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ORIGINAL ARTICLES.

I.—ON A COLLECTION OF JURASSIC CEPHALOPODA FROM WESTERN AUSTRALIA—OBTAINED BY HARRY PAGE WOODWARD, F.G.S., GOVERNMENT GEOLOGIST—WITH DESCRIPTIONS OF THE SPECIES.

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(PLATE XIII.)

(Continued from the September Number, p. 393.)

AMMONITES (SPHÆROCERAS, Bayle).

Ammonites (Sphæroceras ?) Woodwardi,¹ sp. nov. (Pl. XII.
Figs. 6a and b.)

Sp. char.—Shell (cast) discoidal, somewhat inflated, rather rapidly increasing. Whorls somewhat inflated, very convex on the periphery, less convex on the sides, rounded near the umbilicus. Umbilicus moderately wide, occupying nearly one-third of the diameter of the shell. Number of whorls and amount of inclusion unknown. Height of outer whorl rather more than one-third of the diameter of the shell. Each whorl ornamented with about 20 short, thick, umbilical ribs, each of which commences at the suture, extends radially or with a very slight forward inclination over one-fourth of the width of the lateral area, and terminates in a radially-elongated tubercle. Each tubercle gives rise to three, or more rarely to two, subangular ribs (in the cast), which pass uninterruptedly over the periphery. There are about 48 of these ribs to a whorl; at the periphery, the interspaces are twice the width of the ribs. Length of body-chamber unknown. Margin of the aperture prominent, provided on each side with an apophysis. Septa and suture-line unknown. Test not preserved.

Dimensions:—

Diameter of the shell	60 mm.
Width of umbilicus	20 „
Height of last whorl	22 „
Thickness of last whorl	16+ „

Since the fossil has been somewhat distorted, these dimensions must be considered only as approximate; the height of the outer whorl has probably been somewhat increased, whilst the thickness of the whorl has been considerably reduced.

Remarks.—The only example representing this species is a rather crushed natural cast of the greater portion of the outer whorl, much abraded on one side. The inner whorls are not visible, and unfortunately there is no trace of the suture-line. A portion of the mouth-border is preserved, and there are remains of the prominent base of one of the lateral apophyses.

¹ Not *Ammonites Woodwardi*, H. G. Seeley, Ann. Mag. Nat. Hist. [3], vol. xvi. 1865, p. 236, pl. xi. f. 3, which probably belongs to the section *Hoplites*, Neumayr.

Affinities and differences.—In its general form and ornamentation this species closely resembles *Ammonites Sauzei*, d'Orbigny (Pal. Franç. Terr. Jur. vol. i. 1842, p. 407, pl. cxxxix.). A specimen of the latter from the Inferior Oolite of Sherborne, Dorset (Brit. Mus. No. C. 3230), 61 mm. in diameter, gives the following measurements: Width of umbilicus, 19 mm.; height of outer whorl, 24 mm.; thickness of outer whorl, 30 mm. Allowing for the compression of the Australian specimen, d'Orbigny's species was probably a more inflated shell with somewhat coarser ornaments and fewer umbilical ribs (14–15).

In its sculpture *Ammonites Bainii*,¹ Sharpe, from Sunday River, S. Africa, somewhat resembles the present species, but it has much more inflated whorls, and a narrower and deeper umbilicus.

From such forms as *Ammonites biplex*,² J. Sowerby, the present species is at once distinguished by the presence of a tubercle at the point of bifurcation of each umbilical rib.

In proposing for the Australian form the specific name *Woodwardi*, the writer has great pleasure in associating with the fossil the name of Mr. H. P. Woodward, Government Geologist, Western Australia.

Locality.—Champion Bay, Western Australia.

Ammonites (Sphæroceras) semiornatus, sp. nov. (Pl. XIII. Figs. 1a, b.)

1870. *Ammonites Brocehii*, C. Moore, Quart. Journ. Geol. Soc. vol. xxvi. pl. xv. f. 4.

Sp. char.—Shell discoidal, somewhat inflated; greatest thickness at a point distant from the umbilicus about one-third of the width of the lateral area, about one-third of the diameter; height of outer whorl about one-third of the diameter of the shell. Whorls six; inclusion two-thirds, diminishing considerably in the outer whorl, so that at the commencement of the outer whorl the inclusion is not one-half; umbilicus wide, rather deep, exposing the inner area of the whorls. Suture-line imperfectly seen, and depth of chambers unknown. Whorl lunate in section at base of body-chamber, and about as wide as high, becoming at the anterior part of the body-chamber more elliptical in section, and rather higher than wide; periphery convex, forming a continuous curve with the sides; inner area sloping towards the umbilicus, feebly convex. Each whorl ornamented with about twenty-two primary ribs, slightly curved and forwardly inclined, extending from the suture over about one-third of the width of the lateral area; each then dividing into three, or more rarely into two, less prominent ribs which cross the periphery without interruption, the number of these peripheral ribs being about sixty-nine to a whorl. Up to the point where the diameter of the umbilicus is 8 mm. the inner area of the whorls (as seen within the umbilicus) is quite smooth.

Dimensions:—

Diameter of shell	61 mm.
Width of umbilicus	22·5 "
Height of outer whorl	20 "
Thickness of outer whorl	17·5 "

The specimen from which the above measurements were taken has a maximum diameter of 64 mm., but at this diameter the other dimensions cannot be so accurately determined. The anterior portion of the body-chamber appears to be slightly crushed, so that the thickness of the outer whorl as given above is probably too small.

Remarks.—The description given above is based upon a single

¹ Trans. Geol. Soc. [2], vol. vii. 1847, p. 197, pl. xxiii. f. 2. Pavlow (Bull. Soc. Imp. Nat. Moscou, n.s. vol. v. 1892, p. 493) places this species in a division (*Astieria*) of Neumayr's genus *Oleostephanus*.

² Min. Con. vol. iii. p. 168, pl. cccxiii. 1821.

specimen 64 mm. in diameter. It is a natural cast, and bears only fragments of the test; its outer whorl appears to have been occupied by the body-chamber, traces of the septa being seen at the commencement of this whorl.

Having examined the specimen figured by Moore as *Ammonites Brocchii*,¹ I believe it is to be referred to the present species. Its dimensions are as follows:—

Diameter of shell.....	92 mm.
Width of umbilicus	33 „
Height of outer whorl	about 33 „

The thickness of the outer whorl at a diameter of 72 mm. is 36 mm.; beyond this point the specimen is much crushed. The shell is somewhat distorted, so that the width of the umbilicus is probably exaggerated. Its suture-line cannot be made out, but around the umbilicus can be seen the compressed, forwardly-inclined, short primary ribs, each giving rise to three or four prominent ribs, which pass without interruption over the peripheral area.

To the present species may also probably be referred a specimen (No. C. 4709) in the British Museum (Nat. Hist.), from “the Greenough, Champion Bay, Australia.” It is part of a specimen 127 mm. in diameter; the inner whorls up to a diameter of 25 mm. are fairly well preserved, the innermost being perfectly smooth; about half of the outer whorl is present and in fair condition, and shows the compressed umbilical tubercles or short prominent primary ribs, each branching into three less prominent, but well-marked, ribs, which cross the periphery without interruption. On the anterior half of the outer whorl the primary ribs are more forwardly-inclined than on the posterior half. A projection on the lateral area at the anterior extremity of the specimen may be a portion of the prominent mouth-border. The sculpture of the posterior part of the outer whorl greatly resembles that of the large specimen from Cape Riche, which I have referred to *Ammonites (Perisphinctes) Championensis* (see p. 436), but the latter appears to have been a more inflated shell.

Affinities and differences.—J. Sowerby's type-specimens of *Ammonites Brocchii*² are much more inflated than the present species, whilst the type-specimen of *Ammonites Brodiaei*³ of the same author has more distinct and somewhat larger primary ribs and very prominent tubercles at the points of subdivision of the primary ribs. *Ammonites contractus*⁴ of J. de C. Sowerby is a much more inflated shell with a smaller umbilicus. D'Orbigny's figure of *Ammonites linguiferus*⁵ represents a more inflated shell, with more numerous ribs and more prominent lateral tubercles; and *Ammonites dimorphus*⁶ of the same author has fewer whorls, a differently-formed umbilicus, and its whorls bear constrictions at nearly regular intervals.

¹ Quart. Journ. Geol. Soc. vol. xxvi. (1870), pl. xv. f. 4.

² Min. Con. vol. ii. p. 233, pl. 202, both figs. [Brit. Mus. No. 43906].

³ Min. Con. vol. iv. p. 71, pl. 351 [Brit. Mus. No. 43905].

⁴ Min. Con. vol. v. p. 162, pl. 500, f. 2.

⁵ Pal. Franç. Terr. Jur. vol. i. pl. 136.

⁶ Pal. Franç. Terr. Jur. vol. i. pl. 141.

Compared with *Ammonites Gervillii*, J. Sowerby,¹ [*Ammonites Brongiartii* (pars), A. d'Orbigny,²] the Australian fossil is less inflated and differently ornamented, whilst the greater inclusion of its whorls, its narrower umbilicus, and the smoothness of its inner whorls distinguish it from *Ammonites polymerus*, W. Waagen³ [*Ammonites Brongiartii* (pars) d'Orbigny].⁴

The British Museum Collection contains examples of an apparently undescribed species from the Inferior Oolite of Dundry, Somerset, which resemble the present species most closely; they have, however, a somewhat larger umbilicus, finer ornaments, and their inner whorls (as seen within, the umbilicus) are distinctly ribbed, even where the umbilicus has a diameter of only 2·5 mm.

Locality.—Champion Bay, Western Australia.

AMMONITES (PERISPINCTES, W. Waagen).

Ammonites (*Perispinctes*) *Championensis*, sp. nov. (Pl. XIII.

Figs. 2 a, b, and c.)

Sp. char.—Shell (cast) discoidal, with somewhat inflated whorls; greatest thickness near the margin of the umbilicus, exact thickness unknown; outer whorl about two-fifths of the diameter of the shell in height. Number of whorls not seen; inclusion (in the outer whorl) about three-fifths; umbilicus not very deep, wide, about one-third of the diameter of the shell in width. Whorl somewhat oval or almost lunate in section, probably wider than high; indented to about two-fifths of its height by the preceding whorl; periphery probably narrowly convex; sides convex; inner area steep, almost perpendicular, slightly convex. Chambers shallow. Suture-line rather complex, incompletely known; outer saddle only partly known; the first lateral lobe deep, narrow, trifid; the first lateral saddle much broader than the first lateral lobe, divided into four principal branches, that forming the most anterior portion of the suture-line being again divided by a secondary lobe into two branches, the outer of which is again subdivided by a small lobe; the second lateral lobe scarcely one-half the size of the first lateral lobe, indistinctly trifid, the median portion being very short; the second lateral saddle small, divided by a small lobe into two unequal branches, the inner of which is again subdivided by a minute lobe; between the second lateral saddle and the suture of the shell three auxiliary lobes and saddles. Each whorl ornamented with about nineteen or twenty compressed, not very elevated, short ribs, or radially elongated tubercles, each giving rise to three or four rounded, slightly elevated ribs, thirty-eight of which can be counted in half a whorl, the interspaces being of about the same width as the ribs.

Dimensions :—

Diameter of the shell	about	115 mm.
Width of umbilicus		39 "
Height of outer whorl	about	45 "
Thickness of outer whorl	(?)	"

The thickness of the outer whorl cannot be ascertained, since only one side of the specimen is preserved.

Remarks.—The above diagnosis has been drawn up chiefly from a natural cast about 115 mm. in diameter, consisting of one side of the outer whorl fairly well preserved, bearing fragments of the test and exhibiting the greater part of the suture-line; the inner whorls are not preserved. The collection, however, includes another speci-

¹ Min. Con. vol. ii. p. 189, pl. clxxxiv. A, fig. 3.

² Pal. Franç. Terr. Jur. i. p. 403, pl. 137, ff. 3, 4 (non ff. 1, 2, 5).

³ Ueber die Zone des *Ammonites Sowerbyi*, Benecke's Geogn.-paläont. Beiträge, vol. i. p. 605.

⁴ Pal. Franç. Terr. Jur. i. p. 403, pl. 137, ff. 1, 2 (non ff. 3, 4).

men, probably referable to this species, which exhibits a portion of the suture-line that supplements in a certain degree the suture-line of the example selected as the type. The collection also contains, from "Cape Riche, about 50 miles E. of Albany," a large specimen 160 mm. in diameter, which is probably a more mature example of this species. It consists of the outer whorl only. Although its suture-line cannot be made out, its general form resembles that of the present species so closely that it is referred to this species.

The present species appears to be represented in the British Museum Collection by a crushed and distorted portion of the outer whorl of an example from "the Greenough, Champion Bay," about 110 mm. in diameter (No. C. 4708). It bears fragments of the test.

Probably to this species may also be referred an example in the collection of Western Australian fossils in the Bath Museum. It is labelled "*Ammonites macrocephalus*"; but is not the specimen figured by Moore. It has the following dimensions: Diameter of shell, 109 mm.; width of umbilicus, 37 mm.; height of outer whorl above preceding whorl, 27 mm.; thickness of outer whorl, 40 mm.; width (as seen within the umbilicus) of the penultimate whorl at the greatest diameter of the shell, 12 mm. The body-chamber commences where the shell has a diameter of 88 mm., and therefore occupies nearly a whorl.

Affinities and differences.—This species greatly resembles *Ammonites Cautleyi*,¹ Oppel, from the Jurassic rocks of Laptel, in Gnari-Khorsum, Thibet; but Oppel's species possesses constrictions and is a more compressed shell. Unfortunately the suture-line is not available in Oppel's species for comparison. Compared with *Ammonites albinus*,² Oppel, from the Oxfordian of Würtemberg, the Australian species is more robust and has a different suture-line. In Oppel's species, moreover, the ribs which cross the periphery disappear at a diameter of 75 mm., but they are quite distinct in the Australian specimen at a diameter of 110 mm. The present species differs from *Ammonites polymorphus*,³ d'Orbigny, from the Inferior Oolite, in having more inflated whorls, larger and fewer tubercles around the umbilicus, and ribs which are uninterrupted on the peripheral area. Although somewhat resembling *Perisphinctes obtusica*⁴ and *Perisph. paramorphus*,⁵ Waagen, from the Callovian of Cutch, the Australian species has much finer ornaments and a very different suture-line.

The general arrangement of the suture-line is not unlike that of *Olcostephanus Brancoii*,⁶ Neumayr and Uhlig, but the latter is a more inflated and more coarsely ornamented species. The ornamentation of the present form agrees somewhat closely with that of *Olcostephanus Keyserlingi*,⁷ Neumayr and Uhlig, but the suture-line of

¹ Pal. Mittheil. p. 279, pl. lxxviii. figs. 1a, b; 2a, b.

² *Ibid.* p. 161, pl. l. figs. 3a, b.

³ Pal. Franç. Terr. Jur. vol. i. 1842, p. 379, pl. cxxiv.

⁴ Pal. Indica, Jurassic Fauna of Cutch, vol. i. (Cephalopoda), p. 146, pl. xxxviii. figs. 1a, b; 2; 3a, b.

⁵ *Ibid.* p. 162, pl. xlv. figs. 1a, b; 2a, b; pl. xlvii. fig. 3.

⁶ Palæontographica, vol. xxvii. p. 156, pl. xxvi. fig. 1.

⁷ *Ibid.* p. 155, pl. xxvii. figs. 1-3.

the latter differs considerably from that of the Australian species. *Ammonites polytychus*,¹ Keyserling, resembles the Australian species in its external form, but is distinguished by its dichotomous ribs and the form of its suture-line. *Ammonites arbustigerus*,² d'Orbigny, occurring in the Bathonian of France, is a closely allied species; but the Australian form is distinguished by the greater prominence of its short umbilical ribs, by its finer sculpture, and by its suture-line. The sculpture of the shell and the form of the suture-line distinguish the present species from the form figured by d'Orbigny as *Ammonites planula*³ from the Bathonian of France.

Localities.—Champion Bay; Cape Riche, E. of Albany, Western Australia.

Ammonites (Perisphinctes) robiginosus, sp. nov. (Pl. XIII.
Figs. 3 a and b.)

Although a complete diagnosis of the species cannot be given the following characters may be noted :—

Shell (cast) discoidal, rather widely umbilicated; its greatest thickness at a short distance from the inner edge of the whorl, about two-sevenths of the diameter of the shell; height of outer whorl about equal to its thickness. Umbilicus wide, probably about three-sevenths of the diameter of the shell in width. Whorl obtusely cordate in section, about as wide as high; indented to about one-fourth of its height by the preceding whorl; periphery rather broadly convex; sides somewhat flattened, sloping away from the periphery; inner area sloping towards the umbilicus. The cast is ornamented with a number of primary umbilical ribs, or very compressed, elongated tubercles, having a decided forward inclination: each primary rib divides into three secondary rounded ribs, which cross the periphery without interruption, and are separated by interspaces of rather more than their own width.

Remarks.—This species is represented by a portion of the outer whorl of an example of about 160 or 170 mm. in diameter. It is a natural cast in a ferruginous matrix; one side is fairly well preserved; the other is crushed and much weathered. It exhibits no trace of the suture-line. Its extreme length measured along the median line of the periphery is about 200 mm., the radius of curvature of the periphery being about 86 mm. In a length of 173 mm. along the periphery there are 21 peripheral ribs, which are connected with 7 primary ribs. The latter are about 12 mm. apart, whilst the secondary ribs have a thickness of about 3 mm., the interspaces being a little wider than the ribs.

Affinities and differences.—The present species is very nearly related to *Ammonites Wagneri*, Oppel,⁴ from the Bathonian of France, but the primary ribs of the Australian fossil are straighter, more prominent, and trifurcate more regularly. Compared with d'Orbigny's figures⁵ of *Ammonites Panderi*, Eichwald, the present

¹ Petschora-Land, 1846, p. 327, pl. xxi. figs. 1-3; pl. xxii. fig. 9.

² Pal. Franç. Terr. Jur. vol. i. 1842, p. 414, pl. cxliii.

³ Pal. Franç. Terr. Jur. vol. i. 1842, p. 416, pl. cxliv. According to Oppel (Juraformation, p. 477), d'Orbigny's figure does not represent Hehl's *Amm. planula*: he, therefore, alters the name of d'Orbigny's species to *Wagneri*.

⁴ A. Oppel, Die Juraformation, 1856-58, p. 477 [*Ammonites planula*, d'Orbigny, Pal. Franç. Terr. Jur. vol. i. p. 416, pl. cxliv. (*non* Hehl)].

⁵ D'Orbigny, in Murchison, de Verneuil and de Keyserling, Géologie de la Russie d'Europe et des montagnes de l'Oural, vol. ii. 1846, p. 430, pl. xxxiii. figs. 1-5 (figs. 1, 2 especially).

species has the primary ribs proportionately nearer together, and the secondary ribs proportionately finer. Its primary and secondary ribs are straighter than in *Ammonites uralensis*, d'Orbigny,¹ and cross the periphery without interruption.

Locality.—Champion Bay, Western Australia.

Of the fossils referred to in the foregoing descriptions the *Belemnites*, *Nautilus*, and *Ammonites* (*Dorsetensia*) are preserved in a yellowish limestone, the *Ammonites* (*Stephanoceras*) sp. and *Ammonites* (*Perisphinctes*) *robiginosus* in a highly ferruginous matrix, and the rest in a red or red and yellow limestone, but the specimens are not accompanied by any notes on the sequence of the beds from which they were obtained. The Mesozoic rocks, however, in the portion of Western Australia whence the fossils were derived, have been described by Mr. H. Y. L. Brown in his "Report on a Geological Exploration of that portion of the Colony of Western Australia lying southward of the Murchison River and westward of Esperance Bay." Referring to the rocks of the "Mesozoic or Secondary Epoch—Oolitic Period," Mr. Brown says: "The character of the strata belonging to this period may be described as follows: Beds of highly ferruginous clay, stone, or shale, sandstones, grits, conglomerates, clays, and limestone, placed in horizontal layers upon the older rocks, which originally they must have almost entirely covered, but have since been cut into and denuded to a great extent from off them, in such manner as to leave tablelands, isolated table hills, and peaks with steep escarpments and slopes. Their average elevation is about 600 feet above sea-level. The surface of this formation is generally coated with a deposit of sand, arising from the weathering of the sandstones, the larger areas being known by the name of sand plains. There are two principal areas occupied by this formation. The first, which varies in width from 10 to 30 miles, extends from the neighbourhood of Gingin and Yatheroo to the Murchison, and probably a long distance farther northward, in a line more or less parallel to the coast. Proceeding eastward it thins out, and only exists there as outliers and cappings on the hills. Its average thickness, where best developed, is some 400 feet. The second area commences near Cape Riche, and stretches in a north-east direction beyond the Phillips River, thinning out eastward to mere cappings on the hills.

"The uppermost beds in the first-named area are generally more ferruginous than the lower, and consist of highly ferruginous concretionary claystone, shale, and grit.

* * * * *

"The great denudation which has operated since the close of this period has removed a great portion of the rocks, leaving the remainder as undulating plateaux and flat-topped hills, at the bases of which the older rocks outcrop. As a rule these strata are horizontal, although in some cases a slight undulating dip is perceptible. The interstratified beds of white, yellow, and sometimes ferruginous

¹ D'Orbigny, *ibid.* p. 429, pl. xxxii. figs. 6–10.

limestone, attaining the thickness of 30 feet, which occur chiefly in the neighbourhood of Champion Bay, do not seem to be persistent, but are found as it were in patches, which gradually thin out. As the limestone composing them is made up of shells, which in some cases have consolidated into a solid rock, in others have retained their original form, it seems most probable that the accumulation of shells in hollows, in the ancient sea-beds, is the cause of their now being found in isolated areas. The most common fossils found includes species belonging to the [families] *Ammonitidæ*, *Belemnitidæ*, *Ostreidæ*, *Pectinidæ*, *Trigonidæ*, *Rhynchonellidæ*, etc. These fossils are generally found in the limestone, whole masses of rock being composed of them; they are also found in the hard ferruginous shale and sandstone, in which case they have been converted into oxide of iron. In a paper published in the Proceedings of the Geological Society, the author, Mr. C. Moore, considers the fossils from these beds to represent the fossil fauna of the Lias and Lower Oolitic formations of England.

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“The second principal area of this formation, which embraces the country extending from near Cape Riche to beyond the Phillips River, consists of a series of horizontal sandstones, grits, and conglomerates, capped generally by the usual ferruginous claystones, the whole thinning out on to the granite along its northern boundary at a level of from 600 to 700 feet above the sea, and forming level plains and table hills, with steep escarpments, along the Gairdner, Fitzgerald, Hamersley, Phillips, and Jerdicart Rivers. To the southward and eastward the formation, which attains a thickness of some three or four hundred feet, rests on the slaty rocks of the Mount Barren and Jerdicart country. In lithological and stratigraphical character and position, they are almost precisely similar to the same formation in the more northern parts of the colony. White marly saliferous sandstones, ferruginous grits and claystones, conglomerate, reddish sandstones, etc., are the principal rocks met with. Perfect specimens of fossil sponges are frequent in some of the caves which occur along the escarpments, hanging from the roof and sides, where the rock has weathered away; worn casts are also abundant. Mainbenup, near Esperance Bay, is the farthest point eastward where I have observed the formation. At Cape Riche beds of white and mottled sandstone, overlying granite, form low but steep cliffs along the shore of the bay.”

The present collection of Cephalopoda confirms the view expressed by Clarke¹ and by Moore² as to the existence of rocks of Lower Oolite age in Western Australia. Possibly the highly ferruginous rocks may represent a somewhat higher portion of the Oolite, but the evidence of the present collection is by no means conclusive. No species of Middle Liassic age has been recognised in the collection.

¹ Quart. Journ. Geol. Soc. vol. xxiii. (1867), p. 9.

² *Ibid.* vol. xxvi. (1870), p. 230.

The species here described do not appear to be in any way related to the forms which have been recorded¹ from New Guinea.

It may be observed in conclusion that an excellent Geological Sketch-map of Western Australia by the Government Geologist, Mr. Harry Page Woodward, F.G.S., has recently been issued.

EXPLANATION OF PLATES XII. AND XIII.

[All the figures are drawn one-half the natural size unless otherwise stated.]

PLATE XII.

- FIG. 1. *Nautilus perornatus*, sp. nov.: *a*, lateral view, showing portions of the test, and the course of the suture-lines; *b*, peripheral view; *c*, portion of the test on the periphery. *a* and *b* are drawn one-fourth nat. size, *c* is drawn nat. size.
- FIG. 2. *Ammonites (Dorsetensia) Clarkei*, sp. nov.: *a*, lateral view; *b*, front view; *c*, suture-line.
- FIG. 3. Suture-line traced from the specimen figured by Moore (Quart. Journ. Geol. Soc. vol. xxvi. (1870), pl. xv. fig. 2) under the name of *Ammonites radians*; nat. size.
- FIG. 4. *Ammonites (Stephanoceras) Australis*, sp. nov.: *a*, lateral view; *b*, peripheral view.
- FIG. 5. *Ammonites (Stephanoceras)*, sp.: *a*, lateral view; *b*, peripheral view.
- FIG. 6. *Ammonites (Sphæroceras?) Woodwardi*, sp. nov.: *a*, lateral view; *b*, peripheral view.

PLATE XIII.

- FIG. 1. *Ammonites (Sphæroceras) semiornatus*, sp. nov.: *a*, lateral view; *b*, peripheral view.
- FIG. 2. *Ammonites (Perisphinctes) Championensis*, sp. nov.: *a*, lateral view; *b*, front view; *c*, portion of the suture-line. The right-hand portion of the first lateral lobe may not be quite correct, the fossil being badly-preserved at this part.
- FIG. 3. *Ammonites (Perisphinctes) robiginosus*, sp. nov.: *a*, lateral view of fragment devoid of septa; *b*, section of whorl at S.

All the specimens are from near Champion Bay, Western Australia.

II.—ON SOME LIFE ZONES IN THE LOWER PALÆOZOIC ROCKS OF THE BRITISH AREAS, AS DEFINED MAINLY BY RESEARCHES DURING THE PAST 30 YEARS.

By HENRY HICKS, M.D., F.R.S., F.G.S.

(Continued from the September Number, page 405.)

Middle Cambrian.

FROM the foregoing remarks it will be seen that the Middle Cambrian, as at present defined, is characterized by having numerous Life Zones in which, usually, species of the genus *Paradoxides*, or of some closely allied forms, may be considered the dominant organisms. Up to the present the genus *Olenellus*, so typical of the Lower Cambrian rocks, has not been found in direct association with *Paradoxides*, but some of the associated genera are equally characteristic both of the Lower and of the Middle Cambrian.² The *Olenellus* fauna, as a whole, seems to have dis-

¹ R. Etheridge, *fl.*, Records Geol. Surv. New South Wales, vol. i. pt. 3, 1889 (1890), pp. 172-179, pl. xxix.

² Mr. G. F. Matthew, who has worked out the zones in the Cambrian rocks of New Brunswick, Canada, with much care and success, has recently described a new

E.C. & G.M. Woodward del. et lith.

West, Newman & Co. imp.

Western Australian Cephalopoda.