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CAVENDISH SQUARE, W. 1.

L. F. Spath—Ammonites from Spitsbergen. 297

On Ammonites from Spitsbergen.

By L. F. SPATH, M.Sc., F.G.S.

OF the rich collections of fossils made by Professors J. W. Gregory and E. J. Garwood, as members of Sir Martin Conway's expedition to Spitsbergen in 1896, only a few Labyrinthodont remains, so far, have been described¹; but through the kind offices of Dr. A. Smith Woodward, the writer some time ago was entrusted with the naming of the Cephalopoda in those collections. The Ammonites are of the greatest interest, both from a palæontological and a stratigraphical point of view; and in view of the impossibility of publishing, in the near future, a full description of the fauna, with the necessary number of plates, it is intended to give a short preliminary account of these Cephalopoda. It is matter for regret that other groups of invertebrate fossils, such as the Triassic Pelecypoda, or the Upper Jurassic Aucellids, could not be dealt with, and their detailed study, probably, would yield important results. Spitsbergen Vertebrata, on the other hand, always have received considerable attention.²

The collections include 325 Ammonites from the Lower and Middle Trias, but there are no Upper Trias forms, such as the Carnian *Nathorstites* and *Dawsonites*, which are common enough on Bear Island, and which also have been recorded from Spitsbergen.³ Triassic Nautiloidea are only represented by three examples of *Orthoceras*, one from the Lower Triassic "Nodule bed", another (without label) associated with an indistinct impression of an *Arctoceras*?, and the third from a black limestone that may be of Middle Triassic age.⁴

Two fragmentary examples of *Atractites* sp.? probably are the "Belemnites", mentioned in bed E₃ of Professor Gregory's section I, but there was no label with these specimens, though they were associated with Ammonites from Trident, Sassendal.

Thirty-one Ammonites are of Upper Jurassic (Kimmeridgian to Purbeckian) age, and a few fragments of Belemnites are referred to the same age. Finally, there are nine Cretaceous Ammonites, two of which can more or less definitely be dated as

¹ A. Smith Woodward, "On Two New Labyrinthodont Skulls of the genera *Capitosaurus* and *Aphaneramma*": *Proc. Zool. Soc.*, vol. ii, 1904.

² For bibliographies see e.g. C. Wiman, *Bull. Geol. Inst. Univ. Upsala*, vol. vi, 1919, p. 85, and E. Andersson Stensjö, *ib.*, p. 80.

³ Wittenburg, P. v., "Üb. einige Trias. Fossil. v. Spitzbergen": *Trav. Mus. Géol. Pierre le Grand*, vol. iv, 1910, p. 38. The Upper Trias seems to be developed chiefly on the eastern side of Spitsbergen. It may be mentioned in this connexion that a collection of fossils, made this summer (1920) by Mr. W. J. Reynolds, and lately presented to the British Museum, includes a number of Middle Triassic Ammonites from Sassen Bay and Bell Sound, Spitsbergen; but both Upper and Lower Trias are unrepresented by Ammonites in this collection.

⁴ A *Grypceras*? *nordenskjöldi*, Lindström sp., from "West of Fortress" near Cape Staratshin, West of Green Harbour, is in the Reynolds Collection.

Valanginian, whereas the others are doubtfully referred to the Albian. The stratigraphical information supplied unfortunately consists only of the data here copied from the labels attached to the specimens. The localities are mentioned in Sir Martin Conway's well-known book, *The First Crossing of Spitsbergen*,¹ and mostly recorded on the map appended to that work and to his paper in the *Geographical Journal*.² Since the mineral wealth of Spitsbergen is now attracting considerable attention,³ it may be hoped that additional material and more extensive stratigraphical observations will soon be available.

After this paper was completed, Professor J. W. Gregory kindly sent the writer his "Note on the Sequence across Central Spitsbergen, from Advent Bay to Agardhs Bay", published herewith, so that it has been possible to insert some references to the beds mentioned in Professor Gregory's sections. But in view of the fact that some of the specimens were collected from loose blocks, that there are differences in the nomenclature that the writer is unable to settle, also that most of the specimens collected by Professor E. J. Garwood, especially the Jurassic ones, come from other localities, a complete list of the Ammonites, arranged according to the sections mentioned by Professor Gregory, cannot be given. The table at the end of the chapter on the Triassic portion of the Ammonite fauna, however, is an attempt at a correlation for that period.

I. TRIASSIC.

The great majority of Ammonites belong to the Lower Trias, and can be referred to the following genera:

<i>Arctoceras</i> ⁴	<i>Prionites</i>
<i>Olenekites</i> ?	<i>Anasibirites</i>
<i>Flemingites</i> ?	<i>Keyserlingites</i>
<i>Gyronites</i> ?	Gen. nov. (<i>Danubites</i> ?)
<i>Goniodiscus</i>	<i>Xenodiscus</i> ?
<i>Tellerites</i>	<i>Prospingites</i> ?

The last two are represented by 100 and 66 specimens respectively; *Arctoceras* by 82. The latter genus includes, in addition to a number of less definitely identifiable species, seven forms described by

¹ 1897, J. M. Dent & Co., London.

² Vol. ix, No. 4, April, 1897, pp. 353-68, map, p. 472.

³ See "Recent Developments in Spitsbergen", by Dr. R. N. Rudmose Brown: *Scott. Geogr. Mag.*, vol. xxxvi, April, 1920, No. 2, pp. 111-16; also the same author's "The Coal-fields of Spitsbergen": *Nature*, October 9, 1919. The summer population of Spitsbergen (1919) is estimated at 1,000.

⁴ Hyatt, 1900 (in Zittel's *Text-book of Palæontology*, vol. i, p. 559), non *Arctoceras*, J. Böhm, 1899 ("Üb. Triad. Foss. v. d. Bären-Insel": *Zeit. Deutsch. Geol. Ges.*, vol. li, p. 326). In 1904 J. Böhm ("Üb. d. Obertriad. Fauna d. Bären-Insel": *Kon. Svensk. Vet.-Akad. Handl.*, vol. xxxvii, No. 3, 1903, p. 61) withdrew his *Arctoceras* in favour of Hyatt's term, and replaced it by another generic name for his Carnian group.

Mojsisovics,¹ namely *Arctoceras polare* (Mojs.), *A. simplex* (Mojs.), *A. whitei* (Mojs.), *A. blomstrandii* (Lindström), *A. lindströmi* (Mojs.)², *A. öbergi* (Mojs.), *A. costatum* (Öberg). A number of small specimens, more evolute than the large examples, have lateral folds, or almost a spiniplicate ornament; but they occur with the young of undoubted *Arctoceras*, and, apparently, are connected with these by transitional forms. This may only be a case of convergence, for it is improbable that a spiniplicate development would give rise to forms that acquire costation on the outer whorl, as does *Arctoceras*. Only the smooth and more involute young, therefore, are considered to belong to *Arctoceras*. The others are like the young of "*Ceratites*" *decipiens* Mojsisovics, and of *Olenekites*, e.g. *O. sigmatoides*, Mojsisovics sp. The latter also resemble the young of forms referred to below as gen. nov. (*Danubites*?, *Xenodiscus*?) and Mojsisovics³ derives *Danubites* from *Olenekites*. The small forms, here compared with *Olenekites*, however, have a smooth ventral area, whereas in the gen. nov. there are constrictions across the venter, apparently arising from a spiniplicate ornament. It is impossible to say at present whether *Arctoceras* should be attached to *Dinarites* (in Mojsisovics), to *Olenekites* and *Keyserlingites* (in Hyatt), to *Flemingites* (in Philippi), or to *Meekoceras* (in Stolley).

The writer may add that a true spiniplicate *Olenekites* in the British Museum is distinguished from the small forms here discussed by its square saddles, characteristic for *Dinaritidæ*.

Four specimens consist of umbilical impressions of very large shells, probably *A. lindströmi*, Mojsisovics sp.; their matrix indicates the *Posidonomya* shales. Fifteen examples are merely impressions in more or less weathered slabs of rock. But, whereas the well-preserved specimens and the umbilical casts above referred to clearly come from the *Posidonomya* shales⁴ and generally are associated with numerous examples of *Posidonomya mimer* Öberg, these impressions are preserved in a very fine-grained black limestone, weathering yellow, and including (besides? *Hærnessia*) large smooth *Pseudomonotis* of the type of *P. (Claraia) decidens* (Bittner)⁵

¹ "Arktische Triasfauna": *Mém. Acad. Imp. Sci. St. Pétersbourg*, ser. VII, vol. xxxii, No. 6, 1886, pp. 29-38.

² Non "*Arctoceras*" *lindströmi*. J. Böhm in J. G. Andersson ("Üb. d. Stratigr. und Tektonik d. Bären-Insel": *Bull. Geol. Inst. Univ. Upsala*, vol. iv, 1890, pt. ii, No. 8 (1900), p. 265), a *Nathorstites*, that has nothing to do with the Lower Triassic *Arctoceras lindströmi* (Mojsisovics).

³ *Geb. u. Hallstatt*, Supplement, 1902, p. 329.

⁴ Or rather from limestone-nodules in the bituminous, marly shales, mostly wrongly referred to in literature as "*Posidonomya Kalk*", as has been pointed out by Professor Wiman ("Ein paar Labyrinthodonte-reste a. d. Trias Spitzbergens": *Bull. Geol. Inst. Univ. Upsala*, vol. ix, (1908-9), 1910, p. 34). Most of the specimens are from "Nodule Bed, Base of Trident, Sussoidal"; three examples only came from "lowest line of nodules" or "Lowest Limestone" on Mt. Marnier.

⁵ "Trias Bruch. & Lamell.": *Mém. Geol. Surv. India, Pal. Indica*, ser. xv, *Himal. Foss.*, vol. iii, pt. ii, 1890, pl. 3, fig. 24.

or of *P. (Claraia) aurita* (Hauer) in Diener.¹ These slabs are labelled "Lower Lamellibranch zone", Trident, but a few are from Sticky Keep, and there called "Upper Flags" (= Calcareous Flags, Bed above nodules?). The presence of iron-pyrites in the latter, however, is reminiscent of the calcareous *Arctoceras* nodules in the *Posidonomya* shales, and the rock is hard, whereas the somewhat similarly weathering examples from the "Upper Lamellibranch zone", with a very large *Pseudomonotis (Eumicrotis)*, generally have a more earthy, brownish appearance. One *Arctoceras* impression, merely labelled "Sassendal", may have come from this higher zone, but it is for future workers to investigate the range of *Arctoceras* in the shales and flags above the "Nodule bed".

A specimen of *Arctoceras blomstrandii* (Lindström) was attached to the umbilical impression of a very large shell, characterized by strong spiral ornament, on account of which the specimen is doubtfully referred to *Flemingites*. The longitudinal striation in this genus, however, is considerably finer than it is in the Spitsbergen example; and the writer at one time was inclined to compare this specimen with certain *Phloioceras* and other *Nautiloidea*. It seems most probable, however, that the example is a *Flemingites*, though spiral striation is also indicated in certain *Arctoceras*.² Another specimen of *Arctoceras* and numerous *Posidonomya mimer* are to be observed in the same specimen.

Two of the specimens referred to *Goniodiscus* are closely comparable with *Meekoceras gracilitatis* White,³ but the periphery is slightly broader. Young examples of the same form, however, have the costation of *Anasibirites*, and are so nearly related to the forms here referred to that genus, to *Prionites* and to *Tellerites*, that the resemblance to the genus *Meekoceras* (with perfectly smooth inner whorls) can only be a case of convergence. The suture-line of this new species of *Goniodiscus* agrees with that of *G. typus* Waagen,⁴ but the external saddle is a little wider in the Spitsbergen form. The latter also has a narrower and more sharply defined periphery.

Another new species of *Goniodiscus* has coarse pleats at the middle of the side, near the end of the shell, and thus is transitional to

¹ "Triassic Faunæ of Kashmir": *Mem. Geol. Surv. India, Pal. Indica*, n.s., vol. v, Mem. No. 1, 1913, pl. v, fig. 9.

² E.g. *A. öbergi* (Mojsisovics), loc. cit., p. 33, pl. viii, fig. 3. *Ceratites concentricus* Öberg ("Om Trias-Först. fr. Spitsbergen": *K. Svenska Vet. Akad. Handl.*, vol. xiv, No. 14, 1877, p. 15, pl. ii, fig. 12) has concentric markings, but Mojsisovics (loc. cit., p. 8), who examined the type, states that they are the result of crushing. To judge by a number of specimens in the Reynolds Collection, this form is a crushed *Ptychites* of the *Daonella* Beds.

³ In Hyatt & Smith, "The Triassic Ceph. Gen. of America": Prof. Paper No. 40, U.S. Geol. Surv., 1905, p. 143, pl. xii, figs. 7-9. Dr. C. T. Trechmann lately presented to the British Museum (Nat. Hist.) a very fine series of Triassic Ammonites from California, Nevada, and Idaho, U.S.A., including many topo-types of Hyatt & Smith's species.

⁴ "Salt Range Fossils": II. Fossils from the Ceratite Formation": *Mem. Geol. Surv. India, Pal. Indica*, ser. XIII, 1895, p. 128, pl. ix, figs. 7-10.

Prionites. A third form, at last, has these *Prionites*-folds very close, resembling in shape *Anasibirites hircinus* Waagen sp.,¹ but with the costæ pronounced only at the middle of the side, not near the periphery. The cross-sections of the last two forms approach to that of *Prionites tuberculatus* Waagen.²

A new species of *Prionites* is like the above in the character of the inner whorls. These somewhat resemble *Meekoceras sibiricum* Mojsisovics,³ but are more evolute, i.e. more like *M. sp. ind. aff. jolinkense* Krafft in Diener.⁴ On the other hand, the outer whorl agrees with that of the example of *Prionites tuberculatus* (Waagen), figured by Frech.⁵ The periphery, however, still suggests the *Goniodiscus-Anasibirites* stock; and since Waagen's type of *Prionites* is a much earlier form, it is quite possible that the forms of the *Stephanites*-zone do not belong to this genus. A large but fragmentary specimen of a *Prionites* sp. nov. aff. *tuberculatus* Waagen, has a more rounded outer whorl that strikingly suggests a transition to *Keyserlingites*.

A small specimen, probably belonging to a new form of *Tellerites*, but slightly malformed and not showing the suture-line, has the sigmoidal ornament of *T. furcatus* (Öberg), but the deeply channelled periphery of *Hedenstræmia* already at the diameter of Mojsisovics' small specimen,⁶ which latter, then, is still rounded. This ammonite, also, cannot be separated from the other "*Meekoceras*"-like forms here discussed, and certainly has nothing to do with the Middle Triassic *Norites*, with which *Tellerites* has been associated by Mojsisovics and Haug.

The genus *Anasibirites* is represented by thirteen examples from the Nodule Bed of the Trident, Sassendal, including one curious new form, transitional to *Goniodiscus*, and others comparable with such species as *A. ibex* (Waagen), *A. angulosus* (Waagen), and *A. spiniger* (Krafft). Several more small examples are attached to large specimens of *Keyserlingites*, of which the collection includes nine fine examples, belonging to a new species, near to *K. middendorfi* (Keyserling).⁷ The Spitsbergen form, however, has a simpler suture-line, with only bifid external lobe.

The numerous specimens here referred to *Prosphingites*? include

¹ *ib.*, p. 123, pl. ix, fig. 4.

² *ib.*, p. 58, pl. v, fig. 2.

³ *Loc. cit.*, 1886, p. 85, pl. xi, figs. 1-6.

⁴ *Loc. cit.*, 1913, p. 25, pl. iv, fig. 3.

⁵ *Lethæa (Geogn.*: II. Mesozoic; vol. i, Trias, pt. ii, 1905, pl. xxviii, fig. 2.

⁶ *Loc. cit.*, 1886, pl. x, fig. 19a-b, p. 80. Öberg's original figure (*loc. cit.*, pl. iii, fig. 6) is much nearer the new form.

⁷ In Mojsisovics, *loc. cit.*, pl. iii, p. 38. The form figured and described by Diener ("The Cephalopoda of the Muschelkalk": *Mem. Geol. Surv. India, Pal. Indica*, ser. xv, Himalayan Fossils, vol. ii, Trias, pt. ii, 1895, p. 28, pl. v, fig. 7) as *Ceratites* sp. ind. ex aff. *C. middendorfi* (Keyserling) from the Muschelkalk, like his Middle Triassic *Sibirites prahlata* (*ib.*, p. 37, pl. vii, fig. 5), have nothing to do with the Lower Triassic forms here discussed. There is not one Muschelkalk form found in association with the latter at Spitsbergen.

several new forms, externally resembling such species as *Nannites herberti* Diener and *N. hindostanus* Diener,¹ but with toothed lobes. *Prosphingites austeni* Hyatt & Smith² has a similar suture-line, but is too involute; on the other hand, some of the specimens greatly resemble the inner whorls of *Prosphingites czekanowskii* Mojsisovics,³ though in this form, as also in *Paranannites aspenensis* Hyatt & Smith,⁴ the external lobe is too complicated.⁵ The radial folds and pseudo-constrictions of some examples are pronounced; other forms are quite smooth and globose, but they agree in suture-lines. Only one example was attached to a typical *Arctoceras*, but many small specimens came out of the matrix of a large specimen of *A. lindströmi* (Mojsisovics) from "lowest line of nodules in flags, 400–450 feet above camp, Mt. Marmier".

The numerous forms referred to above as gen. nov. (*Danubites*?, *Xenodiscus*?) belong to a group of which "*Dinarites*" *evolutus* Waagen,⁶ and *Ceratites minutus* Diener⁷ [non *Dinarites minutus* Waagen] probably are examples. The former has been compared with *Bittnerites*, and also with *Xenodiscus*, and some forms referred to the latter genus by Diener, e.g. *X. cf. lissarensis* Diener⁸ and *X. comptoni* Diener,⁹ indeed, greatly resemble the later forms. But the Spitsbergen Ammonites, probably, are nearly related to *Danubites*, e.g. *D. hyperboreus* (Mojsisovics), and to *Olenekites*, though the constrictions and coarse folds of the inner whorls somewhat resemble the Middle Triassic *Cuccoceras*. Again, the notched periphery of some of the more involute forms has the appearance of that of *Anasibirites ceratitoides* (Waagen),¹⁰ but the suture-line of the whole group is very close to that of the form described as *Xenaspis marcovi* by Hyatt & Smith.¹¹ There is no resemblance to the Indian forms of *Xenodiscus*, with flattened periphery, in the British Museum Collections, nor to the forms of *Xenodiscus*, recorded with *Paratirolites* and *Stephanites* from Djulfa by Stoyanow,¹² and supposed to correspond with those of the Himalayan *Hedenstræmia*-beds.

On the whole, then, the group is, perhaps, closer to the Arctic

¹ "The Cephalopoda of the Lower Trias": loc. cit., Himalayan Fossils, vol. ii, pt. i, 1897, pp. 68, 69, pl. vii, figs. 2, 3.

² Loc. cit., 1905, p. 72, pl. vii, figs. 1–4.

³ Loc. cit., 1886, p. 64, pl. xv, figs. 10–12.

⁴ Loc. cit., 1905, p. 81, pl. viii, figs. 1–15; pl. lxxiii, figs. 1–30.

⁵ *Prosphingites ali* Arthaber (*Albania*, 1911, pl. xxii, fig. 6) has a similar external lobe, but the saddles and lobes are only about half as high in the Spitsbergen species. *Paranannites mediterraneus* Arthaber (ib., pl. xviii, fig. 8), on the other hand, has quite a different suture-line.

⁶ Loc. cit., 1895, p. 32, pl. x, fig. 3.

⁷ "Triad. Ceph. Fauna d. Ostibir. Küstenprovinz": *Mém. Com. Géol. St. Pétersb.*, vol. xiv, No. 3, 1895, p. 15, pl. ii, fig. 6.

⁸ Loc. cit. (Kashmir, 1913), p. 5, pl. i, fig. 11.

⁹ *Ib.*, p. 10, pl. ii, fig. 7.

¹⁰ Loc. cit., 1895, p. 115, pl. viii, fig. 10.

¹¹ Loc. cit., 1903, p. 116, pl. vii, figs. 26–33.

¹² "On the Character of the Boundary of Palæozoic and Mesozoic near Djulfa": *Verh. Russ.-Kais. Min. Ges.*, ser. II, vol. xlvi, 1909, pp. 86, 87.

Danubites than to any other development, and it should be mentioned that Waagen's *D.?* *evolutus* also is associated with *Anasibirites*. The young of some of the Spitsbergen forms also resemble the example figured by Diener¹ as *Danubites* nov. sp. ind., with evolute whorls, parabolæ-like costæ, and constrictions like Diener's Fig. 7a. Only the suture-line in this form of *Danubites* has the external lobe subdivided, whereas in the Spitsbergen group it is entire, like that of *Ceratites minutus* Diener non Waagen. The largest specimen of the group, a form very near to *D.?* *evolutus* Waagen, attains a diameter of 70 mm.

Apart from over ninety specimens of this group of *Danubites*? the collections include some more or less unidentifiable impressions of similar Ammonites in a black limestone, possibly from the "Lower Lamellibranch zone"; also some in a softer, more brownish rock that may belong to the "flags above the nodule bed", with the large ribbed *Pseudomonotis*. It should be mentioned, however, that according to Stolley,² a very hard, splintery limestone occurs in large nodules above the *Posidonomya* shales. Stolley would include this in the Lower Muschelkalk, and considers *Arctoceras lindströmi* and *A. costatum* to belong to this bed. But the large specimen of *A. lindströmi*, referred to above, from the "lowest line of nodules in flags, 400–450 feet above camp, Mt. Marmier", has *Posidonomya* attached to the matrix, and the writer cannot separate it from the fauna of the *Posidonomya* nodules. The impressions referred to represent evolute more or less smooth shells, and their attribution to *Danubites*, of course, is quite uncertain. One specimen in a soft, dark shale resembles *Meekoceras* (*Gyronites*) *nathorsti* J. Böhm,³ but the periphery is not shown.⁴

Two specimens require special mention. They were discovered, accidentally, in what almost is a bone-bed, among portions of Labyrinthodonts and Coelacanthid fish-remains, associated with *Posidonomya*, to judge by other specimens, and undoubtedly of the age of the *Posidonomya* shales. One of these specimens is a crushed and incomplete example of ?*Gyronites*, comparable with *G. aplanatum* (White),⁵ which also has been recorded from the *Arctoceras* bed by Stolley⁶; the other is a fragment, resembling "*Danubites*" *strongi* Hyatt & Smith⁷ in its angular periphery, in ornament, and in evolution, but having the lateral folds a little closer.

¹ Loc. cit., (1895, Ostsibir.), pl. i, fig. 7.

² "Zur Kenntn. d. Arkt. Trias": *N. Jb.*, vol. i, 1911, p. 122.

³ "Üb. Trias Verstein. v. Bell-Sunde auf Spitzbergen": *Arkiv f. Zool.*, vol. viii, 1913, No. 2, p. 11, pl. i, figs. 17–19.

⁴ From Professor Gregory's section I it will be seen that there are 600 feet of black shales and yellow flags (from which these *Danubites* may have come) between the undoubtedly Lower Triassic "Nodule Bed" (C.) and the probably Middle Triassic "Earthy Limestone" (D₁).

⁵ See Hyatt & Smith, loc. cit., 1905, p. 146, pl. xi.

⁶ Loc. cit., 1911, p. 123, pl. ix, fig. 5.

⁷ Loc. cit., 1905, p. 165, pl. ix, figs. 4–10.

One slab from the "Nodule bed" of the Trident, Sassendal, full of *Posidonomya mimer*, and containing, in addition to *Arctoceras*, a fragment of one of the species of the gen. nov. (*Danubites* ?), also includes a portion of what Dr. A. Smith Woodward considers to be *Belonorkynchus wimani* A. Smith Woodward.¹ The writer, at first, thought that these plentiful *Danubites* ? might be what Wiman² calls the commonest Ceratite of the "fish-bed". Other fish-remains in the British Museum (*Acrolepis*), and some Coelacanthid remains associated with *Arctoceras* and *Posidonomya mimer*, also are preserved in the black limestone that must have come from nodules in the *Posidonomya* shales. But only a few isolated specimens of *Danubites* ? are found associated with *Arctoceras* and *Posidonomya*, whereas the nodules in which these *Danubites* ? occur in clusters are crowded with a very convex *Pseudomonotis*. This also characterises the matrix of *Anasibirites* and *Keyserlingites*, but it does not seem to be found in the slabs with *Posidonomya mimer*, where a less convex and smoother form (still of the *P. boreas* type) rarely occurs.

Professor Wiman³ recorded his Labyrinthodont remains from the lower part of the *Posidonomya* shales of Mt. Marmier, and thought that the "fish-bed", not quite at the base of the Trias, might not represent the exact horizon from which Mojsisovics' *Arctoceras* fauna was obtained.⁴ From the evidence of the specimens labelled "Lower Nodule Bed", and from Professor Gregory's section I, it would appear as though both the typical *Arctoceras* fauna, recorded by Mojsisovics, corresponding with the "*Posidonomya* nodules" aforementioned, and the *Anasibirites*-*Keyserlingites*-*Prionites*-*Goniodiscus* assemblage, recorded here from the "*Pseudomonotis* nodules", occurred at about the base of the "*Posidonomya* shales". The fish-bed of Professor Wiman⁵ also may be near this horizon, C₁.

Whether the whole of the 600 feet of "*Posidonomya* shales" above this horizon belong to the Lower Trias is doubtful. The "Lower Saurian horizon" of Professor Wiman, 300 feet above the fish-bed, may coincide with the bed from which ? *Gyronites aplanatus* and ? *Danubites strongi* have been recorded, those species being known to occur in the "*Meekoceras*" beds of Idaho and California. Hyatt & Smith⁶ record *Anasibirites* from the same beds, so that

the two species mentioned (the identification of which is not definite) may belong to the uppermost Lower Trias. In the nodule bed a doubtful *Flemingites* has been found, and the *Anasibirites* and *Keyserlingites* are characterized by simple sutures, so that horizon C₁ may very probably be somewhere near the border-line between the *Flemingites* beds below and the *Stephanites* zone above.¹ The latter probably includes the lower half or more of the *Posidonomya* shales, but an exact correlation is impossible in the present state of our knowledge.

(To be continued.)

L. F. Spath—Ammonites from Spitsbergen. 347

On Ammonites from Spitsbergen.

By L. F. SPATH, D.Sc., F.G.S.

(Concluded from p. 305.)

There appears to be a good deal of variation in the Lower Triassic succession of the different parts of Spitsbergen, even between Ice Fjord and Bell Sound, at which latter *Gyronites nathorsti* J. Böhm

¹ This has taken place since this paper was handed in for publication, the writer opening a discussion on the subject at the Geological Society meeting of 8th June, 1921.

¹ "Notes on some Fish-remains from the Lower Trias of Spitsbergen"; *Bull. Geol. Inst. Univ. Upsala*, vol. xi, 1912.

² "Ichthyosaurier a. d. Trias Spitzbergens"; *Bull. Geol. Inst. Univ. Upsala*, vol. x, 1910-11, Nos. 19 and 20, p. 127.

³ *Loc. cit.*, 1910, p. 34.

⁴ *Loc. cit.*, 1911, p. 127.

⁵ *Ib.*, p. 126.

⁶ *Loc. cit.*, 1905, p. 49. In 1914 (*The Middle Triassic Marine Invertebr. Faunas of North America*, p. 4: Correlation Table) Professor Perrin-Smith put the Spitsbergen *Posidonomya* "Limestones" as equivalent to the *Meekoceras* Beds of the Himalayas and the *Proptychites* Beds of the Ussuri, that is to say,

occurs in soft shales. The grey sandstones with a Lamellibranch fauna of Werfenian age from Axel Island,¹ again, represent quite a different facies.

The difficulties encountered in studying the Lower Triassic forms, and due, chiefly, to the conflicting evidence of the various matrixes, and to the fact that some of the best-preserved examples were found loose, are met with again in dealing with the Middle Triassic specimens.

Monophyllites sp. cf. *sphaerophyllus*, Hauer sp.,
Ptychites cf. *trochlaeformis*, Lindström sp.,
Ptychites ? sp. cf. *tibetanus*, Mojsisovics,
 ? *Gymnotoceras* cf. *laqueatus*, Lindström sp.

are referable to the Middle Trias (Anisian), though they are only preserved as impressions in a black shale that apparently corresponds with the "Thin Paper Shales" (D₃) of Professor Gregory's section I. This shale is full of comminuted fragments of shells, and quite distinct from any other matrix, and it may be added that the two vertebral centra of *Aphaneramma rostrata* figured by Dr. A. Smith-Woodward have this matrix, whereas the skull is preserved in a hard nodular limestone reminiscent of the *Posidonomya* shales.²

Stolley³ recorded a *Monophyllites* from the *Daonella* beds, and considered these to be of Ladinian age, and the equivalent of the Wengen beds. He found *Nathorstites*, which characterizes Upper Triassic beds on Bear Island and in British Columbia, only a little higher, and thus would draw the boundary-line between the Middle and Upper Trias just above the *Daonella* beds. The large specimen of *Monophyllites*, mentioned above, resembles *M. sphaerophyllus* Hauer sp., but not *M. wengensis* Klipstein sp., and its association with *Ptychites* and *Gymnotoceras* suggests an Anisian age.⁴

The specimen of *Gymnotoceras*, unfortunately, does not show the inner whorls,⁵ and has a different matrix from all the other examples of *Gymnotoceras* in the collection. These occur with *Lingula lindströmi* J. Böhm,⁶ and the other Ammonites given in the list

¹ Wittenburg, "Üb. Werfen. Sch. v. Spitzbergen": *Bull. Acad. Imp. Sci. St. Pétersb.*, ser. vi, 1912, pp. 947-8.

² These specimens are from Sticky Keep, whereas the first three in the above list are from "Bluff, above entrance to Flower Valley, over nodule bed", (Escarpment Shales of Professor Gregory's Section II). The last (*Gymnotoceras*), which has a more slaty (worn) aspect, is from "Sassen-Bay".

³ "Z. Kenntn. d. Arkt. Trias.": *N. Jb. f. Min.*, etc., vol. i, 1911, p. 117.

⁴ Among 3,500 Bosnian Ammonites from the "triodosus-zone", recently named by the writer, the genera *Ptychites* and *Monophyllites* were represented by 640 and 314 specimens respectively, and, besides Arcestids, the dominant element of the fauna.

⁵ There is a certain resemblance in ornament to *Protrachyceras sverdrupi* Kittl ("Die Trias-Fossil. v. Heureka Sund": Report 2nd Norw. Arct. Exped. in the *Fram*, 1898-1902, No. 7, 1907, p. 39, pl. iii, fig. 9) also associated with a *Daonella* very similar to the Spitsbergen form.

⁶ This author (loc. cit., p. 13) has a black, fine-grained limestone with this *Lingula* above the Lower Trias, and since the *Lingula* also occurs in slabs with *Daonella* he considers it of Ladinian (Middle Triassic) age. The form here

below, in a limestone which is very compact and black when fresh, but brownish, softer, and more flaggy when weathered, and which may correspond with the black, fine-grained limestone referred to by J. Böhm. The forms of these black limestones and calcareous flags (as distinguished from the above shales) are:—

Gymnotoceras laqueatum (Lindström), common.
 " *falcatum* (Mojsisovics).
 " *geminatum* (Mojsisovics), common.
Danubites ? sp.
Tropigastrites ? cf. *polygyratus* Smith.
Monophyllites cf. *spetsbergensis* (Öberg).¹

The evidence, however, is by no means satisfactory; for very similar black limestones, weathering to various lighter colours, occur in nodules in the Lower Trias, and it should be mentioned that *Gymnotoceras falcatum* is labelled [by error ?] "Nodule-bed, Trident", and one specimen of *G. cf. laqueatum* comes from "E basement bed of Trident". The latter has the matrix of some thirty specimens of *G. geminatum* (Mojsisovics), comparable with the two crushed specimens figured by Mojsisovics² from the black calcareous shales of the Hyperite Hat. It agrees with the "Calcareous Flags above nodules", referred to above, characterized by a *Pseudomonotis*, but it may only represent a more weathered condition of the black crystalline limestone that contained *Lingula*, *Monophyllites*, and [doubtfully] *Gymnotoceras falcatum*. On the other hand, a similar *Pseudomonotis* occurs in the *Ptychites*-beds.³

Two quite indeterminable impressions of Ammonites are labelled "Phosphate Series, near Botanists' Camp, de Geer Valley Delta, Sassen Bay", and probably came from one of the Oozy Mound Beds (E) of Professor Gregory's section I. Phosphatic shales are mentioned by Nathorst,⁴ as occurring both in the Lower and, more frequently, in the Middle Trias (*Daonella* shales), but the more involute impression (unfortunately crushed quite flat) may even be a *Nathorstites*, and thus indicate a Carnian horizon.

The only fragment of an Ammonite, actually associated in the same slab with *Daonella*, unfortunately is indeterminable. On the

referred to *L. lindströmi*, like *Gymnotoceras falcatum* and *Monophyllites* cf. *spetsbergensis*, are preserved in a black limestone that is characterized by the brownish calcite, replacing the shells; but *Arctoceras* may be similarly preserved.

¹ This small form is characterized by three saddles, like Himalayan species of the group of *M. suessi*, figured by Diener (1895, pl. xxxi), but in shape more like *M. nara* Diener or *M. spetsbergensis* (Öberg).

² Loc. cit., 1886, p. 49, pl. ix, figs. 13, 14 only. Many examples of this form from "West of Fortress", near Cape Staratshin, and from Trias Point, North Side of Van Keulen's Bay, Bell Sound, are in Mr. Reynolds's Collection.

³ After seeing Professor Gregory's section I, the writer would put this *Gymnotoceras* fauna into D₁ ("Earthy Limestone").

⁴ "Beitr. z. Geol. d. Bären-Insel, Spitzb. und d. Kön. Karl Landes": *Bull. Geol. Inst. Univ. Upsala*, vol. x, 1910-11, Nos. 19 and 20, p. 352.

alternans from apparently contemporaneous beds of Greenland,¹ and, on account of the single costation, also to the form referred to *Amæboceras* cf. *bauhini* (Oppel), by Ilovaïsky, from his highest bed D.² Lahusen³ refers to this "Schwarzer Brandschiefer" of Spitsbergen, with *A. nathorsti*,⁴ as containing *Aucella radiata* and *Aucella bronni*, but though some of the slabs of this micaceous shale with *Amæboceras* contain isolated *Aucella* of the type of *A. spitsbergensis* and *A. reticulata* Lundgren, these *Aucella* are more plentiful in other examples of this shale, not associated with Ammonites.

In the finer-grained, non-micaceous shales that Lindström⁵ and Lundgren⁶ mention as containing *A. triplicatus*⁷ and *Aucella*, shells of the latter genus also are very abundant, but the *Aucella mosquensis* probably was misquoted for a plicate variety of *A. pallasi*. This occurs together with *A. bronni* Rouiller, so that a Kimmeridgian age (zone of *Aucella bronni* of Lahusen) is most probable. Pompeckj,⁸ however, records *Perisphinctes* cf. *triplicatus* (Lindström), together with *Aulacostephanus* (and corresponding *Aucella*), thus suggesting a higher horizon in the Kimmeridgian (Hoplitenschichten of Lahusen) than is indicated by the forms of *Pictonia* which belong to the lower *alternans* beds. The Ammonite impressions in this black shale, characterized by its weathering to various colours, unfortunately are badly preserved; there is great resemblance to the forms of *Pictonia* quoted above, but also to *Perisphinctids* of the *achilles-decipiens* group. The primary ribs distinguish the forms from *Rasenia*, e.g. *R. triplicata* (Sow. in Damon),⁹ or the still higher *Virgatites*. On the other hand, one example agrees very well with *V. polygyratus* (Trautschold) in Pavlow,¹⁰ so that it appears probable that a number of horizons

¹ J. P. J. Ravn, "On Jurass. and Cret. Foss. from N.E. Greenland": *Mus. Min. Géol. Univ. Copenhagen, Comm. Paléont.*, No. 10, 1911, p. 486, pl. xxxvi, figs. 1-3.

² "L'Oxf. et le Séquan. d. Gouv. de Moscou et de Riasan": *Bull. Soc. Imp. Nat. Moscou*, n.s., vol. xvii (1903), 1904, p. 273, pl. xi, fig. 2.

³ "Üb. d. Russ. Aucellen": *Mém. Com. Géol. St. Pétersb.*, vol. viii, No. 1, 1888, p. 44.

⁴ Additional examples of *A. nathorsti* in the Reynolds Collection come from the south side of Van Keulen's Bay, Bell Sound, and from Green Harbour (south-west).

⁵ "Om Trias och Jura-Först. fr. Spetsbergen": *K. Svenska Vet.-Akad. Handl.*, vol. vi, No. 6, 1866, pp. 10, 19.

⁶ Loc. cit., 1883, p. 3.

⁷ Sowerby's *A. triplicatus* (xcii, 2) is a *Rasenia*; *A. triplex* (ccxciii, 4) and *A. trifidus* (ccxcii) are Corallian *Perisphinctids*.

⁸ In Nathorst, "Eine vorläuf. Mitt. v. Prof. J. F. Pompeckj üb. d. Altersfrage d. Juraablag. Spitzbergens": *Geol. Fören. Förh.*, vol. xxxii, Heft 6, Nov. 1910, p. 1503 (table).

⁹ *Supplement to the Geology of Weymouth, etc.*, new ed., 1888, pl. xiii, fig. 3.

¹⁰ *Études, etc.*, i, 1889, p. 60, pl. iii, fig. 3a only. Trautschold's original (*A. polygyratus* Rein., "Z. Fauna d. Russ. Jura": Moskau, 1866, p. 19, pl. iii, fig. 4) is quite different.

of the Kimmeridgian and Portlandian may be represented, and that the so-called *A. triplicatus* includes a variety of forms.

The specimen referred to *Virgatites* cf. *scythicus*, Vischniakoff sp.,¹ is very close to, but more evolute than, Michalski's figure 2² of that species, and has the same fine, dichotomous costation. It is preserved in a slightly different shale, without *Aucella*, that resembles the matrix both of *Rasenia* and of that of the gigantic *Virgatites* cf. *nikitini*, which latter includes crushed *Aucella*. This specimen of *Virgatites*, 240 mm. in diameter (with two fragmentary specimens of a closely comparable form), superficially resembles the large Ammonite figured by Nikitin³ as *Perisphinctes martelli* Oppel, but which Siemiradzki⁴ considers to be an intermediate form between *P. martelli* and *P. orientalis* Siemiradzki. Large "*Perisphinctes*" of the group of *P. wartæ* Bukowski are recorded from beds that contain an early (Corallian) development of *Amæboceras* ("zone of *P. wartæ* and *Cardioceras alternans*" in Salfeld⁵), but the crushed example here discussed, with its *Aucella* (not radially marked), is a *Virgatites*,⁶ and not a Corallian "*Perisphinctes*", that is to say, it comes from above, not from below, the micaceous shales with *Amæboceras* cf. *nathorsti*.

The specimens of *Rasenia* apparently came out of nodules in the black shales, and since Salfeld⁷ records *Amæboceras kitchini* from the zone of *Rasenia cymadoce*, it is possible that they belong to the same horizon as the micaceous shales with *Amæboceras* cf. *nathorsti*. The specimens are not very well preserved, and there does not seem to be a very close resemblance to the common Market Rasen species (*R. evoluta*, *involuta*, etc.). The example compared with de Loriol's figure of *R. trimera*,⁸ with a diameter of about 150 mm., exceeds in size the form of *Rasenia* figured by Quenstedt⁹ as *A. cf. trifurcatus* Zieten.

¹ A comparable specimen in the Reynolds Collection comes from Ulla Berg, North Side of Van Keulen's Bay, Bell Sound.

² "D. Amm. d. Unt. Wolga-Stufe": *Mém. Com. Géol. St. Pétersb.*, vol. viii, No. 2, 1890, p. 121, pl. vii, fig. 2 only.

³ "Allg. Geol. Karte v. Russland, Blatt 71, Kostroma": *Mém. Com. Géol.*, vol. ii, No. 1, 1885, p. 125, pl. iii, fig. 14.

⁴ "Monogr. Beschreib. d. Amm. Gattung *Perisphinctes*": *Palæontographica*, vol. xlv, pts. iv, v, 1898-9, p. 269.

⁵ "Die Gliederung d. Ob. Jura in N.W. Europa, etc.": *N. Jb. f. Min.*, etc., Beil. Bd. 37, 1914, p. 129, and table i.

⁶ There is very good agreement with *Per. nikitini* Michalski (loc. cit., p. 232, pl. xiii, fig. 1), but the much larger outer whorl has the aspect of that of such gigantic forms as *Virgatites virgatus* (in Michalski, loc. cit., pl. iii, fig. 1) or of "*Perisphinctes*" *losseni* Neumayr & Uhlig ("Üb. Ammonitid. a. d. Hilsbild. Norddeutschl.": *Palæontographica*, vol. xxvii, pts. iii-vi, 1881, p. 144, pl. xviii). The inner whorls characterize the latter as probably a *Polyptychites*, so that the resemblance of the outer whorl is only superficial.

⁷ Loc. cit., 1914, p. 129; also "Certain Upper Jurassic Strata of England": *Quart. Journ. Geol. Soc.*, vol. lxxx, 1913, p. 423.

⁸ "Mon. Pal. z. à *A. tenuilabatus*, etc.": *Mem. Soc. Pal. Suisse*, vol. iii, 1876, p. 86, pl. xiii, fig. 13.

⁹ *Amm. d. Schwäb. Jura*, 1888, p. 998, pl. cxii, fig. 3.

The two forms of *Craspedites* are characterized by their compressed and almost smooth inner whorls, with a deep and comparatively small umbilicus. The outer whorl of the first example agrees very well with Nikitin's fig. 20,¹ and is just a little coarser in ornament, though not nearly so nodate as fig. 19, which, however, it equals in size. The other example resembles in its more sharply defined costation (of the outer whorl only) certain forms of *Craspedites* from the Rjasan horizon,² and the Neocomian *Tollia*, but it is quite different from the finely costate Valanginian forms from Northern Germany in the British Museum. The inner whorls of the type of those of a compressed *C. okensis* d'Orbigny sp.³ show this second form to belong to the Purbeckian *Craspedites*.⁴

Some fragments of belemnites, apparently from the Upper Jurassic beds of Cape Staratshin, seem to be referable to *Piesetrobelus magnificus* (d'Orbigny) in Pavlov.⁵

III. CRETACEOUS.

The only Ammonite in the collections from Green Harbour, a fairly well-preserved specimen of

Polyptychites sp. nov. cf. *suessi* Koenen,

indicates the presence of the lowest Cretaceous or Valanginian. The form differs from Koenen's type⁶ in having a deeper and more funnel-like umbilicus, and in the weakening of the costation on the outer whorl. *P. sphaericus* Koenen⁷ and *P. stubendorffi* (Schmidt) Pavlov⁸ also are somewhat similar. The loss of the costation on the outer whorl is reminiscent of such forms as *P. variisculptus* Pavlov⁹ and *P. sp.* (*Olcostephanus* cf. *triptychiformis* Nikitin et *syzranicus*

¹ Loc. cit., 1885, p. 133, pl. v, fig. 20.

² E.g. *C. ["Olcosteph."]* *bidoceras* Bogoslovsky, "D. Rjasan Horizont, seine Fauna, etc.": *Mat. z. Geol. Russl.*, vol. xviii, 1897, p. 56, pl. iii, figs. 3, 4.

³ In Murchison, Verneuil, & Keyserling, *Geol. d. l. Russ. d'Europe*, etc., vol. ii, pt. iii, Pal., 1845, p. 439, pl. xxxiv, figs. 13-17. Tullberg ("Üb. Verstein. a. d. Aucellen-Schichten Novaja-Semljas": *Bihang till K. Svenska Vet.-Akad. Handl.*, vol. vi, 1881, No. 3, p. 7) records *Craspedites okensis* from Novaja-Zemlya, where *Amæoceras* also is found.

⁴ Salfeld ("Monogr. d. Gattg. *Ringsteadia*": *Palæontographica*, vol. lxii, pl. ii, 1917, pp. 73-4) points out that certain *Involuticeras* of a much lower horizon have been confused with *Craspedites* (e.g. by Burckhardt, 1906), but the boreal forms here described have no resemblance to the Southern *Involuticeras*. Their poor state of preservation, unfortunately, prevents exact comparison with the numerous similar *Craspedites* of the *subditus-plicomphalus* group in the Blake Collection.

⁵ *Argiles de Specton*, 1892, p. 44, pl. v (ii), figs. 1, 2; also Sibir. Sept., loc. cit., 1913, p. 16, pl. ii, fig. 4.

⁶ "Die *Polyptychites*-Arten d. Unt. Valangin.": *Abh. k. Preuss. Geol. Landesanst.*, N.F., Heft 59, 1909, p. 76, Atlas pl. xii, figs. 2, 3.

⁷ "Die Ammonitid. d. Nordd. Neoc.": *Abh. k. Preuss. Geol. Landesanst.*, N.F., vol. xxiv, 1902, p. 122, pl. iv, fig. 1 only. This, however, belongs to a higher zone and the suture-line is different.

⁸ "Les Céph. d. Jura et du Crét. Inf. d. l. Sibir. Sept.": *Res. Scient. d. l'Exp. Pol. Russ.*, 1901-3, Sect. C; "Geol. & Pal.", *Livr. 4*": *Mém. Acad. Imp. Sci. St. Pétersb.*, ser. VIII, vol. xxi, No. 4, p. 29, pl. vi, fig. 1.

⁹ *Ib.*, p. 19, pl. iii, fig. 2.

Pavlov) in Bogoslovsky,¹ both of which, however, have a wider and less funnel-like umbilicus. The suture-line is characterized by four saddles between the siphonal line and the umbilical tubercle, the third of which (second lateral) is deeply bifid.

The matrix of this specimen is a very dark and hard limestone; but a fragmentary specimen preserved in a less calcareous rock, that partly is a true clay-ironstone, probably belongs to beds of the same age. This was collected at Fastness Camp, Cape Staratshin, and on account of its association with the similarly preserved *Rasenia*, *Virgatites*, etc., the writer at first was inclined to put it into *Gravesia*, though the umbilical tubercles are not rounded, but sharp and comma-shaped, or into *Cadoceras*. The specimen, unfortunately, is fragmentary, and shows no trace of the suture-line, representing probably the body-chamber of a large form ($D = 150$ mm.), with the inner whorls poorly preserved in crystalline calcite.

The specimen may be compared with

Euryptychites cf. *gravesiformis* Pavlov,

especially the smooth form figured on pl. xi, figs. 2c, 3,² but it has a less depressed whorl section and thus a more rounded periphery. *Polyptychites tschekanovskii* Pavlov,³ on the other hand, is too compressed and too involute, and still costate at a large diameter. *P. similis* Koenen⁴ and *P. solidus* Koenen⁵ show a somewhat similar smooth and fat outer whorl.

To judge by the two specimens mentioned, it would appear as though the Valanginian deposits were closely connected with the Purbeckian and Portlandian beds below, yielding *Craspedites* and *Virgatites*. The matrix of the specimens of *Euryptychites* and *Craspedites* is very similar and agrees with that of numerous *Aucella* of the group of *A. terebratuloides*. Other examples that appear to include the higher *A. keyserlingi* are "phosphatic".

On the other hand, the *Ditrupe* sandstones, with *Crioceras*, that may be as high as Aptian,⁶ clearly belong to another set of deposits. Stolley records clays, with concretions, and a very doubtful fragment of a *Garnieria* [= a Valanginian *Platylenticeras* ?] below a flaggy, grey sandstone of the Flysch facies, with interbedded clayey seams; further, a very doubtful *Polyptychites* or *Simbirskites* from the *Ditrupe* sandstones. A change of facies between Cape Staratshin and Green Harbour on the one hand, and Advent Bay on the other, is, of course, possible, but the writer would refer all the Ammonites

¹ "Mat. z. Kenntn. d. Untercret. Amm. Fauna v. Centr. und N. Russl.": *Mém. Com. Géol.*, n.s., *Livr. 2*, 1902, p. 140, pl. xvii, fig. 1.

² Loc. cit. (Sibir. Sept.), 1913, p. 37.

³ *Ib.*, p. 34, pl. xviii.

⁴ Loc. cit., 1909, p. 50, pl. xx, figs. 1, 5.

⁵ *Ib.*, p. 52, pl. xxii, figs. 1, 2.

⁶ Stolley, "Üb. d. Kreideform. und ihre Fossil. auf Spitzbergen": *K. Svenska Vet.-Akad. Handl.*, vol. xlvii, No. 11, 1912, pp. 10-12.

in the collection that come from Bunting Bluff, Advent Bay, to the Albian.¹ The specimens are extremely poorly preserved in a purple or brown, ferruginous sandstone, and associated with *Panopæa* of the type of *P. plicata*, a small smooth *Pecten*, etc. They are referred to:—

Sommeratia ? sp. cf. "*Hoplites*" *jachromensis* (Nikitin).²

„ ? sp. cf. *latisulcata*, Sinzow.³

„ ? (*Hoplites*?) spp. ind.

Cleaniceras ? cf. *bicurvatoides* Sinzow sp.⁴

Pompeckj⁵ recorded "*Virgatites*-like" Ammonites, resembling the Albian *Hoplites jachromensis* Nikitin, from a sandstone (*Dentalium* beds) of the Fyrkanten Berg; but on account of the bad state of preservation of the fossils he could not assign a more definite horizon to them than "Portlandian (Lower Cretaceous)", with possibly the Albian included. It is matter for regret that the species here recorded are equally unsatisfactory, but they certainly seem to be nearer to Albian forms than to those of any other stage. It may also be added that they had already been referred to "*Hoplites*" in the field.

A comparatively well-preserved but small fragment of the body-chamber of an Ammonite similar to the first form recorded in the above list was collected by Mr. W. J. Reynolds this summer (1920) at Whale's Head. It is comparable with the form figured by Bogoslowky from the "*dentatus* zone" of the Albian, but not identical with Sinzow's *Sommeratia jachromensis*.⁶

Stolley⁷ thinks it possible that the hundreds of feet of sandstones, between the *Ditrupta* (= "*Dentalium*") beds, with *Crioceras* and the Tertiary strata, may include the Gault and the whole of the Upper Cretaceous; but the apparent gaps and certain doubtful plant-bearing beds make a re-examination of the whole of the Cretaceous succession very desirable.

In conclusion, the writer would like to express his indebtedness to those who have kindly assisted him in the examination of this fauna, namely, to Dr. A. Smith Woodward, F.R.S., and to Dr. C. W. Andrews, F.R.S., for their help in connexion with the fish and amphibian remains, to Mr. W. J. Reynolds for his ready assistance with stratigraphical information, and to Professor J. W. Gregory, F.R.S., for his continued help and interest in the preparation of this paper.

¹ The writer is unable to assign these specimens to any bed of Professor Gregory's succession.

² In Bogoslowky, loc. cit., 1902, p. 128, pl. vi, fig. 4.

³ "Beitr. z. Kenntn. d. südruss. Apt. und Alb.," *Verh. Russ. Kais. Min. Ges. zu St. Pet.*, ser. II, vol. xlvii, 1909, p. 31, pl. ii, figs. 27-9.

⁴ *Ib.*, p. 29, pl. ii, figs. 7-18.

⁵ In Nathorst, loc. cit., p. 1500.

⁶ "Untersuch. Ammonit. Unt. Gault Mangyschlaks und Kaukasus": *Verh. Russ. Kais. Min. Ges.*, ser. II, vol. xlv, 1907, p. 473, pl. iii, figs. 9-13.

⁷ Loc. cit., p. 12.