THE

QUARTERLY JOURNAL

OF THE

GEOLOGICAL SOCIETY OF LONDON.

EDITED BY

THE ASSISTANT-SECRETARY OF THE GEOLOGICAL SOCIETY.

[illegible] si cui mortalium cordi et curæ sit non tantum inventis hærere, atque iis uti, sed ad ulteriora [illegible] ; atque non disputando adversarium, sed opere naturam vincere ; denique non belle et probabiliter [illegible] sed certo et ostensive scire ; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjun[illegible]ant.
[illegible] *Organum, Præfatio.*

VOLUME THE SIXTY-NINTH.

1913.

LONDON:

LONGMANS, GREEN, AND CO.

PARIS: CHARLES KLINCKSIECK, 11 RUE DE LILLE.

SOLD ALSO AT THE APARTMENTS OF THE SOCIETY.

MCMXIII.

25. *On* Jurassic Ammonites *from* Jebel Zaghuan (Tunisia). By Leonard Frank Spath, B.Sc., F.G.S. (Read March 5th, 1913.)

[Plates LII & LIII.]

Contents.

I. Introductory Remarks.

The fossils described in the following pages were collected on a hurried excursion to the mountain of Zaghuan, the graceful, sharp-peaked summit of which is a prominent landmark that greets the eyes of travellers in the Regency of Tunis. Apart from being the most conspicuous mountain in the country—though inferior in absolute height to Jebel Chambi,—Zaghuan also forms the most important elevation of the Tunisian Atlas from a geological point of view, and the tectonic problems which it suggests are manifold and of exceeding interest. Without discussing these, it may suffice to mention that the late Dr. Pervinquière in 1903[1] summarized the existing geological knowledge of the mountain as follows:

'Massive limestones of Liassic age form the principal mass of the mountain, whereas the Oxfordian and Tithonian play but a subordinate part in its constitution.'

As a matter of fact, the 'Oxfordian' fossils of Pervinquière characterize the zone of *Peltoceras transversarium*, which corresponds approximately with what was at one time called in this country the zone of *Aspidoceras perarmatum*. On the other hand, he mentions Kimmeridgian forms, but includes them in the Tithonian.

A later work by the same author[2] is devoted entirely to Tunisian cephalopods. Very few of the ammonites are of Jurassic age, however, and of these only about ten come from Jebel Zaghuan, none from the pre-Corallian deposits. Several other works on the geology of Tunis have been published since; but, so far as I am aware, no new facts regarding the mountain have come to light. I offer the following notes, therefore, in the hope that they may be of general interest; for the study of the ammonites has revealed

[1] 'Étude Géologique de la Tunisie Centrale' Paris, 1903, p. 253: 'Djebel Zaghouan.'
[2] 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' Text & atlas, Paris, 1907.

a few interesting facts, despite the circumstance that the small collection consists of casts and impressions which are not in a very good state of preservation. In consequence, specific determination has proved tedious, and, so far as some worn Upper Jurassic specimens are concerned, too unsatisfactory to warrant the expression of an emphatic opinion. But the observations modify the current opinion, insomuch as there is now good evidence in favour of the presence of the zone of *Reineckeia anceps*, hitherto believed to be absent, with all the other strata intervening between the Middle Lias and the Corallian. Domerian (that is, Middle Liassic) ammonites are also recorded for the first time, and the discovery of a rich cephalopod fauna of Argovian age throws interesting light on certain ammonites described by previous authors as of Lower Tithonian age.

It is a matter for regret that further stratigraphical observations or visits to the locality were impossible.

II. The Jurassic Rocks of Jebel Zaghuan and their Cephalopod Fauna.

(1) The Lias.

The Lias is represented at Zaghuan by thick, massive, bluish-grey limestones of confused stratification. The base is unknown, and it is impossible to say at present which are the oldest beds represented. The late Prof. Baltzer[1] had collected a number of Liassic ammonites in 1893, and the list compiled with the help of Prof. Mayer-Eymar, and published in 1895,[2] included (besides belemnites and lamellibranchs) forms of the following Lower Liassic genera: *Vermiceras* [*Arietites*], *Coroniceras* [*Arietites*], *Arnioceras* [*Arietites*], *Arietites*, *Deroceras* [*Ægoceras*], *Androgynoceras* [*Ægoceras*], *Platypleuroceras* [*Ægoceras*]; and also the Toarcian *Dactylioceras* [*Cœloceras*] *anguinum* (Rein.).

They are the only Liassic ammonites that have ever been recorded from Zaghuan (and, indeed, from the whole of Tunisia), and were collected below the ridge near the Col de Bourzen, partly among the screes. The matrix is not the same in all the specimens, and the curious mixture of Lower, Middle (to French geologists), and Upper Liassic forms seems to have made both Dr. Pervinquière and Prof. Haug somewhat sceptical about the identifications. The former[3] records only little-determinable belemnites and *Terebratulæ* from these limestones; but M. Ficheur and Prof. Haug[4] found, besides belemnites 'of the *acuti* group,' '*Pygope*' *aspasia* Meneghini (Von Buch), a brachiopod common to

[1] 'Beiträge zur Kenntniss des Tunisischen Atlas' N. Jahrb. vol. ii (1893) pp. 26–41.
[2] *Id. ibid.* vol. i (1895) pp. 105–106.
[3] 'Étude Géologique de la Tunisie Centrale' 1903, p. 29.
[4] C. R. Acad. Sci. Paris, vol. cxxii (1896) p. 1354.

the Alpine, Italian, and Sicilian Domerian.[1] Prof. Haug[2] therefore classed the beds in the Middle Lias, and stated that the Toarcian seemed to be absent in Tunisia.

I have not been able to find Lower Liassic ammonites; but my search among the screes and rocks between the Col de Bourzen and the summit-ridge was of a superficial nature, since I did not recognize the locality at the time. I was fortunate enough, however, to collect the following Domerian forms in loose débris by the side of the path to the Poste Optique (975 metres) just before that path reaches the final slope: that is, at a height of about 900 metres:—

Protogrammoceras cornacaldense Tausch, var. *zeugitanum*, nov.
Pr. aff. *costicillatum* (Fucini), var. *detractum* Fucini.
Pr. sp. nov.
['*Lioceras*'] gen. et sp. nov. aff. *grecoi* (Fuc.).

Together with these specimens was found a fragment of an ammonite similar as to matrix and mode of preservation, which strikingly resembles the well-known *Harpoceras bicarinatum* Ziet. *non* Münster sp. (=*cumulatum* Hyatt). On account, however, of its association with Domerian fossils, I am inclined to think that my specimen is a heterochronous homœomorph of that *Harpoceras*, rather than that the latter appeared earlier in Tunis than it did in Europe, where it seems to be unknown in the lowest zones of the Toarcian. In either case, the evidence in favour of the presence of the Toarcian afforded by this fragment, which shows neither umbilicus nor suture-line, is most unsatisfactory[3]; and, further, it is possible that the above-cited *Dactylioceras anguinum* (Rein.), collected by Prof. Baltzer, may really be one of the many similar Domerian 'Cœlocerates' recently described from Italian deposits. Hence the Mesoliassic character of at least the main mass of the grey limestones would remain established; whereas better evidence would be required in confirmation of the presence of the Toarcian.

[1] The term Domerian is here used in Bonarelli's sense, that is, to denote the Upper Pliensbachian (Upper 'Charmouthian' in Bonarelli), which corresponds with what the Officers of the Geological Survey call the Middle Lias: namely, the zones of *Amaltheus margaritatus* and of *Paltopleuroceras spinatum*. Mr. Buckman (in 'Yorkshire Type-Ammonites') also uses the term Domerian for this stage, but he restricts the term Charmouthian to Bonarelli's Lower Charmouthian. Mr. W. D. Lang (in Geol. Mag. dec. 5, vol. x, 1913, p. 401) introduces the term Carixian for the Lower Pliensbachian (which latter has priority before Charmouthian, Liasian not being acceptable): that is, for the zones from *Echioceras raricostatum* below, up to, and including, that of *Ægoceras capricornus*. The new term deserves general acceptance, since it enables us to keep the term Pliensbachian for the whole, with its original connotation. The incoming of *Seguenziceras* and other Hildocerates at the base of the Domerian (zone of *Seguenziceras algovianum* of Buckman), together with the appearance of Amaltheids and the almost complete extinction of the Liparoceratidæ, is the most important palæontological characteristic.

[2] 'Traité de Géologie' vol. ii (1908) pt. 2, p. 987.

[3] See also under specific descriptions.

(2) The Callovian.

Reineckeia anceps (Rein.) and *Lunuloceras lunula* (Ziet.) have been recorded from Batna in Algeria; and a specimen of a *Reineckeia* comparable with the type-form, or, in any case, belonging to the '*substeinmanni*' group of Lemoine,[1] from Foum Islamen, Constantine, is in the British Museum (Natural History).[2] But it was generally believed that the whole series of beds from the Domerian to the Argovian was absent in Northern Tunisia. I have, however, found the two forms mentioned below on the path to the Poste Optique, about half way up, where a branch of it leads into a small pit of red limestone, evidently used for getting material to repair the path. The outcrop is small, much overgrown, and obviously forms quite an isolated patch amid unfossiliferous grey limestone of different age. The matrix (red marble) is the same as that of the specimen from Foum Islamen, and both my specimens were cut out of the rock-surface. They are *Reineckeia* aff. *hungarica* Till and *Perisphinctes* cf. *bieniaszi* Teisseyre.

Both forms belong to the zone of *Reineckeia anceps*, and the world-wide distribution of the genus *Reineckeia* in deposits of Callovian age has long been proved.

(3) The Corallian.

The lower part of the Corallian, as interpreted by Mr. Buckman[3] (that is, the *cordatus* and *precordatus* zones), as also the upper zones of the Divesian (Oxfordian) seem to be absent; but the Argovian, or zone of *Peltoceras transversarium*, is well represented. Pervinquière quotes only *Phylloceras manfredi* Opp., *Sowerbyceras tortisulcatum* (d'Orb.), and *Ochetoceras arolicum* (Opp.) with unidentified Phyllocerates, *Perisphinctes*, and *Aspidoceras* from a small outcrop of greenish-grey limestone on the Télégraphe. But G. Le Mesle[4] also found (perhaps at the same spot):—

Lytoceras liebigi Opp.	*Peltoceras transversarium* (Quenst.).
Taramelliceras [*Oppelia*] *anar* (Opp.).	*Perisphinctes* (*Biplices*) cf. *kobelti* Neum.
Taramelliceras [*Oppelia*] cf. *bachianum* (Opp.).	

Whereas Baltzer records from the south of the mountain, near the 'Gabrielle' mine:—

Taramelliceras [*Oppelia*] *callicerum* (Opp.).	*Peltoceras eugenii* (Rasp.).
Taramelliceras [*Oppelia*] *flexuosum* (Münst.).	*Perisphinctes plicatilis* (Sow.).
Aspidoceras ægir (Opp.).	*Perisphinctes martelli* (Opp.).
	Simoceras [*Perisphinctes*] *doublieri* (d'Orb.).

[1] P. Lemoine, 'Pal. Madagascar: pt. 8—Ammonites Jurass. Supér. d'Analalava' Ann. Paléont. vol. v (1910) p. 9 [145].

[2] Specimen No. C 10568.

[3] See G. W. Lamplugh & F. L. Kitchin, 'On the Mesozoic Rocks in some of the Coal-Explorations in Kent' Mem. Geol. Surv. 1911, p. 132.

[4] 'Sur le Jurassique du Zaghouan' Bull. Soc. Géol. France, ser. 3, vol. xvii (1888) p. 63.

At a locality which may be that marked 'Bou Goubrine' in fig. 1 of Baltzer's pl. iii,[1] I collected a large number of ammonites preserved in red limestone. Most of them had weathered out of the rock, and lay loose at the surface, which was overgrown with brushwood to such an extent that the relations of the outcrop could not be traced clearly. The forms are:

Phylloceras cf. *mediterraneum* Neum.
Phylloceras cf. *subptychoicum* Dacqué.
Phylloceras manfredi (Oppel).
Phylloceras cf. *saxonicum* Neumayr.
Phylloceras cf. *isotypum* Benecke.
Sowerbyceras protortisulcatum (Pompeckj).
Sowerbyceras cf. *loryi* (Mun.-Chalmas).
Lytoceras cf. *gastaldii* Gemmellaro.
Lytoceras aff. *polycyclum* Neumayr.
Ochetoceras arolicum (Oppel).
Ochetoceras canaliculatum (Münst.).
Ochetoceras sp.
Taramelliceras cf. *anar* (Oppel).
'*Lissoceras*' *erato* (d'Orb.).
Perisphinctes (Grossouvria) cf. *regalmicensis* Gemm.
Perisphinctes (Grossouvria) cf. *navillei* Favre.
Perisphinctes (Grossouvria) cf. *densicosta* Gemm.
Perisphinctes (Biplices) kobelti Neum.
Perisphinctes (Ataxioceras) æneas Gemm.
Perisphinctes (Ataxioceras) cf. *michalskii* Buk.
Perisphinctes (Ataxioceras) cf. *depereti* de Riaz.
Perisphinctes (sensu stricto) cf. *sayni* de Riaz.
Perisphinctes (do.) cf. *jelskii* Siem.
Perisphinctes (do.) *plicatilis* de Riaz, *non* Sow., *nec* Siem.
Perisphinctes (do.) cf. *convolutus* (Quenst.).
Perisphinctes (do.) sp. nov. aff. *trichoplocus* Gemm.
Peltoceras toucasianum (d'Orb.).
Peltoceras cf. *toucasianum* (d'Orb.).
Peltoceras pervinquieri, nom. nov. mihi = *fouquéi* Pervinq. *non* Kil.
Peltoceras aff. *fouquéi* Kil.
Aspidoceras cf. *ægir* (Opp.).

There is perfect similarity of matrix in all the specimens: the outcrop consists of a truly Alpine, ammonitic 'Knollenkalk,' which contains apparently no other organisms; but the list includes forms from the *transversarium* zone mixed with some from the *acanthicus* beds. If we call to mind the curious fact that, not only in the Southern Alps, but also in Sicily there is a great development of the Argovian to the exclusion of the higher beds of the Corallian, followed without any apparent break by the *acanthicus* beds, it appears quite probable that the two 'zones' occur here in a similar manner, and that the apparent mixture is not due to doubtful identifications.

Most of the forms enumerated above are of undoubted Argovian age. With regard to the remainder, a brief discussion of their stratigraphical value may be desirable.

Peltoceras fouquéi Pervinq. *non* Kil. seems to be the only form that had previously been recorded from this locality or its vicinity. The matrix also is a red limestone, and Aubert collected it 'près de la zaouia de Sidi Bou Goubrine.' Pervinquière originally gave the age of the ammonite as Sequanian,[2] but in 1907 he figured it as a Lower Tithonian form. The latter age seemed to him 'more probable, especially as nothing else indicates the occurrence

[1] Neues Jahrb. vol. ii (1893).
[2] 'Étude Géologique de la Tunisie Centrale' 1903, p. 28.

of the lower beds at that locality.' This does not apply now, however.

Peltoceras fouquéi Kil. occurs in Algeria, together with *transversarium*-zone ammonites; but the type comes from Andalusian beds of probably a higher horizon, and several authors record it from the Lower Tithonian. The evidence afforded by this form, therefore, is not satisfactory.

Perisphinctes (Biplices) kobelti Neum. is another ammonite figured and described by Pervinquière as a Lower Tithonian form. Neumayr[1] stated that the horizon was not directly known; but he thought that, judging by the general appearance of the ammonite, it undoubtedly belonged to the upper regions of the Upper Jurassic. The matrix is a red limestone, identical with the *Diphya* Kalk of the Southern Alps, and the type-specimen was collected by Dr. Kobelt rather high up on the northern slope of Jebel Zaghuan, at a spot where ammonites of fair size were abundant. It is impossible to say whether this refers to some locality on the Poste Optique, other than the greenish-grey limestone outcrop mentioned by Pervinquière — as at Bu Gubrîn, where similar red marble occurs, all the seventy specimens that I collected were of small dimensions. Le Mesle, as we have seen above, cited this form together with *Peltoceras transversarium*; a statement which caused Pervinquière to point out that Le Mesle, as well as Baltzer, had certainly mixed up 'Oxfordian' and Tithonian. The Tithonian age of this form, as well as of *Peltoceras fouquéi* Kil., seems by no means proved, however, and Pervinquière, who lays much stress on the resemblance of the red marble matrix with his Lower Tithonian limestone from Jebel Ben Saidan, 'known to belong without doubt to the beginning of the Tithonian,' has himself been misled. It is well to remember here that Pervinquière includes Upper Kimmeridgian (that is, the old '*acanthicus*-zone') forms in his Lower Tithonian.

Perisphinctes simoceroides Font. is another ammonite, figured and described by Pervinquière as probably of Lower Tithonian age, although the specimen came from the greenish-grey 'Oxfordian' limestone of the Poste Optique. It is possible, as that writer thinks, that the form the type of which comes from the *tenuilobatus* beds of Crussol appeared earlier in Tunis; but the identification may also be at fault, for Pervinquière says:

'at any rate, the ammonite can be more closely attached to *simoceroides* than to the "Oxfordian" species *sutneri* Choff. or *trichoplocus* Gemm.'

The evidence afforded by those Phyllocerates and Lytocerates which are of '*acanthicus*' age is equally unsatisfactory. The specimens are imperfect casts, and it will be necessary to mention in the specific descriptions that some of the identifications are doubtful. The same may be said of *Sowerbyceras loryi* (Mun.-Chalm.). That form—or, at least, two closely-allied, non-constricted

[1] 'Geogr. Verbr. d. Juraform.' Denkschr. K. Akad. Wissensch. Wien, vol. 1 (1885) p. 139.

ammonites, the dimensions of which agree fairly well with the type—occurred together with a very large number of specimens of *Sowerbyceras protortisulcatum* (Pomp.), and although *S. loryi* has been quoted from various horizons, it certainly occurs in beds higher than the Argovian. Yet Pervinquière mentions already[1] the singularly close resemblance of one of his fragments to *S. loryi*, although Munier-Chalmas was of opinion that the specimens (associated with *Ochetoceras arolicum* Opp. sp. and other Argovian ammonites) belonged to *S. tortisulcatum*. As Pervinquière says, the two forms are indeed closely allied; and, since the differences do not seem so constant as has been made out, there will often be great difficulty in the distinction. This case, then, is similar to that of *Peltoceras fouquéi* Pervinq. *non* Kil., which is found with the older *P. toucasianum* and *P. transversarium* and an intermediate form.

It may be added that Pervinquière mentions also a true *Sowerbyceras loryi* from Zaghuan; but the evidence, like that of *Simoceras* cf. *doublieri* (d'Orb.),[2] a doubtful impression in red limestone, does not appear strong enough to warrant the attribution of these forms to the Lower Tithonian with certainty. Until the relations have been more clearly determined, the presence of the '*acanthicus*' beds, which would include both the Upper Kimmeridgian and the Lower Tithonian, cannot be considered as proved beyond doubt. Their presence is quite probable, since, on the neighbouring Jebel Ben Saidan, similar red limestones with undoubted '*acanthicus*' forms occur; but it should be pointed out that the distinction between the so-called 'Lower Tithonian' and the Argovian is a matter of great difficulty with the material that is at present at our disposal.

(4) Conclusions.

The absence in the Tunisian Atlas of all strata intervening between the Middle Lias and the Argovian has generally been regarded as an established fact. The presence of the Callovian, however, necessitates some modification of that view. The Middle Jurassic transgression began in Callovian times, since deposits of that age probably rest directly on the Domerian. The latter has now yielded typical ammonites, but the question as to whether the Toarcian is completely absent must remain undecided.

Whether the higher beds of the 'Oxfordian' are represented or have, perhaps, been cut out by the extensive faulting, of which the general calamitization seems to afford proof, so that the Middle Oolitic succession may be more complete than we think, or whether new transgressions in Argovian and Upper Kimmeridgian times brought back the sea and exactly similar deposits of red ammonitic limestones, it is impossible to say at present.

The *Ellipsactinia* Limestones which have been recorded from

[1] 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' (1907) p. 15.
[2] *Ibid.* p. 29.

Jebel Zaghuan appear to indicate the incoming of a different facies at the top of the Jurassic System.

It remains only for me to acknowledge very gratefully my indebtedness to the officials of the Geological Department of the British Museum (Natural History) for facilities afforded during the examination of the specimens in their charge; and to express my great obligation to Dr. A. Morley Davies and Mr. C. P. Chatwin, for kindly looking through this paper and offering valuable suggestions.

III. Description of the Ammonites.

(1) LIAS.

Family Hildoceratidæ Hyatt *em.* S. Buckman.

Protogrammoceras, gen. nov.

A brief explanation is necessary in justification of the establishment of this new genus.

The present state of the classification of the Domerian Hildoceratidæ is unsatisfactory. Most authors either group the forms which are here considered with ammonites of later lineages, but similar external appearance, or else refer them to the convenient though much-abused genus *Harpoceras*, *sensu latissimo*.

A few examples may be mentioned. Prof. Haug[1] quotes the typical rectiradiate Domerian *Seguenziceras algovianum* (Opp.) alternately as *Grammoceras* and *Harpoceras*, which, in turn, also are used to accommodate A. d'Orbigny's *Ammonites normanianus*. A. Fucini,[2] again, places the latter in *Hildoceras*, also a strictly Toarcian genus; and P. Rosenberg[3] restricts the genus *Harpoceras* to forms with a carinatisulcate periphery, although that genus had already been restricted by Mr. Buckman to the true Toarcian *falciferi* twenty-two years earlier.[4] On the other hand, Dr. Rosenberg identified a Middle Liassic sickle-ribbed form with *Grammoceras fallaciosum* Bayle from the *jurense* zone, whereas it is not difficult to see that Bayle's excellent figure[5] is distinguished by a particular straightness of the costæ on the lateral area.

The present desideratum is a genus in which to place the ammonites collected at Zaghuan. Unfortunately, the material is very scanty, and even in the British Museum collections Mesoliassic Hildoceratidæ are almost unrepresented, wherefore an original study of the sutures, inner whorls, and probable septate character of the carina could not be carried out. On the other hand, it is not

[1] 'Traité de Géologie' vol. ii (1908) pt. 2.
[2] 'Cefalop. Liass. del Mte. di Cetona' pt. 5, Pal. Ital. vol. xi (1905) p. 108.
[3] 'Liasische Cephal.-Fauna d. Kratzalpe' Beitr. Paläont. & Geol. Œsterr.-Ung. vol. xxii (1909) p. 304.
[4] Geol. Mag. dec. 3, vol. iv (1887) p. 397.
[5] 'Expl. Carte Géol. France' vol. iv (1878) pl. lxxviii, figs. 1 & 2.

desirable to propose a more detailed classification of these forms, when one has to rely largely on the published descriptions of previous authors. I will indicate, therefore, only a few groups into which the ammonites in question might be collected within the genera *Seguenziceras* Levi (=*Arieticeras* Seguenza) and *Protogrammoceras*, nov. Further subdivision will doubtless be necessary as our knowledge of these forms grows.

The classification is based on the course of the radial line, in the first place, as the most constant feature of the shells. Mr. S. S. Buckman has shown how it may well be used, in conjunction with the suture-line, as a basis for classification[1] in the Hildoceratidæ in any case. Objections on account of the change in the radial line on the same ammonite will hardly be raised. Such changes do occur, not only in Hildoceratidæ (notably, for example, in certain *Ludwigellæ*), but also in many other families ('Polymorphidæ': *Fontannesia*; Oppelidæ: '*Haploceras*,' etc.). They are always limited to, at most, the last 30° in circular measure of the body-chamber, leading up to the mouth-border, and can easily be distinguished. By far the greater part of the body-chamber and the previous whorls have, for all practical purposes, an identical radial curve. It is interesting to note here that, even in cases where the irregular development of the ornament is said to be very striking, as in *Indoceras baluchistanense* Nœtling,[2] the sigmoidal course of the radial line is really fixed, and it seems that only the change in its character (from striate to costate) follows no law.

With regard to the suture-line, I am fully aware of the difficulties attending the proposed classification. The sutures of these early forms are too similar in general outline to have received much attention in the past, and they are, therefore, but imperfectly known. We now know, however, that in some striking cases an identical radial line may be combined with a notable difference in the suture-line, and I am quite unable to endorse Dr. Rosenberg's view. That author,[3] after studying well-preserved material, refrained from giving detailed descriptions and figures of the sutures of his 'Harpocerates' because 'they offer no or only very slight distinctions for specific separation.' In fact, a comparison of the sutures given by Dr. Fucini[4] for his various forms of '*Harpoceras*,' '*Grammoceras*,' and '*Hildoceras*,' seems to show that they differ more in 'species' of the same genus than they do in certain 'species' of different genera. But this merely emphasizes the undesirability of adopting Fucini's classification. He deems it impossible to separate the varieties *costicillatum* and *inseparabile* of

[1] 'Inferior Oolite Ammonites: pt. 10—Supplement' Monogr. Pal. Soc. vol. lii (1898) pp. i & ii.

[2] F. Nœtling, 'Die Entwicklung von *Indoceras baluchistanense* Nœtlg.' Geol. & Palæontol. Abhandl. (Jena) n. s. vol. viii (1906) pt. 1.

[3] 'Liasische Cephal.-Fauna der Kratzalpe' 1909, p. 288.

[4] 'Ammoniti del Lias Medio dell' Appennino Centrale' Pal. Ital. vol. vi (1900–1901) pp. 17–65 & text-figs. 24–48.

d'Orbigny's *normanianum* from the type, merely on account of the section, which is quadrate in the former two and acute in the latter—and I quite agree with him there. In my proposed classification they would also be united, assuming, of course, that there is agreement in the radial curve of the three forms: since the rather bad figures do not let this character come out very clearly. Our belief in the close affinity of these forms receives a shock, however, when we compare the sutures of, for instance, the var. *costicillatum* of '*Grammoceras*' *normanianum* (d'Orb.)[1] with that of its subvariety *detractum*, and find that there are marked differences. The former has an unsymmetrically-bifid external lobe, and a wide external saddle with a quadrate, bifid, inner branch. The second lateral saddle is also bifid, the first auxiliary lobe wide and low. In the latter variety, on the other hand, the lateral lobe is regularly trifid and the external saddle narrower, with a slender, monophylloid, internal branch; a similar, narrow, monophylloid, second lateral saddle is present, and there is also a strong forward inclination of the rest of the suture.

All this clearly shows the need for a revision of these forms, whenever more observations and material are at our disposal.

It is scarcely necessary to add now that the classifications of those Continental authors who consider the radial line variable, and in the absence of suitable sutures base them on the outward shape of the conch only, opposing forms with a carinatisulcate venter to those of oval-lanceolate section and an angular periphery, seem to me unjustifiable. A study of the inner whorls of some of the forms belonging to the lineages here considered has shown the anagenetic character of the periphery, from fastigate to carinate and subsulcate and then to carinatisulcate; and, if we were to be guided solely by that criterion in our classification, we might possibly refer several fragments of the same ammonite to three different genera. Of course, as Württemberger[2] pointed out more than thirty years ago, this difficulty applies equally to many other groups now accepted universally; and it could be argued that the radial line also (or, indeed, even the suture) does not help us in the distinction of the ill-characterized inner whorls. But it is maintained here that, although there are transitions in the radial line, we shall generally be able to group together forms of close genetic relations; whereas, in each of the several groups distinguished by different radial curves, we find produced forms with, for example, a carinatisulcate venter—they are only morphological equivalents, and cannot be classed together. A striking example is afforded by pl. ix of Fucini's work (already cited) on the Cephalopoda of the Central Apennines. Here, on account of a common acute venter, a number of forms are united as 'Grammocerates,' including '*Grammoceras*' *subtile* Fuc. (fig. 10), probably a derivative of the

[1] A. Fucini, 'Amm. del Lias Medio dell' App. Centr.' p. 30 & figs. 29–30.

[2] 'Studien über die Stammesgeschichte der Ammoniten' Darwinistische Schriften, No. 5, Leipzig, 1880.

true recticostate Seguenzicerates, whose generic difference will be admitted readily by most palæontologists.

Many of the ammonites in question occur in the Middle Lias of Italy, and a great number of forms are founded on imperfect specimens, the figures of which are of as much value as those of the older authors, who paid so little attention to the course of the radial line. For instance, the true curve of the ornament is very doubtful in A. d'Orbigny's *Ammonites normanianus*[1] or in '*Harpoceras antiquum*' Wright,[2] and I question the correctness in the former, because of the unusual character of the curve clearly shown in a tracing; the latter form, which, I may mention, does not seem to have been rediscovered and is quoted by its author from the *jamesoni* zone (!), is represented in three widely differing drawings. The type-specimens are not in the British Museum collection. Finally, the grouping under '*Harpoceras*' *boscense* Reynès of forms of such widely differing appearance as those figured by Meneghini, Zittel, Geyer, and others, has caused a great deal of confusion.

The radial curve, then, enables us to separate the Middle Liassic Hildoceratidæ into Rectiradiata and Flexiradiata. The former belong to the genus *Seguenziceras* Levi (=*Arieticeras* Seguenza); but the definition given by Zittel[3] will have to be altered, so as to include also forms with a narrow umbilicus and a more compressed section, having simply a carinate venter. Some of the very evolute forms are apparently transitional to Lower Liassic Polymorphids. By far the greater number of the ammonites belonging to the genus *Seguenziceras*, including the type, are subrecticostate; but there are lateral branches developing truly recticostate and rursiradiate forms respectively.

The flexiradiate forms are here united in the one genus *Protogrammoceras*, but belong to two separate divisions: one being distinguished by increasing peripheral projection, and giving rise to subfalciradiate and falciradiate forms; the other, where there is reduction in the peripheral projection, develops subanguliradiate and angulirursiradiate forms. They may, then, be arranged as follows:—

- Genus *Seguenziceras* .....
  - Rectiradiata: example *bertrandi* (Kil.).
  - Subrectiradiata: example *algovianum* (Opp.).
  - Rursiradiata: example *retrorsicosta* (Opp.).
- Genus *Protogrammoceras*.
  - Increase in projection.
    - Subfalciradiata: example *antiquum* Geyer *non* Wright.
    - Falciradiata: example *celebratum* Fuc.
  - Decrease in projection.
    - Subanguliradiata: example *normanianum* Fuc. *non* d'Orb.
    - Angulirursiradiata: example *lavinianum* Mgh., especially var. *retroflexum* Fuc.

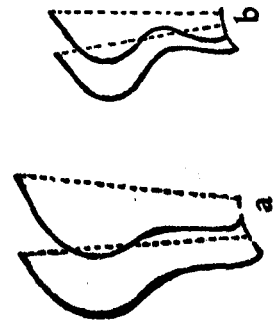
[1] 'Pal. Française: Terr. Jurass.—Céphalopodes' vol. i (1842–49) pl. lxxxviii & p. 291.
[2] 'Lias Ammonites' Monogr. Pal. Soc. (1878–86) pl. lvii, figs. 1–4 & p. 431.
[3] 'Grundzüge der Paläontologie' vol. i (1910) p. 487 (under *Arieticeras*).

Figs. 1–4 illustrate typical radial lines belonging to the four groups.

Fig. 1.—*Subfalciradiate.*

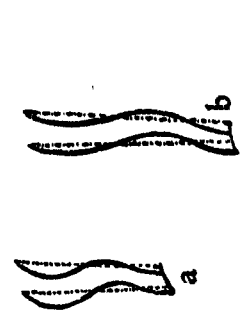
['*Harpoceras*' *antiquum* Wright, in Geyer, 'Hinter-Schafberg' 1893, pl. ii, fig. 8*a*.]

Fig. 2.—*Falciradiate.*



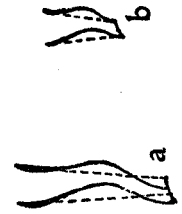
[*a* = '*Grammoceras*' *bassanii* Fucini, 'Appen. Centr.' 1900, pl. x, fig. 6; *b* = '*Grammoceras celebratum*' Fucini, *ibid.* pl. x, fig. 2.]

Fig. 3.—*Subanguliradiate.*



[*a* = '*Grammoceras*' *normanianum* var. *costicillatum*, subvar. *detractum* Fucini, 'Appen. Centr.' 1900, pl. viii, fig. 3; *b* = '*Harpoceras*' *cornacaldense* Tausch, 1890, pl. i, fig. 2.]

Fig. 4.—*Angulirursiradiate.*



[*a* = '*Hildoceras*' *lavinianum* Mgh., var. *conjungens* Fucini, 'Mte. Cetona' 1905, pl. v (xiv), fig. 11; *b* = '*H.*' *l.* var. *retroflexum* Fucini, *ibid.* pl. iii (xiii), fig. 7.]

A brief formal diagnosis of the new genus might, then, be framed as follows:—General form of the shell resembling *Seguenziceras* as here emended: that is, more or less evolute; compressed or quadrate in section, and always keeled—the venter ranging from acute to carinatisulcate. The ornament consists of falciradii, varying within the limits defined in the foregoing table (p. 550). Sutures like *Seguenziceras*.

The introduction of subgenera will have to be delayed until a study of the suture-lines has been accomplished. Further, I believe that no careful observations have been made hitherto, as to the succession in time of the various forms discussed here. Most of them are quoted from the '*margaritatus*' zone; but I think it probable that the two subdivisions of the new genus here established are later than, and have developed from, the older Seguenzicerates of *algovianum* type, with increase and decrease of peripheral projection respectively, added to a flexiradius. Increased knowledge may permit us further to separate from the forms described here two apparently distinct lineages: that of '*Harpoceras (?)*' *dilectum* Fuc.,[1] which tends to develop a typical Harpocerate undercut umbilical edge, but is still subfalciradiate; and that of *Ammonites acutus* Tate, a 'perfalciradiate' form, in which the strong and notched carina becomes so conspicuous a feature.

PROTOGRAMMOCERAS CORNACALDENSE (Tausch) var. ZEUGITANUM nov. (Pl. LII, figs. 1 *a* & 1 *b*.)

Comparable forms:—

1867–81. *Harpoceras pectinatum* Meneghini, 'Fossiles du Medolo' [in Stoppani's 'Paléont. Lombarde' ser. 4, App.] p. 6 & pl. i, figs. 1–3.
1884. *Harpoceras normanianum* (d'Orb.) Wright, 'Lias Ammonites' Monogr. Pal. Soc. p. 470 & pl. lxxxiii, figs. 1–2.
1890. *Harpoceras cornacaldense* Tausch, 'Fauna d. grauen Kalke der Südalpen' Abhandl. K.K. Geol. Reichsanst. vol. xv, pt. 2, p. 36 & pl. i, fig. 1.
1895. *Harpoceras (?) cornacaldense* Tausch, var. *bicicolæ* Bonarelli, 'Fossili Domeriani della Brianza' Rendic. R. Ist. Lombard. ser. 2, vol. xxviii, p. 339.
1900. *Grammoceras normanianum* (d'Orb.) var. *inseparabile* Fucini, 'Amm. del Lias Medio dell' Appennino Centrale' Pal. Ital. vol. vi, p. 29 & pl. viii, fig. 5.
1900. *Hildoceras cornacaldense* Tausch, mut. *medolense* Bettoni, 'Fossili Domeriani della Provincia di Brescia' Mém. Soc. Paléont. Suisse, vol. xxvii, p. 63.
1909. *Harpoceras cornacaldense* (Tausch) Rosenberg, 'Liasische Cephal.-Fauna der Kratzalpe' Beitr. Paläont. Geol. Œsterr.-Ung. vol. xxii, p. 307 & pl. (vii) xvi, figs. 1–2.

The specimen is a cast in compact grey limestone, and has the following dimensions:—

Diameter	60 millimetres.
Height of the last whorl	30 per cent. of the diameter.
Thickness of the last whorl	18 per cent. of the diameter.
Umbilicus	46 per cent. of the diameter.

The whorls are much compressed, and show the peculiar wedge-like thinning towards the periphery characteristic of all the forms

[1] 'Cefalop. Liass. del Mte. di Cetona' pt. 4, Pal. Ital. vol. x (1904) p. 278 (244) & pl. xxxix (xviii), figs. 11–12.

belonging to this group. The ventral area is carinatisulcate on the last whorl; the penultimate one is more rectangular, with a tabulate periphery and a high keel, which is probably hollow, although the crystalline infilling does not let this character show itself very clearly. The inner whorls are much compressed and oval-lanceolate in section, with an acute periphery. The umbilicus is wide (the inclusion being rather less than a quarter) with well-defined perpendicular walls, but a rounded border.

The ornament consists of very close costæ, which seem to degenerate into irregular striæ towards the end; both have a very distinct bend at the inner third of the side (subanguliradiation), and the outer part of the radial curve is somewhat rursiradiate, has only slight peripheral projection, and becomes indistinct before reaching the ventral area. This kind of ornament is limited to the outer whorls only, however; before then the ribs are much stronger and more distant, and, finally, disappear altogether on the inner whorls.

The suture-line is, unfortunately, not clearly visible, but seems to agree with that of the type.

The form here described differs from Dr. Tausch's form in the larger umbilicus (46 per cent. of the diameter instead of 42) and in the beginning of degeneration of the ornament.

The form which Dr. Rosenberg figures comes very near to the type, and his section 2 *b* (pl. xvi) agrees well with that of my specimen. The costation is also too prominent; and, moreover, it is probably exaggerated, so far as the lateral bend is concerned.

The ammonite figured by Wright has little affinity with A. d'Orbigny's *Ammonites normanianus*, as has been pointed out by several authors. Dr. Geyer[1] thinks that it probably belongs to a form of the *boscense* group, and Fucini compares it with his variety *inseparabile* of '*Grammoceras*' *normanianum* (d'Orb.) since their dimensions agree. Dr. Tausch, on the other hand, says that Wright's form is distinguished from *Harpoceras cornacaldense* Tausch only by its section, which is thicker (20 per cent. of the diameter). According to my measurements on the specimen preserved in the British Museum (Natural History), the umbilicus is 42 per cent. of the diameter: that is, the same as in *H. cornacaldense*. The ornament is, however, stronger and very regular; it consists of eighty-five costæ on the last whorl, and only near the end (of a specimen measuring 30 mm. more in diameter than the shell here described) does degeneration set in. A new name, *Protogrammoceras wrighti*, nom. nov. (=*Harpoceras normanianum* Wright *non* d'Orb.[2]), may well be proposed for this ammonite. I may here add that Wright's figure is not quite correct. The radial line should indicate the lateral angularity at the inner third, and the inner whorls, which are smooth at first,

[1] 'Mittelliasische Cephal.Fauna des Hinter-Schafberg' Abhandl. K.K. Geol. Reichsanst. vol. xv, pt. 4 (1893) p. 18.
[2] 'Lias Ammonites' Monogr. Pal. Soc. (1878–86) p. 470 & pl. lxxxiii, figs. 1–2.

show no excentrumbilication. The venter is narrower than shown in the figure, has finer keels, and agrees better with that of the type than the figure would lead one to believe. Wright mentioned that the history of the specimen was not known; but, judging by the matrix, he thought that it might be of Middle Liassic age. The specimen is labelled 'Upper Lias, Somerset,' although the authority for that statement cannot now be ascertained. If the latter age were correct, we have here a striking example of deceptive homœomorphy; but the different style of the ornament in *Hildoceras* and the catagenetic character of the periphery in *Pseudogrammoceras* from carinatisulcate to fastigate do not suggest connexion of Wright's form with the Toarcian Hildoceratidæ. The suture-line is, unfortunately, not visible on the specimen, and I was unable to break it up.

Fucini's var. *inseparabile* of '*Grammoceras*' *normanianum* (d'Orb.), now more correctly named *Protogrammoceras inseparabile* (Fuc.), has a section similar to that of my specimen and not so thick as that of *Pr. wrighti*. The costation, moreover, is coarser in the earlier part of the last whorl than that of the other forms mentioned here; and the radial line may be straighter laterally, showing the form to be somewhat transitional. Fucini's figure is not good enough to enable one to decide this.

Grammoceras cornacaldense (Tausch) var. *bicicolæ* Bonar., is distinguished by a very small umbilicus (32 per cent. of the diameter); and the same percentage is given by Meneghini for his '*Harpoceras*' *pectinatum*, which agrees (especially fig. 3) very well in section and suture with my specimen, but is subfalciradiate.

In Meneghini's variety iii of '*Harpoceras*' *boscense* Reyn. (=*Grammoceras cornacaldense* mut. *medolense* of Bettoni) the umbilicus is only 30 per cent., and the radial curve, owing to the width of the side and a slight peripheral projection, assumes a pseudofalcate character.

PROTOGRAMMOCERAS aff. COSTICILLATUM (Fuc.) var. DETRACTUM Fuc.

1900. *Grammoceras normanianum* (d'Orb.) var. *costicillatum* Fuc., forma *detracta* Fucini, 'Amm. del Lias Medio dell' Appennino Centrale' Pal. Ital. vol. vi, pl. viii, figs. 2–3 & p. 30.
1900. *Grammoceras portisi* Fucini, *ibid.* pl. ix, figs. 1–3 & p. 33.
1904. *Hildoceras portisi* Fucini 'Cefalop. Liass. del Mte. di Cetona' pt. 4, *ibid.* vol. x, pl. xx (xli) figs. 7–11 & p. 287.
1900. *Grammoceras portisi* var. *zittelianum* Fuc. 'Amm. del Lias Medio, &c.' *ibid.* vol. vi, pl. ix, fig. 4 & p. 35.
1900. *Grammoceras portisi* var. *contrarium* Fuc. *ibid.* pl. ix, fig. 5 & p. 36.

This form is preserved only as an impression in the same bluish-grey limestone as the other specimens. The ventral portion is missing, and it is impossible, therefore, to say anything definite about the periphery, except that the venter certainly seems to have been fairly acute and the section compressed. The dimensions are as follows:—

Diameter	67 millimetres.
Height of the last whorl	33 per cent. of the diameter.
Umbilicus	40 per cent. of the diameter.

These dimensions agree with Fucini's variety (only the umbilicus is 40 instead of 42 per cent.) and also with his '*Grammoceras*' *portisi*. But the latter has a sulcicarinate, fairly broad venter and more rounded sides, whereas in the former the sulci are faint and the sides flatter; and these characters, together with the sharper umbilical border, bring it near the present variety.

The ornament consists of flexiradii which are somewhat less angular than those of the group described previously, but would still be classed as subanguliradiate. Some of the ribs are united on the inner half of the side, and come out more prominently then, as illustrated in Fucini's fig. 3 *a* of pl. viii. The costation of the inner whorls also seems to agree very well with that given by Fucini.

Of the other forms cited above, the var. *zittelianum* has an umbilicus of 38 per cent. only: in other words, it is smaller than that of my specimen by the same amount as that by which the type *portisi* exceeds it. The costation is too coarse and distant, however; whereas, on the other hand, in the var. *contrarium* it is too fine, and here the umbilicus is but 33 per cent. of the diameter.

PROTOGRAMMOCERAS (?), sp. nov.

Of this form only a small fragment preserved in grey limestone is in my collection; and, if the specimen had not been found in company with fossils of undoubted Mesoliassic age, I probably should not have hesitated to identify it with *Harpoceras bicarinatum* (Ziet.) =*cumulatum* Hyatt, considering the distinctive characters of this form. But, as I pointed out in the first part of this paper (p. 542), despite this apparently close resemblance, due in part, undoubtedly, to the peculiar mode of its preservation, I am inclined to question its affinity to Zieten's form, especially as the umbilicus and the suture-line are unknown.

The specimen shows close agreement with an undoubted *H. bicarinatum* (Ziet.) from Milhau (Aveyron) in my collection, and also with the figures given by P. Reynès[1] and E. Dumortier.[2] Wright's form[3] seems to be less closely costate, but agrees well in its thin and flat section: it is named *H. bicarinatum* (Münster); but, as Prof. Haug has pointed out, Münster's *bicarinatus* is an *Arcestes*. Hyatt's new specific name for Zieten's *Ammonites bicarinatus* is, therefore, superfluous.

Zieten's figure has more rounded sides and a smaller umbilicus[4] than that given by Wright; also the radial line is less falcate. But there seems to be a good deal of variation in this group (the

[1] 'Monographie des Ammonites du Lias Supér.' pl. v, figs. 18–30.
[2] 'Depôts Jurass. du Bassin du Rhône: pt. 4—Lias Sup.' pl. xi, figs. 3–7 & p. 55.
[3] 'Lias Ammonites' Monogr. Pal. Soc. (1878–86) p. 462 & pl. lxxxii, figs. 9–10.
[4] C. H. von Zieten, 'Verstein. Württembergs' 1830, pl. xv, fig. 9.

change in the course of the radial line at least is probably due to incorrect drawings), and another specimen in my collection from Altdorf (Franconia) shows not only a thicker section but also a smaller number of costæ, similar to figs. 5 & 6 of Dumortier.

So far as I am aware, no Mesoliassic forms so thin as this have been described. My specimen has been slightly squashed obliquely, and is worn on one side, but from the inner whorl shown in section I measured the width of the conch to have been at most 7 millimetres at a whorl-height of 16 mm., precisely the same as in *H. bicarinatum* (Ziet.). The periphery is tabulate, with a fine median keel, as figured by Reynès on pl. v, fig. 29 (*non* 27); the latter is apparently hollow, and certainly so on the inner whorl, where the section is more rectangular and the keel strong and high.

'*Grammoceras*' *celebratum* Fucini[1] has evolute whorls and a distant costation. '*Gr.*' *falcicostatum* Fuc.[2] is similar, but approximates more closely to the form here described in its thin section. It is possible that the latter may represent an involute development of this falciradiate group.

In '*Grammoceras*' *bassanii* Fuc.[3] there is closer and finer costation towards the end, but the curve is only subfalciradiate. *Gr. cornacaldense* (Tausch) mut. *medolense* Bettoni,[4] also has subanguliradiate costation; whereas, in the form here described, the radial line is a true Harpocerate sickle with strong forward projection near the periphery. Bettoni's variety, however, somewhat resembles the form here described in its wide and flat sides and narrow periphery.

In the absence of suture, or even umbilicus, the identification of this interesting fragment must remain doubtful; but, as I have stated before, the association with Domerian ammonites makes it probable that it represents a new form, apparently more or less homœomorphous with the typical Toarcian *Harpoceras bicarinatum* (Ziet.).

Gen. nov. sp. nov. (?). (Pl. LII, fig. 2.)

1900. *Lioceras (?) grecoi* Fucini, 'Amm. del Lias Medio dell' Appenn. Centr.' Pal. Ital. vol. vi, p. 65 & pl. xi, fig. 4.

This interesting fragment was found together with the ammonites described in the foregoing pages. Like Fucini's forms it has a much compressed section, but the umbilicus is smaller than that of his fig. 4*a*, although not quite so small as that of fig. 5*a*: this might be explained, according to Fucini, by the intermediate size of my fragment.

The greatest thickness also occurs at the inner third of the whorl,

[1] 'Ammoniti del Lias Medio dell' Appennino Centrale' Pal. Ital. vol. vi (1900) p. 41 & pl. x, figs. 1–2.
[2] 'Cefalop. Liass. del Monte di Cetona' *ibid.* vol. x (1904) pl. (xviii) xxxix, fig. 13.
[3] 'Amm. del Lias Medio, &c.' Pal. Ital. vol. vi (1900) p. 46 & pl. x, figs. 6–7.
[4] See p. 554.

from which point the sides slope very gradually to the periphery as well as to the umbilicus, although the final edge at the latter is quite sharp.

The periphery, as in Fucini's forms, is 'little spacious' and narrowly rounded, bearing a small keel. Fucini does not state whether this is solid or hollow, and his illustrations are certainly far from good; but he compares his fossils with ammonites described by Meneghini as *A. lythensis* Y. & B., a form which belongs to the hollow-carinate genus *Pseudolioceras*. The latter author[1] also omits to describe the character of the carina.

Now, on the penultimate whorl the form at present considered is distinctly solid-keeled, like the typical Aalenian Liocerates. The section is here also less lanceolate and quite rectangular, with a comparatively broad periphery.

The ornament consists of strong primary costæ near the umbilicus; and, whereas Fucini's form shows fourteen, my specimen possessed probably eighteen to twenty. These costæ bifurcate at the middle of the side, but somewhat irregularly, and the whole of the radial line describes the double curve which is characteristic of the true Liocerates. There are also intermediate costæ, and altogether the character of the costation agrees exceedingly well with that of *Lioceras gracile* S. Buckm. and, less so, with *L. subcostosum* S. Buckm.,[2] both these true Liocerates coming from the *scissi* beds.

Some Pseudoliocerates show superficial resemblance to this specimen. Quenstedt's *Ammonites* cf. *lythensis* (*non* Y. & B.) pl. liv, fig. 54 ('Amm. d. Schwäb. Jura' 1885), is too thick near the umbilical edge and too involute; whereas the style of costation is comparable with that of the form now described only near the end of the last whorl.

Ammonites elegans (*non* Sow.), figured by P. Reynès,[3] also has a different section, and the costæ do not seem to be biarcuate; *Pseudolioceras beyrichi* Schlœnb.,[4] on the other hand, has an approximately similar radial line.

A new generic name might be introduced for these 'Proliocerates' of Domerian age; but, as the sutures of neither Fucini's *grecoi* nor of my specimen are known, and as they are altogether poorly preserved, I will neither venture to propose one myself, nor to speculate on the connexion of the group with the other Middle Liassic Hildoceratidæ.

[1] G. Meneghini, 'Fossiles du Medolo' [in Stoppani's 'Pal. Lombarde' ser. 4, App.] p. 13 (*pars*).
[2] 'Inf. Ool. Ammonites: Suppl.' pt. 10, Monogr. Pal. Soc. vol. lii (1898) pl. vi, figs. 11–13 & 5–7.
[3] 'Monographie des Ammonites du Lias Supér.' pl. v: for example, fig. 10.
[4] U. Schlœnbach 'Beitr. z. Paläont. d. Jura- & Kreide-Format. in N.W. Deutschland: I—Jurass. Amm.' Palæontographica, vol. xiii (1865) pp. 170–71 & pl. xxvii; also S. S. Buckman, 'Inf. Ool. Amm.' pt. 3, Monogr. Pal. Soc. vol. xlii (1888) p. 87 & pl. xx, figs. 7–10.

(2) CALLOVIAN.

Genus REINECKEIA Bayle.

REINECKEIA aff. HUNGARICA Till. (Pl. LII, fig. 3.)

1911. A. Till, 'Amm. Fauna des Kelloway von Villány' Beitr. Paläont. Geol. Österr.-Ung. vol. xxiv, p. 10 & pl. i (v), figs. 1–2; also text-fig. 11.

There is one specimen preserved in red marble, streaked with green, and slightly slickensided in places on the back. Its dimensions are:—

Diameter	65 millimetres.
Height of the last whorl.....	33 per cent. of the diameter.
Thickness of the last whorl ...	28 per cent. of the diameter.
Umbilicus.....	40 per cent. of the diameter.

These measurements agree almost exactly with the dimensions given by Dr. Till, and the sculpture and section also are practically identical.

The last whorl shows about thirty-two primary costæ, each giving rise to two or three secondaries of equal strength and strongly prorsoradiate character. The primaries are short sharp ridges rising to an elongated spine at the point of furcation, and only the innermost whorls bear the rounded tubercles which characterize the *anceps* group. There are four constrictions on the last whorl, more strongly inclined forward than the costæ; and since the costæ also bi- and trifurcate somewhat irregularly, and since some of them, especially those bordering the constrictions, remain single throughout, the sculpture is altogether irregular.

The ventral furrow is very distinct, and bordered by the strong slightly-thickened ends of the secondaries, terminating abruptly at the groove.

The umbilicus is wide, with a nearly perpendicular border.

Dr. Till points out the differences of his form from *Reineckeia kiliani* (Par. & Bon.), *R. straussi* (Weith.), *R. greppini* (Opp.), and *R. fraasi* (Opp.). The ammonite under consideration also bears but little resemblance to these forms.

From *R. greppini* (Opp.) in Till (pl. vi, figs. 4–7) the form here described is distinguished by its smaller umbilicus. Dr. Till does not give the measurements; but, according to his figure, the umbilicus equals about 44 per cent. of the diameter, not 40 as in my specimen: the section also is too thin near the periphery. On the other hand, there is very close agreement in the ornament. The characteristic concave shape of the primary costæ, leading up to the radially elongated spine at the point of bi- or trifurcation, is very distinctive, just as in my specimen; whereas *R. hungarica* Till, the commonest form at Villány, has primaries which are raised into a sharp crest at the middle, not at the end of the short rib. This is the only notable point in which my specimen differs from *Reineckeia hungarica* Till, and approaches *R.* cf. *greppini* (Opp.) Till. I am inclined to consider it an intermediate form, with the *greppini* stage persisting a little longer, and the branching of the secondaries immediately off the umbilical border only occurring once or twice near the end.

R. transiens Till is a transitional form to still more perisphinctoid ammonites, and also resembles my specimen somewhat closely. It has fewer primaries, however (twenty-eight), and its umbilicus (37 per cent. of the diameter) is considerably smaller.

The two ammonites which Waagen figures on pl. lvii, fig. 4 & pl. lix, fig. 1 ('Cephal. of Kutch') as *R. anceps* (Rein.), although they really belong to the *greppini* group, show a similar style of ornament, but are more widely umbilicated (44 and 47 per cent.). The first figure (= *R. waageni* Till) has less numerous and less sharp costæ, and they divide more in the middle of the side, not at the inner fourth. In *R. eusculpta* Till this point of bifurcation has moved still more towards the middle of the side, whereas the section is here quadrate. Waagen's second form (= *R. reissi* Steinmann) has the tubercles more strongly developed.

The *Reineckeia* to which I referred in the first part of this paper (p. 543), from Foum Islamen, Constantine, differs from all the forms mentioned here in its rounded whorls and strong costation. It shows a highly coronate stage persisting almost to the end, and belongs therefore to the true *anceps* group = *substeinmanni* group of Dr. P. Lemoine.

The suture-line is not shown on my specimen, but there can be no doubt about the Callovian age of the ammonite.

I may add that, as the Upper Jurassic was known to occur on Jebel Zaghuan, I first endeavoured to compare my specimen with those Kimmeridgian and Tithonian forms which were at one time included in the genus *Reineckeia*. But the resemblance is, in reality, only quite superficial. For example, *Aulacostephanus phorcus* Font.[1] has similar dimensions, but distant tubercles, not close primary costæ, around the umbilicus; and in the genus *Acanthodiscus* (as, for example, *A. andreæi* Kil.[2] and *A. chaperi* Pictet[3]) the tuberculate character of the ornament is still more distinct, whereas the resemblance with certain forms of *Himalayites* Uhlig[4] is also merely superficial. Apart from the costation, the character of the constrictions and chiefly the inner whorls clearly distinguish the Callovian *Reineckeiæ* from these Upper Jurassic forms.

[1] See E. Dumortier & F. Fontannes, 'Descr. des Amm. de la Zone à *Amm. tenuilobatus* de Crussol' 1876, p. 108 & pl. xv, fig. 3; also P. de Loriol, 'Monogr. Pal. des Couches de la Zone à *Amm. tenuilobatus* de Baden (Argovie)' Mém. Soc. Pal. Suisse, vol. v (1875) pl. xvi, fig. 4.

W. Kilian, 'Mission d'Andalousie: II—Études Paléont. sur les Terrains Secondaires & Tertiaires de l'Andalousie' Mém. Ac. Sci. Paris, vol. xxx (1889) p. 670 & pl. xxxii, fig. 1.

[2] F. J. Pictet, 'Mél. Pal.' pt. 4, 1868, p. 242 & pl. xxxvii, figs. 1–3.

[4] V. Uhlig, 'Fauna of the Spiti Shales' Pal. Indica, ser. 15, vol. iv (1910) pl. xxxviii.

Genus PERISPHINCTES Waag. *em.* Siem.

PERISPHINCTES cf. BIENIASZI Teiss. (Pl. LII, fig. 4.)

1899. J. von Siemiradzki, 'Monogr. Beschreib. d. Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 302 & pl. xxvi, fig. 49.

This is the only specimen of *Perisphinctes* found in the *anceps* zone of the Poste Optique; and, although it resembles, in its red marble matrix, the many perisphinctoid forms collected in higher beds on another side of the mountain, it is clearly distinguished by its ventrally rursicostate ornament. The specimen consists of only a poorly-preserved cast, and its dimensions are:—

Diameter	110 millimetres.
Height of the last whorl	31 per cent. of the diameter.
Thickness of the last whorl	27 per cent. of the diameter.
Umbilicus	46 per cent. of the diameter.

The specimen is septate throughout, and its diameter would, therefore, be considerably increased by the presence of the body-chamber, which is of importance in view of the affinities of the ammonite to *Grossouvria*.

The whorls are compressed: that is, the section is higher than wide, especially towards the end, showing flat sides between a rounded, but distinct, umbilical border and a circular periphery. The whorl is thickest near the umbilical border.

The umbilical wall itself is almost perpendicular, and the umbilicus moderately deep and wide. The inclusion is rather less than half of the previous whorl.

The last whorl of the specimen here described is very badly preserved; but, at about 70 mm. diameter, the ornament consists of some thirty-five primary costæ which are thickened, slightly prorsoradiate, and virguloid, with the concave side forwards. They begin on the umbilical edge, and reach to the middle of the side, where they bi- or trifurcate, so that on the periphery we can count about 110 delicate rursiradiate costæ. Some intercalated secondaries also occur. The course of the whole of the radial curve is therefore sigmoidal, and this character is shown also by the two constrictions on the whorl (at 70 mm. diameter), although these latter are more oblique: that is, more distinctly prorsoradiate. Slight attenuation of the secondaries is shown along the median line of the periphery. Parabolar knobs are not visible.

The inner whorls, unfortunately, are very badly preserved, but seem to be regularly costate, as in Quenstedt's *Ammonites convolutus gigas*.[1]

The suture-line is similar to that given by Quenstedt[2] for an ammonite which Siemiradzki includes in the synonymy of *Perisphinctes orion* (Opp.), and resembles also that of *Grossouvria curvicosta* (Opp.) as given by Siemiradzki.[3]

[1] 'Amm. d. Schwäb. Jura' 1887, pl. lxxxi, fig. 21 & p. 693.
[2] 'Cephalopoden' 1849, p. 171 & pl. xiii, fig. 6.
[3] 'Monogr. Beschreib. d. Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv (1898) p. 97 & fig. 8.

If then, despite this close agreement in dimensions and all details, I do not entirely identify my specimen with the type, it is on account of its bad state of preservation.

The ammonite which M. Neumayr figures and describes[1] as *Perisphinctes curvicosta* (Opp.), but belongs, according to Siemiradzki, to the group of *P. caroli* Gemm., shows much resemblance to the form here described. Its section is, however, wider; the costæ are more strongly sigmoidal and rursiradiate; there are parabolar knobs; and altogether the ammonite has still much more affinity with the typical *Grossouvriæ* than with the form here described, and has probably been excluded from that subgenus only on account of its large size. It may be considered a transitional form from the *Grossouvria-curvicosta* group to the groups of *Perisphinctes caroli* and *P. orion*, the latter including the ammonite here described with initial Perisphinctate costation of a more prorsorectiradiate character and much larger dimensions.

With the true *Perisphinctes curvicosta* (Opp.) Siem.,[2] and especially *P. curvicosta* (Opp.) in Waagen,[3] which has a very irregular ornament and rounded section, there is, therefore, correspondingly less agreement.

Dr. Till figures a *Perisphinctes* cf. *curvicosta* (Opp.),[4] which also bears a certain resemblance to the form here described; but in this the costation is similarly rursiradiate and the umbilicus is too narrow. Of the other forms figured by the same author, only *P. villányensis* Till and *P. leptoides* Till somewhat resemble my specimen. In the former the umbilicus is narrower, and the primary costæ are fewer than in my specimen. *P. leptoides* has parabolar knobs and a section too wide near the periphery.

With the other ammonites included in the groups of *P. caroli* and *P. orion*, my specimen is less closely comparable.

(3) UPPER JURASSIC.

Genus PHYLLOCERAS Suess.

PHYLLOCERAS cf. MEDITERRANEUM Neum.

1898. A. de Riaz, 'Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)' pl. xvi, figs. 9–10 & p. 40.

Seven out of fourteen Phyllocerates belong to this form, which seems fairly common at Sidi Bu Gubrîn. These agree very closely with the figures given by A. de Riaz; and the form is, indeed, easily recognized by its comparatively-wide umbilicus, its five

[1] 'Cephalop. Fauna d. Oolithe von Balin' Abhandl. K.K. Geol. Reichsanst. vol. v (1871) pl. xii, fig. 2 & p. 34.
[2] 'Monogr. Beschreib. d. Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv (1898) p. 96.
[3] 'Jurassic Fauna of Kutch' Pal. Indica, ser. 9, vol. i (1873) pl. xxxix, figs. 4–6 & p. 169.
[4] 'Amm. Fauna des Kelloway von Villány' Beitr. Paläont. Geol. Œsterr.-Ung. vol. xxiv (1911) pl. (iv) viii, fig. 5.

gently-bent constrictions, slightly rursiradiate near the periphery, and its trifid lateral lobe.

With the material at my disposal: that is, imperfect casts bearing no trace of the shell-ornament, and showing only the suture-line in disconnected portions, it is impossible to decide whether the form should really be included in Neumayr's *Ph. mediterraneum*; but the smaller number of constrictions (which seems very constant) may well enable us to separate the Argovian forms from the type.

Neumayr's form [1] came from the *macrocephalus* zone, and closely comparable ammonites from the same beds have been figured by Gemmellaro,[2] Popovici-Hatzeg,[3] and others. Dr. P. Lemoine [4] has recently created the var. *indica* for the Indian form of *Ph. mediterraneum* Neum. figured by Waagen,[5] which occurs also in Madagascar, being distinguished by less inclusion and a wider umbilicus. All these Callovian forms have seven (or eight) constrictions.

Dr. M. Canavari[6] describes the form from the *Aspidoceras-acanthicum* beds. As he figures only a fragment, it is impossible to say whether there is agreement with the Callovian forms; but the Argovian forms, at any rate, seem already distinct, and we may reasonably doubt whether the ammonite really persisted from the *macrocephalus* zone to the uppermost Jurassic, as is generally assumed.

Phylloceras zignodianum (d'Orb.), a form which differs only in having more angular constrictions and a bifid lateral saddle, does not seem to occur in Mediterranean deposits.

An eighth specimen in my collection from Zaghuan has straighter constrictions and a smaller umbilicus than the other seven; but as the specimen is worn, and as one of A. de Riaz's figures [7] also shows constrictions which on the cast are almost straight, I include it here.

PHYLLOCERAS cf. SUBPTYCHOICUM Dacqué. (Pl. LIII, fig. 1.)

1873. W. Waagen, 'Jurassic Fauna of Kutch' Pal. Indica, ser. 9, vol. i, p. 30 (*pars*) [as *Ph. ptychoicum*] & pl. vii, fig. 2.
1910. E. Dacqué, 'Dogger & Malm aus Ostafrika' Beitr. Paläont. Geol. Œsterr.-Ung. vol. xxiii, p. 7 & pl. ii, fig. 1.

One specimen in the collection belongs to the *ptychoicum* group, but no labial ridges are visible. These, most probably, have been worn down; but, since they are absent on the chambered parts

[1] 'Jurastud. 3: Phylloceraten des Dogger & Malm,' Jahrb. K.K. Geol. Reichsanst. vol. xxi (1871) p. 340 & pl. xvii, figs. 2–5.
[2] 'Faune Giur. & Liass. della Sicilia' 1872–82, pl. xvii, fig. 2.
[3] 'Céphal. Jurass. moyen du Mt. Strunga' Mém. Soc. Géol. France (Paléont.) vol. xiii (1905) No. 35, pl. iii, figs. 9 & 10.
[4] 'Pal. Madagascar: pt. 8—Amm. d'Analalava' Ann. Paléont. vol. v (1910) p. 3 & pl. i, fig. 1.
[5] Pal. Indica, ser. 9, vol. i (1873) p. 34 & pl. v, fig. 1, pl. vii, fig. 3.
[6] 'Fauna degli Strati con *Aspidoceras acanthicum* del Mte. Serra' Pal. Ital. vol. ii (1896) p. 38.
[7] 'Description des Ammonites des Couches à *Pellioceras transversarium* de Trept (Isère)' 1898, pl. xvi, fig. 10.

of the younger shells belonging to this group, and since my cast is septate throughout, it is possible that they never existed on the specimen. The dimensions are:—

Diameter	80 millimetres.
Height of the last whorl.....	57 per cent. of the diameter.
Thickness of the last whorl	42 per cent. of the diameter.
Umbilicus.....	8 per cent. of the diameter.

These measurements agree closely enough with Waagen's figures, and the flattened sides and gentle slope towards the umbilicus, shown on my ammonite, are also characteristic of the Indian form. On the other hand, the suture-line of the specimen, though worn at the periphery, shows only a subtetraphylloid external saddle, and the first lateral saddle is subdiphylloid; altogether quite like those of *Phylloceras euphyllum* Neum.

No similar intermediate form between the latter, which ranges, according to Neumayr, from the *macrocephalus* to the *cordatus* beds, and the typical Tithonian *Phylloceras ptychoicum* Quenst. (see especially K. A. von Zittel's 'Stramberger Schichten' pl. iv for figures) seems to have been described from European deposits. *Phylloceras subptychoicum* Dacqué occurs in India and German East Africa in the '*perarmatum*' zone, and differs, as we have seen, in its clearly tetraphylloid lateral saddle. According to its author, the Corallian form differs from the younger *Ph. ptychoicum* Quenst. in having on the umbilical side of the external saddle a peculiar leaflet below the summit-branches; and an identical arrangement is observable on my specimen.

Phylloceras feddeni Waagen,[1] from the same zone of India and Madagascar, has the external saddle still diphylloid and only the peripheral leaflet shows initial division. The umbilicus in this form is deeper, moreover, and the section wider, coming nearer to the true *Ph. ptychoicum* (Quenst.). Waagen erroneously gave the thickness as only 22 per cent. of the diameter, but his illustration shows that this figure must at least be doubled.

Ph. jaraense Waagen [2] has a different section and a rosette of short curved constrictions at the umbilicus. Its suture-line is not unlike that of my specimen; the external saddle is tetraphylloid, but the siphonal lobe is almost as long as the lateral lobe, and the first lateral saddle is also tetraphylloid.

Ph. insulare Waagen [3] also has a different section and a very long siphonal lobe.

With regard to all these forms of Indo-Malagasy affinities, it is interesting to note that Pervinquière [4] considers the *Perisphinctes beyrichi*, described by Futterer [5] from the Jurassic of German East Africa, to be identical with his *P. adelus* Gemm. found in Tunis and Sicily.

[1] 'Jurassic Fauna of Kutch' 1873, pl. vii, fig. 1 & p. 27.
[2] *Ibid.* pl. v, fig. 6 & p. 28.
[3] *Ibid.* pl. ix, fig. 3 & p. 29.
[4] 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' 1907, p. 23.
[5] 'Beitr. z. Kenntn. d. Jura in Ost-Afrika' Zeitschr. Deutsch. Geol. Gesellsch. vol. xlvi (1894) p. 9 & pl. ii, figs. 1–3.

PHYLLOCERAS MANFREDI (Oppel).

1863. *Ammonites manfredi* Oppel, 'Ueber Jur. Amm.' Pal. Mitt. Mus. d. K. Bayerisch. Staates, p. 215 & pl. lvii, fig. 2.
1871. *Phylloceras manfredi* Neumayr, 'Jurastudien: 3—Phylloceraten des Dogger & Malm' Jahrb. K.K. Geol. Reichsanst. vol. xxi, p. 37 & pl. xiv, fig. 8.
1907. *Phylloceras* cf. *manfredi* Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 13.

A small ammonite, not very well preserved, seems to agree with this form; its dimensions are:—

Diameter	23 millimetres.
Height of the last whorl	55 per cent. of the diameter.
Thickness of the last whorl	38 per cent. of the diameter.
Umbilicus	9 per cent. of the diameter.

These dimensions agree with those given by Neumayr. There are also four constrictions which begin indistinctly near the umbilicus, and become wider and more conspicuous near the periphery. The sides are bulging (as figured by Neumayr), and what can be seen of the suture agrees also with fig. 8 *b* of that author.

Pervinquière records this form from Jebel Zaghuan, but thinks that it is very difficult to determine whether his three small ammonites belong really to the form here described or to *Ph. puschi* (Oppel). My specimen shows neither the numerous constrictions, nor the thin section and small umbilicus, of the latter form.

The state of preservation of a second specimen, which I refer doubtfully to *Ph. manfredi* (Oppel), is rather bad.

PHYLLOCERAS cf. SAXONICUM Neum.

1871. M. Neumayr, 'Phylloceraten des Dogger & Malm' Jahrb. K.K. Geol. Reichsanst. vol. xxi, p. 315 & pl. xiii, fig. 4, pl. xiv, figs. 1–2.
1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 12.

A poorly-preserved cast, referred doubtfully to this form, has the following dimensions:—

Diameter	90 millimetres.
Height of the last whorl	60 per cent. of the diameter.
Thickness of the last whorl	32 per cent. of the diameter.
Umbilicus	3 per cent. of the diameter.

Neumayr's form agrees so far very well, and in section especially; but on my specimen no trace of the umbilical rosette of virguloid grooves is to be seen. Pervinquière also mentions a rather badly-worn specimen from the Lower Tithonian of Jebel Ben Saidan, and this approaches to *Ph. saxonicum* Neum. in thickness, but has no rosette. What there is to be seen of the suture-line, especially the diphylloid external saddle and the triphylloid first lateral saddle, seems to agree equally well with Neumayr's type.

Since my specimen shows no trace of the original shell-ornament, no comparison can be made with *Ph. dyscritum* Canavari—a form distinguished from *Ph. saxonicum* Neumayr by prorsiradriate lineation, instead of recti- to rursicostation.

PHYLLOCERAS cf. ISOTYPUM (Benecke).

1865. E. W. Benecke, 'Ueber Trias & Jura in den Südalpen' Geogn. Pal. Beitr. p. 184 & pl. vii, figs. 1–2.
1871. M. Neumayr, 'Phylloceraten des Dogger & Malm' p. 314 & pl. xiii, fig. 3.
1896. M. Canavari, 'Strati con *Aspidoceras acanthicum* del Mte. Serra' p. 32.
1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 11.

One small ammonite in the collection seems to be comparable with Benecke's form. It has the flattened sides, deep umbilicus bordered by steep walls, and radial striation at the periphery: the section, however, is not rounded-quadrate, but more elliptical. Its thinness excludes it also from the var. *appenninicum* Canav. of *Ph. isotypum* (Ben.).

A larger specimen has the somewhat broadened venter of Benecke's form, but the umbilicus is smaller and fairly shallow, although it may only have been worn down. It resembles in this respect *Phylloceras serum* (Oppel); but the latter ammonite is much thinner, especially near the periphery.

This ammonite is very common in the '*acanthicus*' zone of the Alps and Sicily, and Pervinquière has recorded it (although not with certainty) from Jebel Ben Saidan in Tunisia. I have not come across any Argovian *Phylloceras* with which my specimens could be compared; but, in view of the fact that they were collected together with a large number of *transversarius*-zone fossils, I may mention that there is a possibility of the first specimen representing the inner whorls of *Ph. plicatum* Neumayr. It has the peripheral ornament, but differs apparently in the umbilicus. In any case, it must be remembered that it is a young specimen, and that the other ammonite, as well as *Phylloceras* cf. *saxonicum* Neum., described previously, are worn specimens, so that their attribution to the '*acanthicus*' zone is doubtful.

According to Dr. Pompeckj,[1] *Ammonites heterophyllus albus* Quenstedt,[2] from the *bimammatum* zone of Laufen, differs from Benecke's type only in having a narrower umbilicus and less flat sides.

Genus SOWERBYCERAS Par. & Bon.

SOWERBYCERAS PROTORTISULCATUM (Pomp.). (Pl. LIII, figs. 2*a*–2*c*.)

1893. J. F. Pompeckj, 'Beiträge zur Revision der Ammoniten d. Schwäbischen Jura' pt. 1, p. 53 & pl. ii, figs. 1–2.
1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 15.

This easily-recognizable ammonite is exceedingly common at Sidi Bu Gubrîn, and I can identify twenty-one specimens with Pompeckj's types, whereas only two specimens appear to belong to a different form of *Sowerbyceras*. They are all casts, and the measurements of eleven forms are as follows:—

[1] 'Beitr. z. Revision d. Ammon. d. Schwäbischen Jura' pt. 1, 1893, p. 28.
[2] 'Ammoniten d. Schwäbischen Jura' 1888, p. 901 & pl. xcvii, fig. 7.

Diameter.	*Height.*	*Thickness.*	*Umbilicus.*
Millimetres.	Per cent.	Per cent.	Per cent.
20	45	45	25
21	43	43	25
21	42	43	26
22	42	41	27
23	44	45	22
25	45	48	24
36	42	47	25
37	46	48	22
41	44	41	22
42	43	40	26
43	44	42	24

The other specimens are less well preserved. I state the dimensions in detail, because they show that, despite some variation, the height of the last whorl is almost equal to the thickness; whereas in *Sowerbyceras tortisulcatum* (d'Orb.), which, moreover, belongs to the *athleta* zone, the proportion of height to thickness is about 4 : 3. This, together with the sharp and high umbilical edge, was the principal distinction in separating the Argovian forms from A. d'Orbigny's 'Oxfordian' type.

Pervinquière records from Jebel Zaghuan one fragment and three small ammonites, referable to *Sowerbyceras tortisulcatum* (d'Orb.), and associated with *Ochetoceras arolicum* (Opp.) and other Argovian ammonites. They also doubtless belong to the same form as the specimens here described.

SOWERBYCERAS cf. LORYI (Munier-Chalmas).

1876. *Ammonites (Phylloceras) silenus* Dumortier & Fontannes, 'Descr. des Amm. de la Zone à *Amm. tenuilobatus* de Crussol' p. 33 & pl. v, fig. 2.
1877. *Phylloceras silenus* in Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 185 & pl. xvi, figs. 1–3.
1907. *Phylloceras loryi* in Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 15 & pl. i, figs. 1–2.

The two specimens which I refer to this form have the following dimensions:—

	No. 1.	*No.* 2.
Diameter	37 mm.	33 mm.
Height of the last whorl	50	49 per cent. of the diameter.
Thickness of the last whorl ...	? 40	43 per cent. of the diameter.
Umbilicus	17	18 per cent. of the diameter.

The narrower umbilicus, with sloping walls and rounded edge, combined with the absence of constrictions, seems to separate these two ammonites from *Sowerbyceras protortisulcatum* (Pomp.). Since the specimens are not very well preserved, however, the identification must remain doubtful; and, in view of the fact that I collected a great number of Sowerbycerata and other forms of the *transversarius* zone at the same place, I hesitate to assume a later age for these two imperfect specimens.

Pervinquière mentions one specimen of *Sowerbyceras loryi* (Mun.-Ch.) from Zaghuan; but, near the neighbouring Jebel Ben Saidan, he collected some twenty specimens of *S. loryi* in the

acanthicus zone, and he therefore regards the present form as the commonest Tithonian ammonite of Tunis. Its rarity or absence at Sidi Bu Gubrîn is consequently very significant.

Genus LYTOCERAS Suess.

LYTOCERAS cf. GASTALDII Gemmellaro.

1870. *Lytoceras montanum (pars)* Gemmellaro, 'Fauna del Calcario à *Terebratula janitor* del Nord di Sicilia' Giorn. Sci. Nat. Palermo, pt. 1, p. 33 & pl. vi, fig. 1.
1872. *Lytoceras orsinii* Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 33 & pl. viii, figs. 2–3.
1875. *Lytoceras gastaldii* Gemmellaro, *ibid.* p. 114.
1898. *Lytoceras* cf. *polyanchomemum* (Gemm.) De Riaz, 'Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)' p. 39 & pl. xvi, fig. 4.

The dimensions of the specimen which I refer here are:—

Diameter	37 millimetres.
Height of the last whorl	38 per cent. of the diameter.
Thickness of the last whorl	35 per cent. of the diameter.
Umbilicus	43 per cent. of the diameter.

The wide umbilicus and hardly overlapping, slowly increasing whorls, with section slightly higher than wide, agree well with the type. The cast is smooth, however, and no trace of the original shell-ornament is left.

Another specimen has a smaller umbilicus (40 per cent. of the diameter only) and possibly more flattened sides, similar to *Lytoceras subtile* (Opp.); but, as the specimen is somewhat worn, specific determination becomes very difficult. Oppel's type comes from the Tithonian of Stramberg; on the other hand, *L. polyanchomemum* Gemm., with which A. de Riaz compares a specimen from the *transversarius* zone of Trept, has been described from the *macrocephalus* beds of Sicily. According to Gemmellaro, the Sicilian form has an umbilicus measuring only 38 per cent. of the diameter, and a high elliptical section; De Riaz's form is more evolute, however, and comes nearer the form to be described next.

In *Lycoceras orsinii* Gemm. the umbilicus is 40 to 43 per cent., as in my two ammonites; but the better-preserved specimen, at any rate, seems to resemble the Argovian form more than it resembles this *acanthicus*-zone fossil. It is unfortunate that one cannot express an emphatic opinion on the age of these forms; but, as I have pointed out before, the fact is very significant that among a large number of forms belonging to the *transversarius* zone, the apparent exceptions should belong to the little-changing genera *Lytoceras* and *Phylloceras*.

LYTOCERAS aff. POLYCYCLUM Neum.

1873. M. Neumayr, 'Fauna der Schichten mit *Aspidoceras acanthicum*' Abhandl. K.K. Geol. Reichsanst. vol. v, p. 160 & pl. xxxi, fig. 4.
1877. G. G. Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 188 & pl. xvi, fig. 5.
1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 17 & pl. i, fig. 4.

This ammonite is very evolute, the umbilicus measuring, at least,

48 per cent. of the diameter. It greatly resembles Neumayr's form from the *acanthicus* zone, and also *Protetragonites quadrisulcatus* (d'Orb.) from the Tithonian. It is perfectly smooth, however, and shows neither the sulci of the latter form nor the periodic ridges indicated in Gemmellaro's figure of *Lytoceras polycyclum*.

The whorls, although circular and hardly touching on the inner part of the shell, seem to be greatly depressed at the end. It is probable that this character is merely due to squashing of the last whorl, which is incomplete. If not squashed, the specimen would have greatly exceeded, in this depression of the outer whorl, *L. liebigi* (Opp.), which has been quoted from Jebel Zaghuan together with Argovian ammonites; but, as it is a typical Tithonian form, I am inclined to think the identification at fault.

The specimen which A. de Riaz figures as *L.* cf. *polyanchomemum* Gemm. is more involute than my form; in all probability, its section also is different. I have not come across the description of any other widely-umbilicated *Lytoceras* from the *transversarius* zone.

Genus Ochetoceras Haug.

Ochetoceras arolicum (Oppel).

1863. A. Oppel, 'Ueber Jur. Amm.' Pal. Mitt. Mus. d. K. Bayerisch. Staates, p. 188 & pl. li, figs. 1-2.
1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 18.

The two specimens in my collection consist of only septate whorl-fragments, but the characters of this thin and smooth tricarinate form are very distinct, and the identification therefore reliable.

The form is a characteristic fossil of the Argovian (Pervinquière says of the 'Lower Oxfordian'), and has been recorded already from the Poste Optique on another side of the mountain of Zaghuan.

Ochetoceras canaliculatum (Münster).

1830. Münster, in C. H. von Zieten, 'Verstein. Württ.' p. 37 & pl. xxviii, fig. 6.
1831. L. von Buch, 'Recueil de Planches de Pétrif. Remarq.' pl. i, figs 6-8.
1863. A. Oppel, 'Ueber Jur. Amm.' Pal. Mitt. Mus. d. K. Bayerisch. Staates, p. 157 & pl. li, fig. 3.
1898. A. de Riaz, 'Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)' p. 49 & pl. xvii, figs. 4-6.

My specimen agrees with the figures cited above, as also with specimens that come from the *transversarius* zone of Aargau and from Les Vraconnaz (Vaud). The form is a characteristic Argovian ammonite, and occurs almost throughout the whole range of the *transversarius* zone from South-Western Poland through the Carpathians, the Alps, France, and Spain to North Africa.

Ochetoceras sp.

1875. *Ammonites hispidus* (Opp.) Favre, 'Description des Fossiles du Terrain Jurassique de la Montagne des Voirons' Mém. Soc. Pal. Suisse, vol. ii, p. 27 & pl. ii, fig. 8.

This genus is further represented by the inner whorls of a form

probably like *O. hispidum* Opp. as figured by Favre, or even like *O. canaliculatum* Von Buch. It is only towards the end of the last whorl that the crescents of the outer area appear; previously to that the sides are smooth, and show only the spiral groove.

Genus Taramelliceras de Camp.

Taramelliceras cf. anar (Oppel).

1863. A. Oppel, 'Ueber Jur. Amm.' Pal. Mitt. Mus. d. K. Bayerisch. Staates, p. 207 & pl. lv, fig. 1.
1871. M. Neumayr, 'Jurastudien: 4—Die Vertretung der Oxfordgruppe im östlichen Theile der Mediterranen Provinz' Jahrb. K.K. Geol. Reichsanst. vol. xxi, p. 366 & pl. xviii, fig. 5.

The first half of the last whorl of my specimen is quite smooth (perhaps worn), and it is only with some hesitation that I refer it to Oppel's form. The latter part of the last whorl, however, is much like fig. 1 *d* of Oppel's pl. lv, and the specimen also agrees in section and umbilicus so well with the figures, that, if not identical with the type, it must at least represent a very closely-allied form.

Neumayr's specimen differs from mine in section, as well as in its larger umbilicus, and it seems doubtful whether it is really identical with Oppel's type.

Genus Lissoceras (?) Bayle.

'Lissoceras' erato (d'Orb.).

1847. A. d'Orbigny, 'Pal. Franç.: Terr. Jurass.—Céphal.' p. 531 & pl. cci, figs. 3-4.
1875. E. Favre, 'Descr. des Foss. du Terrain Jurass. de la Montagne des Voirons' Mém. Soc. Pal. Suisse, vol. ii, p. 28 & pl. i, fig. 15 *a*.

A small ammonite, somewhat fragmentary, but showing the inner whorls well, clearly belongs to this form. Its smoothness and flatness, combined with a rounded venter and fairly open umbilicus, make it easily recognizable.

Another nearly complete and larger specimen has the umbilicus somewhat narrower, probably measuring only 27 per cent. of the diameter, as compared with the 30 per cent. in D'Orbigny's type. It also seems that the periphery is slightly more acute in my specimen than in the type; but, as the ammonite is worn, I include it with the other specimen in D'Orbigny's well-known 'species,' which is so common a fossil of the Argovian.

In accordance with present custom, I leave his form in the genus '*Lissoceras*' Bayle (= *Haploceras* Zittel); but there can be no doubt that the Argovian forms have no generic connexion with the true Bajocian Lissocerates. It seems that several lineages within the Oppelidæ developed these smooth, rounded forms, and increased knowledge and more material will doubtless enable us to assign to those later groups, which, wrongly, have been put in the genus *Lissoceras*, their proper places within the family Oppelidæ.

Genus PERISPHINCTES Waag. *em.* Siem.

PERISPHINCTES (GROUSSOUVRIA) cf. REGALMICENSIS (Gemmellaro). (Pl. LIII, figs. 3 *a* & 3 *b*.)

1875. *Ammonites regalmicensis* Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 119 & pl. xiv, fig. 3.
[1867. *Ammonites birmensdorfensis* Mœsch, 'Aarg. Jura' Beitr. z. Geol. Karte der Schweiz, No. 4, p. 291 & pl. i, fig. 3.]
1898. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 87 & fig. 4.

The outer whorl of my specimen is somewhat worn, so exact measurements cannot be made; but the umbilicus amounts to probably 55 per cent. of the diameter, and this exceedingly slow character of the coiling, together with the obliqueness of the constrictions, forms the most noticeable feature of my specimen. It resembles in this respect, as well as in its state of preservation and size, the ammonite figured by Gemmellaro; but, according to Siemiradzki, *P. regalmicensis* has flattened sides, whereas the rounded walls of my specimen remind one of *P. birmensdorfensis* Mœsch, although the costation of the latter form is finer. This has also a larger umbilicus (57 per cent.) than *P. regalmicensis* Gemm.; but, on the whole, I am inclined to associate my specimen with the Sicilian form, as the figure given by Mœsch also shews the last constriction to be almost radial instead of being still strongly prorsoradiate.

In *P. navillei* Favre the obliquity of the costæ, and especially of the constrictions, is a still less noticeable feature.

The ammonite is undoubtedly of Argovian age.

PERISPHINCTES (GROSSOUVRIA) cf. NAVILLEI Favre.

1875. E. Favre, 'Descr. des Foss. du Terrain Jurass. de la Montagne des Voirons' Mém. Soc. Pal. Suisse, vol. ii, p. 34 & pl. iv, fig. 1.

The identification of this specimen is difficult, owing to its bad state of preservation; but it seems to be closely comparable with Favre's form from the Birmensdorf Beds of Voirons.

At a diameter of 60 millimetres the umbilicus measures 49 per cent., and there are about fifty-five costæ slightly prorsoradiate, but becoming worn near the venter, so that my specimen might even be a *Simoceras*, two forms of this genus (*randenense* and *doublieri*) being very similar.

Perisphinctes birmensdorfensis (Mœsch) has a larger umbilicus (57 per cent.) and a circular whorl-section, as well as closer costation, which latter also distinguishes *P. regalmicensis* Gemm. from my specimen.

The ammonites which A. de Riaz figures as *P. birmensdorfensis* (Mœsch)[1] show at a diameter of 51 mm. only forty-five costæ; according to Siemiradzki, they do not, therefore, belong to Mœsch's

[1] 'Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)' 1898, p. 27 & pl. x, figs. 6–7.

form. Their section is broader than high, however, and this distinguishes them equally from my ammonite. A. de Riaz's forms may be possibly identified with *Perisphinctes* sp. nov. aff. *birmensdorfensis*, quoted by Siemiradzki[1]; but the number of costæ in the latter seems to be at least fifty at a diameter of 58 mm.

PERISPHINCTES (GROSSOUVRIA) cf. DENSICOSTA Gemmellaro.

1877. G. G. Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 200 & pl. xvi, fig. 7.
1898. J. von Siemiradzki, *op. supra cit.* Palæontographica, vol. xlv, p. 89.

A fragment shows the oblique dichotomous costæ as in the type; but the secondaries seem to be more regularly bifurcating, and the two branches pass across the periphery without the strong forward bend. The section also is probably slightly flatter at the sides, and these form more of an angle at the umbilical border.

The type comes from the lower beds of the *acanthicus* zone of Sicily.

There does not seem to be any Argovian form with which my specimen might be more closely connected; but, since I possess only a fragmentary specimen, comparison becomes both difficult and unreliable.

PERISPHINCTES (BIPLICES) KOBELTI Neumayr.

1885. M. Neumayr, 'Geogr. Verbr. d. Juraform.' Denkschr. K. Akad. Wissensch. Wien, vol. 1, p. 82 (138) & pl. i, fig. 1.
1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 22 & pl. i, fig. 5.

Two specimens from Sidi Bu Gubrîn seem to agree well with the figures and descriptions given for this form. They show the wide umbilicus of about 50 per cent. of the diameter, a section which is slightly broader than high, and two very deep constrictions on the last whorl. The number of costæ (fifty-five) and their continuity across the venter seem to show that my ammonite is even nearer Neumayr's type than the specimen figured by Pervinquière.

One of the specimens, which seems to have suffered in earth-movements, might possibly belong to an allied Simocerate form, as its periphery is not well preserved.

As I mentioned in the first part of my paper, I am not at all satisfied that the age of this form is 'certainly Tithonian.' Le Mesle has found it with 'Oxfordian' fossils, and its association at Sidi Bu Gubrîn with ammonites the great majority of which belong to the *transversarius* zone does not confirm Pervinquière's view.

Uhlig considers these forms of the *tiziani* group to be true *Perisphinctes*; but, since he omits to state his reasons for not accepting Siemiradzki's classification, and, further, since he does not seem to have made a detailed study of the early Perisphinctoids, I prefer to leave the form here described in the subgenus *Biplices* v. Sutn.

[1] 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv (1898) p. 87: *Ammonites colubrinus (pars)* Quenst.

PERISPHINCTES (ATAXIOCERAS) ÆNEAS Gemmellaro.

1877. G. G. Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 162 & pl. xx, fig. 12.
1898–99. J. von Siemiradzki, 'Monogr. Beschreib. d. Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, pp. 184 & 342.
1898. A. de Riaz, 'Descr. des Amm. des Couches à *Peltoceras transversarium* de Trept (Isère)': as *P. virgulatus* (Quenst.) p. 20 & pl. x, fig. 4.

I possess only half an ammonite, measuring about 70 millimetres in diameter; but the fine costation and somewhat flat compressed section make this common fossil of the *transversarius* zone easily recognizable.

Siemiradzki unites De Riaz's ammonite with Gemmellaro's type; but in the latter the costation is certainly much finer and the umbilicus larger—characters in which my specimen comes very near to the type.

PERISPHINCTES (ATAXIOCERAS) cf. MICHALSKII Bukowski.

1898. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 188 & pl. xx, fig. 1.
1898. A. de Riaz ('*P. schilli*') 'Descr. des Amm. des Couches à *Peltoceras transversarium* de Trept (Isère)' p. 33 & pl. xii, fig. 6.

The figures cited above only represent outer whorls, whereas my specimen consists of half a young ammonite measuring not more than 28 mm. in diameter. The section with its greatest thickness near the umbilical border, the amount of evolution, and the character of the prominent costation (showing a very strong hook at the umbilical end of the ribs), seem, however, to agree excellently with this form.

The ammonite occurs in the *transversarius* zone of Niort and Trept, as also in the *cordatus* beds of Czenstochau.

PERISPHINCTES (ATAXIOCERAS) cf. DEPERETI De Riaz.

1898. A. de Riaz, 'Descr. des Amm. des Couches à *Peltoceras transversarium* de Trept (Isère)' p. 19 & pl. x, fig. 1.
1899. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 343.

The small and badly-preserved specimen which I refer to this form agrees very well with De Riaz's figure, but the flexiradiate character of the ornament is not very pronounced. It is, therefore, possible that the ammonite does not even belong to the subgenus *Ataxioceras*, and may in reality form the inner whorls of a true *Perisphinctes*, such as that figured by De Riaz on pl. vii, fig. 4 of the above-cited work (as *P. lucingensis* Favre), which is considered by Siemiradzki to be *P. jelskii* Siem. There is little resemblance to the typical development of the latter form, however, though a true *P. lucingensis* Favre from Chavaz (Savoy) in my collection is considerably nearer. However, since the fact that the peripheral part of my specimen is worn may account for the indistinctness of the flexiradiation, and since in other respects the specimen closely resembles De Riaz's form, I prefer to unite it with that form rather than with the other 'species' mentioned.

PERISPHINCTES cf. SAYNI De Riaz.

1898. A. de Riaz, 'Descr. des Amm. des Couches à *Peltoceras transversarium* de Trept (Isère)' p. 18 & pl. xv, fig. 5.
1899. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 309 & fig. 75.

One of my small ammonites agrees with De Riaz's figure, but this represents only the outer whorl of a large specimen.

According to Siemiradzki, the inner whorls have a depressed quadrate section and strong straight costæ, which bifurcate into much weaker branches on the ventral area. My specimen agrees in these particulars very well. Pseudotrifurcation is also shown, and altogether the shell has somewhat the aspect of an annulose *Peltoceras*, or, as De Riaz says, if the costæ did not branch, of *Simoceras*.

My form seems to differ in not having the costæ as close as the type (sixty costæ per whorl, according to Siemiradzki), but this difference might be accounted for by its small size, especially as a fragment of a younger whorl depicted by A. Borisyak[1] shows ribbing of a character exceedingly like that of my specimen.

PERISPHINCTES cf. JELSKII Siem.

1887. *Ammonites convolutus* Quenstedt, 'Ammoniten d. Schwäbischen Jura' pl. xciv, fig. 8.
1898. *Perisphinctes jelskii* Siemiradzki, 'Monogr. Beschreib. d. Ammonitengattung *Perisphinctes*' p. 274 & pl. xxiv, fig. 36 only.

My specimen has unfortunately only the ventral region well preserved, and comparison with the above figures, which represent lateral views, is difficult. The ventral sinus described by the secondary costæ on the periphery and the almost grooved siphonal line are shown in fig. 40 of Quenstedt's pl. xciv. But this form (also called *A. convolutus* by Quenstedt) is referred by Siemiradzki to *P. obliqueradiatus* Yüssen, and in that lineage (*Ataxioceras-lothari* group) no parabolar markings are developed, whereas my specimen shows about six pairs of knobs per half-whorl. It is on account of these parabolar markings that I refer my specimen to *P. jelskii* Siem., a form in which the young whorls have a similar depressed section, with strong prorsiradiation and constrictions.

P. jelskii Siem. occurs in the *transversarius* zone of Poland, Swabia, and France.

PERISPHINCTES PLICATILIS De Riaz (*non* Sow. *nec* Siem.).

1898. A. de Riaz, 'Descr. des Amm. des Couches à *Peltoceras transversarium* de Trept (Isère)' p. 9 & pl. iii, figs. 1–4.
1899. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 343.

One specimen, consisting of about three-quarters of an ammonite

[1] 'Fauna des Donez-Jura: I—Cephalopoda' Mém. Com. Géol. Russie, n. s. No. 37, 1908: '*P. sayni*, de Riaz' p. 75 & pl. vi, fig. 1, pl. ii, figs. 15–17.

measuring 36 mm. in diameter, agrees with De Riaz's figure in the obliqueness of the costation and constrictions, the flattened sides, and the distinct umbilical rim. Unfortunately, the ammonite is worn, and therefore the identification must remain doubtful.

Another larger ammonite, 55 mm. in diameter, has its outer whorl somewhat worn, but seems to agree in all details (except in its thin section) with the ammonites figured by A. de Riaz in his pl. iii as *P. plicatilis* Sow.

In section, the specimen would agree more with *P. obliqueplicatus* Waagen, as figured in Siemiradzki's pl. xxii, fig. 23*a* and text-fig. 2, p. 84. But the costation is not oblique enough here.

The ammonite figured by De Riaz as *P.* cf. *obliqueplicatus* Waag. (pl. xv, fig. 4) has the costæ too distant; Siemiradzki regards it as a new form '*P. bifurcatus*,' but gives no figure of the section.

Since my specimen is not well enough preserved, I prefer to leave it with the equally indefinite Trept forms. Siemiradzki unites all the four ammonites (which, it may be mentioned, differ somewhat one from the other) with his '*plicatilis* (Sow.) d'Orb.' from the 'Lower Oxfordian,' and this makes me adopt the above designation for the Argovian forms.

PERISPHINCTES cf. CONVOLUTUS (Quenst.).

1888. F. A. von Quenstedt, 'Ammoniten d. Schwäbischen Jura' *convoluti* (pars) pl. xciv, figs. 20 & 43.
1898. A. de Riaz, 'Descr. des Amm. des Couches à *Peltoceras transversarium* de Trept (Isère)' (*P. convolutus* Quenst.) p. 19 & pl. ix, figs. 5*a* & 5*b*.
1899. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 341.

My small ammonite probably corresponds with the inner whorls of a convolute *Perisphinctes* similar to that figured by De Riaz, and seems to be somewhat intermediate between figs. 20 and 43 of Quenstedt's pl. xciv. It is very finely costate, with a broad flat venter, forming an angle with the sides, and shows about seven fine constrictions per whorl. At a diameter of 13·5 mm. its thickness is about 55 per cent. and the height of the last whorl 33 per cent., whereas De Riaz's form has, at an equal percentage of height, a thickness of only 46 per cent.; but the diameter is here much larger.

Pervinquière[1] mentions under *Holcostephanus* cf. *celsus* (Opp.) an ammonite from the red limestone of Jebel Ben Saidan, and this seems to be distinguished from the form here described only by a coarser costation and fewer and wider constrictions, if we assume it to resemble in this respect the specimen figured by him from a different locality. *Spiticeras proteanum* (Zitt. *non* Opp.) = *Sp. celsum* (Opp.), also bears some resemblance in its inner whorls[2] to the form now described; but the different character of the constrictions

[1] 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' 1907, p. 41 & pl. ii, figs. 9–10.
[2] K. A. von Zittel & A. Oppel, 'Die Cephalop. der Stramberger Schichten' Pal. Mitt. Mus. K. Bayer. Staates, vol. ii, pt. 1 (1868) p. 90 & pl. xvi, fig. 2*b*.

and costation distinguishes these later forms. My ammonite does not seem to be a *Holcostephanus*; as the innermost whorls, however, are not shown, it is impossible to make a definite statement on this point.

Siemiradzki calls A. de Riaz's form a '*mutatio descendens*' of *P. (Grossouvria) mirus* Bukowski from the *cordatus* zone of Poland. My specimen may belong to that group of Siemiradzki's *Grossouvria*, but its many constrictions separate it from *P. mirus* itself.

PERISPHINCTES sp. nov., aff. TRICHOPLOCUS Gemm. (Pl. LIII, fig. 4.)

1877. G. G. Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 163 & pl. xx, fig. 13.
1898. J. von Siemiradzki, 'Monogr. Beschreib. der Ammonitengattung *Perisphinctes*' Palæontographica, vol. xlv, p. 273.

I have not been able to find the description of any ammonite more comparable with my specimen than Gemmellaro's form.

My specimen differs, however, in having a larger umbilicus (about 50 per cent. at a diameter of 70 mm. instead of 45 per cent.) and also a larger number of single costæ. Siemiradzki says that single costæ are not frequent, and, as a matter of fact, Gemmellaro's figure shows among eleven costæ on the last whorl three single ones; but in my specimen there are from two to three single ribs between each bifurcating pair, a feature that brings the ammonite very near to certain Simocerates. At a diameter of 60 mm., however, the costæ still pass uninterruptedly across the venter, and it is only on the last half of the outer whorl that the sinus, which is formed on the periphery by the meeting of the secondaries, becomes clearly broken in the siphonal line.

In whorl-section my specimen agrees with Gemmellaro's form, the height from the umbilical junction being a little larger than the width. Only one constriction is visible on my specimen, owing to the umbilicus being partly covered by matrix; but it is comparatively broad, as figured by Gemmellaro, and not narrow and shallow as Siemiradzki mentions.

Genus PELTOCERAS Waag.

PELTOCERAS TOUCASIANUM (d'Orb.). (Pl. LII, figs. 5*a* & 5*b*.)

1847. A. d'Orbigny, 'Pal. Franç.: Terr. Jurass.—Céphal.' p. 508 & pl. cxc.
1871. M. Neumayr, 'Jurastudien: 4—Vertretung der Oxfordgruppe, &c.' Jahrb. K.K. Geol. Reichsanst. vol. xxi, p. 368 & pl. xix (xx), fig. 1.
1877. G. G. Gemmellaro, 'Faune Giur. & Liass. d. Sicil.' p. 166 & pl. xx, fig. 17.

The dimensions of my specimen are as follows:—

Diameter	53 millimetres.
Height of the last whorl	36 per cent. of the diameter.
Thickness of the last whorl	33 per cent. of the diameter.
Umbilicus	40 per cent. of the diameter.

Oppel united Quenstedt's *Ammonites transversarius* with A. d'Orbigny's form, and Neumayr followed him, although he pointed out that the two ammonites did not quite agree. Neumayr considered, however, that the differences were only apparent, and that

they were due to different age, in so far as the specimens from Central European localities generally were of smaller dimensions than those of Mediterranean origin. He stated that, with increase in diameter, the umbilicus widened, and that the sides sloped less steeply towards the ventral margin : that is, that in the adult *Peltoceras transversarium* changed into *P. toucasianum*.

After being separated again by A. de Riaz,[1] the two forms were once more united by P. de Loriol,[2] who considered the occurrence of a number of transitional forms as proof of their close affinity, and who, moreover, regarded Quenstedt's type-figure as representing an exceptional variety. Dr. H. Salfeld,[3] who in 1906 renewed the discussion of the identity of the two forms, has been able to demonstrate, however, the correctness of Quenstedt's original drawing,[4] and has refigured the type of *transversarius*, together with additional specimens.

There can be no doubt that A. d'Orbigny's *P. toucasianum* can clearly be distinguished from Quenstedt's form, even if we do not accept Dr. Salfeld's interpretation of the former in its entirety. In the true *P. toucasianum* the ribs are sigmoidal and strongly rursiradiate; in *P. transversarium* they are simply curved backwards, even in the young. According to Dr. Salfeld[5] also, the periphery broadens in the adult *P. toucasianum*, whereas in *P. transversarium* the narrowing of the periphery is a fairly constant feature, which is the reverse of what Neumayr had believed to be the case.

If we consider the costation only, the change from one form into the other also seems to take place the other way about: that is, rather from *P. toucasianum* into *transversarium* than *vice versâ*, and we may, with Dr. Salfeld, therefore regard *P. toucasianum* as the Mediterranean ancestor of the Birmensdorf form.

A. d'Orbigny's ammonite, at a diameter of 75 millimetres, has the following dimensions :—

Umbilicus.....	39 per cent. of the diameter.
Height of the last whorl.....	34 per cent. of the diameter.

Gemmellaro's specimen, at 67 mm. diameter, shows :—

Umbilicus.....	41 per cent. of the diameter.
Height of the last whorl.....	34 per cent. of the diameter.

My slightly smaller specimen is almost equal in dimensions, and for larger proportions the specimen of '*Perisphinctes*' *transversarius*

[1] 'Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)' 1898, p. 54.

[2] 'Oxfordien Supérieur & Moyen du Jura Lédonien' Mém. Soc. Pal. Suisse, vol. xxx (1903) p. 103.

[3] 'Beitrag z. Kenntnis des *Peltoceras toucasi* (d'Orb.) & *P. transversarium* (Quenst.)' N. Jahrb. vol. i (1906) p. 81.

[4] F. A. von Quenstedt, 'Cephalopoden' 1849, pl. xv, fig. 12 & p. 199; and 'Ammoniten d. Schwäbischen Jura' 1888, pl. xci. fig. 26 & p. 830.

[5] *Op. supra cit.* p. 87, footnote.

from Torri, Lake of Garda (Neumayr, pl. xix, fig. 1), at 110 mm. diameter shows :—

Umbilicus.....	42 per cent. of the diameter.
Height of the last whorl.....	33 per cent. of the diameter.

Quenstedt's type of *transversarius*, on the other hand, at 45 mm. diameter has :—

Umbilicus	35·5 per cent. of the diameter.
Height of the last whorl	40 per cent. of the diameter.

The largest figured specimen of a true *transversarius* (figs. 7 *a* & 7 *b* of Salfeld) is only fragmentary, and comparison of measurements in the adult is, therefore, impossible; but the persistence of the close, slightly curved rursicostæ and the trapezoidal section are still very characteristic.

Neumayr's fig. 1 *a*, at a diameter of 70 mm., represents the peculiar sigmoidal curvature of the costæ, which, as well as being so conspicuous a feature of A. d'Orbigny's type, is well shown in Gemmellaro's figure and is also very distinct on my specimen. It is absent, so far as I am aware, in all the other specimens of '*toucasianum*' or '*transversarium*' figured, and in my opinion clearly distinguishes A. d'Orbigny's form from its descendant, although it remains to be investigated whether the branching of the costæ may permit us to recognize several varieties of *Peltoceras toucasianum*.

The form is characteristic of the *transversarius* zone of the Mediterranean Middle Corallian, and occurs throughout the Alpine 'geosyncline,' from the Carpathians to Sicily and the range of the Atlas.

PELTOCERAS cf. TOUCASIANUM (d'Orb.).

1906. *Peltoceras toucasi* (d'Orb.) Salfeld, 'Beitrag z. Kenntnis des *Peltoceras toucasi* (d'Orb.) & *Peltoceras transversarium* (Quenst.)' Neues Jahrb. vol. i (1906) p. 81 & pl. x, fig. 4 only.

My collection contains only a septate whorl-fragment 21 mm. high, agreeing fairly in ornament with the figure cited above. The costæ are simply curved backwards, and form rather strong points at the latero-peripheral angles. The side of the whorl is slightly concave, but the section seems to be distinguished by a broader periphery than is shown, for example, in Salfeld's pl. x, fig. 3 *b*. My specimen is too fragmentary, however, to enable me to make a closer comparison.

I may add here that the latero-peripheral angle of the costæ is situated in the middle of the outer branch of the external saddle (which is subdivided by a lobule), whereas in whorl-fragments which I refer to the forms described below the end of the costæ comes close to the lobule. Thus here the saddle still goes some distance across the venter, showing a broader periphery corresponding with a lower umbilical rim. The whole of the suture is not preserved, unfortunately, in any of my specimens.

The ammonite is neither *P. toucasianum* nor *P. transversarium*,

but represents one of those intermediate forms which seem to be the commonest, and to which, for instance, besides Quenstedt's figs. 21 & 29, the figures of P. de Loriol,[1] those of A. de Riaz,[2] and also some of Dr. Salfeld's *P. toucasi* (as, for example, his fig. 3 of pl. x) belong. Fig. 27 of Quenstedt's pl. xci [3] represents neither an old *toucasianum* nor an old *transversarium*, but a densicostate fragment of an undetermined variety. With the scanty material at my disposal I refrain from naming these varieties.

PELTOCERAS PERVINQUIÈRI, nom. nov. = P. FOUQUÉI Perv. *non* Kil.

1907. L. Pervinquière, 'Études de Paléontologie Tunisienne: I—Céphalopodes des Terrains Secondaires' p. 28 & pl. i, fig. 9.
non 1877. G. G. Gemmellaro, 'Faune Giur. & Liass. della Sicilia' p. 166 & pl. xx, fig. 16.
non 1889. W. Kilian, 'Mission d'Andalousie: II—Études paléontologiques sur les Terrains Secondaires & Tertiaires de l'Andalousie' Mém. Ac. Sci. Paris, vol. xxx, p. 631 & pl. xxvi, fig. 2.

Dr. Kilian's figure shows, at a diameter of 90 mm., an umbilicus measuring 43 per cent. and height of the last whorl 38 per cent. It is only the last three-quarters of the final whorl that are radially recticostate. Before then, the ribs are close, slightly rursicostate, and, finally, seem to be of the usual *toucasianum* type. Gemmellaro's form, at a diameter of 150 mm., has an umbilicus measuring 43 per cent. also, and the height of the last whorl equals 35 per cent. The inner whorls are badly preserved, but apparently similar to those of Dr. Kilian's ammonite.

Now, the specimen which Pervinquière identifies with Dr. Kilian's form has an umbilicus of only 38 per cent., not 43 per cent.; but, what is more important, the exceedingly coarse and distant costation is essentially radial and straight already at a very small diameter. It probably forms the final development in that direction, and certainly has a good claim to be separated from *P. fouquéi* Kil.

The ammonite figured by Dr. Salfeld as a large specimen of *P. toucasianum* from Palermo [4] closely resembles Gemmellaro's form (fig. 16 only), but its dimensions are, at a diameter of 115 mm.:—

Umbilicus	38 per cent. of the diameter.
Height of the last whorl	36 per cent. of the diameter.

Similarly, a cast in my collection, taken from a specimen from Mœnthal (Switzerland), shows at a diameter of 120 mm.:—

Umbilicus	39 per cent. of the diameter.
Height of the last whorl	37 per cent. of the diameter.

It is equally recticostate on the last whorl. These two forms would, then, represent an involute variety of *P. fouquéi* Kil.; but the study of the inner whorls of the ammonites belonging to this

[1] *Op. cit.* Mém. Soc. Pal. Suisse, vol. xxx (1903) pl. xv, figs. 5 & 6.
[2] 'Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)' 1898, pl. xix, figs. 1–4.
[3] 'Ammoniten d. Schwäbischen Jura' 1888.
[4] *Op. cit.* N. Jahrb. vol. i (1906) pl. xii, fig. 11.

group becomes an absolute necessity if the specific distinction of *P. fouquéi* from *P. toucasianum* is to be definitely established. Taking Neumayr's fig. 1 of pl. xix as an example of a large *P. toucasianum*, we notice that the costæ are not yet radial at the end, and it appears that *P. fouquéi* is distinguished only by an earlier appearance of subrecti- and then recticostation. In all forms of *P. fouquéi* the section is very nearly rectangular.

I have to describe here two fragments of chambered whorls, measuring respectively 18 and 16 mm. in height. The first agrees in its perfectly straight and radial costation, low umbilical edge, and flat sides with Pervinquière's figure. The second has its costæ slightly curved, but shows a low umbilical rim and otherwise close agreement, though it might possibly more correctly be included in *P. fouquéi*.

The occurrence of all these forms together at Sidi Bu Gubrîn is a significant fact. I am inclined to think that not only *P. toucasianum*, the *transversarium*-like forms, and their close ally *P. fouquéi*, but also *P. pervinquièri* occur in Argovian deposits. The latter two may have persisted at least in *bimammatum* times; this would account for their occurrence in the *transversarius* zone of Algeria and Sicily, and in higher beds in Andalusia and elsewhere.

Genus ASPIDOCERAS Zittel.

ASPIDOCERAS cf. ÆGIR (Opp.).

1863. A. Oppel, 'Ueber Jurass. Amm.' Pal. Mitt. Mus. d. K. Bayerisch. Staates, p. 226 & pl. lxiii, fig. 2.
1871. M. Neumayr, 'Jurastudien: 4—Vertretung der Oxfordgruppe, &c.' Jahrb. K.K. Geol. Reichsanst. vol. xxi, p. 372 & pl. xx, fig. 2, pl. xxi, fig. 2.

I refer, with some hesitation, a small specimen of *Aspidoceras* to this form, because the latter is so common a fossil in the *transversarius* zone and has also been recorded (by Baltzer) from Jebel Zaghuan before. As Oppel points out, it is distinguished from what has generally been considered on the Continent as *Aspidoceras perarmatum* (Sow.) by flatter sides and the earlier appearance of the umbilical tubercles; but, at the diameter of my specimen (about 18 mm.), which, besides, is not very well preserved, distinction from other similar Aspidocerates is impossible.

In its quadrate section the ammonite in question also resembles *Aspidoceras faustum* Bayle [1] and *A. ruppelense* (d'Orb.), as figured in the 'Paléontologie Française' [2] and by Thurmann [3]: in the adult, only, however. The young of the latter ammonite is much too spinous, and in *A. faustum* the inner whorls are smooth, not costate.

Certain small ammonites in my collection from the Ampthill Clay of St. Ives (Huntingdon), which I have referred to *A. babeanum* (d'Orb.), seem to be distinguished from the Tunisian ammonite

[1] 'Expl. Carte Géol. France' vol. iv (1878) pl. xlvii, fig. 1.
[2] 'Terr. Jurass.—Céphal.' p. 538 & pl. ccv, fig. 2.
[3] J. Thurmann & A. Etallon, 'Lethæa Bruntrutana' 1861, p. 78 & pl. ii, fig. 8.

only by a wider and more rounded peripheral region, but probably represent exactly the same horizon.

EXPLANATION OF PLATES LII & LIII.

Plate LII.

(All figures, except fig. 4, are of the natural size.)

Fig. 1 *a*. *Protogrammoceras cornacaldense* (Tausch), var. *zeugitanum* nov. Middle Lias (Domerian), Poste Optique, Jebel Zaghuan. 1 *b*. Ornament of last whorl, where not weathered. (See p. 552.)

2. Gen. nov. sp. nov. (aff. *Lioceras ? grecoi* Fucini). Middle Lias (Domerian), from the same locality. (See p. 556.)

3. *Reineckeia* aff. *hungarica* Till. Callovian, from the same locality. (See p. 558.)

4. *Perisphinctes* cf. *bieniaszi* Teisseyre. Callovian, same locality. Part of suture enlarged. (See p. 560.)

5 *a*. *Peltoceras toucasianum* (d'Orb.). Argovian (zone of *Peltoceras transversarium*), near Sidi Bu Gubrîn, Jebel Zaghuan. 5 *b*. Outline-section of the last whorl. (See p. 575.)

Plate LIII.

(All figures, except fig. 2 *c*, are reduced to four-fifths linear.)

Fig. 1. *Phylloceras* cf. *subptychoicum* Dacqué. Argovian. Near Sidi Bu Gubrîn, Jebel Zaghuan. (See p. 562.)

2 *a*. *Sowerbyceras protortisculatum* (Pompeckj). Argovian. Same locality. 2 *b*. Peripheral view, partly restored. 2 *c*. Suture-line, magnified. (See p. 565.)

3 *a*. *Perisphinctes (Grossouvria)* cf. *regalmicensis* (Gemm.). Argovian. Same locality. 3 *b*. Peripheral view, partly restored. (See p. 570.)

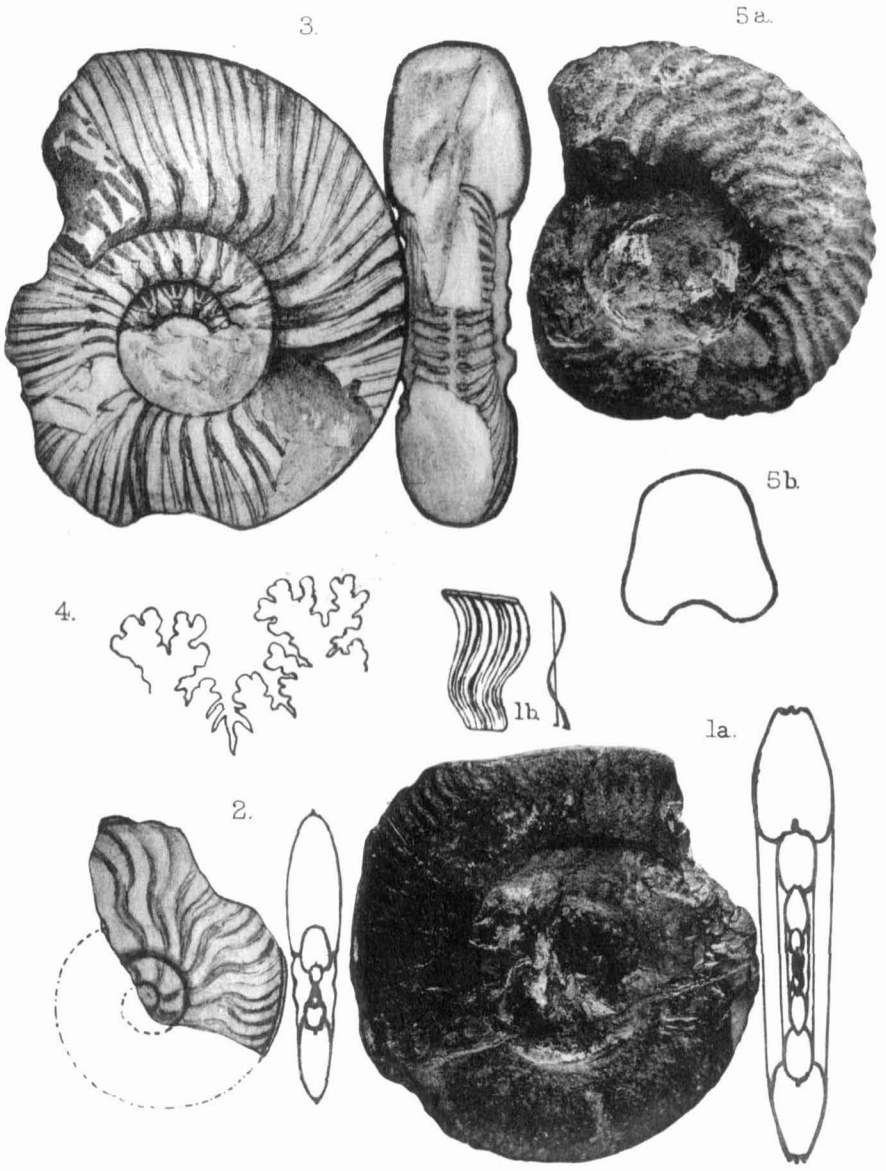
4. *Perisphinctes* sp. nov., aff. *trichoplocus* Gemmellaro. Argovian. Same locality. (See p. 575.)

Discussion.

Mr. Buckman heartily congratulated the Society on the paper which they had just heard. The Author showed rare ability in his knowledge of ammonites, and was evidently working on what the speaker considered to be the right lines. The Author had shown that he possessed a full grasp of his subject; and the speaker could not help feeling pleased at the able use which the Author made of a terminology for which he (the speaker) was so largely responsible. The Author seemed to have a more intimate acquaintance with the terms than the speaker had himself, and this was an agreeable surprise.

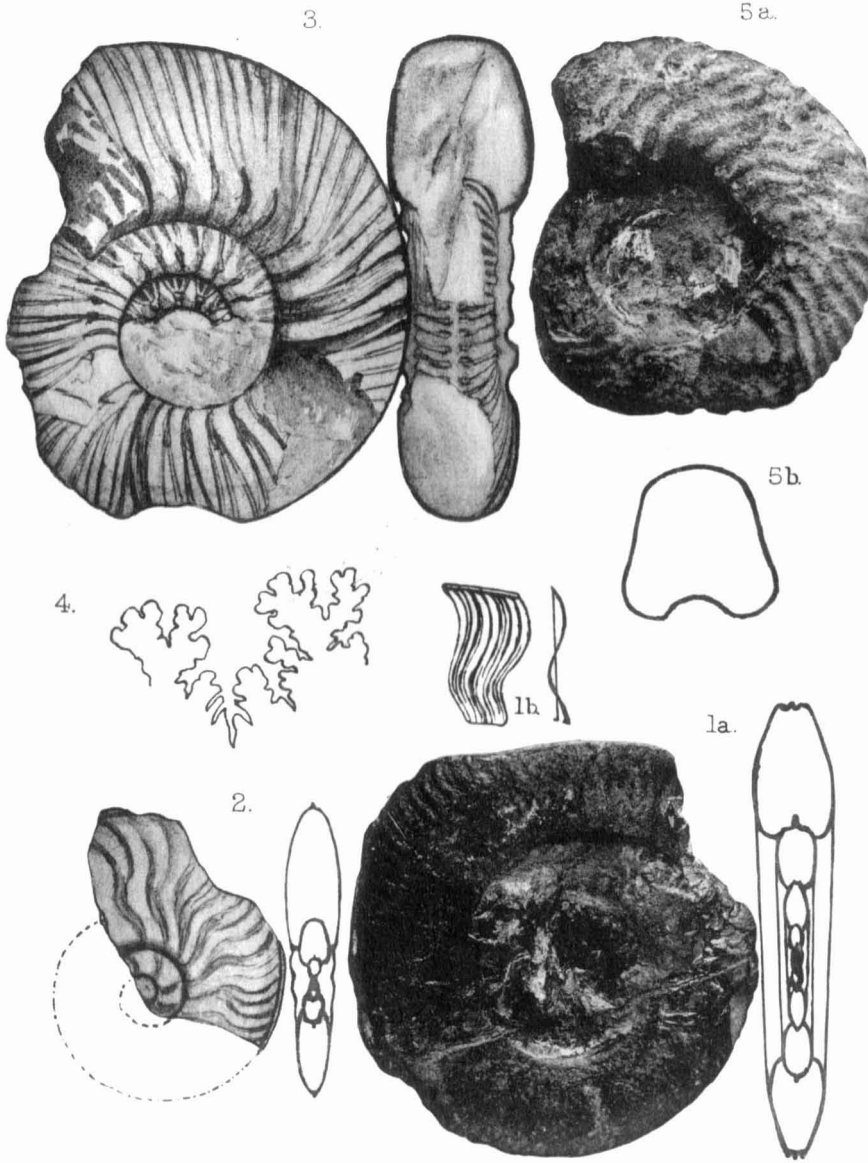
The Author, in reply, thanked the President and Fellows for the kind and interested way in which they had received his paper, and Mr. Buckman for his encouraging words.

With regard to the fitness of the new generic term *Protogrammoceras*, the Author thought that if the Hildoceratidæ were a monophyletic family, the ancestral forms of the Toarcian genera would have to be looked for in the Domerian predecessors and, therefore, probably in the far too comprehensive genus *Protogrammoceras*. Since not relationship but external resemblance to the later *Grammoceras* was chiefly referred to, however, when choosing *Protogrammoceras*, the Author agreed with Mr. Buckman in considering that a non-descriptive term might preferably have been adopted.



J.H. Photo., L.F.S. del. Bemrose, Colls., Derby.

AMMONITES FROM JEBEL ZAGHUAN.



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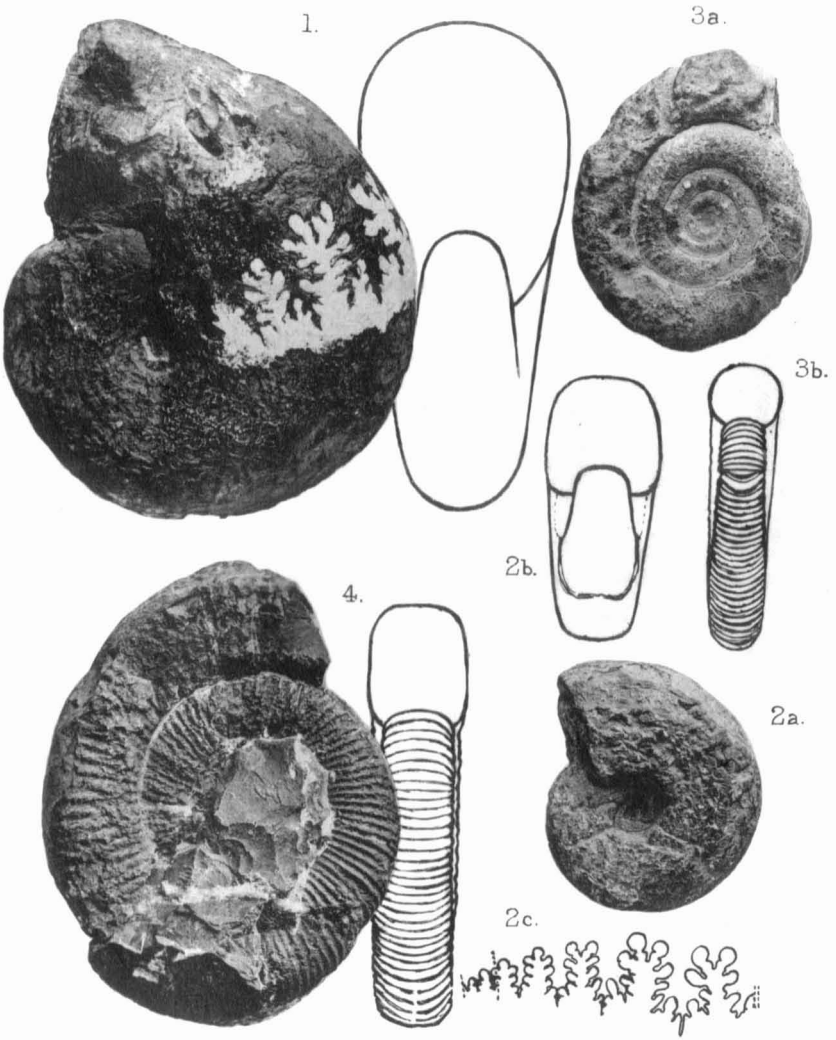

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