraga, near Gingin. (3.) In the list referred to in the above foot-note an example of this species is reported from the South Coast, near Eucla.

PALÆOZOIC—continued.

DEVONIAN—continued.

Genus and Species.		Locality.				Reference.	Exhibited.					
Class Gastropoda. Sub-Class Streptoneura. Order Aspidobranchia. Sub-Order Rhipidoglossa.		Kimberley.	Barker Gorge, Napier Range.	Gascoyne River.			Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
<b>Euomphalus</b> sp.	.. .. .	..	×	..	..	..	×	..	..	..	..	..
<b>Loxonema</b> sp.	.. .. .	..	×	..	..	..	×	..	..	..	..	..
Class Cephalopoda. Sub-Class Tetrabranchia. Order Nautiloidea. Sub-Order Orthochoanites.												
<b>Goniatites (Brancoceras)</b> <i>c.f. rotatorius</i> (De Kon.)	.. .. .	×	×	..	..	..	×	..	..	..	..	..
W " sp.	.. .. .	×	×	..	..	I.o.r.	×	..	..	..	..	..
W <i>Orthoceros</i> spp	.. .. .	×	×	..	..	I.o.r.	×	..	..	..	..	..
Sub-Kingdom ARTHROPODA. Class Crustacea. Sub-Class Trilobita. Order Opisthoparia.												
<b>Proetus</b> sp. nov.	.. .. .	..	×	..	..	t.	×	..	..	..	..	..

NOTE.—A fragment of bone of a coccostean fish was found associated with these Barker Gorge fossils, but it was too fragmentary to permit Dr. A. Smith-Woodward, F.R.S., to whom the specimen was submitted, to say more than that it belonged to a Coccostean fish, probably a new species allied to Coccosteus, and a new record for Australia.

PALÆOZOIC—continued.

CARBONIFEROUS.

	Genus and Species.	Locality.											Reference.	Exhibited.					
	Sub-Kingdom PROTOZOA. Class Rhizopoda. Order Foraminifera. Sub-Order Porcellanea.	Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
*	Cornuspira Schlumbergi (Howchin)	..	..	..	..	..	..	..	×	×	..	..	k.M. ..	..	..	..	..	..	..
*	Nubecularia Stephensi (Howchin)	..	..	..	..	..	..	..	×	×	..	..	k.M.r.S.v.	×	×	..	..	..	..
	Sub-Order Vitro-Calcareo.																		
	Bulimina (?) sp. .. ..	..	..	..	..	..	..	..	..	..	..	×	n.r.S. ..	..	..	×	..	..	..
*	Endothyra (?) sp. .. ..	..	..	..	..	..	..	..	×	×	..	×	n.r.S. ..	..	..	×	..	..	..
	Froncicularia Woodwardi (Howchin)	..	..	..	..	..	..	..	×	×	..	..	k.M. ..	..	..	..	..	..	..
*	Nodosaria Irwinensis (Howchin)	..	..	..	..	..	..	..	×	×	..	..	k.M. ..	..	..	..	..	..	..
	Pulvinulina exigua (?) (Brady)	..	..	..	..	..	..	..	..	..	..	×	n.r.S. ..	..	..	×	..	..	..
	Truncatulina Haidingeri (D'Orb.)	..	..	..	..	..	..	..	..	..	..	×	n r.S. ..	..	..	×	..	..	..
	Valvulina plicata (Brady) ..	..	..	..	..	..	..	..	..	..	..	×	n.r.S. ..	..	..	×	..	..	..

\* These species are represented in the collection of Mr. Walter Howchin of the Adelaide University.

PALÆOZOIC—continued.

CARBONIFEROUS—continued.

	Genus and Species.	Locality.										Reference.	Exhibited.						
	Sub-Kingdom COELENTERATA. Sub-Branch Cnidaria. Class Hydrozoa, Stomatoporoidea.	Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
W(?)	<i>Actinostroma clathratum</i> (Nich.)	×	..	..	..	..	..	..	..	..	..	..	I.	..	..	..	..	×	..
	<i>Stomatopora concentrica</i> (Goldf.)	×	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	„ <i>placenta</i> (Phil.)	×	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	„ <i>sp.</i> ..	×	..	..	..	..	..	..	..	..	..	..	e.	..	..	..	..	..	..
W(?)	<i>Stomatoporella Eifeliensis</i> (Nich.)	..	×	..	..	..	..	..	..	..	..	..	I.	..	..	..	..	×	..
	Class Anthozoa. Sub-Class Tetracoralla.																		
W	<i>Amplexus nodulosus</i> (Phil.)	..	×	×	×	..	×	..	×	..	..	..	d.o.	..	..	..	×	×	..
W	„ <i>pustulosus</i> (Hudl.)	..	×	×	×	..	×	..	×	..	..	..	D.I.n.o.p.	×	..	..	×	×	..
	„ <i>Selwyni</i> (de Kon.)	..	..	..	..	..	..	..	×	..	..	..	..	×	..	..	..	..	..
W	<i>Cyathophyllum depressum</i> (Hinde)	×	×	..	..	..	..	..	..	..	..	..	I.o.r.	×	..	..	..	..	..
W	„ <i>virgatum</i> (Hinde)	×	×	..	..	..	..	..	..	..	..	..	I.o.r.	×	..	..	..	..	..
	„ <i>sp.</i> ..	×	..	..	..	..	..	..	..	..	..	..	d.e.o.r.	..	..	..	..	..	..

	<i>Lithostrotion (Lithodendron) affine</i> (Flem.)	×	..	..	..	..	..	..	..	..	..	..	e.o.r. ..	..	..	..	..	..
W	" <i>sp.</i> <b>Pleurophyllum</b> (1) <b>Australe</b> (Hinde)	×	..	×	×	..	×	×	..	×	×	..	c. l.j.n.o.p.r. S.	×	×	..	×	×
W	" <b>sulcatum</b> (Hinde)	..	×	..	..	..	×	..	×	×	..	..	l.j.o.s. ..	×	..	..	×	..
W	<b>Zaphrentis</b> <i>sp.</i> .. ..	×	×	..	×	..	..	..	..	..	..	..	d.e.o.r. ..	×	..	..	..	..
Sub-Class Hexacoralla. Order Madreporaria. Sub-Order Tabulata.																		
W	<b>Alveolites obscurus</b> (de Kon.) ..	..	×	..	..	..	×	..	..	..	..	..	..	×	..	..	..	..
	<i>Chaetetes tumidus</i> (Phill.) ..	×	×	..	×	..	..	..	..	..	..	..	e.o.r. ..	..	..	..	..	..
W	<i>Favosites</i> <i>sp.</i> .. ..	..	..	..	..	..	..	..	..	..	..	..	D.n.o.P.r.	×	×	..	×	..
W	<b>Hexagonella (Evactinopora) crucialis</b> (Hudl.)	×	×	..	×	×	×	×	..	..	..	..	D.I.n.p.r.	×	×	..	×	×
W	" <b>dendroidea</b> (Hudl.)	×	×	..	×	×	×	×	..	..	..	..	g. l.o.r.	..	..	..	(?)	..
W	" <i>sp.</i> <b>Pachypora tumida</b> (Hinde)	×	×	..	..	..	..	..	..	..	..	..	d.	..	..	..	..	..
	" <i>sp. nov.</i> .. ..	..	×	..	×	..	..	..	..	..	..	..	..	×	..	..	..	..
	" <i>sp.</i> .. ..	×	×	..	×	..	..	..	..	..	..	..	..	×	..	..	..	..
	<b>Stenopora Leichardti</b> (Nich. & Eth.)	..	..	..	..	..	..	×	..	..	..	..	q.	..	..	×	..	..
W	" <b>Tasmaniensis</b> (Lonsd.)	×	×	..	×	..	×	..	..	..	..	..	d.e.o.r. ..	..	..	..	..	..
W	" <i>sp.</i> .. ..	×	..	..	..	..	..	..	..	..	..	..	g. l.o.r.	..	×	..	(?)	..
	<b>Syringopora reticulata var. patula</b> (Hinde)	..	×	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..
	" <i>sp.</i> .. ..	×	×	..	..	..	..	..	..	..	..	..	e.i.o.r. ..	..	..	..	..	..

(1) In the original article by Dr. G. J. Hinde the word is spelt Plerophyllum. All subsequent authorities quote the name as given in this list.

PALÆOZOIC—continued.

CARBONIFEROUS—continued.

Genus and Species.		Locality.											Reference.	Exhibited.					
Sub-Kingdom ECHINODERMATA. Sub-Branch Pelmatozoa. Class Crinoidea. Order Larviformia.		Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Surv. Lond. Museum.
	<i>Symbathocrinus</i> sp. ( <i>vide</i> F. A. Bather)	..	..	..	..	..	..	..	×	..	..	..	.. ..	..	..	..	..	×	..
	Order Camerata.																		
W	<i>Actinocrinus</i> (?) sp. .. ..	×	×	..	..	..	..	..	×	×	..	..	e.l.o.q.r.v.	×	..	×	..	..	..
	<i>Platyerinus</i> sp. .. ..	×	×	..	..	..	..	..	×	×	..	..	e.o.r.v...	×	..	..	..	..	..
	<i>Poteriocrinus crassus</i> (Miller) ..	×	×	..	×	..	×	..	..	..	..	..	d.e.o.r...	..	..	..	..	..	..
	<i>Rhodocrinus</i> (?) sp. .. ..	×	×	..	..	..	..	..	..	..	..	..	l. ..	..	..	..	..	..	..
	Order Fistulata.																		
W	<i>Cyathocrinus</i> sp. .. ..	..	×	..	×	..	×	..	..	..	..	..	d.o. ..	..	..	..	..	..	..
	Crinoid head .. ..	..	×	..	×	×	×	×	×	×	..	×	..	×	×	×	×	×	×
	.. stems, etc. .. ..	×	×	×	×	×	×	×	×	×	..	×	n.r.s.u.v.	×	×	×	×	×	×

	Class Blastoida. Order Regulares.																			
	<i>Pentremites</i> sp. . . . .	×	..	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	Sub-Kingdom VERMES. Sub-Order Tubicola (Sedentaria).																			
(?)	<i>Serpula</i> spp. . . . .	×	..	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	<b>Spirorbis ambiguus</b> (Flem.) ..	..	×	..	..	×	..	..	..	..	..	..	..	P.	..	×	..	..	..	..
	„ <i>omphalodes</i> (Goldf.) ..	..	×	..	..	..	..	..	..	..	..	..	..	i.	..	..	..	..	..	..
	„ <i>spp.</i> .. . . .	×	..	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	Sub-Kingdom MOLLUSCOIDEA. Class Bryozoa. Order Gymno- lasmata. Sub-Order Cylcostomata.																			
	<i>Ceripora</i> sp. . . . .	×	..	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	Sub-Order Cryptostomata.																			
W	<b>Fenestella plebeia</b> (McCoy) ?	×	×	..	×	..	×	..	×	×	..	..	..	d.e.o.r.S.v.	×	..	..	..	..	..
	„ <b>fossula</b> (Lonsd.)	..	..	..	..	..	..	..	..	..	×	..	..	..	×	..	..	..	..	..
	„ <b>plebeia</b> var. <b>densa</b> (Eth. fil.)	..	..	..	..	..	..	..	..	..	×	..	..	..	×	..	..	..	..	..
	„ <b>spp.</b> .. . . .	×	×	..	..	..	..	×	×	×	×	..	..	o.r.	..	×	..	..	..	..
W	<b>Polypora Australis</b> (Hinde) ..	..	×	..	..	..	..	..	..	..	..	..	..	I.o.	..	×	..	..	..	..
W	<b>Protoretepora ampla</b> (Lonsd.) ..	..	×	..	×	..	×	×	×	×	×	..	..	d.i.o.	..	×	..	..	..	..
	„ <b>antiqua</b> (Lonsd.)	×	×	..	..	..	..	..	..	..	..	..	..	e.	..	..	..	..	..	..
W	<b>Rhombopora tenuis</b> (Hinde) ..	..	×	..	..	×	×	..	..	..	..	..	..	I.n.o.r.u.	..	..	..	..	×	..



CARBONIFEROUS—continued.

		Genus and Species.	Locality.											Reference.	Exhibited.					
		Class Brachiopoda. Order Neotremata.	Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
		<i>Crania</i> sp.    ..    ..    ..	×	..	..	..	..	..	..	..	..	..	..	e.	..	..	..	..	..	..
		<i>Discina</i> sp.    ..    ..    ..	×	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
		Order Protremata.																		
		<b>Aulosteges Baracoodensis</b> (Eth. fil.)	..	×	..	..	..	×	×	×	×	..	..	n.P.r.u.v.	×	..	..	×	..	..
		<i>Choneles Hardrensensis</i> (Phil.)	×	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
W		„ <b>Pratti</b> (Davidson)	..	×	×	×	×	×	..	×	×	..	..	J.n.o.p.r.S.	×	..	..	×	×	..
		„ <b>spp.</b> ( <i>non pratti</i> )	..	×	..	..	..	..	..	..	..	×	..	u.v. h.I.n.o.r.S.	×	..	..	(?)	×	×
		<b>Derbyia</b> sp. c.f. <i>senilis</i> (Phil.) (1)	..	..	..	..	..	..	..	×	×	..	..	q.	..	×	×	..	..	..
		<i>Orthis resupinata</i> (Martin)	..	×	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
		„ c.f. <b>Michelini</b> (Martin)	..	×	..	..	..	..	×	..	..	..	..	..	..	×	..	..	..	..

W	" spp.	×	×	..	×	..	×	..	×	..	d.e.	×	..	..	..	..	..
W	<b>Orthotetes (Streptorhynchus) (2)</b>	×	×	..	..	..	×	×	..	..	e.i.j.o.p.r.v	×	..	×	..	..	..
	<b>senilis (Phill.)</b>																
W	<b>Productus brachythærus (Sowerby)</b>	×	×	..	×	..	×	×	×	..	d.g.h.r.s.	×	×	..	(?)	..	..
	" " <i>var.</i> (Eth. fil.)	..	..	..	..	..	×	×	..	..	s.	×	..	..	..	..	..
	" Cora (d'Orb.)	..	..	..	..	..	×	×	..	..	..	..	..	×	..	..	..
	" <i>c.f.</i> Cora (d'Orb.)	..	×	..	..	×	..	..	..	..	..	×	..	..	×	..	..
	" <i>giganteus</i> (Mart.)	×	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	" <i>longispinus</i> (Sowerby)	×	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	" <i>c.f. margaritaceus</i> (Phill.)	..	..	..	..	..	×	×	..	..	..	×	..	..	..	..	..
	" <i>scabriculus</i> (Mart.)	..	..	..	..	..	×	×	..	..	..	×	..	..	..	..	..
	" <i>semireticulatus</i> (Mart.)	×	×	×	×	×	×	×	..	..	e.n.o.P.r. s.u.v.	×	..	..	×	..	..
	" " <i>var.</i> <i>pugilis</i> (Phill.) &	..	..	..	..	..	×	..	..	..	..	×	..	..	..	..	..
	" <i>c.f. spiralis</i> (Waagen) and <i>subcostatus</i> (Waagen)	..	×	..	..	×	..	..	..	..	..	×	..	..	..	..	..
W	" <i>subquadratus</i> (Morris)	..	..	..	..	..	×	×	×	×	I.j.n.o.r. S.v.	×	×	..	×	×	..
W	" <i>tenuistriatus</i> (De Vern.)	..	×	..	×	..	×	×	..	..	I.j.o.r.s.u. n.P.r.S.v.	×	×	..	×	×	..
	" " <i>var.</i> <i>Foordi</i> (Eth. fil.)	..	×	..	×	..	×	×	..	..	..	×	×	..	..	..	..
W	" <i>undatus</i> (Defr.)	..	×	..	..	..	×	×	..	..	I.j.o.q.r.s. v.	×	×	×	×	×	..
	" spp.	×	×	..	×	×	×	×	..	..	d.e.g.n.u.v. I.n.o.q.r.	×	..	..	(?)	..	×
	<b>Strophalosia Clarkei</b> (Eth. fil.)	×	×	×	..	..	×	×	..	..	h.	×	..	×	..	×	..
	" <i>c.f.</i> Gerardi (King)	..	..	..	..	..	×	×	..	..	d.P.	×	×	..	..	..	..
	" sp.	..	×	×	×	..	..	..	..	..	h.	×	..	..	(?)	..	..
	<b>Strophomena analoga</b> (Phil.)	..	×	×	..	..	×	×	..	..	u.v.	×	..	..	..	..	..
	" sp.	..	×	×	..	..	×	×	..	..	..	×	..	..	..	..	..

(1) *Vide* also *Orthotetes* below and Chapman, Proc. Royal Soc. Vict., Vol. XIII., p.323, 1904.  
crenistris, or *O. crenistris*.(2) Sometimes quoted as *Streptorhynchus*

Genus and Species.		Locality.										Reference.	Exhibited.						
Order Telotre mata.		Kimberley.	Gascoyne.	Mimilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
W	<i>Actinoconchus c.f. planosulcatus</i> (Phill.)	..	..	..	..	..	..	..	×	×	..	..	..	×	..	..	..	..	..
	„ <i>sp. (or Cleiothyris sp.)</i>	..	..	..	..	..	..	..	×	×	..	..	..	×	..	..	..	..	..
	<i>Atrypa sp.</i> .. ..	×	..	..	..	..	..	..	×	..	..	..	e.	×	..	..	..	..	..
	„ (?) <i>sp.</i> .. ..	×	..	..	..	..	..	..	×	..	..	..	..	×	..	..	..	..	..
	<i>Athyris ambigua</i> (Sowerby)	×	..	..	×	..	..	..	×	..	..	..	e.	×	..	..	..	..	..
	„ <i>sp.</i> .. ..	×	×	×	×	×	×	×	×	×	×	..	u.	×	×	..	×	×	..
	<b>Cleiothyris (Athyris) Macleayana</b> (Eth. fil.)	×	×	×	..	×	×	×	×	×	×	..	G.L.m.o.P. r.s.u.v.	×	×	..	×	×	..
„ „ <i>var. Baracodensis</i> (Eth. fil.)	..	×	..	..	..	×	..	..	..	..	..	P.	×	×	..	..	..	..	
„ „ <i>sp. near Macleayana</i> (Eth. fil.)	..	..	..	..	..	..	..	×	×	..	..	..	..	×	..	..	..	..	
W	„ „ <b>Royssii</b> (Lev.)	..	×	..	×	..	..	×	×	..	..	..	d.o.	×	×	..	..	..	..
	„ „ <i>sp.</i> ..	×	..	..	..	..	..	×	×	..	..	..	e.n.	×	×	..	..	..	..

[illegible]

## PALÆOZOIC—continued.

## CARBONIFEROUS—continued.

	Genus and Species.	Locality.											Reference.	Exhibited.					
	Order Telotrema—continued.	Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
W	<b>Spirifera Hardmani</b> (Foord) ..	×	×	..	..	×	×	..	×	×	..	..	I.n.o.P.r. u.v.	×	×	..	×	×	..
W	„ <b>Kimberleyensis</b> (Foord)	..	×	..	..	..	×	..	×	..	..	..	I.o.	×	..	..	..	..	..
W	„ <b>lata</b> (McCoy) ..	..	×	..	×	×	×	×	×	..	..	..	I.n.o.r.u.v.	×	..	..	..	..	..
	„ „ <b>var.</b> with ribbed sulcus	..	×	..	..	×	..	..	..	..	..	..	P.	×	×	..	..	..	..
W	„ <b>Musakheylenis</b> var.	..	×	..	..	×	×	×	×	×	..	..	I.j.n.o.P.r.	×	×	..	..	..	..
	„ <b>Australis</b> (Foord)	..	×	..	..	×	×	..	×	..	..	..	u.v.	×	×	..	..	..	..
W	„ <b>striata</b> (Martin) ..	×	×	..	×	×	×	..	×	..	..	..	d.e.o.	×	..	..	×	×	..
	„ <b>c.f. striata</b> (Martin) ..	..	..	..	..	..	..	..	×	..	..	..	..	×	×	..	..	..	..
	„ <b>Stutchburyi</b> (?) (Eth. fil.)	..	..	..	..	..	..	..	..	..	×	..	p.	×	×	..	..	..	..
	„ (Martinopsis) subradiata (Sowerby)	..	×	..	..	..	..	..	..	..	..	..	..	×	×	×	..	..	..
	„ <b>trigonalis</b> (Martin) ..	..	×	..	×	..	×	×	×	×	..	..	..	×	..	..	×	×	×
W	„ <b>vespertilio</b> (G. Sowerby)	..	×	..	..	..	×	..	×	..	..	..	d.o. (?)	×	..	..	..	..	×
	„ <b>spp.</b> .. ..	×	×	..	..	×	×	×	×	×	×	..	e.g.n.P.r. S.u.v.	×	×	..	(?)	..	..
	„ <b>sp. (or Martinopsis sp.)</b>	×	..	..	..	..	..	..	×	..	..	..	..	×	×	×	×	×	..
W	<b>Syringothyris exsuperans</b> (De Kon.)	..	×	..	..	..	×	..	×	×	..	..	i.j.o.v.	×	..	×	×	×	..

Sub-Kingdom MOLLUSCA. Class Pelecypoda. Order Prionodesmacea.																			
W	<b>Anthracoptera</b> sp. . . . .	..	×	..	..	..	×	..	..	..	..	..	r.u.	..	×	×	..	..	..
	<b>Arca</b> (?) sp. . . . .	..	..	..	..	..	..	..	×	×	..	..	..	..	×	..	..	..	..
	<i>Aviculopecten granosus</i> (J. de C. Sowerby.)	×	..	..	..	..	..	..	..	..	..	..	e.	..	..	..	..	..	..
	„ <b>multiradiata</b> (Eth. sen.)	..	×	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..
	„ <b>Sprenti</b> (Johnst.)	..	..	..	..	..	..	×	×	..	..	r.S.v.	..	×	×	..	..	..	..
	„ <b>tenuicollis</b> (Dana)	×	×	×	..	×	×	..	×	×	..	g.I.P.r.u.v	×	×	..	..	..	×	..
W	„ <b>spp.</b> . . . .	..	×	×	..	×	×	×	×	×	×	e.h.i.n.o.r.	×	..	..	..	..	..	..
	<b>Cardiomorpha oblonga</b> (Sowerby)	×	..	..	..	..	..	..	..	..	..	S.v.	..	..	..	..	..	..	..
	<b>Chænomya</b> (?) sp. . . . .	..	..	..	..	..	..	×	×	..	..	e.	..	..	..	..	..	..	..
	<b>Conocardium</b> ( <i>Pleurorhynchus</i> ) sp.	×	..	..	..	..	..	×	×	..	..	e.r.s.v.	×	..	..	..	..	..	..
	„ „ (?) sp.	..	..	..	..	..	..	×	×	..	..	..	..	×	..	..	..	..	..
	<i>Conocardium Hibernicum</i> (?) (Sowerby)	×	..	..	..	..	..	..	..	..	..	e.	..	..	..	..	..	..	..
W	<b>Deltopecten</b> ( <i>Aviculopecten</i> ) <b>Il-</b> <b>lawarensis</b> (Morris) (?)	..	×	..	..	×	×	..	..	..	..	d.o.	..	×	..	..	..	..	..
	„ <b>leniusculus</b> (Dana)	..	×	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..
W	„ <b>limæformis</b> (Morris)	..	×	..	×	..	×	..	..	..	..	d.o.	..	×	..	..	..	..	..
	„ <b>subquinque lineatus</b> (McCoy)	..	..	..	..	..	..	..	..	×	..	n.r.S.v.	×	×	..	..	..	..	..
W	„ <b>spp.</b> . . . .	..	..	..	..	..	..	..	×	×	..	h.	..	×	..	..	×	(?)	..
	<b>Edmondia</b> spp. . . . .	×	..	..	..	..	..	×	×	×	..	g.i.o.v.	×	×	..	..	..	..	..
W	<b>Modiola</b> spp. . . . .	×	..	..	..	..	..	×	×	×	..	i.n.o.r.S.v	×	×	..	..	..	..	..
	<b>Myalina</b> (?) <i>Mingenewensis</i> (Eth. fil.)	..	..	..	..	..	..	..	..	×	..	n.r.S.v.	×	×	..	..	..	..	..
	„ <b>spp.</b> . . . .	..	×	..	..	×	×	..	×	×	..	..	..	×	×	..	..	..	..
	<b>Mytilops</b> (?) sp. . . . .	..	..	..	..	..	..	..	..	×	..	..	..	×	..	..	..	..	..

## PALAEOZOIC—continued.

## CARBONIFEROUS—continued.

Genus and Species.		Locality.										Reference.	Exhibited.					
Order Prionodesmacea—contd.		Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.	Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
W	<i>Mytilus</i> spp. . . . .	×	..	..	..	..	..	..	..	..	×	..	e. . .	×	..	..	..	..
	„ sp. (or <i>Modiomorpha</i> )	..	..	..	..	..	..	..	..	..	×	..	..	×	..	..	..	..
	<i>Parallelodon</i> ( <i>Palæarca</i> ) subar- guta (De Kon.)	×	..	..	..	..	..	..	×	..	..	..	g.h. . .	×	..	(?)	..	..
	„ sp. ( <i>Macrodon</i> sp.)	..	..	..	..	..	..	..	×	..	..	..	..	×	..	..	..	..
	<i>Pterinea</i> ( <i>Merismoptera</i> ) mac- roptera (Morris)	×	..	..	..	..	..	..	..	..	..	..	g. . .	..	..	(?)	..	..
	<i>Sanguinolites</i> c.f. <i>Hibernicus</i> (Hind)	..	..	..	..	..	..	..	×	..	..	..	q. . .	..	×	..	..	..
	„ sp. . . . .	..	..	..	..	..	..	..	×	×	×	..	i.o.v. . .	×	..	..	..	..
	<i>Stutchburia</i> c.f. <i>Randsi</i> (Eth. fil.)	..	..	..	..	..	..	..	×	×	..	..	v. . .	×	..	..	..	..
	„ sp. . . . .	..	..	..	..	..	..	..	×	×	..	..	r.S.v. . .	×	..	..	..	..
Order Anomalodesmacea.																		
	<i>Allorisma</i> c.f. <i>curvatum</i> (Morris)	..	..	..	..	..	..	..	×	..	..	..	q. . .	..	×	..	..	..
	„ c.f. <i>maximum</i> (Portl.)	..	..	..	..	..	..	..	×	..	..	..	q. . .	..	×	..	..	..

Order Teleodesmacea.																			
W	<i>Curtonotus elegans</i> (Salter) ..	×	..	..	..	..	..	×	×	..	..	..	e.	..	×	..	..	..	..
	<b>Pleurophorus</b> ( <b>Pachydorus</b> )	..	×	..	..	..	..	×	×	..	..	..	i.j.o.	..	×	..	..	..	..
	carinatus (1) (Morris)	×	..	..	..	..	..	×	×	..	..	..	g.h.v.	..	×	×	..	(?)	..
	„ „ spp.	×	..	..	..	..	..	×	×	..	..	..	g.h.v.	..	×	×	..	(?)	..
Class Gastropoda. Sub-Class Streptoneura.																			
Order Aspidobranchia. Sub-Order Rhipidoglossa.																			
W	<b>Baylea (Ivania) Levellii</b> (De Kon.)	..	..	..	..	..	..	×	×	..	..	..	..	×	×	..	..	..	..
	<b>Bellerophon costatus</b> (J. de C. Sowerby)	..	..	..	..	..	..	×	×	..	..	..	r.S.v.	..	×	..	..	..	..
	„ <b>decussatus</b> (Flem.)	..	..	..	..	..	..	×	×	..	..	..	i.j.o.	..	×	..	..	..	..
	(?)																		
	„ <i>Urei</i> (Flem.) ..	×	..	..	..	..	..	×	×	..	..	..	e.	..	×	..	..	..	..
	„ sp. ..	×	..	..	..	..	..	×	×	..	..	..	e.v.	..	×	..	..	..	..
W	<b>Euomphalus</b> spp.	×	..	..	..	..	..	×	×	..	..	..	v.	..	×	..	..	..	..
	„ (?) spp.	×	..	..	..	..	..	×	×	..	..	..	l.	..	×	..	..	×	..
	<i>Euphemus Orbignii</i> (Portl.) ..	×	..	..	..	..	..	×	×	..	..	..	g.	..	×	..	..	(?)	..
	<i>Mourlonia</i> ( <i>Pleurotomaria</i> ) <i>humilis</i> (De Kon.)	×	..	..	..	..	..	×	×	..	..	..	g.	..	×	..	..	(?)	..
	<b>Pleurotomaria</b> spp.	×	..	..	..	..	..	×	×	..	..	..	e.o.r.v...	..	×	..	..	..	×
W	„ (?) sp.	×	..	..	..	..	..	×	×	..	..	..	e.l.o.r...	..	×	..	..	×	..
	<b>Ptychomphalina Maitlandi</b> (Eth. fil.)	..	×	×	..	..	..	×	×	..	×	..	n.P.u.	..	×	..	..	..	..
	„ sp.	..	..	..	..	..	..	×	×	..	×	..	..	×	×	..	..	..	..

(1) Or *Mænia carinata* (Morris) fide Eth. fil. Geol. and Pal., Queensl., p. 283.



ZOIC—continued.

EROUS—continued.

	Genus and Species.	Locality.											Reference.	Exhibited.					
	Order Ctenobranchia. Sub-Order Platypoda.	Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
	<b>Acroculia (Platyceras) sp.</b> ..	×	..	..	..	..	..	..	×	×	..	..	v.	×	..	..	..	..	..
	<i>Loxonema sp.</i> .. ..	×	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	<i>Natica sp.</i> .. ..	×	..	..	..	..	..	..	..	..	..	..	e.o.r.	..	..	..	..	..	..
	Class Cephalopoda. Sub-Class Tetrabranchiata. Order Nautiloidea. Sub-Order Orthochoanites.																		
	<b>Cæloanutilus Chesterensis</b> (De Kon.) ..	..	..	..	..	..	..	..	..	×	..	..	..	×	..	..	..	..	..
W	<b>Discites c.f. Omalianus</b> (De Kon.) ..	..	..	..	..	..	..	..	×	..	..	..	i.j.o.	×	..	..	..	..	..
	“ <b>sp.</b> .. ..	..	..	..	..	..	..	..	×	..	..	..	i.j.o.	×	..	..	..	..	..
	<b>Nautilus (?) sp. (Mesozoic ?)</b> ..	..	..	..	..	..	..	..	×	×	..	..	..	×	..	..	..	..	×
W	<b>Orthoceras spp.</b> .. ..	×	..	..	..	..	..	..	×	×	..	..	e.i.j.o.v.	×	..	..	×	×	×

	Sub-Order Cyrtchoanites.																		
	Actinoceras sp. .. ..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..
	Order Ammonoidea. Sub-Order Eurycampyli.																		
	Gastrioceras Jacksoni (Eth. fil.)	..	..	..	..	..	..	×	..	..	..	r.S.	..	×	..	..	..	..	..
	Glyphioceras sphæricum (Goldf.)	×	..	..	..	..	..	..	..	..	..	e.	..	×	..	..	..	..	..
	” sp. .. ..	×	..	..	..	..	..	..	..	..	..	e.	..	×	..	..	..	..	..
	” (?) sp. .. ..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..
	Sub-Order Phyllocampyli.																		
W	Agathiceras micromphalum (Morris)	×	..	..	..	..	..	×	..	..	..	I.q.	..	×	..	×	..	×	..
	Sub-Order Pachycampyli.																		
	Brancoceras sp. .. ..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..
	Sub-Kingdom ARTHROPODA. Class Crustacea. Sub-Class Trilobita. Order Opisthoparia.																		
	Phillipsia grandis (Eth. fil.) ..	..	×	..	..	..	×	..	..	..	..	..	..	..	..	×	..	..	..

## PALÆOZOIC—continued.

## CARBONIFEROUS—continued.

	Genus and Species.	Locality.											Reference.	Exhibited.					
	Super-Order Ostracoda.	Kimberley.	Gascoyne.	Minilya River.	Lyons River.	Wyndham River.	Gascoyne River.	Wooramel River.	Irwin.	Irwin River Coal.	Mingenew P.C.	Collie Coalfield.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Dept. of Mines, N.S.W. Museum.	British Museum.	Geol. Soc. Lond. Museum.
	Various species .. .. .	..	×	..	..	..	×	..	..	..	..	..	.. ..	×	..	..	..	..	..
	Crustacean tracks (?) .. ..	..	×	×	..	..	..	..	..	..	..	..	n.P. ..	×	..	..	..	..	..
	VERTEBRATA. Class Pisces. Sub-Class Selachii.																		
W	<i>Edestus Davisii</i> (H. Woodw.) ..	..	×	..	..	..	×	..	..	..	..	..	F.o. ..	×	..	..	..	..	..
	<i>Pocilodus Jonesi</i> (Ag.) ..	×	..	..	..	..	..	..	..	..	..	..	c. ..	×	..	..	..	..	..
	Small tooth .. .. .	×	..	..	..	..	..	..	..	..	..	..	c.v. ..	×	..	..	..	..	..

## PART II.

## MESOZOIC FOSSILS.

Rocks containing animal remains of Mesozoic age cover a fair percentage of the sedimentary area of the State. The beds consist for the most part of yellowish, reddish, or brownish ferruginous sandstones, occasionally containing a large amount of calcareous matter, and even passing into yellowish limestone bands that are highly crystalline and full of fossils, all showing a typically Jurassic facies. Naturally the sandstones, though often very fossiliferous, are not remarkable for the good state of preservation of the animal remains they contain. Still, numerous excellent specimens have been obtained by the officers of this Department and have been incorporated in the Geological Survey Collection, now on exhibit in the Geological Gallery of the Western Australian Museum.

One of the earliest geological observers in the colony, F. T. Gregory, reported the presence of the Cretaceous strata near Gin Gin, in the form of chalk, and records the collection of Ammonites, etc., from the beds, thus giving them a truly Mesozoic facies. Subsequent authorities seem to have placed little faith in this discovery, reported in the Q. J. G. S., Vol. XVI. 1861, pp. 475-483, especially as one of the Lamellibranchs (Pelecypods) was found to be a truly Jurassic form, *Trigonia Moorei* (Lycett). There seems little doubt, however, that these beds are homotaxial with the Cretaceous of Europe when the whole of the known Gingin fauna is considered. (*Vide* Article VIII., p. 115, *et. seq.*).

In this portion of the list, the same general plan adopted in Part I has been followed, but it has been thought advisable to introduce a column for doubtful or vague localities which are distinguished as under :—

" Western Australia "	..	..	1
Champion Bay	..	..	2
Gascoyne River District	..	..	3

MESOZOIC.  
JURASSIC ONLY.

Genus and Species.	Locality.									Reference.	Exhibited.						
Sub-Kingdom PROTOZOA. Class Rhizopoda. Order Foraminifera.	Shark Bay.	Moresby Range.	Greenough R.	Tibraddon.	Moonyoonooka.	Sand spring.	Woolanooka.	Snake Farm.	Mount Hill.	Doubtful Locs.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Bath Museum.	British Museum.	Geol. Soc. Lond. Museum.
Bulimina Gregorii (Chapm.) .. ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
Cristellaria costata var. compressa (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" " var. seminuda (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" cultrata var. radiata (Moore)	..	..	..	..	..	..	..	..	..	I	b.(c.)o.	..	..	×	..	..	..
" Daintreei (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" decipiens (Wisnow.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" c.f. limata (Schw.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" prominula (Reuss)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" rotulata (Lamarek)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" subalata (Reuss) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
Discorbina rosacea (D'Orb.) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
Flabellina dilatata (Wisnow.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
Haplophragmium neocomianum (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
Marginulina compressa (D'Orb.) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" solida (Terquem)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
Polymorphina burdigalensis (D'Orb.) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" compressa (D'Orb.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
" gutta (D'Orb.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..

	Textularia crater (Chapm.) .. ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..
	Truncatulina Wuellerstorfi (Schw.) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..
	Vaginulina intumescens (Reuss) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..
	"    lata (Corn.) .. ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..
	"    Schloenbachi var. interrupta (Reuss) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..
	"    strigillata (Reuss.) ..	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..
	Sub-Kingdom ECHINODERMATA. Sub-Branch Pelmatozoa. Class Crinoidea. Order Articulata.																
	Pentacrinus spp. .. ..	..	×	..	..	..	..	..	..	..	..	l	b.	..	..	×	..
	Sub-Branch Echinozoa. Class Echinoidea.																
W	Spines of Echini .. ..	..	..	..	..	..	..	..	..	..	..	l	b.	..	..	..	..
	Sub-Kingdom VERMES. Sub-Order Tubicola (Sedentaria).																
W	Serpula conformis (Goldf.) .. ..	..	..	×	..	..	..	..	..	..	..	T.	×	..	..	..	..
	"    spp. .. ..	..	×	..	..	..	..	..	..	..	..	a.b.	..	..	×	..	..
	Sub-Kingdom MOLLUSCOIDEA. Class Bryozoa.																
W	Bryozoa .. ..	×	×	..	..	..	..	..	..	..	..	b.	..	..	..	..	..

## MESOZOIC—continued.

## JURASSIC ONLY—continued.

Genus and Species.		Locality.									Reference.	Exhibited.						
		Shark Bay.	Moresby Range.	Greenough R.	Tibbaddon.	Moonyoonooka.	Sandspring.	Woolanooka.	Snake Farm.	Mount Hill.	Doubtful Locs.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Bath Museum.	British Museum.	Geol. Soc. Lond. Museum.
Class Brachiopoda. Order Telotre mata.																		
W	<i>Rhynchonella variabilis</i> (Schl.) ..	×	×	..	..	×	..	..	×	×	1	a.B.c.o.T.	×	..	..	×	..	..
	„ <i>c.f. solitaria</i> (Moore) ..	..	×	×	..	..	..	..	..	..	1	..	..	..	×	..	..	..
	„ spp. .. ..	..	×	×	..	..	..	..	..	..	1	a.b.	..	..	..	×	..	..
Sub-Kingdom MOLLUSCA. Class Pelecypoda. Order Prionodesmacea.																		
W	<i>Arca</i> sp. .. ..	..	×	..	..	..	..	..	..	..	..	a.	..	..	..	..	..	..
	<i>Alectryonia (Ostrea) Marshii</i> (Sowerby)	×	×	×	×	×	×	×	..	×	..	a.b.c.o.T.	×	×	..	..	..	..
	„ <i>c.f. Marshii</i> (Sowerby)	..	×	×	..	..	..	..	..	..	..	..	..	×	..	..	..	..
	<i>Avicula æqualis</i> (Moore)	..	×	..	..	..	..	..	..	..	..	(c.)	×	..	..	×	×	..
	„ (Maccoyella) Barklyi (Moore)	..	..	..	..	..	..	..	..	..	1	B.(c.)	..	..	..	×	×	..
W	„ <i>echinata</i> (Sowerby) ..	..	×	×	..	..	..	..	..	..	..	b.c.o.	..	..	..	..	..	..
W	„ <i>inæquivalvis</i> (Sowerby)	..	×	..	..	..	..	..	..	..	1	b.c.o.	..	..	..	..	..	..
W	„ <i>Munsteri</i> (Bronn.) ..	..	×	..	..	..	..	..	..	..	..	a.b.c.o.	..	..	..	..	..	..
	„ spp.	..	×	..	..	..	..	..	..	..	..	a.	..	..	..	..	..	..
	<i>Ctenostreon (Lima) pectiniformis</i> (Schl.)	..	×	×	×	×	×	×	..	×	2	r.Q.T.	×	×	×	×	×	..
	<i>Cucullæa inflata</i> (Moore) ..	..	..	×	..	..	..	..	..	..	..	B.c.o.	..	..	..	×	..	..
	„ <i>c.f. inflata</i> (Moore) ..	..	..	..	..	..	×	..	..	..	..	T.	..	×	×	..	..	..

W	„	oblonga (Sowerby) ..	..	×	×	..	..	..	..	..	..	..	1	b.c.o. ..	..	..	..	×	..	..
W	„	semistriata (Moore) ..	..	..	×	×	×	×	×	×	..	×	2	B.c.o.q.r.T	×	×	×	×	..	..
	„	c.f. semistriata (Moore) ..	..	..	..	..	..	..	..	..	×	..	..	..	×	..	..	..	..	..
	„	tibraddonensis (Eth. fil.) ..	..	..	..	×	×	×	×	×	..	..	1	T. ..	×	×	..	..	..	..
	„	spp. ..	..	×	×	×	×	×	×	×	..	×	1	a.b.T. ..	×	..	×	×	..	..
	Gryphaea	spp. ..	..	×	×	×	×	×	×	×	..	2	r. ..	×	..	×	..	..	..	..
	Hinnites	sp. ..	..	×	..	..	..	..	..	..	..	..	1	a. ..	..	..	..	..	..	..
	Lima	Gordonii (Moore) ..	..	..	..	..	..	..	..	..	..	..	1	B. ..	..	..	..	×	..	..
W	„	proboscidea (Sowerby) ..	..	×	×	..	..	..	..	..	..	1	a.b.c.o. ..	..	..	..	×	..	..	..
W	„	punctata (Sowerby) ..	..	×	..	..	..	..	..	..	..	1	b.c.o. ..	..	..	..	×	..	..	..
	„	spp. ..	..	..	×	×	×	×	×	×	×	2	a.b.r. ..	..	..	..	..	..	..	..
	Modiola	Maitlandi (Eth. fil.) ..	..	..	..	×	×	×	×	×	×	..	T. ..	×	×	..	..	..	..	..
	Mytilus	c.f. gygerensis (D' Orb.) ..	..	..	..	..	..	..	..	..	..	2	a.r. ..	..	..	..	..	..	..	..
	„	sp. ..	..	..	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	..
	Nucula	sp. ..	..	..	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	..
	Ostrea	tholiformis (Eth. fil.) ..	..	..	..	×	×	×	×	×	×	..	T. ..	×	×	..	..	..	..	..
	„	c.f. tholiformis (Eth. fil.) ..	..	..	..	×	×	×	×	×	×	..	..	×	×	..	..	..	..	..
	„	spp. ..	..	..	×	×	×	×	×	×	×	..	b.T. ..	×	×	..	..	..	..	..
	„	sp. (very small) ..	..	..	×	..	..	..	..	..	×	..	a. ..	×	×	..	..	..	..	..
W	Pecten	calvus (Goldf.) ..	..	×	×	..	..	..	..	..	..	1	b.c.o. ..	..	..	..	×	..	..	..
W	„	cinctus (Sowerby) ..	..	×	×	×	×	×	×	×	×	1	b.c.o.q.T. ..	×	×	×	×	..	..	..
	„	c.f. frontalis (Dum.) ..	..	..	×	×	×	×	×	×	×	..	r. ..	×	×	..	..	..	..	..
	„	Greenoughiensis (Moore) ..	..	..	×	..	..	..	..	..	×	..	B.c.o. ..	×	×	..	..	..	..	..
	„	valoniensis (Defr.) ..	..	..	..	..	..	..	..	..	..	3	..	×	×	..	..	..	..	..
	„	c.f. vesicularis ..	..	..	×	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	..	..
	„	spp. ..	..	..	×	×	×	×	×	×	×	..	a.T. ..	×	×	..	..	..	×	..
	„	sp. (or Ctenostreon sp.) ..	..	..	×	×	×	×	×	×	×	..	..	×	×	..	..	..	..	..
	Perna	sp. (or Inoceramus sp.) ..	..	..	×	×	×	×	×	×	×	..	..	×	×	..	..	..	..	..
W	Platula	sp. ..	..	×	..	..	..	..	..	..	..	1	b. ..	..	..	..	..	..	..	..
W	Radula	(Lima) duplicata (Sowerby) ..	..	×	×	×	×	×	×	×	×	1	b.c.T. ..	×	×	×	×	..	..	..
	„	sp. ..	..	×	×	×	×	×	×	×	×	..	a. ..	..	..	..	..	..	..	..
W	Trigonia	Moorei (Lycett) ..	..	×	×	×	×	×	×	×	×	3	B.c.o.q.r. ..	×	×	×	×	×	..	..
	„	costata (Clarke) (? Moorei) (Lyc) ..	..	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	..	..
	„	sp. ..	..	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	×	..



## MESOZOIC—continued.

## JURASSIC ONLY—continued.

Genus and Species.				Locality.								Reference.	Exhibited.							
Order Anomalodesmacea.				Shark Bay.	Moresby Range.	Greenough R.	Tibraddon.	Moonyoonooka.	Sandspring.	Woolanooka.	Snake Farm.	Mount Hill.	Doubtful Locs.		Geol. Soc. Lond. Museum.	Australian Museum.	Victorian Museum.	Bath Museum.	British Museum.	Geol. Soc. Lond. Museum.
W	Gresslya donaciformis (Phill.) ..			×	..	×	..	..	..	..	..	..	1	b.c.o. ..	..	..	..	×	..	..
	" sp. .. ..			..	..	..	..	..	..	..	..	..	2	b.r. ..	..	..	..	..	..	..
	" (?) sp. .. ..			..	..	..	..	..	..	..	..	..	1	..	..	..	..	×	..	..
	Homomya (?) sp., .. ..			..	..	..	..	..	..	..	..	..	1	b.(c.) ..	..	..	..	×	..	..
W	Myacites liassianus (Quenst.) ..			×	..	..	..	..	..	..	..	..	1, 2	b.c.o. ..	×	×	..	×	..	..
W	" Sanfordii (Moore) ..			..	..	×	..	×	..	..	..	×	1, 2	B.c.o.r.	×	×	..	×	..	..
	" spp. .. ..			..	×	×	..	..	..	..	..	..	..	a.b. ..	..	..	..	×	..	..
W	Pholadomya ovulum (Agassiz) ..			×	×	×	..	..	..	..	..	..	1	b.c.o. ..	×	..	..	..	..	..
	" sp. .. ..			..	×	..	..	..	..	..	..	..	..	a.b. ..	..	..	..	..	..	..
	Pleuromya sp. (?) .. ..			..	..	×	..	×	..	..	..	..	2	r. ..	×	..	..	..	..	..
Order Teleodesmacea.																				
W	Astarte apicalis (Moore) .. ..			..	..	×	..	..	..	..	..	..	..	B.c.o. ..	..	..	..	..	..	..
W	" Cliftoni (Moore) .. ..			×	..	×	×	×	..	×	..	×	2	B.c.o.q.r.	×	×	×	..	..	..
	" spp. .. ..			×	×	×	..	..	..	..	..	×	2	a.b. ..	×	..	..	×	..	..

W	<i>Cardium</i> sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	a.b.o. . .	..	..	..	×	..	..
W	<i>Cypriocardia</i> sp. . . . .	×	..	..	..	..	..	..	..	..	..	..	..	..	b.o. . .	..	..	..	×	..	..
W	<i>Isocardia</i> sp. . . . .	×	..	..	..	..	..	..	..	..	..	..	..	..	b.o. . .	..	..	..	×	..	..
	<i>Lucina</i> sp. (? <i>Pseudavicula</i> , Eth. fil.) . .	..	×	..	..	..	..	..	..	..	..	..	..	..	a. . .	..	..	..	..	..	..
	<i>Opis</i> sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	a. . .	..	..	..	..	..	..
	<b><i>Panopæa</i> (<i>Glycimeris</i>) <i>rugosa</i> (Moore)</b> . .	..	..	..	..	..	..	..	..	..	..	2	..	..	×	..	..	..	..	..	..
	„ <b>sp. nov.</b> . . . . .	..	..	..	..	..	..	..	..	..	..	2	..	..	×	..	..	..	..	..	..
	„ <b>sp.</b> . . . . .	..	×	..	..	..	..	..	..	..	3	..	..	×	..	×	..	..	..	..	..
W	<i>Tancredia plana</i> (?) (Moore) . . . . .	..	×	×	×	..	×	..	..	..	..	..	..	..	b.(c.)o. . .	..	×	..	..	..	..
W	<i>Teredo</i> ( <i>Pholas</i> ) <i>Australis</i> (Moore) . .	×	×	..	..	..	..	..	..	..	1	..	..	..	a.B.c.o. . .	..	..	..	×	..	..
W	<i>Unicardium</i> sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	b.o. . .	..	..	..	..	..	..
	„ (?) sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	b. . .	..	..	..	..	..	..
Class Scaphopoda. Family Dentaliidae.																					
<i>Dentalium</i> sp. . . . .		..	×	..	..	..	..	..	..	..	..	..	..	..	a. . .	..	..	..	..	..	..
Class Gastropoda. Order Aspidobranchia. Sub-Order Rhipidoglossa.																					
W	<i>Amberleya</i> sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	b.o. . .	..	..	..	..	..	..
W	<i>Phasianella</i> sp. . . . .	×	..	..	..	..	..	..	..	..	1	..	..	..	b.o. . .	..	..	..	×	..	..
	<b><i>Pleurotomaria</i> <i>Greenoughiensis</i> (Eth. fil.)</b> . .	..	..	..	..	×	..	×	..	..	..	..	..	..	T. . .	×	..	..	..	..	..
	„ <b>sp.</b> . . . . .	..	..	..	×	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..
W	<i>Trochus</i> sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	b.o. . .	..	..	..	..	..	..
	<i>Turbo Australis</i> (Moore) . . . . .	..	×	×	..	..	..	..	..	..	..	..	..	..	B.c.o. . .	..	..	..	×	..	..
W	„ <i>lævigatus</i> (Sowerby) . . . . .	..	×	×	..	..	..	..	..	..	..	..	..	..	b.c.o. . .	..	..	..	..	..	..
	„ sp. . . . .	..	×	..	..	..	..	..	..	..	..	..	..	..	a.b. . .	..	..	..	..	..	..

## MESOZOIC—continued.

## JURASSIC ONLY—continued.

Genus and Species.		Locality.										Reference.	Exhibited.					
Order Ctenobranchiata. Sub-Order Platypoda.		Shark Bay.	Moresby Range.	Greenough R.	Tibraddon.	Moonyoonooka.	Sand spring.	Woolanooka.	Snake Farm.	Mount Hill.	Doubtful Locs.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Bath Museum.	British Museum.	Geol. Soc. Lond. Museum.
W	<i>Cerithium Greenoughiensis</i> (Moore) ..	×	..	×	..	..	..	..	..	..	..	B.c.o. ..	..	..	..	..	..	..
	„ <i>sp.</i> .. ..	..	×	..	..	..	..	..	..	..	..	b. ..	..	..	..	..	..	..
W	<i>Chemnitzia sp.</i> .. ..	..	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	..
	<i>Eulima (?) sp.</i> .. ..	..	×	..	..	..	..	..	..	..	..	b.o. ..	..	..	..	..	..	..
	<i>Nerinea sp.</i> .. ..	..	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	..	..	..
W	<i>Rissoina Australis</i> (Moore) ..	×	..	×	..	..	..	..	..	..	..	B.c.o. ..	..	..	..	×	..	..
Order Opisthobranchia. Sub-Order Tectibranchiata.																		
	<i>Actæon depressus</i> (Moore) .. ..	×	..	..	..	..	..	..	..	..	..	B. ..	..	..	..	×	..	..
Class Cephalopoda. Sub-Branch Tetrabranchiata. Order Nautiloidea. Sub-Order Orthochoanites.																		
W	<i>Nautilus perornatus</i> (Crick) (1) ..	×	×	×	×	×	..	..	×	×	2	b.c.L.o.r.t. ..	×	×	..	..	×	..
	„ <i>sinuatus</i> (Sowerby) (?) ..	..	×	..	..	..	..	..	..	..	1	a.c.o. ..	..	..	..	..	..	..
	„ <i>spp.</i> .. ..	×	×	..	..	..	..	..	..	..	..	a. ..	..	..	..	×	×	×

Order Ammonoidea.																
	Ammonites lautus .. ..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	×
W	" Walcottii (Sowerby) ..	×	..	×	..	..	..	..	..	..	..	b.c.o. ..	..	..	..	×
W	" (Dorsetensia) Clarkei (Crick) (2)	×	×	×	×	×	..	×	×	×	2	a.B.c.L.O., r.T.	×	×	×	×
W	" (Dorsetensia) sp. ..	..	..	..	..	..	..	×	..	..	..	..	×	..	..	..
	" (Dumortieria) Moorei (Lycett)	×	×	×	..	..	..	..	..	..	..	a.B.c.l.o.	..	..	×	..
	" (Macrocephalites) macrocephalus (3) (Schlot)	×	×	×	×	..	..	..	..	..	..	B.c. ..	..	..	×	..
	" (Macrocephalites) sp. ..	..	..	×	..	..	..	..	..	..	..	..	..	..	×	..
	" (Perisphinctes) Championensis (Crick)	..	..	×	×	×	..	..	..	×	2	L.o.Q.r.t.	×	..	×	×
	" (Perisphinctes) robiginosus (Crick)	..	..	..	..	..	..	..	..	..	2	L.o.r. ..	..	..	..	×
W	" (Sphaeroceras) semiornatus (4) (Crick)	..	..	..	×	..	..	..	..	..	2	B.c.L.o.r. T.	×	..	×	×
	" (Sphaeroceras) (?) Woodwardi (Crick)	..	..	..	..	..	..	..	..	..	2	L.o.r. ..	..	..	..	×
	" (Stephanoceras) Australis (Crick)	}	..	×	×	..	×	..	..	×	2	L.o.g.r.	..	×	×	×
	" (Normannites) Australis (Crick) (vide Chapman)		..	×	×	..	×	..	..	×	2	L. b.	..	×	×	×
	" (Normannites) sp. ..		×	..	..	..	..	..	..	..	2	L. b.	..	×	×	×
	" spp. .. ..	×	×	..	×	×	..	×	..	×	..	b. ..	×	..	×	×
Sub-Class Dibranchiata.																
Sub-Order Belemnoidea.																
W	Belemnites canaliculatus (Schl.) ..	×	×	×	..	..	..	×	..	×	..	a.B.c.o.	×	..	×	×
	" c.f. canaliculatus (Schl.) ..	..	..	×	..	..	..	..	..	×	..	a. ..	×	..	×	×
(?)	" Canhami (Tate) .. ..	..	..	..	..	..	..	..	..	..	2	..	×	..	×	×
	" sp. .. ..	..	..	×	×	×	×	..	×	×	2, 3	a.L.o.r.	×	×	..	×

(1.) This is the *N. semistriatus* of Moore; vide Crick. Geol. Mag., Dec. IV., Vol. 1 (1894), p. 387. (2.) This is the *A. radians* of Moore's paper; Crick. op. cit., pp. 388-391. (3.) Vide *Stephanoceras Australe* Crick. op. cit. p. 391. (4.) This is the *A. Brocchii* of Moore's paper Crick. op. cit., p. 435.

## MESOZOIC—continued.

## JURASSIC ONLY—continued.

	Genus and Species.	Locality.								Reference.	Exhibited.							
	Sub-Kingdom ARTHROPODA. Class Crustacea. Sub-Class Eucrustacea. Super-Order Ostracoda.	Shark Bay.	Moresby Range.	Greenough R.	Tibraddon.	Moonyoonooka.	Sandspring.	Woolanooka.	Snake Farm.	Mount Hill.	Doubtful Locs.		Geol. Surv. Museum.	Australian Museum.	Victorian Museum.	Bath Museum.	British Museum.	Geol. Soc. Lond. Museum.
	Cythere corrosa var. grossepunctata (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
	„ drupacea var. fortior (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
	„ lobatula (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
	Cytheropteron australiense (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
	Loxococoncha elongata (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
	„ jurassica (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
	Paradoxorhyncha foveolata (Chapm.)	..	..	×	..	..	..	..	..	..	..	Q.	..	..	×	..	..	..
W	Ostracoda—Species of .. ..	..	..	..	..	..	..	..	..	..	I	F.	..	..	..	..	..	..

# VI.—Western Australian Fossil Plants,

BY

LUDWIG GLAUERT, F.G.S.,

Field Geologist.

As explained in the general introduction the fossil flora of the State is very scanty, still it has been the cause of a good deal of discussion from time to time, as may be gathered from the Introduction and Historical Sketch in the *Glossopteris Flora* (1) by Mr. E. A. Newell Arber, of Cambridge University, and from several of the Bulletins issued by this Department. (2).

The Collie plant-remains were originally considered to be of Mesozoic Age, as explained by Mr. H. P. Woodward, in the Annual General Report for the year 1890, of the Government Geologist (page 40). A little later the late R. Etheridge, F.R.S., determined them as Permo-Carboniferous, basing his opinion on the specimens submitted to him for examination. In 1897, Mr. E. F. Pittman, the Government Geologist of New South Wales, classed them as Mesozoic in consequence of "Mr. R. Etheridge's (junr.), doubtful recognition of *Sagenopteris*." On the other hand, in 1898, Sir Frederick McCoy reported the determination with certainty of *Glossopteris Browniana* (Brong), and stated that the beds were of "the exact geological age of the great Coalfields of Newcastle in New South Wales." Dr. Jack, during his investigation, as Royal Commissioner, of the Collie Coal Industry, in 1904, came to the conclusion that the beds were of much later date, writing "I am at present inclined to believe that 'the Collie Coalfield will turn out to be possibly of Cretaceous Age. . . .'" (3). In the following year, Mr. F. Chapman, of Melbourne, after examining some specimens in the Collection of the National Museum, Melbourne, identified five species of *Glossopteris*, as well as the following Foraminifera whose range in time is as under:—

Name.	Range in Time.
<i>Endothyra</i> , sp. . . . .	Carboniferous Limestone
<i>Valvulina plicata</i> (Brady) . . . .	L and U. Carboniferous
<i>Bulimina</i> (?) sp. . . . .	Permo-Carbonif. of N.S.W., Triassic to Recent
<i>Truncatulina Haidingeri</i> (D'Orb)	Permo.-Carboniferous
<i>Pulvinulina c.f. exigua</i> (Brady)	(Genus) Lower Lias to Recent.

(1.) Catalogue of the Fossil Plants of the *Glossopteris Flora* in the Department of Geology, British Museum (Natural History), London 1905.

(2.) Bulletin G.S., W.A., 26, p. 58 *et. seq.*, Bull. 27, articles 1 and 2, 1907.

(3.) Report of the Royal Commission on the Collie Coal Field, 15 p. 7—1905.

Although the two doubtful forms may belong to more recent beds, the species determined with certainty are typically Carboniferous, the whole series "point in a general way to the Palæozoic (Permo-Carboniferous) Age of the series in which they were found." Since that time, no conflicting evidence has come to hand, so that in spite of the peculiar lithological character of the beds there seems little if any doubt about the age of the Collie Coal Seams, and their associated fossils. (1).

Though the known Palæozoic flora of the State is scanty, that obtained up to the present from the Mesozoic beds is much more so. Before the specimens described by Mr. Newell Arber in this Bulletin were found, the discoveries were limited to badly-preserved fossil wood, similar to the pieces referred to by Mr. Arber on page 27, so that the determination of even the one species, *Otozamites Feistmanteli* (Zigno), is a great advancement, one which suggests that the locality near Mingenew may yield a good harvest at some future time when it is possible to make a prolonged and systematic search in the beds, whence these few plants were obtained by Mr. W. D. Campbell, in 1908.

*References.*—The plan adopted in the list of the fossil fauna is continued.

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(1) *Glossopteris* is a genus of ferns which is looked upon as being not younger than Triassic or Rhætic, E. A. Newell Arber, *loc. cit.*

# WESTERN AUSTRALIAN FOSSIL PLANTS.

(a.) PALÆOZOIC.

The following plants are recorded from Carboniferous and Permo-Carboniferous Strata :—

Genus and Species.	Locality.	Reference.	Exhibited.		
			Geol. Surv. Museum.	Australian Museum.	Victorian Museum.
<i>Calamites</i> sp. . . . .	Kimberley . . . . .	e. . . . .	..	..	..
<b>Chondrites (?) sp.</b> . . . . .	Minilya R. . . . .	n.P.u. . . . .	×	..	..
<i>Cyperites</i> (?) sp. . . . .	Kimberley . . . . .	I. . . . .	×	..	..
<b>Glossopteris Browniana</b> (Brong.) . . . . .	Gascoyne R. and Collie Coal-field	n.r.S. . . . .	×	..	×
„ <b>angustifolia</b> (Brong.) . . . . .	Collie Coalfield . . . . .	n.r.S. . . . .	×	..	×
„ <b>communis</b> (Feistm.) * . . . . .	Do. . . . .	n.r.S. . . . .	..	..	×
„ <b>gangamopteroides</b> (Feistm.) . . . . .	Do. . . . .	n.r.S. . . . .	×	..	×
„ <b>Indica</b> (Brong.) * . . . . .	Do. . . . .	n.r.S. . . . .	..	..	×
„ <b>spp. ind.</b> . . . . .	Do. . . . .	n.r.S. . . . .	×	×	..
„ <b>(Vertebraria) sp.</b> . . . . .	Collie Coalfield and Bulls Brook	n.r.S. . . . .	×	..	×
<b>Lepidodendron</b> sp. . . . .	Kimberley . . . . .	e.i.r. . . . .	×	..	..
„ <b>(Knorria condition) sp.</b> . . . . .	Do. . . . .	e.i. . . . .	×	..	..
„ <b>(Sagenaria) sp.</b> . . . . .	Do. . . . .	e. . . . .	..	..	..
<i>Lepidophyllum</i> (?) sp. . . . .	Do. . . . .	e. . . . .	..	..	..
<i>Lepidostrobus</i> sp. . . . .	Do. . . . .	e.i. . . . .	..	..	..
<i>Rhizomopteris</i> (?) sp. . . . .	Collie Coalfield . . . . .	S. . . . .	..	..	×
<i>Sigillaria</i> sp. . . . .	Kimberley . . . . .	e. . . . .	..	..	..
<i>Stigmara</i> sp. . . . .	Do. . . . .	e.r. . . . .	..	..	..
<b>Noeggerathia</b> (?) sp. . . . .	Collie Coalfield . . . . .	r.s. . . . .	×	..	..

\* Some authorities consider these two species to be identical. *Vide* Bulletin 27, pp. 12 and 13.



WESTERN AUSTRALIAN FOSSIL PLANTS--continued.

(b.) MESOZOIC.

The following plants are recorded from Jurassic Strata :—

Genus and Species.	Locality.	Reference.	Exhibited.		
			Geol. Surv. Museum.		
<i>c.f. Araucaria peregrina</i> (Kurr.) .. .. .	3 m. South of Mingenew ..	t. .. ..	×	..	..
<i>c.f. Cunninghamites Australis</i> (Ten. Woods) ..	Do. .. ..	t. .. ..	×	..	..
<i>c.f. Pagiophyllum</i> sp. .. .. .	Do. .. ..	t. .. ..	×	..	..
<i>Otozamites Feistmanteli</i> (Zigno) .. .. .	Do. .. ..	t.u. ..	×	..	..
" sp. .. .. .	Mount Hill .. ..	u. .. ..	×	..	..
<b>Fern fronds</b> .. .. .	3m. South of Mingenew ..	t.u. ..	×	..	..
<b>Seed Vessels</b> .. .. .	Do. .. ..	t.u. ..	×	..	..
<i>c.f. Williamsonia pecten</i> (Phill.) * .. ..	Point Torment near Derby ..	.. ..	×	..	..

\* This is the first indication of the presence of Mesozoic strata in the Kimberley Division of the State.

*VII.—New Fossils from the Napier Range,  
Kimberley,*

BY

LUDWIG GLAUERT, F.G.S.,

*Field Geologist.*

During Mr. H. P. Woodward's visit to the Kimberley area in the year 1906, with a view of reporting on the Narlarla Hills, he had an opportunity of collecting a few fossils which have proved to be of great interest and importance, on account of the light which they shed upon the exact age of large tracts of country, and the bearing they have on the Geological Maps of the district, as interpreted by the late E. T. Hardman and Dr. R. Logan Jack. These two authorities considered the Napier Range to consist of Carboniferous beds only, with a bed of conglomerate at the base of the series. This "basement conglomerate" mainly consists of fragments of the older igneous and metamorphic rocks and appear to greatly resemble the "Basement Conglomerate" so often found under the Carboniferous Limestone, etc., in the British Isles, and considered to be of Carboniferous age.

From Mr. Woodward's results, however, it is evident that the conglomerate is truly Devonian, and that most likely in Western Australia it is the basal bed of the Devonian strata, and not of the Carboniferous.

Perhaps at this juncture it is advisable to quote Mr. Woodward's account of the beds as exposed in the Barker Gorge—a gorge cut through the Range by the Barker River in its course from the King Leopold Ranges to the Meda River and the Sea. Mr. Woodward writes as follows:—

"The Napier Range consists of a series of crystalline limestone beds which strike in a north-westerly and south-easterly direction and dip at an angle which varies from 12 to 23 degrees to the south-westward. These beds present the usual character of the Palæozoic limestone of this State, viz., they consist of a series of thick solid crystalline beds of a grey colour interbedded with soft calcareous bands of a more argillaceous character, whilst the basement beds consist of calcareous breccia and conglomerate, the enclosures in which consist of masses, fragments, boulders or pebbles of schist, granite, and quartz derived directly from the crystalline schists, granites, and greenstones upon which they rest. This range, which rises to an elevation in places to 400 feet above the adjoining plain from which it rises abruptly, is

fairly riddled with caverns and has been intersected at one or two points by watercourses which have cut deep gorges through it, varying from 2 to 4 miles in length.

"In the gorge formed by the Barker River (142° 43' E. long., 170° 16' S. lat.), one of the tributaries of the Meda River, a fine section of these limestones is exposed dipping beneath the sandstones and shales which form the plain to the south-westward and have provisionally been classed as Upper Carboniferous.\*

"Some little time was spent in searching for fossils in the softer beds above-mentioned, but without success. Just before my departure, however, some red coloured limestones were discovered in a small branch gully upon the south side of the Gorge and near the base of the series, which proved to be full of organic remains. Owing to their hardness, however, forms could only be identified upon the weathered surfaces, and since my party had already started I was only able to carry away as many as my pockets would hold."

These specimens were in due course forwarded to the British Museum, London, for identification by the officers on the staff of that Institution. On the 16th of March, 1908, Dr. Henry Woodward, F.R.S., the late Keeper of the Geological Department, returned the fossils, writing as follows in his covering letter of the same date:—

"I now return the specimens, with such information as I have been able to collect concerning them."

[6923.] 1.—The fish bone with "berry"-like sculpturing  
(F327) upon its surface must be referred to a large Devonian fish (new to science) allied to *Cocosteus*, but the specimen is not sufficient to determine accurately its relation to the skeleton.

[6928.] 2.—Tail of a Trilobite genus—*Proetus*, a new species.  
(F334)

[6928A.] 3.—Head of a Trilobite (part of same specimen) (?)  
(F335) and counterpart of tail.

[6926.] 4.—Crinoid stem (?) also remains of a gasteropod  
(F331) shell seen in section, *Loxonema* sp. (?)

[6929.] 5.—Imperfect specimen of a gasteropod, in white  
(F336) spar. *Euomphalus* sp. (?)

[6925.] 7.—A Rhynchonella, near to *R. (Uncinulus) Timorensis* Beyr. and *Pachypora* sp. on same block.  
(F329)

[6924.] 10.—A coral, *Phillipsastræa* sp.  
(F328)

[6925A.] 11.—*Pachypora* sp. (see [6925], above).  
(F330)

[6927A.] 13.—Two crinoidal stems (not determined).  
(F333)

[6927.] 14.—A. Crinoidal arm )  
(F332) B. *Goniatites* sp. ) on same block.

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\* See Hardman's 1884 Report, pages 9 and 20.

"I am sorry to offer you such poor determinations, but (although the rock is full of fragments) the specimens are very imperfect and obscure, the small Brachiopod, the pygidium (tail) of the Trilobite and the coral, *Phillipsastræa*, being the only clearly preserved ones. The facies of the fauna, especially the fish plate *Coccosteus* (c.f.), is undoubtedly Devonian."

On an enclosed slip Dr. Woodward writes:

"The matrix and the fossils agree closely with the Devonian of Adorf in Waldeck, Germany, see E. Halzapfel, 'Die Goniatiten-Kalke von Adorf in Waldeck,' *Palæontographica* Bd. XXVIII., Lief. VI., Jan., 1882, pp. 225-262, pls. XLIV., (I.), XLIX., (VI)."

Two other enclosures are of interest, being letters from Dr. A. Smith Woodward concerning the fish remains. On the 25th of March, 1907, this authority writes:

"The Western Australian Fossil looks remarkably like a piece of a large Devonian Coccostean, hitherto unknown in the Australian Region, but it is not good enough for exact determination. I will try a fragment under the microscope to discover whether the tissue is true bone."

Again, on the 25th of the following month the same gentleman gives the following information:—

"I have compared this bone again and am sorry it is too imperfect to determine from its shape its true nature. The texture and the ornament agree more closely with those of Coccostean fishes than with any other. I therefore think the new fossil belongs to one of the armoured Devonian fishes such as have not hitherto been satisfactorily determined in Australia."

It will be thus seen that competent opinion is agreed upon the age of these red limestones being Devonian, in fact, not the slightest suspicion is expressed by Dr. Woodward in his letter as nothing could be more definite than his assertion.

If we regard such genus represented separately we notice that the facies is as follows (1):—

Genus.	Distribution in Time.
1. <i>Pachypora</i> sp. . . . .	Silurian to Devonian.
2. <i>Phillipsastræa</i> sp. . . . .	Devonian and Carboniferous.
3. <i>Rhynchonella</i> ( <i>Uncinulus</i> )	Devonian chiefly.
4. <i>Euomphalus</i> sp. . . . .	Silur. Dev. Carbonif., Perm., Trias.
5. <i>Loxonema</i> sp. . . . .	Silur. Dev. Carbonif. Perm. Trias.
6. <i>Goniatites</i> ( <i>Glyphioceras</i> )	Devonian and Carboniferous.
7. c.f. <i>Coccosteus</i> . . . . .	(Coccostean fish) Devonian only.

On analysis it is apparent that the facies is most decidedly Devonian. We have one form, the Coccostean fish, which is absolutely confined to that age; one genus, *Pachypora*, which becomes extinct before the Carboniferous, a coral, *Phillipsastræa*, which,

though present in Carboniferous rocks is most plentiful in the Devonian, and a cephalopod, *Goniatites* (*Glyphioceras*) that is equally abundant in Devonian and Carboniferous times. *Euomphalus* and *Loxonema* though at their prime in the Carboniferous are plentiful in the Upper marine Devonian. The only possible exception is the *Rhychonella* (*Uncinulus*) *c.f.* *Timorensis*, but this loses its weight when we remember that the specimen is *not identical* with the Timor form but that it bears a *great resemblance* to that shell, and bear in mind that some of the Brachiopod shells living to-day in the seas off the coast of Australia, Great Britain, etc., can scarcely be distinguished from their ancestors found in some of the oldest fossiliferous beds of Europe and America.

The existence of the true Devonian beds in Western Australia was formerly more or less a matter of conjecture, as the true Devonian fossils were few and very far between, so that this confirmatory evidence from the Napier Range is very opportune, and reflects credit upon the authorities who determined the presence of Devonian beds when undertaking the pioneer geological work in this vast State twenty years ago.

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# VIII.—The Geological Age and Organic Remains of the Gingin "Chalk,"

BY

LUDWIG GLAUERT, F.G.S.,

*Field Geologist.*

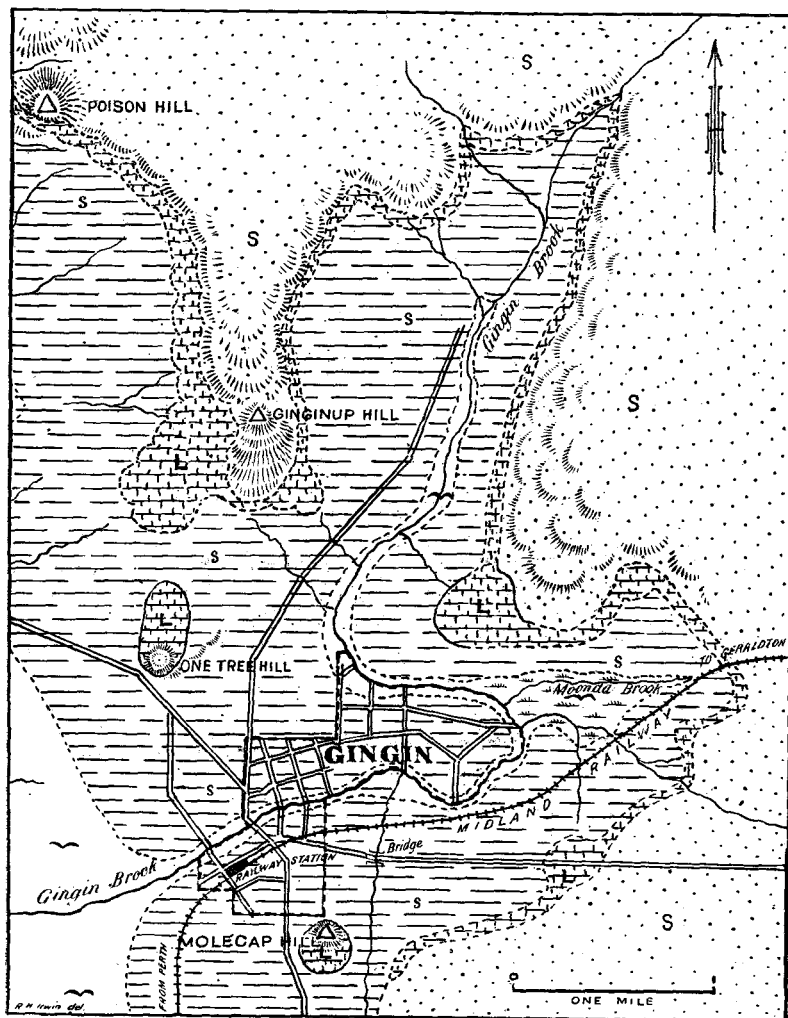
The name "Gingin Chalk" has been given to a thin bed of white chalky limestone that is exposed in various places in the vicinity of Gingin, \* the best known being the summit of One Tree Hill, where the stone has been quarried for the manufacture of lime and cement.

The exposure shows a white chalk without flints, about 15 feet in thickness, which passes downwards into a greenish glauconitic marl and below that into a clayey rock. The character of the beds is not at all constant, as the most easterly patches consist mainly of clay (block 127, South of Moonda Brook), the amount of limestone increasing to the westwards. In all the localities the presence of the beds can be determined by the exceedingly rich black clayey soil due to the weathering and disintegration of the rock, a soil which bears rich crops of grass or cereals, remarkable even in that good Agricultural District. The knolls on the flanks of Ginginup, or Sunday Hill, and on both banks of the Moonda Brook, as well as the outliers forming the crowns of One Tree Hill and Molecap Hill, are recognisable in this way, but where the beds are situated in an escarpment, or hill side, the debris from the overlying ferruginous sandstone beds tends to obliterate this feature, thus rendering the tracing of the beds a matter of some difficulty. The largest exposure is on the western and southern sides of Ginginup, or Sunday Hill, and is several square miles in extent. As is usually the case in this district no good exposures or escarpments are visible, so that it is difficult to ascertain the dip and strike of the beds. Several small masses of limestone, which seems to be *in situ*, were noticed and, though the dip varied both in direction and amount, the general trend of the strata seemed to be horizontal. The rich black soil studded with fragments of limestone of all sizes was very conspicuous in the ploughed land and in the banks of the small gullies.

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\* *Vide* Lands Department 80 chain Lithographs 28 and 31.

FIG. 4.



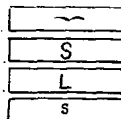
## EXPLANATION

ALLUVIUM

FERRUGINOUS SANDSTONE

GINGEN "CHALK" &amp; CLAY

VARIEGATED CLAY (? Shale)



*Boundaries obscured by drift sand and superficial deposits.*

The One Tree Hill exposure is the best example, as the position is very prominent and is also conveniently situated. It has received attention from the industrial world, as for some years the "chalk" has been quarried and burnt for lime in the two draw-kilns close at hand. Although the quality seems to have been excellent, the time required for "slaking" was considered detrimental by builders and contractors, so that the industry had to be abandoned for the time being.

The quarry however, is of special interest, as it presents, we may say, the only clear section of the beds. Under a layer of soil and subsoil, averaging about 12 inches in thickness, there is a band of white, rather crumbly, limestone almost free from impurities and containing no fossils; measuring about 18 inches. This is followed by a "chalk" which becomes richer in alumina and silica as it is followed downwards, till finally at about 15 feet below the purer limestone it resembles a greenish glauconitic clay.

The large Lamellibranchs are found in the upper portion of the main bed, and seem rare or entirely absent in the lower strata, where dwarfed Corals, Brachiopods, Lamellibranchs and Gastropods, as well as numerous Serpulæ and Echinoderm spines represent the remains of the animal life of the day, which appears to have been very adversely influenced by the muddy, if not turbid, water in which the creatures were compelled to pass their existence.

The fossils which were obtained during a visit (June, 1909), have not yet been subjected to careful examination owing to the lack of time, still, amongst the new records are Corals and Gastropods, as well as a species of Serpula very different from the involute form so plentifully represented in all the collections of Gingin fossils.

In this locality the beds have a slight northerly dip of eight or nine degrees.

The bow formed by the Gingin Brook before being joined by the Moonda, partly encloses another mass that has similar character and rivals the One Tree Hill outcrop in extent.

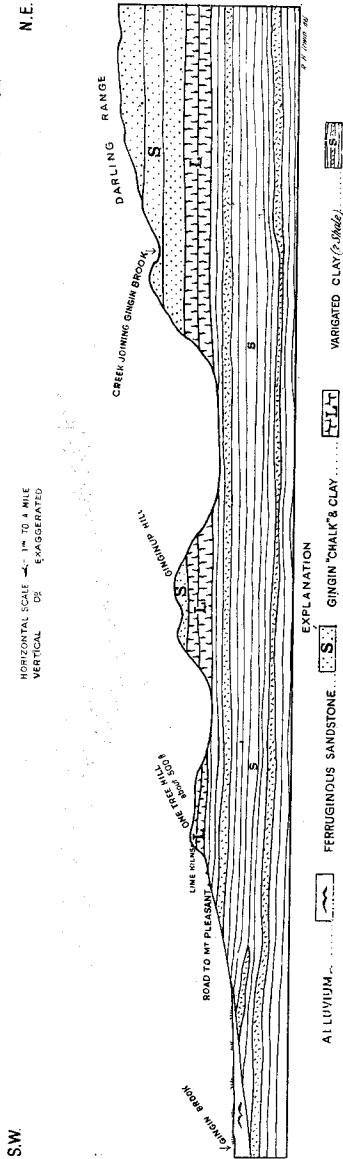
At the eastern edge of the patch on the Bindoon Road, two miles from Gingin Railway Station, an exposure in a gully shows the greenish-yellow glauconitic clay with two or three thin layers of limestone. Lastly, on the hillside east of Moonda, the clay is noticed in the channel of a gully without any trace of the limestone.

The exact relationship between the "chalk" and the overlying ferruginous sandstone and the underlying variegated clay or shale could not be definitely established as no section was to be seen, still, the general character of the beds in the district suggests the absence of any unconformity, although it must be noted that a bed of sandstone below the lime-kilns on One Tree Hill had an apparent dip of eight degrees south, which may be due to settling after the removal of the underlying clay by the rain, etc.



Fig. 5.

## GENERALISED SECTION FROM GINGIN BROOK THROUGH ONE TREE HILL TO GINGINUP HILL AND THE DARLING RANGE



The following section shows the probable course and distribution of the various beds proceeding from the flats below Gingin through One Tree Hill to Ginginup and the Darling Range in a N.N.W. direction.

The presence of a bed of chalk in Western Australia has been known for over 50 years. Gregory's map of 1860 \* shows two patches of "chalk and sandstones containing flints and Cretaceous fossils"; they are situated at Gin Gin and Yatheroo, and measure, roughly speaking, eight by five miles and six by three miles respectively. This map was exhibited at a meeting of the Geological Society to illustrate a paper by F. T. Gregory on the Geology of the Colony, and was subsequently printed.† In the paper Gregory states :

"The Cretaceous (?) are the most extensively developed of the sedimentary rocks of Western Australia, and are almost exclusively silicious in character, containing only a few beds of chalk of very inferior quality." "They abound however, more in fossils than the Carboniferous do, and, with the exception of the recent coast limestones, more so than any other formation. Flints are rarely found in them." "The bed of the Greenough River is the best spot for procuring specimens, although a few

are found in the chalk hills near Gin Gin (Echinoderm spines, etc.)"

\* General outlines of the Geology of Western Australia, compiled by F. T. Gregory, F.R.G.S.—1860. Published in 1861 by John Arrowsmith of London.

† On the Geology of a part of Western Australia. Quart. Jour. Geol. Soc. (London), 1861, Vol. XVI. pp. 475-483.

These remarks are of interest, as they show that Gregory considered the Gingin Chalk to be Cretaceous in age, and very closely connected with the Jurassic Beds of the Greenough River. That these latter are thought to be Cretaceous is confirmed, firstly by his map (1), and secondly by the fossils which he presented to the Geological Society being classed by him as Cretaceous (?).

Mr. C. Moore examined these fossils and found them to consist "of a single cast of *Trigonia Moorei*, Lycett, and a very much worn *Pecten*, of uncertain species, both evidently of Oolitic age. They were accompanied by a *Ventriculites* in flint, a portion of a chalk Ammonite, and also by a considerable number of specimens of the age of the Carboniferous Limestone."

In the paper on "Australian Mesozoic Geology and Palaeontology," (2) from which the above quotation is taken, Mr. Moore also refers to the "siliceous cast of a *Micraster* from the Chalk" in a set of fossils forwarded by Mr. Shenton.

Mr. H. Y. L. Brown in his general Report of 1873, writes as follows on page 13:—

"The white chalky limestone of Gin Gin, Yatheroo, and Dandarragan, which outcrops from beneath the sandy soil of these localities in patches, most likely is also of Mesozoic age. As yet, owing to the surface accumulations of sand, etc., which hides it from view, no sections are to be seen which show whether it is over, or underlies the ferruginous rocks of the District."

A Geological Map of Western Australia \* was issued to show the work done from August 1870, to June, 1872, by Mr. H. Y. L. Brown, who was the Government Geologist during that period. Upon this map the three patches of "white limestone" referred to above are shown to be approximately of equal area, measuring about seven miles by six miles.

In the year 1903, Mr. E. S. Simpson paid a short visit to the locality and examined some of the outcrops. In the quarry on One Tree Hill he obtained some fossils which were forwarded to Mr. R. Etheridge, Curator of the Australian Museum, for examination.

His conclusions upon these fragmentary and badly preserved specimens are given on page 38 of Bulletin No. 27 †, and are now quoted in full.

*Fossils from Chalk Pit One Tree Hill, Gingin.*

[5551].—Chert ? semi-stalactitic.

[5552].—*Ostrea*, allied to *O. vesicularis*, Lamk.  
(F238)

(1.) In a section taken from this Map as shown as fig. 2, on page 477 of Vol. XVI. (1861) of the Quarterly Journal of the Geological Society, the Carboniferous beds of the Kennedy Range are classed as Cretaceous (?), the true relationship of the beds is shown by Mr. A. Gibb-Maitland the Government Geologist in fig. 6, page 15 of Bulletin No. 33—1909.

(2.) Quarterly Journal of the Geol. Soc. London, Volume XXVI., page 227, 1870.

(\*) Printed by H. G. deGruchy, & Co. Melbourne—no date.

† Palaeontological Contribution to the Geology of Western Australia, II.—Bulletin No. 27—Perth, 1907.

[5553].—Crushed Brachiopod, possibly a *Magellanic*.  
(F239)

[5554].—*Terebratulina* (?) This is quite distinct from any  
(F240) other described Australian Tertiary Brachiopod,  
and if examples can be obtained, showing the interior,  
is worthy of description.

[5555].—*Serpula*, quite undescribed as an Australian form. It  
(F241) is allied to the European Tertiary *Serpula*. *S. Bognoriensis*.  
Specimens are retained for description.

[5556].—Spines of two species of Echinids *Phyllocanthus*,  
(242) spines belonging to species of this genus have been  
found in the Tertiary beds of Willunga, S.A.

[5557].—Portion of the shell of the Bivalve *Placunanomia*.  
(F243) Could a more or less perfect example be procured  
it would be worth description.

“The fossils from One Tree Hill Chalk Pit are certainly not older than Tertiary, but the evidence is of too limited a nature to enable me to suggest any horizon within that great formation, but I suspect the deposit must be well up in the series; for the sake of a name, and until more is known, call it Upper Tertiary. The condition of the fossil is not one that lends itself to accurate determination, but the *Terebratulina* (?) *Serpula* and *Placunanomia* certainly seem to be new, and if additional specimens of the first and last can be obtained the whole are worthy of description.”

It will be noticed that Mr. Etheridge remarks upon the very unsatisfactory state of the few fossils submitted to him, and there is no doubt that if the associated fossils obtained from the same quarry at various times and presented to the Western Australian Museum had been sent to him with those of the Survey collection, he would have come to very different conclusions; that is to say, he would unhesitatingly have classed them as Cretaceous.

The Palaeontological Contribution to which Mr. Etheridge's determinations form an introduction, is a list and description of Gingin Chalk Foraminifera. Thirty-seven species of these small organisms are described, eight of which are practically, if not entirely, confined to Cretaceous beds in the other parts of the globe. On the other hand only four species (one of them doubtful) are peculiar to the Upper Tertiaries, whilst 27 are known to have existed in Cretaceous times.

These facts struck Mr. Chapman of the National Museum, Melbourne, for in a letter to the Government Geologist under the date of February 22nd, 1908, he writes: “Mr. Howchin's list of Foraminifera from Gingin interests me very much, and *I cannot help concluding from the evidence of that group alone, that the deposit is decidedly Cretaceous.*”

In order to place the matter more clearly, and as an assistance for future reference, these Foraminifera are given in tabular form together with their distribution in Geological Time.

	FORAMINIFERA—Genus and Species.	Cambrian, etc.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Eocene.	Oligocene.	Miocene.	Pliocene.	Pleistocene and Recent.
* R.	<i>Miliolina oblonga</i> (Montagu) .. .. .													
1	<i>Spiroloculina</i> (?) <i>grata</i> (Terq.) .. .. .													
C.	„ <i>asperula</i> (Kar.) .. .. .													
1	<i>Placopsilina vesicularis</i> (Brady) .. .. .													
S.	<i>Textularia trochus</i> (d'Orb.) .. .. .													
R.	„ <i>turris</i> (d'Orb.) .. .. .													
R.	„ <i>sagittula</i> (Defr.) .. .. .													
R.	„ <i>globulosa</i> (Ehr.) .. .. .													
C.	„ <i>gibbosa</i> (d'Orb.) .. .. .													
1	<i>Verneuilina spinulosa</i> (Reuss) .. .. .													
C.	„ <i>polystropha</i> (Reuss) .. .. .													
R.	<i>Lagena hispida</i> (Reuss) .. .. .													
R.	„ <i>globulosa</i> (W. & I.) .. .. .													
C.	<i>Nodosaria consobrina</i> var. <i>emaciata</i> (Reuss) .. .. .													
S.	„ <i>vertebralis</i> (Batsch) .. .. .													
S.	„ <i>soluta</i> (Reuss) .. .. .													
1	„ <i>obliqua</i> (Linné) .. .. .													
1	<i>Fronicularia intermittens</i> (Reuss) .. .. .													
S.	„ <i>chapmani</i> (Perner) .. .. .													
1	„ <i>gaultina</i> (Reuss) .. .. .													
S.	<i>Flabellina interpunctata</i> (v.d. Marck) .. .. .													

1 One specimen only. C. Common. R. Rare. S. Several.

FORAMINIFERA—Genus and Species.						Cambrian, etc.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Eocene.	Oligocene.	Miocene.	Pliocene.	Pleistocene and Recent.
C.	<i>Marginulina costata</i> (Batsch) .. .. .																	
C.	<i>Cristellaria rotulatu</i> (Lam.) .. .. .																	
C.	„ <i>cultrata</i> (Mont.) .. .. .																	
Sc.	„ <i>orbicularis</i> (d'Orb.) .. .. .																	
M.C.	„ <i>acutauricularis</i> (F. & M.) .. .. .																	
R.	„ <i>ovalis</i> (Reuss) .. .. .																	
V.C.	<i>Globigerina bulloides</i> (d'Orb.) .. .. .																	
S.	„ <i>cretacea</i> (d'Orb.) .. .. .																	
V.C.	„ <i>linnaeana</i> (d'Orb.) .. .. .																	
Sc.	<i>Discorbina opercularis</i> (d'Orb.) .. .. .																	
R.	<i>Truncatulina lobatula</i> (W. & I.) .. .. .																	
Sc.	„ <i>variabilis</i> (d'Orb.) .. .. .																	
R.	<i>Rotalia Beccarii</i> (Linné) .. .. .																	
Sc.	„ <i>broeckhiana</i> (Kar.) .. .. .																	
1	„ <i>soldanii</i> (d'Orb.) .. .. .																	
1	<i>Nonionina asterizans</i> (F. & M.) .. .. .																	

C. Common.

M.C. Moderately common.

V.C. Very common.

Sc. Scarcely.

1 One specimen only.

R. Rare.

S. Several.

In the Geological Survey Museum there is an interesting suite of fossils which were presented to the Western Australian Museum in 1897 by Mr. W. R. Philbey; though not in good condition, they are sufficiently well preserved to give an insight into the age of the Gingin chalk beds in which they were found. They comprise examples of various groups of animals Echinoderms, Worms, Brachiopods, Lamellibranchs, Cephalopods, and a Shark's tooth.\*

*Serpula* sp. cf. *S. (V.) concava* (1) Sowerby [10091]. By far the most plentiful are splendidly preserved *Serpulæ*, animals which seem to have found congenial surroundings in that part of the Ocean where this bed of Chalk was forming. The numerous specimens plainly show that there was a certain amount of variation in the shape which the coiled tube assumed. One form may be described as discoid, involute, with a portion of straight tube; almost flat on one side and concave on the other, the innermost whorl(s) often wanting; being the chief point of attachment to the foreign object. (2) The form at the other extreme has one side of the involute tube more concave and the other convex, or obtusely conical. The surface of the tube shows the markings known as "lines of growth" but bears no other ornamentation; longitudinal furrows or ridges which are to be seen on *S. Bognoriensis* (3) are entirely absent. A large umbilicus on the concave side, absent on the other (the side of attachment) owing to the manner in which the shell-matter has been deposited. Section of the tube circular both interiorly and exteriorly, the tube is thick in the older portions but thin at the natural opening, in this way differing from Sowerby's *S. tumida*. (4).

The average dimension (diameter) of the full grown individual is 16 m/m across the widest part of the involute portion, the largest I have seen, measuring  $18\frac{1}{2}$  m/m. The number of whorls is four or five.

I have compared the specimens with the figures and descriptions in the few works of reference to which I have access, and find that Sowerby's *V. concava* is the form most nearly approached by the Gingin shells. Sowerby describes his species, which is from the Greensand of Dilton near Westbury, England, as "discoid, involute, concave on one side, the last whorl but slightly attached." Below he states, "this is almost wholly involute with but a small portion of straight tube, the surface is nearly smooth and even, the involute part is concave on one side only, the other being flat.

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\* These fossils have been forwarded to Mr. R. Etheridge of the Australian Museum for detailed examination.

(1.) Sowerby's Min. Conch. (*Vermicularia concava*), Volume I., page 125, pl. 57, figs. 1-5.

(2.) In the quarry on One Tree Hill, Gingin, I have seen specimens of the *Serpula* attached to fragments of shell, but as soon as they were handled they became disunited. The scars are generally seen on the flat or convex side of the involute tube.

(3.) Sowerby's Min. Conch., Volume VI., page 194, pl. 596, figs. 1-3.

(4.) Sowerby's Min. Conch., Vol. I., page 125, pl. 596, fig. 4.

It seldom exceeds three-fourths of an inch in diameter, with about four turns."

Sowerby's *S. (Vermetus) Bognoriensis* to which Mr. Etheridge compares the *Serpula*, is described: \* "Spiral portion conical, sub-discoid, concave beneath, tube obscurely five sided, with a furrow above and below; the produced part cylindrical, slightly curved. The tube is more angular, and the whorls more numerous than in *V. concava*, to which it nearly approaches, but when the surface is worn it appears cylindrical."

The Gingin specimen differs to some extent from both these specimens, but seems to bear closer relations to them than any other form with which I have been able to compare it, so that it is unnecessary to refer to any other species. There are obvious differences between the Gingin *Serpula* and *S. (V.) concava*, such as the habit of assuming an obtusely conical form, the state of attachment of the last whorl and the thickness of the whorls, but I have no doubt that the shells are closely related.

Among the specimens collected in June, 1909, I have noticed a small *Serpula* [8922] very like Sowerby's *Serpula fluctuata* (1) from the Chalk Marl.

#### ECHINODERMATA.

This group is represented by numerous spines [10092] of varied size and pattern; the longest measures about 43 m/m, whilst the shortest would not exceed one-third of that length. In a general way they resemble the numerous muricated *Cidarid* spines plentiful in the white chalk and other Cretaceous beds of Europe. Mr. Etheridge refers the spines to species of *Phyllacanthus* in his short note upon some of the Gingin remains. (†) Numerous hexagonal plates, evidently portions of the test, were obtained in June last, and have been submitted to Mr. Etheridge for examination.

#### BRACHIOPODA.

The seven Brachiopoda belong to three genera, as far as can be judged from the external characters. One specimen is large but the others are small and delicate.

The large shell [10095] measures 40 by 27 m/m, and bears a striking resemblance to the *Terebratula biplicata* (2) Brocchi, figured by Davidson as a variation of the species. It is possible that this shell is not from Gingin, for the chalky material filling the shell seems harder than the usual Gingin rock, and the state of preservation of the shell is different.

Two small shells [10094] with fine radiating costæ and concentric lines of growth upon a shell showing a marked plication, are

\* Loc. cit.

† Bulletin No. 27, page 38.

(1.) Min. Conch., Vol. VI., page 228, pl. 608, fig. 5.

(2.) Monogr. Brit. Fossil Brachiopoda., Vol. I., part 2, pl. VI., figs. 19-20.

identical with [5554] which Mr. Etheridge has determined as a (?) *Terebratulina*. (1)

Another group [10093] that has a smooth shell very finely punctate, but showing concentric lines of growth and possessing a slight plication, has been referred to by Mr. Etheridge as possibly a *Magellania*. (2)

Two somewhat larger shells showing no plication have been classed provisionally with the above, under number [10093]. The limited number of the specimens and absence of all knowledge of the interior of the shell makes further investigation impossible.

#### PELECYPODA (LAMELLIBRANCHIATA.)

##### *Inoceramus* spp. etc.

After the *Serpulæ* the most commonly represented shells are undoubtedly those belonging to species of *Inoceramus*, etc. [10096].

Almost every rock in this collection of Gingin Fossils contains fragments of the shell of this striking genus so readily distinguished by the prismatic fibres of the thick outer layer of the shell. There are also more or less perfect internal casts, occasionally with fragments of the shell adhering to them.

The general outlines of the individuals and the structure and ornamentation of the shell are good indications of the genus to which these specimens have been referred, though the umbonal region and the hinge line are missing. There are some specimens, which in a general way, resemble the *I. pernoides* from the Queensland Cretaceous, others which remind one of Sowerby's *I. mytiloides*; McCoy's *I. Carsoni*; D'Orbigny's *I. problematicus* or Mr. Etheridge's *I. elongatus*, all of which are referred to by Mr. Etheridge in his Palæontology of Queensland. (3) Several specimens are like *I. constrictus* (Eth. fil.) (4) in form, but all are incomplete.

There are remains, mostly fragmentary, of other Pelecypods, but they are unsatisfactory for purposes of identification, as important portions of the shell are missing.

It seems that the following genera may be represented. *Pseudavicula*, *Ostrea*, *Gryphæa*, *Mytilus* and possibly *Glycimeris*, and others (5.)

See [10096], [10100] and [10103], under which numbers are included all the Pelecypods of the collection.

(1.) Bulletin No. 27, page 33.

(2.) Loc. cit.

(3.) Jack and Etheridge Geol. & Pal. of Queensland, page 463, *et seq.* and plates.

(4.) Queensland Geol. Survey Bulletin No. 13, page 24, plates II. and III.

(5.) A careful comparison of these specimens with the numerous Lamellibranchs of the Older Tertiary of Australia, figured and described by Prof. R. Tate in the Transactions of the Royal Society of South Australia, may have important bearing upon the age and relationship of the strata.



## CEPHALOPODA.

In determining the age of Mesozoic beds, the presence of Ammonites is of great value ; it is therefore satisfactory to be able to state that two genera are present [10101], [10102]; one of which, *Crioceras*. (?) is undoubtedly Cretaceous. The other genus is represented by numerous examples, two more or less perfect casts of a large discoid Ammonite with somewhat inflated whorls.

[10101.] The specimens are in a poor state of preservation, with most of the characteristics either completely obliterated or rendered very indistinct. However, there are several points that can be distinguished. The whorls have an oval section, rendered lunate through their embracing the preceding ones, and are a little higher than wide, they show no signs of a keel and seem to bear a number of ribs which pass across the venter of the shell with a slight forward curve. There are no signs of tubercles, spines or any other secondary ornamentation. The greatest width of the whorl is at the highest point of the encroachment by the preceding one. The umbilicus is very indistinct, though most probably it was not very wide and rather deep and moderately steep. Faint and irregular traces of the suture lines are to be seen which, unfortunately, are too imperfect to be of any use.

The following measurements were taken :—

	Large spn.		Small spn.
Greatest diameter of shell ..	184	..	90
Greatest width of umbilicus ..	?	..	?18
Greatest height of outer whorl	?85	..	?
Greatest width of outer whorl..	70	..	?

Another specimen consists of a small part of the suture line, most likely of an individual closely related to the above ; besides this there are two fragments of whorls and a portion of the external cast that belong to shells of the same species as the preceding.

Those remarkable Ammonities, which have received so much attention on account of the eccentricity of their shapes, are not wanting, for as already stated, we have a portion of a whorl that seems to belong to a *Crioceras* identical with, or closely allied to the *C. Australis* of Moore. (1) [10102].

## CLASS PISCES. SUB-CLASS SELACHII.

Vertebrates are also represented in the Gingen Chalk ; one of the specimens in the W.A. Museum collection consists of the tooth of one of the Lamnidæ [10104]. This tooth, which has a length of 25 m/m, a width of  $8\frac{1}{2}$  m/m at the base, and a maximum thickness of about  $6\frac{1}{2}$  m/m, is *Odontaspis*-like in shape, but at the same time,

(1.) C. Moore, Australian Mesozoic Geology and Palæontology, Q.J.G.S., Vol. XXVI., 1870, p. 257, pl. XV., fig 3.

instead of the crown being curved in the usual manner, it is very faintly sigmoid as in the Mesozoic *Orthacodus*. It is evidently a remain of one of the earliest members of the great shark family, now so plentifully represented in Australian waters, and may be the earliest record. The conclusion arrived at by Mr. F. Chapman, of Melbourne, when he saw Mr. W. Howchin's list of the Foraminifera from Gingin, namely that the beds were of Cretaceous age, is confirmed by the collection of Gingin Fossils. The *Serpula*, *Pseudavicula*, *Inoceramus*, *Gryphæa*, and the *Ammonites* have a most decided Cretaceous aspect and, though *Pseudavicula* and the two genera of *Ammonites* have not been recorded by collectors subsequent to 1897, as far as is known by the Department, there is no reason for doubting that they are obtained from the quarry on One Tree Hill.

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