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ADDITIONAL OBSERVATIONS ON THE INVERTEBRATES (CHIEFLY AMMONITES) OF THE JURASSIC AND CRETACEOUS OF EAST GREENLAND

II.
SOME INFRA-VALANGINIAN AMMONITES FROM LINDEMANS FJORD, WOLLASTON FORLAND; WITH A NOTE ON THE BASE OF THE CRETACEOUS

BY

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WITH 1 FIGURE IN THE TEXT AND 4 PLATES

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I. INTRODUCTION

The first part of the present series of papers on the invertebrates, chiefly ammonites, of the Jurassic and Cretaceous of East Greenland dealt with the *Hectoroceras* Fauna of South-West Jameson Land; and though it was finished before war broke out in 1939, the paper was not published till eight years later. In it I made reference to certain other faunas which were waiting to be dealt with, such as a new *Cadoceras* fauna from Jameson Land, a *Cranocephalites* fauna from Traill Ø[1]), and an assemblage of various species of *Amoeboceras* which in East Greenland characterized the end of the Oxfordian and the beginning of the Kimmeridgian stages. All the fossil material just referred to was brought back by the East Greenland Expeditions between 1926 and 1939 under the leadership of Dr. LAUGE KOCH; but it is not proposed to deal with those faunas now. For while the material involved, and especially the ammonites are of considerable interest, unfortunately no more exact stratigraphical evidence has come to hand than was available before.

Again, the Valanginian faunas of Eastern Kuhn Ø and Albrechts Bugt, Wollaston Forland, though well preserved and including some new forms, were only briefly summarized in a paper (SPATH, 1946) on the Cretaceous ammonite faunas of East Greenland in general. That paper was merely intended to acquaint the scientific world with the presence of these faunas, pending the appearance of fuller accounts. Though these Cretaceous faunas ranged up into the Turonian, they showed that the system was very incompletely represented.

For reasons which will appear in the sequel, the fauna it is intended to describe now is an assemblage of ammonites from Lindemans Fjord, Wollaston Forland, an assemblage that is claimed to have greater importance than any of the other Cretaceous faunas previously referred to. Before the appearance of my summary account of 1946, above mentioned, I had considered the ammonite assemblage in question to consist of Berriasellidae, i. e. of a family believed to be confined to more southern seas, and, in any case, hitherto unknown from the 'Boreal Province', excluding the Riasan area in Central Russia. The collector of these ammonites, Dr. WOLF MAYNC, in his two accounts of 1947

[1]) Ø = Island.

and 1949, in fact, still used the provisional identifications I gave him before the specimens were developed and studied. The resemblance is indeed very striking. Some examples, figured in Plates I to III, in general appearance and especially ribbing, seemed so near species of the well-known genus *Berriasella*, for example *B.* (*'Odontoceras'*) *callistoides* (Behrendsen) Steuer sp. (1897, pl. xvii, fig. 13), the genotype of the genus *Parodontoceras*, or *B.* (*'O.'*) *beneckei* Steuer sp. (*ibid.*, figs. 6—12), that the absence of a peripheral groove, missing also in some French and Crimean Berriasellids, was a trivial matter.

I had for some time doubted the reality of a geological 'Boreal Province', since during the last twenty years more and more ammonites were found to have a curiously wide horizontal distribution. The occurrence of true Berriasellids in East Greenland would therefore have been of the greatest interest and indeed, it led directly to some of the problems which are discussed below.

But in 1946 I thought I recognized the resemblance of the Lindemans Fjord ammonites to Berriasellids to be 'superficial', if that term is permissible in view of our present lack of knowledge. For the simple, *Tollia*-like suture-line of these ammonites suggested that they belonged to an unknown genus, presumably to be classed with the Craspeditidae, for that very reason. This was interesting because *Hectoroceras*, another genus of supposed Craspeditid affinities, also on account of its suture-line, yet of quite different appearance, occurred only some forty feet higher. But since *Tollia payeri* (Toula), still of Infra-Valanginian age, was found at a very much higher level, that is as much as 430 feet higher than *Hectoroceras*, the new genus did not seem to help at first in unravelling the succession.

Fortunately, the bed of micaceous shale that yielded, the new ammonites here described is underlain by a conglomerate with derived fossils of which at least two ammonites are taken to be of Infra-Valanginian age. These two forms are: — *Subcraspedites* aff. *preplicomphalus*, Swinnerton, and *S.* (*Paracraspedites*) aff. *spasskensis* (Nikitin); and they resemble species of the Spilsby Sandstone. It is true that these two ammonites of the basal conglomerate came from the south-west of Kuhn Island, but this is only just opposite the shore of Lindemans Fjord and Dr. Wolf Maync has stated that the conglomerate directly underlies the micaceous shale with ammonites. There seemed to be indeed an unusually interesting Infra-Valanginian succession in this part of East Greenland.

As I pointed out before, the basal conglomerate just mentioned, which yielded the *Subcraspedites* here figured, also contained species of *Laugeites* (e. g. the specimen figured in Plate IV, fig. 4), mixed with other derived Jurassic (Portlandian or post-Portlandian) ammonites, forms of *Buchia*, and especially many fragments of large belemnites which may be portions of Upper Jurassic *Pachyteuthis* or lowest Cretaceous *Acroteuthis*. It will be necessary to discuss some of these in a later chapter, dealing with the age of the new fauna (p. 17), but it is already clear that there cannot be anything like a continuous sequence from the Jurassic into the Cretaceous. The astonishing incompleteness of the Geological Record revealed in this investigation also requires a chapter to itself (p. 34).

Since I first mentioned the Lindemans Fjord succession in 1946 I had occasion to describe (Spath, 1950) a Tithonian ammonite fauna from Kurdistan, and though this country may seem a long way from East Greenland, brief reference must be made to its Upper Jurassic-Lower Cretaceous sequence. For one of the new Tithonian genera (*Phanerostephanus*) is a curious parallel to the Volgian Perisphinctid genus *Laugeites*, already cited; another genus (*Nothostephanus*) shows a strong resemblance in its earlier stages to the typical Russian *Virgatites*. To these Jurassic examples I may add two from the Cretaceous: — one new form of the group of *Subthurmannia boissieri* is a striking homœomorph of *Hectoroceras kochi*, Spath (1947, pl. 3, fig. 1) but has a faint umbilical tubercle; higher up in the Berriasian of Kurdistan there has now been discovered a fauna of a number of new species of *Groebericeras*, previously known only from the Argentine, and one of the species is a truly remarkable '*Craspedites*', even in suture-line.

I take all this as confirmation not only of the view that both the Lower Volgian *Virgatites* beds and the Upper Volgian *Craspedites* zones are somewhere in the Tithonian, but that it is only our failure to appreciate the incompleteness of the Mesozoic Record that makes us attribute most faunal differences to the existence of separate zoological provinces. As the Eotriassic ammonite genera of the Himalayas like *Otoceras*, *Ophiceras*, *Vishnuites*, etc. were re-discovered in East Greenland, and as the Aptian genus *Sanmartinoceras*, known from Patagonia and Australia, Russia and East Greenland has now been found in Alexander I. Land in the Antarctic, so a true *Virgatites*- or *Craspedites*-fauna will one day be discovered in some region where strata exactly contemporaneous with those in Russia are preserved. The presence of the *Anavirgatites* fauna in Somaliland, as in Bavaria, might have been interpreted on similar lines, twenty-five years ago, in view of what I said in my introductory remarks (Spath, 1925, p. 112); but time was not ripe then, the collections of ammonites were rather baffling, and there were a good many errors that could only gradually be put right.

Although I only described the fauna of the lowest (Tithonian) bed of the Kurdistan succession, reference was made to the higher beds which ranged up into the Cretaceous. The line between the Jurassic and Cretaceous Systems was drawn at a certain level (see below, p. 31), but the choice was necessarily governed by the limited amount of imperfect ammonite material at my disposal. In other words the choice of the critical palaeontological level was my own and it is not at all certain that another observer would have drawn the line at exactly the same level or that a fresh collection, made at the same place, would support the first choice. This invited research into what is the base of the Cretaceous, irrespective of localities or so-called provinces. And it was soon discovered that although various areas claimed to have continuous series of passage-beds from the Jurassic into the Cretaceous, there was apparently not a single section described in geological literature, not even in the south-east of France, where the border-line was definitely established. Few authors recognized that all known successions are apparently incomplete.

I cannot thus agree with Wolf Maync (1949, p. 98) that it was quite improbable that 'a gap worth mentioning' between the Jurassic and Cretaceous 'periods' existed in the sequence on the mountain Niesen. The last is the name given by Dr. Maync to the prominent hill overlooking Lindemans Fjord, but on Dr. Koch's latest map (1950, pl. vi) it is only marked as Pt. 688 on the north-coast of Wollaston Forland, opposite Fligelys Fjord. The sections on that hill, given by Dr. Maync in 1947 (p. 63, fig. 19) and 1949 (p. 99, fig. 30) of course, should be consulted by the reader who desires to acquaint himself with the geological details. It is matter for regret that nearly all the derived Portlandian or post-Portlandian ammonites are so poorly preserved as to be unfit for photographic reproduction; and I am afraid that I had to disappoint the collector repeatedly when I felt it unsafe to give definite identifications of these remains from the conglomerates. But I should like to acknowledge gratefully the trouble Dr. Maync has taken to give me all possible information concerning the fossils he collected and I am particularly indebted to Dr. Lauge Koch for the opportunity of studying this interesting assemblage. My thanks are also due to Mr. W. N. Edwards for the facilities he has always afforded me in the Geology Department of the British Museum (Natural History) in connection with the storage of the East Greenland collections. Finally I must express my obligation to the management of the Iraq Petroleum Company Ltd. and to their chief geologist, Dr. R. G. S. Hudson, for kindly permitting me to give the basal Cretaceous succession on Jebel Gara in Kurdistan, quoted below (p. 31).

II. DESCRIPTION OF THE NEW AMMONITES

Order *Ammonoidea.*

Family **Craspeditidae,** Spath, 1924 b.

Sub-Family *Tollinae,* nov.

This family has been dealt with on previous occasions, but since it is now taken to include the new genus *Praetollia* described below, it is necessary to discuss the relations of the latter with the other members of the family, notably the typical genus, *Craspedites* itself. The more extreme, oxycone genera like *Garniericeras* and its probable descendants which I previously (1947, p. 20) attached to Craspeditidae only with some doubt, may perhaps be grouped in a separate sub-family (s. f. Garniericeratinae, nov.) and can here be left aside.

With Nikitin (1881), and contrary to his successors like Pavlow and Michalski, I consider the typical *subditus-okensis* group of *Craspedites* to be derived from a Perisphinctid stock, or possibly various Perisphinctid offshoots, while the Olcostephanidae which are developments of the same main stock are more intimately connected with *Proniceras* and the Spiticeratinae. The *Craspedites*-like form of *Groebericeras*, however, mentioned on p. 7, shows that Spiticeratinae also produced very similar types and it is possible that Craspeditidae have nothing more in common than a simplified Perisphinctid suture-line, with corresponding increase in the number of elements.

It should be pointed out in this connection that the Perisphinctid groups of the end of the Jurassic Period and their descendants in the earliest Cretaceous are as yet very incompletely known. For instance, when describing a presumably Tithonian Perisphinctid from the Salt Range (1939, p. 40) I could not place it in any known genus; and even if I had attached it to some externally similar form, like *Perisphinctes sublorioli*, Kilian (1899, p. 652, pl. xxxiii, figs. 4 a, b) from the Upper Tithonian of Fuento de los Frailes (Andalusia)—a somewhat dangerous proceeding in view of the difference in preservation—I could not have seen any affinity with *Amm. lorioli*, Zittel (1868, pl. xx, figs. 6—8) of which the former species was said to be possibly only a variety. There are many such doubtful Perisphinctids in the uppermost Jurassic, some of them referred to in 1939 (pp. 40—41) and several of these may have given rise to Craspeditids.

Since the Perisphinctids of the highest Jurassic are now referred to several sub-families (e. g. Virgatitinae, Virgatosphinctinae, Pavlovinae) and since we consider these closely related sub-families to be more or less parallel developments, differing chiefly in ribbing, it is not possible to fix on any one form or group of forms as the single root of the whole family Craspeditidae. In other words, it is almost certain that the family is polyphyletic. Thus it has already been mentioned that there is great resemblance between *Praetollia* and the Berriasellidae, a Perisphinctid offshoot that is probably widely different from the main stock which produced *Craspedites* itself and its presumed descendant *Subcraspedites*. I myself stated (1947, p. 12) that the ribbed young *Craspedites* of the *subditus* group showed much resemblance to immature *Epivirgatites* and *Dorsoplanites*; and the former was attached first (1936, p. 84) to Virgatitinae, and later (1950, p. 130) to Virgatosphinctinae, while *Dorsoplanites* was referred to Pavlovinae. Again, I considered (1936, p. 84) that while *Craspedites subditus* and *Subcraspedites preplicomphalus* recalled the ribbing of *Dorsoplanites*, *Paracraspedites* showed more resemblance to other Pavlovinae and to Virgatitinae. In the case of the genus *Hectoroceras*, Spath, 1947, the relationship with Perisphinctidae was at first altogether obscure and I even toyed with derivation from an Oppelid stock; but it was the simplified suture-line and the general resemblance to '*Neumayria*' *tolijensis*, Nikitin, that suggested inclusion of *Hectoroceras* in the family Craspeditidae. The ammonites here described as *Praetollia* are a similar group of forms with resemblance to Perisphinctids and especially to the special offshoot *Berriasella*; and they are likewise included in the Craspeditidae merely on account of the simple suture-line with numerous elements. The importance of this for classificatory purposes is considered to outweigh any resemblance in ribbing these Craspeditids may show to certain types of Perisphinctids, for others, like the group of *Craspedites kaschpuricus* (Trautschold) or *Kachpurites fulgens* (Trautschold), have lost all resemblance to the presumed parent stock. While I am not prepared to dismember the family Craspeditidae because it is polyphyletic, I think it advisable to include the genera *Praetollia*, *Tollia* and, doubtfully, *Hectoroceras* in a separate sub-family *Tollinae*, nov.; for future discoveries may indicate closer relations of these genera with *Berriasella* or *Grayiceras* than with the typical Volgian *Craspedites*.

Among the doubtful Perisphinctids I mentioned in 1939 (p. 41) was *Perisphinctes solowaticus*, Bogoslowski (1895, p. 142, pl. iv, fig. 9, pl. v, fig. 1) the type specimen of which (pl. iv, fig. 9) may seem pathological to some observers, though I have found the presence of trifid ribs on one side of an ammonite and of only bifid ribs on the other side in other groups, not only Perisphinctids. *P. solowaticus* seems to me the type of intermediary between the persistent root-stock and the more or less contemporary *Paracraspedites*, *Subcraspedites*, and perhaps *Tollia* on the one hand, or even the typical but presumably earlier *subditus-okensis* group on the other. In any case it can be seen in the three forms of *Perisphinctes* figured by Bogoslowski (1895, pl. iv, fig. 9, pl. v, figs. 1 and 2) how the inclusion of the inner whorl by the outer increased from 30 % to 36 % and then to 45 %. At the same time the suture-line developed more numerous elements than the ordinary Perisphinctid suture-line; but the changes were almost certainly caenogenetic, not palingenetic. There is only a very small step from this type of Perisphinctid to the Craspeditid inner whorls figured by Bogoslowski as *Olcostephanus* sp. indet. B and C (pl. iv, figs. 7—8).

These forms, of course, are from the Riasan Beds and although I pointed out in 1936 (p. 84) that the faunas of these beds and the ammonites of the underlying Upper Volgian are rather different, I do not think that Bogoslowski was far wrong in considering that *Craspedites suprasubditus*, *C. spasskensis* and *C. stenomphalus*, *C. pressulus* and *C. subpressulus*, and *Tollia bidivexa* all ' belong to one great group". Bogoslowski may also have been right in declaring that the transgressive Riasan Beds must have been deposited immediately after the Upper Volgian; but the sudden appearance of *Riasanites rjasanensis* in enormous numbers in the lower part of the Riasan Beds made me doubt whether the whole story had yet been told (Spath, 1936, p. 84). Now the Lindemans Fjord succession given above shows that *Tollia* and *Subcraspedites* may be as much as 500 feet apart.

In 1950 (p. 131) I correlated the genus *Riasanites* with its Andine equivalent *Corongoceras* of the Lower Neo-Tithonian and thought that the *Craspedites* zones of the Upper Volgian would naturally fall into the Middle Tithonian. This would still leave a gap at the top of the Jurassic, but the Riasan Beds are evidently a condensed deposit. That is to say, the limit between the Cretaceous and the Jurassic is not so clear as Pavlow (1901, p. 43) thought, although he admitted that it was less apparent where the uppermost Jurassic zone of *Riasanites rjasanensis* was present and was immediately followed by the lowest Neocomian zone of *Craspedites stenomphalus*. I may mention here that *Rjasanites rjasanensis* is probably not so very different from the Upper Tithonian *Berriasella oxycostata* (that is the species Kilian considered to be a French representative of the Riasan form) as Mazenot (1939, p. 66) seems to think; and in any case a specimen from the River Oka in the Blake Collection (B. M. no. C. 25343) is associated with two undescribed ammonites from the same locality (nos. C. 25344—5) which are allied to *Riasanites subrjasanensis*, Nikitin sp. (1888, pl. i, fig. 4) but show still more decided resemblance to *Berriasella* of the *carpathica* type, with almost virgatoid ribbing and only a slightly more simplified suture-line than the Koniakau form (Zittel, 1868, p. 107, pl. xviii, fig. 4).

Bogoslowski (1902, p. 160) even put the *stenomphalus* zone in the Valanginian, leaving the *spasskensis* and *rjasanensis* zones in the Berriasian. In fact, there may be one or more intermediate zones; and the ammonites of bed C of Swinnerton (1935, p. 14) which includes forms of *Paracraspedites* resembling *P. kozakowianus*, Bogoslowski sp. (1895, p. 141, pl. ii, figs. 2—5) may be characteristic of one of them. The great thickness of Infra-Valanginian (or Berriasian) strata now revealed, added to the enormous increase in the Tithonian recently discussed (Spath, 1950, p. 133) should be a warning to geologists not to assume, as did even Buckman, that Jurassic chronology is anything like completely known.

With regard to the ammonites from the glauconitic basement bed of the Spilsby Sandstone, I thought at one time that their resemblance to Portlandian types (*Dorsoplanites*) was due to derivation from an earlier deposit, corresponding to the Glauconitic Series of Milne Land (Spath, 1936, p. 163). The presence of *Subcraspedites preplicomphalus*, however, in this basement bed C shows that it cannot be very much older than the *stenomphalus* zone or the higher beds in the Spilsby Sandstone, with far more favourably preserved ammonites. In any case, there is no trace of either the presumed Middle Tithonian true *Craspedites* or the Upper Tithonian *Riasanites*; but I have recorded (Spath, 1947, p. 26) derived Portlandian ammonites (*Crendonites*, *Kerberites*) in the basement bed (with phosphatic nodules) of the Spilsby Sandstone at Nettleton Mine, Caistor, Lincs. The resemblance of the form Pavlow (1892) identified with *Craspedites subditus* (now *Subcraspedites lamplughi*, Spath) from the Spilsby Sandstone to the true Volgian type is really as distant, as that of Pavlow's ammonites from the basal Speeton Clay (bed D 4) to the real *C. fragilis*, Trautschold sp. (Spath, 1924, p. 75).

Genus **Praetollia**, gen. nov.

Type-species: — *P. maynci*, sp. nov. Plate III, fig. 2.

Diagnosis: — Fairly involute platycones, with gently convex whorl-sides, inconspicuous, rounded umbilical wall and more or less narrowly arched venter. Lateral ribbing slightly sigmoidal, mostly bifurcating in young, later becoming trifid or having intercalated secondaries, so that in the more closely ribbed forms there are about 17 secondaries to 5 primary costae. In one form the ribs remain bifurcating or single. The ribs are projected externally, forming a slight sinus pointing forwards on the venter. Inner whorls appearing almost smooth in some forms, owing to ribbing not being continuous to the umbilical wall. Suture-line simple, with seven saddles and lobes gradually ascending towards the umbilicus.

Remarks: — Owing to the crushing of all the specimens, the Craspeditid inner whorls of *Praetollia* could not be isolated; but there is no doubt about the Craspeditid character of the suture-line. The Berria sellid aspect of the ribbing is offset by the high degree of involution of the *Craspedites*-like outer whorl of the form figured in Plate I, fig. 1 b. That is to say, while the typical examples of the group here described may resemble Berriasellidae more than do other Craspeditids, at least at one stage, the tendency of *Praetollia* was evidently in the direction of the later genus *Tollia*, Pavlow. This differs chiefly in its more sigmoidal costation, with thickening of the primary stems which are also more distantly spaced, and there is an increase in the peripheral projection of the secondaries; but it has essentially the same type of suture-line.

The young examples of *Praetollia* figured in Plate I, fig. 4 (below) and in Plate II, fig. 2 show that the ribbing is both finer and sharper, also less regular than in immature Upper Volgian *Craspedites*. It is probable therefore that the connection is only indirect. On the other hand, these young examples are very similar to some small *Subcraspedites* (? *Paracraspedites*) I figured from the *Hectoroceras* Beds of Jameson Land (Spath, 1947, pl. iv, figs. 2, 11—14). The latter were poorly preserved and small and they occurred in a fauna of which the dominant ammonite genus was *Hectoroceras*. Moreover, the large specimens of *Subcraspedites* figured in 1947 (pl. iv, figs. 1 a, b) have a style of ribbing quite different from that of Berriasellids and they are certainly not referable to *Praetollia*.

Some forty feet higher in the section in Lindemans Fjord than the *Praetollia* horizon there occurred the *Hectoroceras* sp. nov.? figured in 1947 (Spath, pl. iii, fig. 2) which was wrongly marked as coming from S. W. Kuhn Ø. It is thus established that the *Praetollia* fauna is earlier than the *Hectoroceras* level which itself is 430 feet below the horizon of *Tollia payeri* (Toula).

Praetollia maynci, sp. nov.

Plates I, II, III, figs. 1—5, IV, figs. 2, 6, 7.

As the typical example of this species I take the original of Plate III, fig. 2 which represents only a plaster-cast of an impression, slightly damaged and crushed, but which shows the sharpness of the ribbing perhaps more clearly than the other specimens. At a diameter of about 75 mm the whorl-height is approximately 46 % and the width of the umbilicus 18 %. This compares well with a height of 45 % and an umbilicus of approximately 20 % in the original of Plate III, fig. 1 which represents a plaster-cast of the large ammonite impression in fig. 1 of Plate II.

The latter example has more distinct and more frequent trifurcation of the ribbing than the type and the spaces between the primary stems seem to become wider with increase in size; but this may be due partly to the crushing and is not considered of more than varietal importance. The original of Plate III, fig. 1 is thus named var. *contigua*, nov. and the other large example figured in Plate II, fig. 1 and the originals of Plate I, fig. 2 and Plate IV, fig. 2 are also referred to this variety. The last example shows the suture-line which is reproduced in text-fig. 1 a.

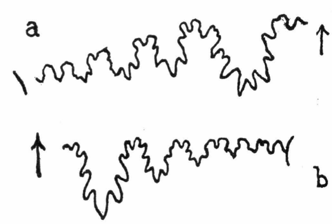

Fig. 1. (a) *Praetollia maynci*, sp. nov., var. *contigua*, nov. (Plate IV, fig. 2). (b) *Praetollia aberrans*, sp. nov. (Plate III, fig. 7). Suture-lines, enlarged and slightly diagrammatic.

The specimen figured in Plate III, fig. 4, representing a plaster-cast of the impression in the centre of Plate I, fig. 1, is taken to be a typical small example of the restricted *P. maynci* and it will be seen that it is even then slightly more coarsely ribbed than the commonest form. This latter (var. *communis*, nov.) is typically represented by the original of Plate I, fig. 1 a but also includes the ammonites figured in Plate III, fig. 3 (upper specimen) and Plate IV, fig. 6. The ribbing in this variety is somewhat intermediate between that of the typical *P. maynci* and the var. *contigua*. It is more closely spaced than that of the former, and more regularly bifurcating than that of the latter, with scarcely any intercalated secondaries. In the case of a number of young examples, e. g. Plate I, fig. 3, Plate III, fig. 5, etc., it is of course impossible to refer them to one variety rather than another.

There remains the original of Plate I, fig. 1 b which at a small diameter already has less sharp ribbing than the examples so far discussed. On what was probably the body-chamber the ribbing is distinctly weakened and towards the end only rather distantly spaced secondaries remain, though the inner half of the whorl-side is missing. There is no indication of the constrictions, so characteristic of *Tollia*, and the ribbing on the whole is much straighter. Since this isolated form is also distinct from the typical *P. maynci*, it may be given a separate varietal name, var. *dispar*, nov.

Among the smaller impressions there are several (e. g. to the left of the central ammonite impression in Plate I, fig. 1 and on the top of fig. 5 in Plate IV) which show the peripheral ribbing; and the ammonite on the left of the fragment figured in Plate IV, fig. 7, though somewhat crushed, also retains the ventral costae. It is clear that there was no median sulcus or interruption of the ribbing.

The suture-line (text-fig. 1a) is characterized by a deep lateral lobe and at least five smaller lobes ascending towards the umbilical suture. The external saddle is only partially seen. The suture-line as a whole is similar to the suture-lines of *Tollia* and *Subcraspedites* figured in 1947 (Spath, figs. 7 a—d on p. 25).

The resemblance of *P. maynci* to *Amm. catenulates* (*non* Trautschold) figured by Eichwald in 1868 (pl. xxxv, figs. 3a—c) is probably not so close as the illustration suggests, judging by the differences in the suture-lines. Nikitin later renamed the Ural species *Oxynoticeras tolijense* (1884, p. 65, pl. ii, figs. 7—8) and if he correctly interpreted the species, there cannot be any affinity between Eichwald's form and *P. maynci.*

Equally remote seem Berriasellids like *Parodontoceras calistoides* (Behrendsen) Leanza (1945, pl. v, figs. 5—6), not so much because of the peripheral interruption of the ribbing, as because of the dependent auxiliaries of the suture-line and the difference of the inner whorls, without any resemblance to those of Craspeditids.

Hectoroceras, Spath, 1947, which is possibly the nearest ally of *Praetollia*, next to *Tollia* itself, and which has a similar suture-line, differs in its small umbilicus and smooth venter, also a somewhat distinct and blunt type of ribbing.

Praetollia aberrans, sp. nov.

Plate III, fig. 7.

This form, represented by a single individual, was previously (Spath, 1946, p. 5) described as belonging to the same undescribed genus, but 'obviously different' from the many individuals of what is now termed *Praetollia maynci*, with its varieties. The differences can be simply defined as consisting of a less elegant, less closely spaced and less flexuous costation with rather irregular single and bifurcating ribs and apparently smooth inner whorls, with rounded umbilical wall. The latter thus have a Craspeditid aspect, even more than the inner whorls of *P. maynci*; on the other hand the Berriasellid appearance of the outer whorl is not nearly so conspicuous as in that species, largely due to the straightness of the ribbing.

The outer whorl is septate almost to the end and the suture-line (text-fig. 1b, p. 14) is more or less clearly visible except for the crushed peripheral portion. The venter was almost certainly rounded, as in *P. maynci*, with the costation continuous across.

The species is obviously only an aberrant member of the *maynci* group and although there are no transitions to that species and its varieties, the peculiar aspect of the present form may be due partly to its defective preservation. On the back of the piece of shale bearing the only example known, there is an impression of *P. maynci*, var. *contigua*, a plaster-cast of which is figured in Plate I, fig. 2.

Of the Riasan ammonites figured by Bogoslowsky, only what he considered a variety of *Tollia bidivexa* (1895, pl. iii, fig. 4) could possibly be compared to *P. aberrans*, but the peripheral costae of the former are much more definitely inclined forwards and the secondaries are more numerous.

'*Hoplites*' *angulatus*, Stanton (1896, p. 80, pl. xviii, figs. 3—4) which also has single and bifurcating, though more projected ribbing than *P. aberrans*, is probably entirely unrelated if its author's comparison with *Stenoceras storrsi* (Stanton) and *Lyticoceras amblygonium* (Neumayr and Uhlig) is at all apt. In any case, Anderson (1938, p. 162) listed '*Berriasella*' *angulata* as an Upper Valanginian form which would remove it completely from the group of *Stenoceras storrsi* and exclude it from the genus *Berriasella*.

III. THE AGE OF THE FAUNA

The only fossils associated with the ammonites above described are valves of *Buchia volgensis* (Lahusen), both left (Plate III, fig. 6) and right (Plate III, fig. 7, Plate IV, fig. 5). The last shows good agreement with LAHUSEN's (1888), pl. iii, fig. 15; the rugose left valve figured in Plate III, fig. 6 is more coarsely ornamented than any of LAHUSEN's examples of the same plate, and in this respect is like *B. okensis*, Pavlow sp. (1907, pl. i, fig. 10a). It is now also attached to *B. volgensis*, as there are many intermediate forms in this apparently homogeneous population. The small *Praetollia maynci* figured in Plate II, fig. 2 is embedded in a right valve of *B. volgensis.*

That species ranges from the Volgian up into the Infra-Valanginian (see SPATH, 1947, p. 34). I am considering it a large species-group rather than a restricted species and in the present state of our knowledge it is probably impossible to give the exact ranges of the many species of *Buchia* at the top of the Jurassic and the base of the Cretaceous.

The ammonites will thus be of greater importance in determining the age of the fauna than the forms of *Buchia*, but since all the forms described belong to a new genus, the only reliable evidence there is at present is their relative stratigraphical position, below *Tollia* and *Hectoroceras*, as mentioned on p. 6, and above a conglomerate which included the two ammonites here figured as *Subcraspedites* aff. *preplicomphalus* and *S.* (*Paracraspedites*) aff. *spasskensis.*

The former (Plate IV, fig. 1) is identical with some Spilsby Sandstone ammonites (e. g. B. M. nos. 43892b, C. 47000, C. 47001) which I would include in *S. preplicomphalus*, Swinnerton (1935, p. 36, pl. iii, fig. 1). The holotype of this species is badly figured and reduced × .6, considerably worn, and almost unrecognizable from the figure; but the topotypes above mentioned show that the form is merely a more coarsely ornamented, more evolute species of the group of *Subcraspedites plicomphalus* (J. de C. Sowerby, 1823, *non* J. Sowerby, 1822, now renamed

S. sowerbyi, nom. nov.)[1]). This differs from *S. preplicomphalus* mainly in having more numerous primary ribs as well as secondaries and a smaller umbilicus, but the Greenland fragment here figured would almost fit into the gap in the outer whorl of the holotype of *S. preplicomphalus* (base of Swinnerton's reduced fig. 1 A).

The fragment of *Subcraspedites* (*Paracraspedites*) aff. *spasskensis*, Nikitin sp. (Plate IV, fig. 3), being a plaster-cast of an impression, shows neither the whorl-shape, nor the peripheral ribbing, and there is no trace of the suture-line; but there is good agreement with the original figures of the Riasan ammonite in Nikitin (1888, pl. i, figs. 9—10) as regards the peculiar style of ribbing. This differs from that of Spilsby Sandstone examples of *S.* (*P.*) *stenomphalus*, Pavlow sp. merely in lacking definite trifurcation. The impression is preserved in a micaceous quartz-grit, with parts of a number of individuals of *Buchia*.

S. (*P.*) *stenomphalus*, like *S. plicomphalus* and *S. sowerbyi*, occurs in the upper beds of the Spilsby Sandstone, whereas *S.* (*P.*) *stenomphaloides* is confined to the basement bed C of Swinnerton (1935, p. 42), so that the recognition by various authors of a lower *spasskensis* zone and a higher *stenomphalus* zone seems reasonable. I previously (Spath, 1924, table to p. 80) adopted them (wrongly associating with them the

[1]) As I pointed out before (1947, pp. 23—24) *S. ptychomphalus*, T. Brown sp. (1837, p. 17, pl. xiii, fig. 2), based on a copy of J. Sowerby's type-figure of *S. plicomphalus* (1822, pl. 359) has no standing and is merely a synonym of J. Sowerby's species. J. de C. Sowerby was wrong in his interpretation of this species. When figuring what he considered to be the inner whorls of *S. plicomphalus* (pl. 404) he stated that it had a very different appearance from the ammonite figured by J. Sowerby in 1822 (pl. 359). According to the younger author, though the two ammonites would not be suspected to be the same, they were actually found united in one specimen which had been proved by breaking the holotype first figured. This is not correct. The two specimens are in the British Museum (Natural History) and though I previously suggested that the smaller example did not seem to represent the inner whorls of the larger, true *S. plicomphalus*, I did not actually take the specimen to pieces. Having done so now, however, I can only repeat that the two forms are different, as Brown suspected in 1837. He wrongly renamed what must always remain the type of *Amm. plicomphalus* and the new name *Subcraspedites sowerbyi* is now intended for the much more finely ribbed smaller example, fairly well figured by J. de C. Sowerby in pl. 404, which could not possibly grow into the coarse form of pl. 359.

It might be added that what the younger Sowerby saw and took to be the young state of *S. plicomphalus*, with its "front transversely furrowed" is in fact the impression of the venter of another individual (visible in the body-chamber of the large figure, along with fragments of other shells). But the costae are much too closely spaced in the drawing. The inner whorls of the true *S. plicomphalus* are as bluntly tuberculate at the umbilical edge as they are in the adult and the rest of the shell is perfectly smooth. The holotype, when broken, however, revealed only two of these widely spaced tubercles, with all the previous whorls replaced by sandy matrix.

Tollia horizon whose exact stratigraphical position was not then known); but contrary to PAVLOW (1907, table to p. 84) I placed the Subcraspeditan Age below the *Platylenticeras* zones which are not represented at Spilsby.

The fact that *Subcraspedites* aff. *preplicomphalus* and *S.* (*Paracraspedites*) aff. *spasskensis* may come from two distinct horizons is not of any significance, for, as already mentioned (p. 6) derived Jurassic fossils, including forms of *Buchia*, have been collected in the same basal conglomerate beds. The only ammonite well enough preserved to be figured is represented in Plate IV, fig. 4 and it is attached to the same rock-specimen (Plate IV, fig. 1) that encloses *Subcraspedites* aff. *preplicomphalus*. The original of fig. 4 is believed to belong to a new form of *Laugeites*, comparable to the Russian specimen of *L.* ('*Kochina*') *stchurowskii* Nikitin sp. referred to on a previous occasion (SPATH, 1936, p. 82), but with flatter whorl-sides. The true *Laugeites stchurowskii*, Nikitin sp. (1881, p. 83, pl. vii, figs. 53—56) came from the Lower Volgian; but two examples of a '*Perisphinctes*' aff. *stchurowskii* recorded by the same author in 1884 (p. 41, pl. iv, fig. 17) were found in the Upper Volgian zone of *Craspedites nodiger*. *Laugeites* may thus have an extended range, corresponding to the Tithonian *Phanerostephanus*, another of the few remaining Perisphinctids in the uppermost Jurassic.

If the two forms of *Subcraspedites* already cited are also derived, as appears probable, then the uppermost of the basal conglomerates must be already younger than the Spilsby Sandstone or the Riasan Beds of Russia. In any case the succession is as follows: —

Infra-Valanginian ..... {
Tollia payeri
Hectoroceras kochi
Gen. nov. (Praetollia)
Subcraspedites spp.

It may be possible, as I stated in 1947, that the knotty problem of the demarcation of the limit between the Jurassic and Cretaceous Systems will be solved by future discoveries in S. W. Jameson Land. Unfortunately the time is not yet; and in Lindemans Fjord the admixture of derived Jurassic ammonites with the presumed basal Cretaceous *Subcraspedites* shows that this northern area is not suitable for establishing the base or yielding a detailed uppermost Jurassic succession. But there seems to be no doubt that the latter will prove as complex as the Infra-Valanginian sequence which is separated from the lowest ammonite horizon of the Valanginian by an unfossiliferous interval of some 280 feet of strata.

Since Infra-Valanginian deposits with ammonites comparable to those of East Greenland are known chiefly from Russia and Siberia, it may seem advisable to list the two successions in a corresponding position. The isolated Spilsby Sandstone of Lincolnshire is believed to be at the base of the Infra-Valanginian; but since the lowest beds of the Speeton Clay of Yorkshire are already in the Valanginian *Polyptychites* zones, it is omitted from this table.

	East Greenland	*Russia-Siberia*
Valanginian...........	Polyptychites zones	Polyptychites zones
	—	Platylenticeras zones
Infra-Valanginian	Tollia payeri	Tollia tolli
	Hectoroceras zone	—
	Praetollia zone	—
	Subcraspedites	stenomphalus z.
	S. (Paracraspedites)	spasskensis zone
Jurassic..............	(Laugeites)	(rjasanensis z.)

In North Germany there is nothing comparable, so far as is known below the *Platylenticeras* (and *Tolypeceras*) zones. The Spitsbergen succession is probably still less complete. When describing some Cretaceous ammonites from Spitsbergen (Spath, 1921, p. 355) I recorded certain Polyptychitids, and to these will probably have to be added not only the doubtful examples of '*Rasenia*' (see Spath, 1935, p. 77), but almost certainly also the badly preserved '*Craspedites*' from Cape Staratshin. Frebold's (1928, p. 14) supposed Riasan '*Craspedites*' from his bed 20 may possibly be similar Polyptychitids, though they were completely flattened and not preserved in a hard black limestone, like those I recorded. Then Sokolov and Bodylevsky (1931, p. 94) recorded a bad example of *Subcraspedites* (resembling *S. subpressulus*, Bogoslowsky sp.), but their discussion of the ammonites found in beds 19—21 does not favour the presence of any forms of the Upper Volgian, the Riasan Beds or the Infra-Valanginian.

The common Spitsbergen Perisphinctids, in fact, are neither Virgatitids, as was generally assumed thirty years ago, nor *Pictonia* or *Decipia*, as the presence of Cardioceratids suggested, but forms of the group first figured by Lindström (1866, pl. iii, figs. 1—2) as *Amm. triplicatus* (*non* Sowerby). I listed some of these ammonites as *Virgatites* cf. *polygyratus* (Trautschold) Pavlow sp.[1]), and Frebold (1928, p. 14) also adopted that name; but Sokolov and Bodylevsky figured forms

[1]) Pavlow's original, obviously a malformation, was said to be from the Spilsby Sandstone and to be in the University of Moscow. I have not seen anything like it, even from the basement beds (see p. 12), and I am at a loss to explain where it could have come from. Trautschold's original *Amm. polygyratus* is the same as *Epivirgatites nikitini* (Michalski) and would be quite out of place in the Spilsby Sandstone.

of the same group as *Perisphinctes* sp. A, *P.* sp. B, and *P.* sp. (1931, pl. ix, figs. 3—5). To judge by numerous additional specimens since received, especially in the collections made by the British-Norwegian-Swedish Expedition of 1939, and likewise associated with *Buchia reticulata*, *B. bronni*, etc., these forms are *Dorsoplanites*, like those I described from Milne Land, and they are certainly not of post-Portlandian age. I do not think we can look to Spitsbergen for a continuous sequence of marine beds passing from the Jurassic into the Cretaceous.

When dealing with the Neocomian Belemnite Beds of the Salt Range (1939, p. 3) I expressed the opinion that we were as yet far from knowing the full story of geological events which determined the baffling succession of ammonite faunas at the end of the Jurassic and beginning of the Cretaceous. The subdivisions of the Valanginian and Infra-Valanginian I then adopted (p. 128) were stated to be nothing like the complete representation of the zones of the lowest Cretaceous, but I had to confess to ignorance even of the true ranges of some of the most widely quoted ammonites of the period. And since the two zones adopted for the Infra-Valanginian (or Berriasian) of the Tethyan areas are so widely different from those listed above for East Greenland, it may well be asked what is the evidence for considering them to be equivalents in time and putting them into the Cretaceous. This obviously needs an enquiry into the base of that system.

According to HAUG (1909, p. 1162) in order to define the limits between the Jurassic and Cretaceous systems, it was only necessary to look for the 'palaeontological level' which corresponded exactly to the lowest Neocomian in the Swiss Jura Mountains. In that region, of course, the lowest Cretaceous rests unconformably on the Purbeckian, as can be seen in an excellent series of sections published by BAUMBERGER (1903). Unfortunately, the Berriasian there is developed in a peculiar, 'litoral' facies, namely a series of limestones and marls with *Natica leviathan*, and it is almost devoid of ammonites. BAUMBERGER recorded and figured only two specimens, one of them of doubtful provenance and probably a Hauterivian true *Acanthodiscus*. In any case the only authentic specimen was wrongly compared to a Speeton species (*Amm. hystrix*, Phillips) of a much later (Valanginian) date. Such is the evidence on which the age of the critical lowest Cretaceous beds in the Jura Mountains had to be determined.

In practice the problem of fixing the base of the Cretaceous is full of difficulties in countries where the marine Jurassic passes gradually up into an equally marine Cretaceous. I shall attempt to demonstrate this in the next chapter by comparing the ammonite faunas at the base of the Cretaceous in a few localities whence detailed successions happen to be available.

IV. THE BASE OF THE CRETACEOUS

A. General.

There is no need to go into the early history of the much discussed Berriasian Stage or into the work of authors that later proved to be wrong, like the first attempts to zone the South American lowest Cretaceous. Suffice it to repeat HAUG's (1909) statement that it was largely the patient researches of KILIAN which established that the Berriasian Stage in the South-East of France corresponded to the first Cretaceous beds in the Jura region. Whether KILIAN was right or wrong, it was universally agreed that this Berriasian be considered to form the base of the Alpine Cretaceous. It may be noted in passing that the stage was also claimed to have a great horizontal distribution in the Mediterranean region; it included a variety of deposits and its designation as a 'horizon' or 'level' was scarcely appropriate. A more serious difficulty was to make the cut between the Jurassic and Cretaceous in a succession where the Tithonian and Berriasian are developed in the same facies and are inseparable lithologically. Yet this means that neither the Tithonian Stage nor the Berriasian can be correctly defined until this border-line is definitely established.

KILIAN (1907, p. 42) also stated that BOGOSLOWSKI was right in considering the Riasan 'horizon' of the 'Boreal Province' to be the equivalent of the Berriasian of the South of France. KILIAN, moreover, thought that this agreed well with the character of the ammonite fauna and explained the presence in the Riasan Beds of more highly developed types of the group of '*Hoplites*' *euthymi*, Pictet sp. besides others reminiscent of Tithonian species. A more satisfactory explanation of the presence of both Jurassic and Cretaceous types in the Riasan Beds was given by PAVLOW (1907), as already mentioned (p. 11), but he also greatly underestimated the Infra-Valanginian part of the succession. Clearly there are as yet too many gaps in our knowledge to speak of obviously heterogeneous assemblages as time equivalents; but it may be advisable first of all to discuss the '*boissieri* zone' of south-eastern France, because this constitutes for many the Berriasian or Infra-Valanginian Stage.

B. The Boissieri Zone and its Subdivisions.

For many years now the lower limit of the Cretaceous has been taken to be at the base of KILIAN's zone of *Subthurmannia* ('*Thurmannites*') *boissieri*, Pictet sp. This is not a difficult ammonite to recognize. I figured an example from the Spiti Shales (1939, pl. ix, fig. 4) and I have specimens before me from as far afield as the Kereru Range of Papua. There the species is associated with a form remarkably like the Andine '*Reineckeia*' *fraudans*, Steuer, which has been adopted as the zonal ammonite for the lower half of the Berriasian in the Argentine. In Kurdistan (but not in the Jebel Gara section) *S. boissieri* has now been found together with what might almost be taken to be a transition to the genus *Hectoroceras*, Spath, hitherto known only from East Greenland. This suggestive occurrence has already been referred to in the Introduction (p. 7).

KILIAN, it may be recalled, made it clear that he spoke only of the south-east of France when he stated that the Cretaceous began with the zone of *S. boissieri*; and he pointed out that the fauna of his rather comprehensive zone included forms that occurred already in the Tithonian below and others that passed up into the Valanginian above. MAZENOT (1939), however, has now been able to show that contrary to what KILIAN himself believed, the zone fossil is not one of these long-ranged species. The records of *S. boissieri* from the Tithonian as well as from the Valanginian are not to be trusted and this ammonite is indeed a 'good zonal index'.

There would thus seem to be no doubt about the 'exact palaeontological level' which marks the base of the Cretaceous. It is the first appearance of *Subthurmannia boissieri*; and since the 'range' of this species is an abstract notion that cannot be directly observed, it has to be applied in practice to a definite succession of rocks, in this case the Berriasian Stage of the Jura Mountains in Switzerland, or, because this is almost devoid of ammonites, at least to the south-east of France, as defined by KILIAN. It cannot, of course, be expected that the fauna remains constant throughout the *boissieri* zone or that the index fossil appeared (and disappeared) at exactly the same moment even in two neighbouring sections. Molluscan populations in the seas are regulated by local conditions and however wide-spread and freely moving *S. boissieri* may have been, it cannot be equally represented everywhere. It may also be conceded that it is possible to use species other than the zonal ammonite to prove the presence of the *boissieri* zone.

Unfortunately some of the most famous of basal Cretaceous deposits in which *Subthurmannia* of the *boissieri* type have been recorded will have to be left out of consideration in this connection. Such are for example the Spiti Shales of the Himalayas and the Belemnite Marls of the Salt Range. There is an almost complete absence of exact stratigraphical information which is all the more deplorable since the deficiencies in the succession of the south-east of France hardly make it an ideal standard for correlation. That many more additional sequences are necessary is shown by the boreal Infra-Valanginian horizons listed on p. 20 which are considered equivalents of the *boissieri* zone, but have nothing in common except a similar stratigraphical position below the *Platylenticeras* zones and above the local uppermost Jurassic or presumed Jurassic.

The base of the *boissieri* zone, accepted on the testimony of KILIAN as the 'palaeontological level' that marked the beginning of the Cretaceous, rests on the uppermost Tithonian zone of *Berriasella privasensis* in the south-east of France; and KILIAN's two subdivisions of that zone are now claimed by MAZENOT (1939) to be in the wrong order. Since the faunas of these two subzones (*chaperi* and *delphinensis*) do not differ essentially, their inversion may be a small matter; but KILIAN is also said to have misidentified the zonal ammonite, *Berriasella privasensis*. I have recently (1950, p. 126) pointed out that MAZENOT's contention was not borne out by his own work but obviously there are difficulties also in establishing the top of the Jurassic. It may suffice here to point out that this level, in the south-east of France is no more definitely established than is the lowest of the three subdivisions of the *boissieri* zone, recognized by both KILIAN and MAZENOT.

On inspection of a typical succession in the Berriasian, such as that at Le Chevallon, Isère, given in MAZENOT's fig. 3 (p. 21), it appears that the ammonites occur in a few, very fossiliferous (and therefore presumably condensed) beds or seams and that these are separated by less prolific or barren limestones, so that although the '*boissieri* zone' may occasionally represent a thickness of some 200 or 300 feet of strata, its sub-division has not proved satisfactory. KILIAN only recorded belemnites (species of *Duvalia*) from his upper sub-zone, but he and MAZENOT considered this 'horizon' to be transitional to the Valanginian. The latter author cited two ammonites (*Kilianella* aff. *pexiptycha*, Uhlig sp. and *Thurmanniceras* aff. *pertransiens*, Sayn sp.) but they are species of the next higher stage and therefore no more characteristic of the upper *boissieri* zone than KILIAN's belemnites. Clearly these subzones require re-investigation in the light of the new evidence discussed below, but there remained the two earlier 'subzones', namely the main *boissieri* horizon above, recognized by both authors, and the '*calistoides* sub-zone' of KILIAN below.

On previous occasions I adopted these two sub-zones of the Berriasian, but MAZENOT has now shown that the Argentinian '*Hoplites*' *calistoides*, Behrendsen (1891) is indeed a Jurassic species and that it does not occur in France. Mazenot, however, also refigured as a typical example of Behrendsen's species the form described by Steuer in 1897 as *Odontoceras calistoides* and this ammonite Mazenot attributed to the Berriasian. Forms of this group and indeed, *Parodontoceras calisto* (d'Orbigny) itself, were known to occur both above and below the borderline between the Jurassic and Cretaceous; but now that Leanza (1945) has established the real range of *P. calistoides* at the top of the Argentinian Jurassic, as mentioned below (see p. 29), that species clearly cannot be used as a zone fossil for the Lower Berriasian, least of all in France.

It is important to note that Kilian had already spoken of this lower, so-called *calistoides* horizon as the main layer of the *calisto*- and *ponticus*-groups, i. e. typically Berriasian forms; but while Mazenot figured two different species as being special to the lower subzone, there seems no need to change the name from *calisto* to *calistoides* or anything else. According to Mazenot (1939, p. 58) "*B. calisto abonde particulièrement dans le Berriasian ou elle est des plus typiques*". The three subdivisions of the *boissieri* zone then include an upper and a lower which are transitional to the beds above and below. This of course is nothing unusual in any large zone and to move the critical 'palaeontological level' up to the base of the middle division, i. e. the *boissieri* zone in the strict sense would be contrary to Kilian's definition of the Berriasian Stage.

The difficulty of ascertaining the base of the *boissieri* zone was felt even in Switzerland, away from the typical Jura localities. Thus Marthe Gerber (1930) adopted a 'neutral zone', whereas Lombard and Coaz (1932) proposed the name '*couches de passage*' for a twenty metre zone between the Tithonian and Berriasian, characterized chiefly by *Berriasella privasensis* and '*B.*' *calisto*. This is very natural; the former species has long been the zonal index for the highest zone in the Jurassic, the latter, as has just been shown, is common in the lowest Cretaceous. Such transitional beds between the Jurassic and Cretaceous, however, had previously been recognized by other authors; they include for example Burckhardt's '*couches limitrophes*' which date from as long ago as 1912. These provisional names merely offer a convenient though not a commendable way out of the difficulty of exact correlation.

I have previously stated my belief that there is no means of exact—as distinct from approximate—parallelization of beds from one continent to another, but this is due merely to our comparative ignorance. For example, it might be thought sufficient, for such correlation of more or less contemporaneous deposits referred to the *boissieri* zone in the enlarged belt of the Tethys and its extensions, to show at least a general similarity in their ammonite faunas, even if not specific identity, and notwithstanding the admixture of local elements. In the absence of *S. boissieri* itself or its local representative, at least closely allied species of the family Berriasellidae might be expected; but it may be many years yet before they are actually found. In any case, Mazenot's work has shown that very little is known so far regarding the vertical distribution of the many ammonites within the *boissieri* zone, even in the south-east of France. As long ago as 1910 Kilian (p. 183) published a scheme of the inter-relations of the Berriasellid forms that group themselves round the zonal ammonite, *S. boissieri*, and their direct descendants, the Neocomitidae. This scheme has been largely modified though not necessarily improved by Mazenot; yet we find with surprise that apart from some French species dated on the basis of their localities, there is almost as complete a lack of definite stratigraphical information as in the case of the equally numerous ammonites of the Spiti Shales.

C. The Spiticeratan Age.

Failing the Berriasellidae, there were few ammonite families existing at this critical period that could offer more satisfactory zonal indexes. The Phylloceratidae, Lytoceratidae, Haploceratidae, and Oppelidae are of little use in correlation on account of the long ranges of their commoner forms which do not reflect the many gaps in the successions. Of the uncoiled types, decendents of the Tithonian Protancyloceratidae, common throughout, but generally ignored, few have so far been described or named; but among the ammonites listed by Kilian as most characteristic of the *boissieri* zone, there are more than twenty species of *Spiticeras*. We might thus speak of the Berriasian Stage as the equivalent of a 'Spiticeratan Age'; for while a few fore-runners of *Spiticeras* occurred already in the Tithonian, only a single species was found in the Valanginian of the south-east of France. Having been recorded from many other parts of the world, *Spiticeras* seemed a useful additional element for recognizing the lowest Cretaceous, but I myself did not realize the very long range of the genus, and in 1924(a) I was wrong about the dates of existence of the South American species.

It has to be admitted that in the present state of our knowledge the Spiticeratidae are no more helpful than the Berriasellidae. Views on the dispersal of a monophyletic *Spiticeras* from somewhere near Central America were expressed by Djanélidzé as long ago as 1922; but they were based on a supposed derivation from the Lower Kimmeridgian genus *Idoceras* and on the presumed absence, from Asia, of the direct fore-runner of *Spiticeras*, namely the predominantly Tithonian genus *Proniceras*. Neither view any longer holds; but what is far more important, is the complete absence of information regarding the vertical distribution of the many species of *Spiticeras* in what may have been their original home and centre of development, i. e. the Himalayan area.

Not only is there no stratigraphical information, but the famous Spiti Shales, of some 500 feet in thickness, probably agree with the other more or less contemporaneous successions here discussed in having the ammonites concentrated in comparatively few layers or nodule beds with unpredictable unfossiliferous gaps and non-sequences in between, so that the rareness or absence of, for example *Berriasella* and *Parodontoceras* (*privasensis* and *calisto* groups of the top of the Tithonian and base of the *boissieri* zone) may be due to a stratigraphical gap and not to displacement by e. g. *Blanfordiceras* which like the closely allied *Himalayites* may occupy a different (higher) horizon. Since the numerous forms of *Spiticeras* described from the Spiti Shales thus may come from a variety of horizons, Berriasian as well as Tithonian, and since only assemblages of the smallest sub-zones are needed for exact correlation, it seems that the magnificent Himalayan material described by Uhlig will remain comparatively useless until the necessary stratigraphical information is obtained.

Moreover, since Djanélidzé wrote, new South American forms of *Spiticeras* have been described by Gerth (1925) and others; and though at first referred to the Berriasian (Infra-Valanginian) or even Valanginian, they are now accepted as Tithonian (zone of *Spiticeras acutum*). They may be local representatives of the typical group of *S. spitiense* (Blanford) whose exact age is unknown; but they are associated with a form that resembles an Indian bituberculate species; and although this is much like a Tithonian form from Chomérac, the exact range of the bituberculate species is as uncertain as that of the typical unituberculate forms. Djanélidzé (1922, p. 3) recognized that bituberculation (which occurs already in the Tithonian) is caenogenetic; but this did not enable us to date the more extreme *Aspidostephanus* (group of *A. depressus* and *A. latior* Steuer sp.) or its contemporary, the less startling but equally degenerate *Spiticeras*-derivative *Groebericeras*, Leanza, 1945. The stratigraphical position of these two genera, fortunately, is now known; it is in the Andine Berriasian, below the zone of *Spiticeras damesi s. s.*, but 150—170 feet higher than the *calistoides* beds (zone of *Substeueroceras permulticostatum*). *Spiticeras acutum* is lower still in the Jurassic, so that this genus is actually proved to have had a very long range.

There is also lack of stratigraphical detail regarding the fine Berriasian fauna of Lamoricière in Algeria or the apparently homogeneous fauna of Theodosia in the Crimea which Kilian correlated with the lower part of his *boissieri* zone. This fauna, however, includes *Proniceras* and other elements of Tithonian affinities and may well represent a mixture of Jurassic and Cretaceous types from just about the border-line between the two systems. It would be very unsafe to attempt to guess the exact age of each constituent of the fauna. But I may add in this connexion that forms of *Spiticeras*, resembling those of the Crimea, have been found in Kurdistan, but not at the only section (Jebel Gara, see p. 31) where they might have been useful. This is probably a case of what Buckman would have called "collection failure".

The *Spiticeras* Beds of San Pedro del Gallo, Mexico, may be considered to be somewhere in the *boissieri* zone or the Berriasian *s. s.* as Burckhardt (1912) indeed clearly recognized. They include several species of *Spiticeras*, in addition to some poorly preserved Berriasellids and two forms of *Neocomites* which are already much like the typical *Neocomites* of the Valanginian, while not differing greatly from the inner whorls of species of *Substeueroceras* (*koeneni* group) that occur in the border-line beds below. Two species of *Acanthodiscus*, described by Burckhardt, however, are unlike European forms and may represent a special, local development, though there is still great difference of opinion concerning the various Acanthodiscids that seem to connect the early Tithonian and Berriasian *Protacanthodiscus*, *Neocosmoceras*, and *Octagoniceras* with the late (Hauterivian) true *Acanthodiscus*. It seems doubtful, in fact, whether they are directly related, considering the large time gap; and I am inclined to consider the Mexican '*Acanthodiscus*' *euthymiformis*, Burckhardt, as well as the Kurdistan Acanthodiscids and the Himalayitid, recorded below from bed 33 (p. 31) to be members of new, unnamed stocks.

All the Durango fossils above mentioned came from a comparatively thin bed of limestone between a massive series of Valanginian deposits above and Upper Jurassic shales with *Substeueroceras* below, so that apparently only a small portion of the Berriasian succession is represented. There is no record of *Subthurmannia boissieri* or its allies, but it was known from the work of Felix (1891) that the zone was present in Oaxaca. At least one of the examples of '*Hoplites*' *tenochi*, Felix (pl. XXIX, fig. 1) is a *Subthurmannia* of the *boissieri* group, and it is associated with a *Spiticeras* and other Berriasian forms. Specimens of *Parodontoceras*, *Subthurmannia*, and *Protacanthodiscus*, in fact, from near Tlaxiaco, Oaxaca, are preserved in the collections of the British Museum (Natural History). More recent work, however, has not brought to light a Mexican succession detailed enough for the present purpose.

In California, Anderson (1938) described a *Spiticeras duncanense* from this lowest zone in the Valanginian Paskenta Group. It is apparently a form of the group of *Spiticeras* (*Negreliceras*) *negreli* (Matheron) which is of Berriasian age in Europe, but '*Neocomites*' *russelli*, Anderson, with which the Californian species was associated, has almost certainly been misidentified, generically. It was, however, considered by its author to belong apparently to the same group as '*N.*' *stippi*, and this was said to resemble *Subthurmannia boissieri*. Unfortunately the associated Crioceratids are quite unlike anything recorded from the Berriasian of Europe, so that the Californian beds cannot as yet be accurately dated.

D. Some Recent Discoveries.

Two imposing basal Cretaceous successions in the Argentine have recently been published by LEANZA (1945) and since they comprise richly ammonitiferous strata and the fauna has been well illustrated, correlation with the *boissieri* zone of Europe would appear to be easy. On closer examination, however, it is found that in both the sections given by LEANZA the presumed Berriasian beds are separated from the underlying Tithonian by considerable thicknesses of strata without ammonites. Of course, this greatly reduces the value of these sequences.

Thus in the section of the Arroyo del Yeso, LEANZA shows a succession of Tithonian beds up to his thin band *g* which has yielded undoubted Jurassic *Aspidoceras* as well as *Substeueroceras* and *Parodontoceras calistoides*, already referred to; but this is followed by an unfossiliferous interval of no less than 167 feet. It is not only uncertain whether the gap includes the local top of the Tithonian, but the first bed (*h*) that follows after the interval contains only species of an ammonite genus (*Argentiniceras*) that is unknown from Europe and possibly a local element. Unfortunately this also applies to the ammonites of the next bed (*l*) forty feet higher which yielded eight species of another presumed local genus (*Cuyaniceras*), at one time considered to be a South American equivalent of the European *Lyticoceras* of Upper Valanginian-Hauterivian age. A new Acanthodiscid, figured by the author as *Neocomites* (?) does not help in fixing the horizon of this bed, but since LEANZA refers these ammonites to his zone of *Spiticeras damesi* and *Cuyaniceras transgrediens*, it is clear that the succession is still in the lower part of the *Spiticeras* beds or the *damesi* zone in the wider sense.

This is confirmed by the ammonites of the succeeding beds with first, *Spiticeras bodenbenderi* (Steuer) in bed *l*/*m* and then *S. damesi* (Steuer) itself in bed *m*, 24 feet higher than bed *l*, while the only ammonite comparable to a European species, '*Thurmannites*' cf. *occitanicus* (Pictet) occurred in bed *m*/*n* at the very top of the 50 feet of beds of the *damesi* zone. If this zone is an approximate equivalent of the upper *boissieri* zone of south-eastern France, the underlying 42 feet of beds with *Argentiniceras* at the base could be of lower *boissieri* age; but they have, at present, no counterpart in Europe and they are still separated by the 167 feet gap from the underlying Tithonian.

LEANZA's second Argentine section (at Mallin Redondo) unfortunately only adds to the difficulties. Here also the top of the local Tithonian, with *Parodontoceras calistoides* is separated from the presumed Berriasian by about 150 feet of unfossiliferous strata, but the next higher bed (1768) is characterized by an ammonite genus (*Groebericeras*) which is unlike anything hitherto described but which has recently been re-discovered in Kurdistan (see below). The associated Berriasellids, including '*Thurmannites*' look like forms of the European *boissieri* zone, but another bed (1771), ten feet higher, yielded two more, strictly Andine elements: '*Octagoniceras*' (*Himalayites*) *egregium* (Steuer) and the entirely new genus *Frenguelliceras*, Leanza. These ammonites are all referred to the *Argentiniceras* (or *fraudans*) zone already mentioned, and this is followed by 40 feet of *Spiticeras* beds (*damesi* zone), terminating, as in the other section, with a horizon characterized by *Pseudoblanfordia australis* (Burckhardt). This form, originally described as from the border beds between the Jurassic and Cretaceous and compared with *Blanfordiceras wallichi* (Gray) of the Spiti Shales, is possibly another local element, and contrary to what MAZENOT believed, can have nothing to do with the group of *Berriasella privasensis*.

In the *damesi* zone of this second locality also species of '*Thurmannites*' (*recte Thurmanniceras*) occur at two horizons, but since the typical Valanginian forms of this genus are directly connected with the Berriasian *Subthurmannia*, such intermediate types might be expected, though they are perhaps local species. The Berriasian section of Mallin Redondo passes up into Valanginian shales with crushed *Neocomites* (?) and beds with *Exogyra couloni*, but at the Arroyo del Yeso the typical Valanginian ammonite *Thurmanniceras pertransiens* (Sayn) was recorded from a bed (*n*) about 13 feet above the top of the *damesi* zone. If this isolated European species can be used to denote the base of the Valanginian, this would be 270 feet above the top of the Tithonian in this section; but it may be borne in mind that a *T*. aff. *pertransiens* has been figured by MAZENOT also from the Upper Berriasian.

The last Berriasian succession here to be considered is in Kurdistan (Northern Iraq) and unlike the two Argentinian sequences just reviewed, it is continuous from the Tithonian upwards, but unfortunately has at least four gaps in the middle. This Berriasian is succeeded by presumed Valanginian deposits which are said to contain only '*Trichites*' but no ammonites, so that the top is indefinite. The sequence may be given in detail being entirely new: —

Bed 38	12	feet	*Groebericeras* (?) sp. ind.
» 37	8	»	'*Neocomites*' *occitanicus* (Pictet).
» 34—6	71	»	. . . .
» 33	3	»	*Groebericeras* spp. nov. (5); *Protacanthodiscus* (?) spp. nov. (4); new Himalayitid.
» 32	12	»	*Groebericeras* sp. nov. (*Craspedites*-like).
» 29—31	40	»	. . . .
» 28	13	»	*Neocomites praeneocomiensis*, Burckhardt.
» 14—27	167	»	. . . .
» 13	13	»	Indet. (including *Parodontoceras* ? sp. ind.).
» 2—12	113	»	. . . .
» 1	14	»	*Berriasella* and *Parodontoceras calisto*, etc.

The lowest assemblage is that already referred to (Spath, 1950, p. 97) as from bed x and taken to mark the base of the Cretaceous. It is itself 270 feet above the Tithonian fauna described, and it is underlain first by some 16 feet of unfossiliferous strata and then by a bed with *Berriasella* of the *privasensis* group, as previously announced. This bed, in the writer's opinion, is at the top of the Jurassic part of the succession.

Apart from the entirely new *Groebericeras* fauna from bed 33, the above list contains the names of one European and one Mexican species that may seem helpful in correlation. The last (*Neocomites praeneocomiensis*) occurs at about 300 feet up in the Cretaceous of Kurdistan, but in the '*Spiticeras* Beds' of San Pedro del Gallo it came out of a thin limestone band at the base of the Berriasian succession, probably a condensed deposit. This also yielded a *Protacanthodiscus* (?) *euthymiformis* (Burckhardt) which is comparable to a new form from bed 33, some 75 feet higher than the first species (*N. praeneocomiensis*).

'*Neocomites*' *occitanicus*, it will be noticed, is about 430 feet above the base of the Cretaceous in Kurdistan. Its age in France is given by Mazenot as Berriasian, without any particular horizon, except that on p. 25 he quotes it from the wider as well as from the restricted *boissieri* zone. In the Arroyo del Yeso section, as already mentioned (p. 29), a presumably comparable form (*Neocomites* cf. *occitanus [sic]*) occurred at the very top of the *Spiticeras damesi* zone.

The *Groebericeras* fauna, in Kurdistan, is developed chiefly at about 350 feet above the basal bed. In the Argentine it occurs immediately above an unfossiliferous stretch of 150 feet, with the Tithonian below, and the base of the Cretaceous may be anywhere in between.

The three forms just cited are obviously not suitable for exact correlation; but it may be asked whether it is just an unfortunate coincidence that these three ammonites were represented or whether any other three or more forms in the present state of our knowledge would have yielded better results. The evidence of the new sections given above suggests that other ammonites might have been equally inconclusive. Again, misidentifications of species there may have been, due to the same form being interpreted differently by different authors. This, however, by itself, is also probably not responsible for our present *impasse*. In the writer's opinion it is that too few successions are so far known in which numbers of wide-spread species occur together in the same bed. What is needed is detailed stratigraphical information of such key-successions as that in the Spiti Shales, though even there we must expect major gaps and non-sequences.

E. Conclusions.

It remains a regrettable fact that three of the latest and most carefully collected ammonite sequences from the base of the Cretaceous have proved of no more immediate use for exact correlation than the successions hitherto considered as typical. None of the characteristic Crimean elements has so far been rediscovered in the ammonite faunas of Kurdistan. Whether the fauna of Theodosia is basal Cretaceous as KILIAN thought, or Jurassic as RETOWSKI (1893) held, or whether it is '*à cheval sur la limite jurassico-crétacée*' as MAZENOT suggested, its special forms of *Proniceras*, already referred to (p. 27), have been declared by DJANÉLIDZÉ (1922) to be different from those of France; and they are not like the types I described from the Tithonian of Jebel Gara. This probably only means that there is room for the Crimean fauna or faunas somewhere in the many gaps indicated in our Cretaceous and Jurassic successions.

The same explanation may well hold for the Mexican and South American sequences here discussed which, with our present, very limited information, we are apt to consider different from their European counterparts for geographical instead of stratigraphical reasons. There is little difficulty in dating almost exactly such Callovian, Oxfordian, or Kimmeridgian portions of the Jurassic record of Mexico as have been published, which in my opinion shows that the distribution of ammonites was more or less world-wide, though this is only gradually being discovered. The Eotriassic *Otoceras* fauna of the Himalayas found again in East Greenland, the Argentinian *Groebericeras* fauna re-discovered in Kurdistan, the almost world-wide distribution of *Sanmartinoceras* of the Aptian, referred to on p. 7, confirm this and I may add that the Campanian *Hoplitoplacenticeras* (= '*Dechenoceras*') occurs together with the same types of *Gaudryceras*, *Desmophyllites*, etc. in North Germany as in the southern hemisphere, in Angola, Madagascar and Patagonia. Truly representative faunas of approximately the same age can be recognized easily enough; but for the base of the Cretaceous and the top of the Jurassic we are obviously as yet a long way from having enough information to draw up a 'standard' succession.

A general correlation table is here inserted, giving basal Cretaceous sequences at four selected localities, partly to show the place in the Lower Neocomian I would assign to the new *Praetollia* fauna here described from East Greenland, partly to explain some of the many gaps which I believe to exist in the succession. The principle adopted in drawing up this scheme is of course BUCKMAN's principle of dissimilar faunas.

Table I. General Correlation.

France		*Boreal*	*Argentine*	*Kurdistan*
Platylenticeras		Platylenticeras	—	—
—		Tollia	—	—
	—	—	—	—
		Hectoroceras	—	—
		—	damesi	occitanicus
		Praetollia	—	—
boissieri	boissieri s. s.	—	—	—
		stenomphalus	—	—
		—	Groebericeras	Groebericeras
		spasskensis	—	—
		—	—	praeneocomiensis
	calisto	—	—	calisto
	chaperi			
privasensis			calistoides	privasensis
	delphinensis			
		rjasanensis		

Most of the gaps are probably due to 'stratal failure' (BUCKMAN, 1920, p. 64) which is a very common phenomenon, unlike 'dispersal failure', a phenomenon 'about which little is accurately known'. Zoological provinces may be very real, at the present day, or in geological history, for extreme organisms like the belemnite *Duvalia* or the Rudistae. They may be negligible in the case of ammonites whose dispersal was fairly rapid and whose empty shells could have been transported across all the seas of the time while the elements of the lowest Cretaceous Age lived.

The discoveries mentioned on p. 29 are all of comparatively recent date. The genus *Engonoceras* whose home was in the Tethys has not long been known from the English Albian; the Canadian genus *Gastroplites*, of another province, is so far known in only a single example. There must be many more such discoveries still to be made and I am afraid that it will be a long time yet before we see some of the gaps being filled.

V. THE INCOMPLETENESS OF THE GEOLOGICAL RECORD

The gaps in the stratigraphical record to which reference has been made in the last chapter happen to be at the top of the Jurassic and the base of the Cretaceous, but it may be advisable to say a few words on the principle of dissimilar faunas above cited and BUCKMAN's work on the earlier Jurassic. For even A. M. DAVIES (1930) thought that BUCKMAN's method of dating strata had proved invaluable when applied "in moderation" but that the later polyhemeral tables "carried it to an extreme".

I welcomed BUCKMAN's Chronology in 1924(c) as a very important advance in stratigraphical correlation which "would remain a monument to its author's genius". It is possible even now to admire BUCKMAN's courage in including for example the Craspeditan, Proniceratan and Mazapilitan Ages in his Upper Jurassic Chronology, as far back as 1922. Later, however, stratigraphers became more and more estranged from BUCKMAN's methods and in 1928 (p. 224) the writer even called his stratigraphical tables "pretentious lists of imaginary hemerae". This was perhaps less justified for the Liassic than for some of the later Ages; for the Liassic succession seemed comparatively well-known though recent work is vindicating BUCKMAN's interpretation in several significant details. Thus a chronology, expressed in a polyhemeral table, however conjectural, is less divorced from reality for the Liassic than for many later portions of the stratigraphical column.

In view of BUCKMAN's confession that he did not anticipate more than small additions to, or subtractions from, his stratigraphical scheme, or in other words that he thought the succession was more or less established, it seemed advisable to issue a warning against the indiscriminate use of those tables. For authors like CRICKMAY (1931) unquestioningly accepted them and obviously had no means of knowing that the 'Chronology' was largely conjectural. It would be premature even now to standardize many portions of the Jurassic and Cretaceous; the beginning and end of the Systems themselves are still uncertain and both have numerous and often baffling gaps throughout their extensive ranges.

It was left to J. W. Evans, not a palaeontologist, to point out that if Buckman's contentions were substantiated it could be concluded that the geological record was of a far more fragmentary nature than was generally believed (1918).

It seems to me now, after so many years, that Buckman never realized the full import of his principle of dissimilar faunas or the incompleteness of the Mesozoic Record, though he insisted often enough on the frequent defectiveness of local stratal development and on the differences in the preservation of corresponding strata in different provinces. Altogether Buckman had attempted far too much, considering our imperfect knowledge. Not only are there many more gaps in the Mesozoic successions than most stratigraphers realized, but what little had been published in sufficient detail for exact chronological purposes was largely misinterpreted, partly owing to the ever-present nonsequences. Thus I am not alarmed now at the apparent anomalies in the Liassic successions of the Jura Mountains and of Mexico of which I wrote in 1931; they may be due partly to misidentifications of species of *Echioceras* (for *Arnioceras*) and so forth, and they may disappear altogether as more and more sequences in beds of about the same age are published. At least we shall then be able to separate the purely local elements from those of more or less universal distribution.

The present work is an extension of Buckman's principle to the correlation of Cretaceous faunas from continent to continent and across so-called zoological provinces. The time represented by the accumulation of the various deposits listed in Table I (p. 33) may correspond to twenty hemerae in Buckman's tables, but it would be quite impossible to adopt hemeral names for these in the present state of our knowledge. Stratal defectiveness may be striking in the Tithonian and the Infra-Valanginian, but it is at least equally pronounced in the Rhaetic Stage of the Triassic or in the Bathonian Stage of the Jurassic, while for the Barremian and Maestrichtian Stages of the Cretaceous our lack of exact information is seriously embarrassing. It will be many years before we can build up a satisfactory zonal scale for these Stages and therein place the very fragmentary British, European and other foreign deposits known and yet to be described. But it is certain that the scheme will have to be based on a very large number of additional successions, wherever they may occur. That is to say, progress will be made only by the patient accumulation of facts and contrary to Buckman I hold that we are only now beginning to realize the gaps in our knowledge.

VI. SUMMARY OF RESULTS

The ammonites here described (genus *Praetollia*, gen. nov.) are new but their age is deduced from their stratigraphical position. They come from a bed which is some 40 feet below shales that have yielded a species of *Hectoroceras*, a genus hitherto known only from Jameson Land and described as of uncertain date but believed to be of Infra-Valanginian age. The *Praetollia* horizon is underlain by a conglomerate with derived Jurassic ammonites, but also two species of *Subcraspedites* which resemble forms of the presumed Infra-Valanginian Spilsby Sandstone of Lincolnshire and the Riasan Beds of Russia. At 430 feet above the *Hectoroceras* horizon there was found an example of *Tollia payeri* (Toula). This is believed to indicate a horizon corresponding with that of *Tollia tolli* (Pavlow) of Siberia, still of Infra-Valanginian age. The first Valanginian ammonite was found 280 feet higher still.

The incompleteness of the Infra-Valanginian succession in these so-called boreal areas makes comparison difficult with the Berriasian of Switzerland and south-eastern France, where the base of the Cretaceous was established by KILIAN. At present we do not know any Infra-Valanginian ammonites common to both Northern and Southern areas though it may be significant that *Praetollia* resembles '*Berriasella*' of the *calisto* zone of Mediterranean countries (except in its simplified suture-line), and that a *Hectoroceras*-like variation of the Berriasian zone fossil, *Subthurmannia boissieri* (Pictet) has been found in Kurdistan. Ammonites even more useful for correlation of boreal and southern deposits are almost certain to be discovered from time to time.

The writer believes that the Infra-Valanginian or Berriasian successions of Mediterranean countries are also incomplete, judging by the sequences so far published; and he cites in support three sections recently described (two in the Argentine and one in Kurdistan) which all fall within the so-called *boissieri* zone of the base of the Cretaceous. It is held that there is as yet scarcely more definite stratigraphical information about the South of France than for example about the Spiti Shales. In consequence the beautiful ammonite fauna described by UHLIG is comparatively useless and the same applies to other assemblages, until the stratigraphical back-ground is supplied.

There is quite an imposing list of ammonite genera now known to be of more or less world-wide distribution and the writer believes with Buckman that we are apt to consider the boreal Upper Jurassic and Lower Cretaceous to be different from their southern equivalents for geographical instead of stratigraphical reasons. That is to say, there are such obvious gaps in our knowledge that many more successions are needed before we can think of standardizing any part of the Mesozoic and at least we shall then be able to distinguish the purely local elements from those of more or less universal distribution. Zoological provinces may be negligible in the case of ammonites whose dispersal was fairly rapid and whose empty shells could have been transported across all the seas of the world while the genera of the lowest Cretaceous age lived. The present attempt then is an extension of Buckman's 'principle of dissimilar faunas' to the correlation of Cretaceous ammonite assemblages from continent to continent and across so-called zoological provinces, much as the writer has done with Triassic ammonites; but in the present state of our knowledge we can do little more than venture a guess as to the many gaps there must be, chiefly owing to 'stratal failure' and not to 'dispersal failure'.

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Færdig fra trykkeriet den 18. april 1952.

PLATES

Plate I.

Fig. 1. (a) *Praetollia maynci*, sp. nov., var. *communis*, nov. (b). *Praetollia maynci*, sp. nov., var. *despar*, nov. With other impressions on a slab of shale.

Fig. 2. *Praetollia maynci*, sp. nov., var. *contigua*, nov. Plaster-cast of an impression on back of original of Plate III, fig. 7.

Fig. 3. *Praetollia maynci*, sp. nov. Plaster-cast of impression of a young example.

Fig. 4. *Praetollia maynci*, sp. nov. Crushed young example (below), with fragments of larger individuals.

All the specimens on this Plate are from the North Coast of Wollaston Forland in Lindemans Fjord, at 235 m altitude (W. Maync Coll., Nos. 1408—1412).

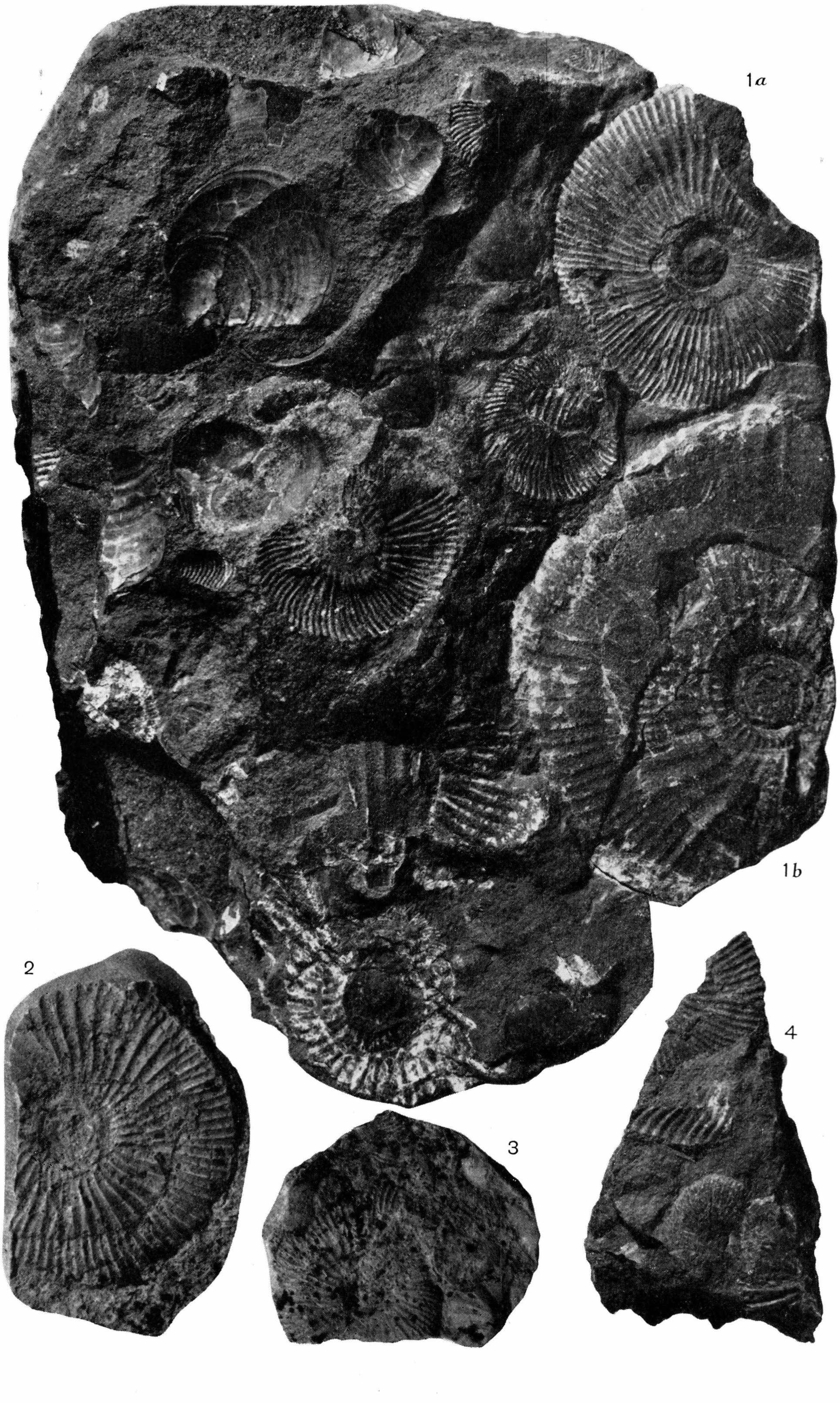
1a
1b
2
3
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Plate II.

Fig. 1. *Praetollia maynci*, sp. nov., var. *contigua*, nov. Two examples, the larger figured again in Plate III, fig. 1 from a plaster-cast. Slab of shale with impressions of various smaller specimens and valves of *Buchia volgensis* (Lahusen).

Fig. 2. *Praetollia maynci*, sp. nov. Small example, embedded in a right valve of *Buchia volgensis* (Lahusen).

The specimens on this Plate are from the North Coast of Wollaston Forland in Lindemans Fjord, at 235 m altitude (W. Maync Coll, Nos. 1408—1412).

1

2

Plate III.

Fig. 1. *Praetollia maynci*, sp. nov., var. *contigua*, nov. Plaster-cast of impression above centre of Plate II, fig. 1.

Fig. 2. *Praetollia maynci*, sp. nov. Typical example. Plaster-cast of an impression.

Fig. 3. *Praetollia maynci*, sp. nov., var. *communis*, nov. (above). Small, crushed example.

Fig. 4. *Praetollia maynci*, sp. nov., Plaster-cast of impression in centre of Plate I, fig. 1.

Fig. 5. *Praetollia maynci*, sp. nov. Average aspect of the numerous crushed fragments.

Fig. 6. *Buchia volgensis* (Lahusen). Left valve, with coarse folds, out of one of the slabs with *Praetollia maynci*, sp. nov.

Fig. 7. *Praetollia aberrans*, sp. nov. Only example found, with original of Plate I, fig. 2 on back.

All the specimens on this Plate are from the North Coast of Wollaston Forland in Lindemans Fjord, at 235 m altitude (W. Maync Coll., Nos. 1408—1412).

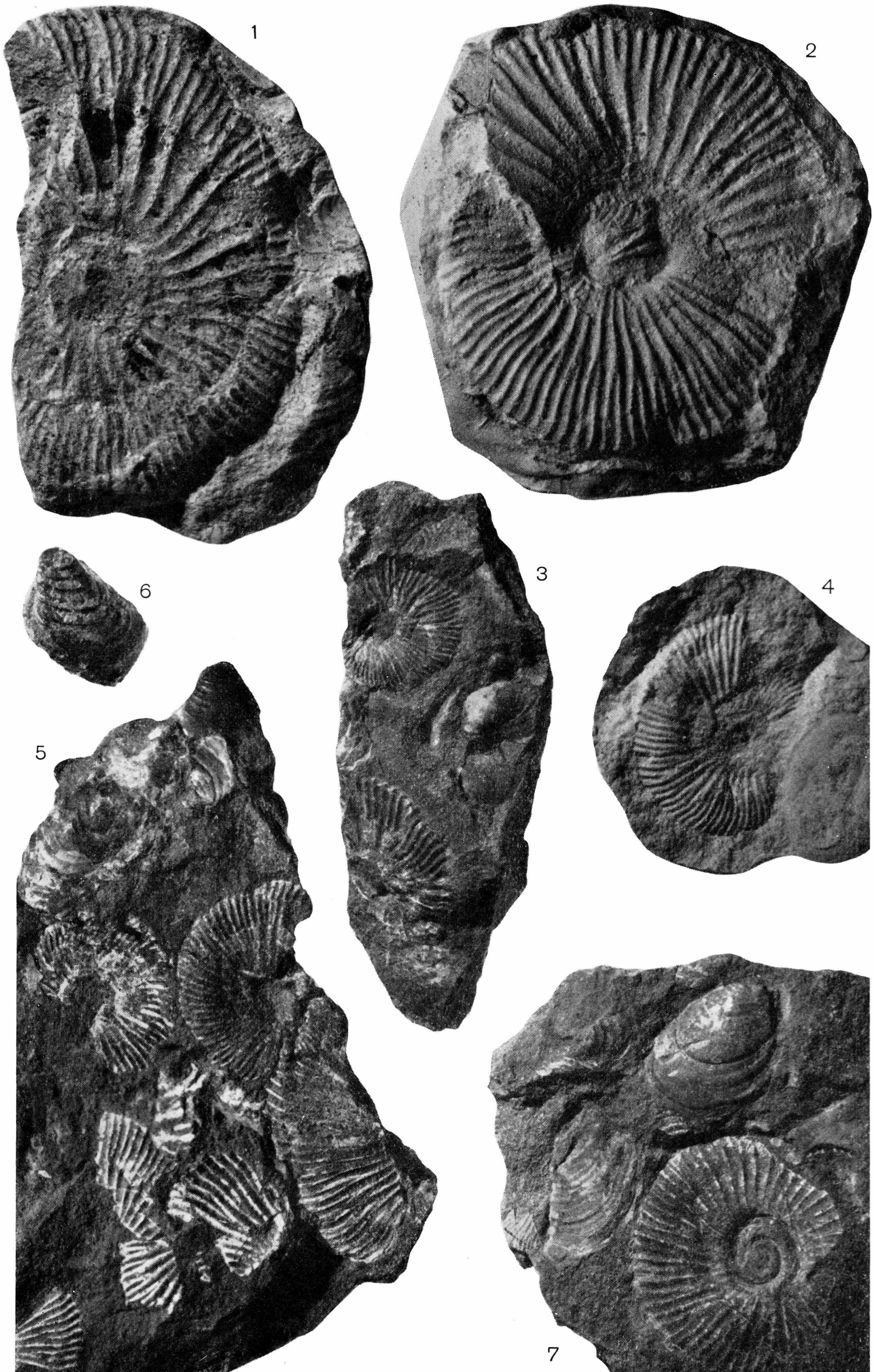
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Plate IV.

Fig. 1. *Subcraspedites* aff. *preplicomphalus*, Swinnerton. Derived in Basal Conglomerate. Original of fig. 4 on back of same specimen.

Fig. 2. *Praetollia maynci*, sp. nov., var. *contigua*, nov. Crushed example showing suture-line.

Fig. 3. *Subcraspedites* (*Paracraspedites*) aff. *spasskensis* (Nikitin). Derived in Basal Conglomerate.

Fig. 4. *Laugeites* sp. nov. Upper Jurassic. Derived in Basal Conglomerate. Other side of example figured in fig. 1.

Fig. 5. *Praetollia maynci*, sp. nov. Two small examples showing periphery.

Fig. 6. *Praetollia maynci*, sp. nov., var. *communis*, nov. Crushed example.

Fig. 7. *Praetollia maynci*, sp. nov. Fragment (left) with periphery and small left valve of *Buchia volgensis* (Lahusen).

Fig. 8. *Tollia payeri* (Toula). Small crushed example. *Tollia* horizon, altitude 380 m, North Coast of Wollaston Forland in Lindemans Fjord (W. Maync Coll., No. 1418).

Originals of figs. 1, 3 and 4 from Haakonshytta, Kuhn Island (W. Maync Coll. No. 1331).

Originals of figs. 2, 5—7 from North Coast of Wollaston Forland in Lindemans Fjord at 235 m altitude (Same Coll., Nos. 1408—1412).

Plate IV.