MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
Bd. 132 · Nr. 3

DE DANSKE EKSPEDITIONER TIL ØSTGRØNLAND 1926–39
Under Ledelse af Lauge Koch

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

I. THE *HECTOROCERAS* FAUNA OF S.W. JAMESON LAND

BY

L. F. SPATH
D. Sc., F. R. S.

WITH 8 TEXT-FIGURES AND 5 PLATES

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI
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PREFACE

During the last few (pre-war) years, and even before the memoir on the Jurassic Invertebrate faunas of Milne Land[1]) was completed, there came to me for description various other new collections of ammonites and associated fossils, all gathered during the progress of the East Greenland expeditions working under the leadership of Dr. Lauge Koch. The members of the various expeditions who collected this material were Mr. A. Rosenkrantz, Dr. H. Aldinger and Mr. Säve-Söderbergh, Dr. Wolf Maync and Messrs. H. Stauber and W. Bierther. Naturally there were many additional examples of previously described and comparatively well-known species, but there were also a considerable number of new forms and of examples in an unusually favourable state of preservation. Clearly it is desirable to make these known to those interested in the Jurassic and Cretaceous of East Greenland, since the original material had often been poorly preserved; in the case of still other species rediscussion was suggested by additions to our stratigraphical knowledge. I may say at once that the collectors already mentioned have always been very ready to supply me with all the information I desired and I must express to them my gratitude for their kind help. Special acknowledgments, however, are due to Dr. Lauge Koch for entrusting me with the description of these fossils and for allowing me to illustrate the account in so generous a way. I also have to thank the Keeper of the Geology Department of the British Museum (Natural History), Mr. W. N. Edwards, for the facilities he has granted me in connection with the storage and study of the new collections.

Since the material now before me included not only some faunas which it seemed best to describe as separate units, but also small or isolated assemblages and finds, the present account is divided into a number of independent chapters. Some of the material has already been referred to in preliminary accounts by the geologists who made the

[1]) The Upper Jurassic Invertebrate Faunas of Cape Leslie, Milne Land. I. Oxfordian and Lower Kimmeridgian. Medd. om Grønl. 99, No. 2, 1935; II. Upper Kimmeridgian and Portlandian. *Ibid.*, No. 3, 1936.

collections, notably Dr. H. Aldinger[1]), and there can be no doubt that the account of the fauna from S. W. Jameson Land, recorded by that author (on my suggestion) as of (?) Infra-Valanginian age, forms one of the most important chapters of the present series. It is possible that the knotty problem of the demarcation of the limits between the Jurassic and Cretaceous systems may yet be solved by future discoveries in that part of East Greenland. The description of additional Callovian ammonites from the Vardekløft Formation, then, reopens the question of those mysterious species of *Olcostephanus* ? or *Simbirskites* ? first recorded by Pompeckj and Madsen; and I think I can now claim to have disposed of that problem. Of the other chapters, some will be of only local importance, such as the description of a new *Cadoceras* fauna from Jameson Land, remarkably similar to that of the English Kellaways Rock; others again, like the succession of species of *Amoeboceras* at the end of the Oxfordian and beginning of the Kimmeridgian stages will be of more general interest. Still other chapters will deal with the Valanginian ammonites of Kuhn Ø, the fauna with *Lytoceras polare* in the northern area, the *Cranocephalites* fauna of Traill Island, etc.

The collections included, in addition to the ammonites, a number of other invertebrates which it seemed advisable to incorporate in the descriptions, especially in the case of the new faunas. For assistance with the determination of these fossils I am greatly indebted to my colleagues at the British Museum (Nat. History), notably Dr. L. R. Cox and Dr. H. Muir-Wood; also to Mr. C. P. Chatwin of H. M. Geological Survey.

[1]) Geologische Beobachtungen im oberen Jura des Scoresbysundes (Ostgrönland), Medd. om Grønl., 99, No. 1, 1935.

A. INTRODUCTION

The fossils dealt with in this first part of the present series were collected by Dr. H. Aldinger and Mr. G. Säve-Söderbergh at a number of localities in S. W. Jameson Land; and the map attached to Dr. Aldinger's paper[1]), already cited, shows the position of these localities near the Horse River and its tributaries, chiefly the Mussel River. The fossils came from the set of beds which in Dr. Aldinger's account are referred to as (?) Infra-Valanginian; and they are mainly from the very fossiliferous band of calcareous sandstone which occurs at the base of his "Upper Sandstone", and from near the top of the lower division, consisting of about 150 m (500 ft.) of dark, sandy shales and friable sandstone. Dr. Aldinger has shown that these beds rest on unfossiliferous sandstones and shales of unknown age, but probably of marine origin, and he stated that it was possible that the series was the marine equivalent of the upper 100 m of the Hartzfjæld Sandstone of Cape Leslie, Milne Land. These latter beds were included in the "undated sandstones with plant remains", shown at the top of the sequence given by myself in 1936[2]). In the absence of fossils that would enable us to date these beds, they were considered to be somewhere near the top of the Jurassic or the base of the Cretaceous.

The typical ammonite of the beds in question was new and did not help in the determination of the age of the deposit, but it occurred in close association with (or together with) badly preserved impressions of other ammonites which seemed to me comparable to forms of the Russian Riasan beds. The fauna was therefore tentatively placed above the Jurasso-Cretaceous border-line rather than below. No fresh finds from Jameson Land have since come to hand, and it will be necessary to examine with particular care whether the evidence of the fossils associated with the ammonites allows of the expression of an emphatic opinion on the age of the fauna. The evidence will be reviewed after the species have been described.

[1]) *Loc. cit.* (Medd. om Grønl., 99, 1), 1935 (July), pl II.
[2]) *Loc. cit.* (*Ibid.*, 99, 3), 1936 (March), p. 149.

B. SPECIFIC DESCRIPTIONS

Phylum *MOLLUSCA.*

1. Class *CEPHALOPODA.*

a. Order *AMMONOIDEA.*

Super-family *Stephanoceratida.*

Family *CRASPEDITIDAE*, Spath.

1924. On the Blake Collection of Ammonites from Kachh. Mem. Geol. Surv. India, Pal. Indica, N. S. vol. IX, part 1, p. 17.

The family Craspeditidae has only recently been discussed[1]) in connection with the uppermost Jurassic fauna of Hartz Mtn. on Milne Land, but it is necessary to review it since the new genus *Hectoroceras*, discussed below, and apparently so distinct, is now referred to the family. There is apparently only slight resemblance to normal *Craspedites* of the *subditus* type, or even to the transitional Spilsby Sandstone form referred by Pavlow[2]) to that species, but renamed by myself[3]) *Subcraspedites lamplughi*. In the young, it is true, *Hectoroceras* has a rounded ventral area; and the umbilicus, though small, shows rather numerous and perfectly concentric, smooth inner whorls, a feature characteristic of most Craspeditids. The ribs, however, have rather long primary stems and comparatively short, secondary branches, a somewhat unusual style of ribbing in this family. The flexuosity of the ribbing and its interruption on the venter, also suggested that there might be affinity between *Hectoroceras* and those *Craspedites* derivatives that Nikitin[4]) included in his group of *Olcostephanus hoplitoides* (= *Nikiti-*

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[1]) *Loc. cit.* (Medd. om Grønl., 99, 1), 1935, p. 83.

[2]) In Pavlow and Lamplugh, Argiles de Speeton et leur equivalents, Moscow, 1892, p. 116, pl. XIII (VI), figs. 5a-c.

[3]) *Loc. cit.* (Medd. om Grønl., 99, 1); 1935, p. 180.

[4]) Les Vestiges de la période crétacée dans la Russie centrale. Mém. Com. géol. St. Pétersb., vol. VI, No. 2, 1888, p. 183.

noceras, Sokolov = *Temnoptychites*, Pavlow). Even these, however, show a different type of branching of the ribs and often a Polyptychitid whorl-shape which is in striking contrast to the flat, discoidal shape of *Hectoroceras*.

Oxynoticeras toliense, Nikitin[1]), then seemed to be the nearest relative of the new genus under discussion; and as soon as I saw Eichwald's[2]) original figure of that species, from the east slopes of the northern Urals (wrongly referred to *Amm. catenulatus*, Fischer), I considered I had found a clue to the ancestry of *Hectoroceras*. The figure is inaccurate, as Nikitin has shown, but, as will be seen on comparing Eichwald's and Nikitin's figures with the illustrations of *Hectoroceras* in Plates 1 and 2, style of ribbing, general shape, and even suture-line are sufficiently close for inclusion of both the Siberian and Greenland forms in the family Craspeditidae. The reasons for separating them generically are given below.

The type-genus of the family is of course *Craspedites*, Pavlow[3]), itself, as genotype of which I had always considered *C. subditus*, Trautschold sp.[4]), since Pavlow especially mentioned that he established the genus for the "*Olcostephani* of the *subditus* group". R. Douvillé[5]) does not appear to have noticed that, since he stated that *C. okensis*, d'Orbigny sp.[6]) was the type, being "the first species cited by the author as an example of the new genus". But since R. Douvillé wrote before me (1911) I am ready to accept his selection as binding. There is general agreement that *C. okensis* and *C. subditus*, although more or less successors in time, are congeneric; and they certainly seem connected by many transitions. The *okensis* group, which includes forms like *Amm. septentrionalis* and *Amm. sagitta*, Eichwald[7]) and an unnamed variety resembling *Amm. cuneatus*, Trautschold[8]) is intimately allied with *Kach-*

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[1]) Allgemeine geologische Karte von Russland, Blatt 56 (Jaroslawl, &c.). Mém. Com. géol. St. Pétersb., vol. I, No. 2, 1884, p. 65 (150), pl. II, figs. 7—8. First *Neumayria toliensis* in: "Die Jura Ablagerungen zwischen Rybinsk, Mologa und Myschkin". Mém. Acad. Imp. Sci. St. Pétersb., sér. VII, vol. XXVIII, No. 5, 1881, p. 61.

[2]) Lethaea rossica, vol. II, 1868, p. 1110, pl. XXXV, fig. 3.

[3]) In Pavlow and Lamplugh, *op. cit.* (1892), p. 116.

[4]) Der französische Kimmeridge und Portland verglichen mit den gleichaltrigen Moscauer Schichten. Bull. Soc. Imp. Nat. Moscou, No. 4, 1876, p. 392.

[5]) Pal. Universalis, No. 213, 1911 (*Amm. okensis*).

[6]) In Murchison, Verneuil and Keyserling: Géologie de la Russie &c. vol. II. Paléontologie (Mollusques), pl. XXXIV, figs. 13—17.

[7]) *Op. cit.* (Lethaea rossica), 1868, pp. 1107—1108, pl. XXXV, figs. 2a-c, 1a, b.

[8]) Recherches géologiques aux environs de Moscou: Couches jurassiques de Mniovniki. Bull. Soc. Imp. Nat. Moscou, vol. XXXIV, pt. 1, 1861, p. 83, pl. VIII, figs. 2a-c (according to Michalski a form of *Virgatites*).

purites, Spath, 1924[1]), created for *Amm. fulgens*, Trautschold[2]). For there are not only examples that combine the whorl-shape of *Craspedites okensis* with the suture-line of *Kachpurites subfulgens*, Nikitin sp.[3]) (see text-fig. 1), but one of the syntypes of the latter species is obviously a *Craspedites* (fig. 46), foreshadowing the later *nodiger* group, as *K. fulgens* itself is somewhat of a morphic prefiguration of the Cretaceous *Subcraspedites cristatus*, Swinnerton[4]).

Moreover, Trautschold[5]) figured as *Amm. fulgens*, var. *hybridus* a form which he himself described as having the aspect of a hybrid between *Amm. catenulatus*, the genotype of *Garniericeras*, Spath, 1924, and *Amm. fulgens*. A comparison of the suture-lines (text-fig. 2) will enable those who are not familiar with actual specimens of all these forms to realise their close affinity and to see why the presence of a keel in *Garniericeras* and its absence in *Kachpurites* are not considered features of paramount classificatory importance.

While there is little doubt, however, that the typical *Craspedites* and the genera *Kachpurites* and *Garniericeras* form a homogeneous systematic unit, closely associated in geological occurrence and connected by transitions and the same type of suture-line, great uncertainty still exists as to their origin and their descendants in the beds at the limit of the Jurassic and Cretaceous systems. With regard to the ancestral forms, it has long been assumed (more recently, e. g. by Salfeld[6]) and the writer[7]) that they were to be found among the Perisphinctids, since these have given rise to so many "Olcostephanid" lineages, and since the ribbed, young *Craspedites* of the *subditus* group show so much resemblance to immature *Epivirgatites* (and *Dorsoplanites*). But it must

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[1]) On the Blake Collection of Ammonites from Kachh, India. Mem. Geol. Surv. India. Pal. Indica, N. S., vol. IX, No. 1, 1924, p. 17.

[2]) Recherches géologiques aux environs de Moscou; Fossiles de Kharachovo et Supplément. Bull. Soc. Imp. Nat. Moscou, vol. XXXIV, pt. 3, 1861, p. 270, pl. vii, figs. 7a, b. Genolectotype is the adult example figured by Nikitin (Die Jura-Ablagerungen zwischen Rybinsk, Mologa und Myschkin an der oberen Wolga. Mém. Acad. Imp. Sci. St. Pétersb., ser. VII, vol. XXVIII, No. 5, 1881, p. 63, pl. vi, fig. 48, as *Neumayria fulgens*), but the principal ribs are badly drawn and much too strong and blunt.

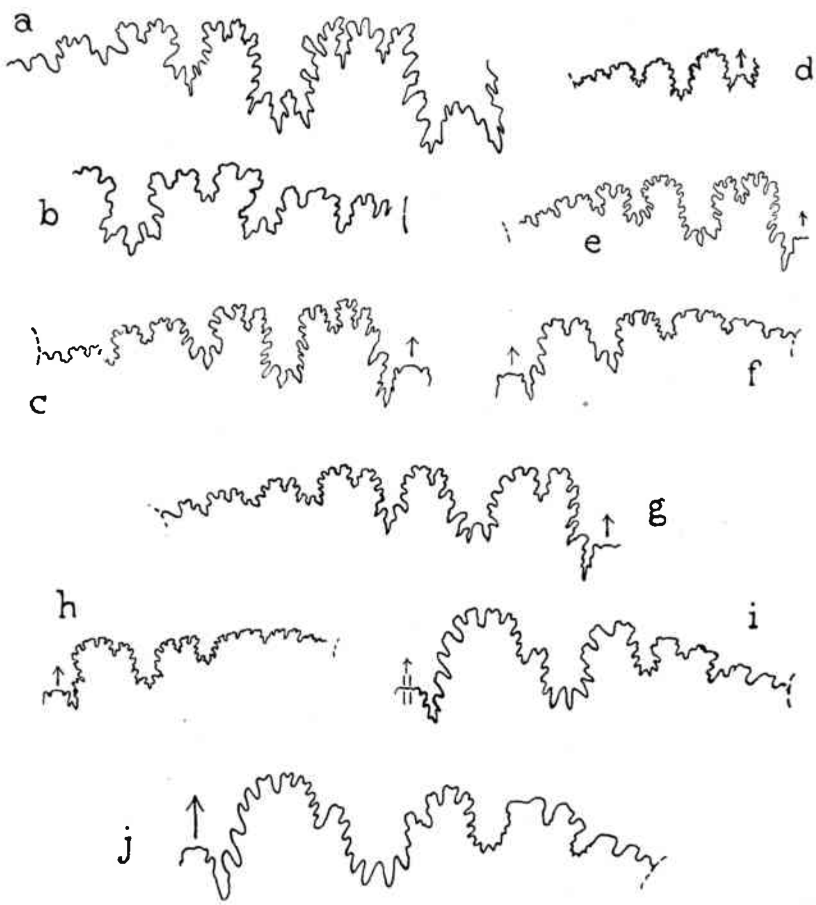
[3]) *Loc. cit.* (Mém. Acad. Imp. Sci. St. Pétersb., vol. XXVIII, 1881, p. 62, pl. vi, figs. 45, 47.

[4]) The Rocks below the Red Chalk of Lincolnshire and their Cephalopod Faunas. Quart. Journ. Geol. Soc., vol. XCI, 1935, p. 33, pl. iii, figs. 4a-c, 5.

[5]) *Loc. cit.* (Bull. Soc. Imp. Nat. Moscou, vol. XXXIV, pt. 3), 1861, p. 272, pl. vii, figs. 9a-c.

[6]) Monographie der Gattung *Ringsteadia*, gen. nov. Palaeontogr., vol. LXII, 1917, p. 73.

[7]) *Loc. cit.* (Pal. Indica, N. S., vol. IX, No. 2, pt. 6), 1933, p. 694; also Medd. om Grønl., vol. 99, No. 3, 1936, p. 84.

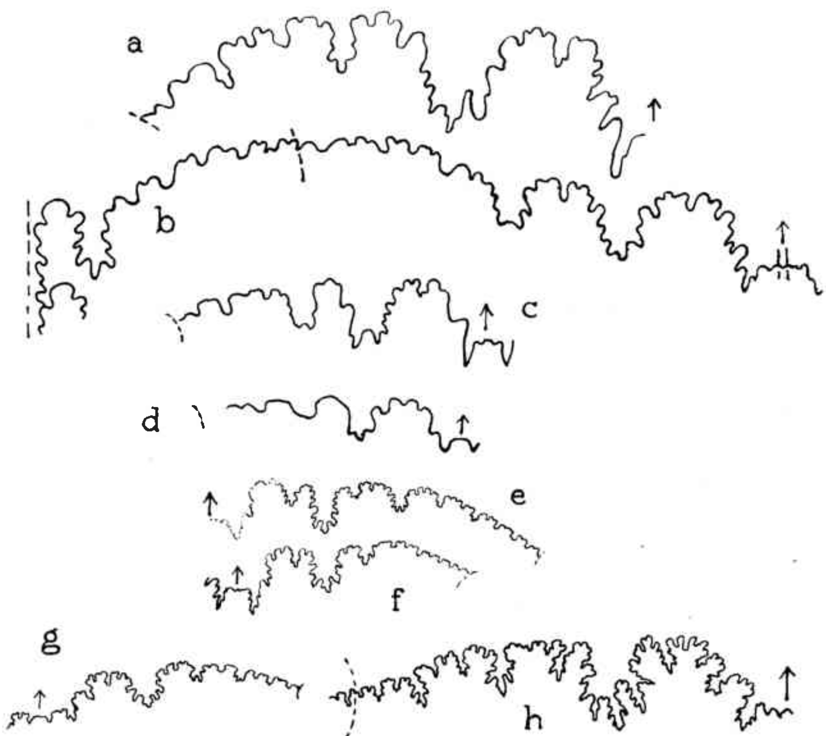


Text-fig. 1. Suture-lines of *Craspedites* (a-h) and *Kachpurites* (i, j) from the Upper Volgian of Russia. (*a*). *Craspedites okensis*, d'Orbigny sp., after Nikitin, 1881, pl. VII, fig. 9 (probably a variety) from Kamenik. (*b*). Part of suture-line of type of the same species after R. Douvillé, Pal. Univers., 1911, No. 213, fig. 2 (× 3) from Jelatma, Oka. (*c*). *C. okensis*, d'Orbigny sp. (var.) from shore at Bolobanovo (B. M. No. C. 39858). (*d*). *C. kaschpuricus*, Trautschold sp. from Kachpur, after Vischniakoff, 1878, pl. I, fig. 5 (last suture-line). (*e*). *C. okensis*, d'Orbigny sp., from north of Simbirsk (B. M. No. C. 25138) at about 65 mm diameter. (*f*). *C. subditus*, Trautschold sp. from Kachpur, north shore (B. M. No. C. 39857) at about 70 mm. (*g*). *C. krylovi*, Prigorovsky, from near Moscow (B. M. No. 19720) enlarged × 2. (*h*). *C.* aff. *okensis*, d'Orbigny sp. Passage-form to *Kachpurites subfulgens* Nikitin sp., from Polivna (B. M. No. C. 7663). (*i. j*). *Kachpurites fulgens*, Trautschold sp., from Bolobanovo (B. M., Blake Coll.) enlarged × 4.

be noted that the smooth *Craspedites* and *Kachpurites* are the first to appear; and since the overlap of *Craspedites* and *Epivirgatites*, previously[1]) noticed, may be due to faulty collecting, it is quite possible

[1]) Spath: Ammonites from New Zealand. Quart. Journ. Geol. Soc., vol. LXXIX, 1923, p. 307.

that the Craspeditids of the base of the Upper Volgian represent an entirely distinct stock, immigrated from some "southern" area, and have no more connection with the ammonites of the Lower Volgian than the presumed common ancestry in the super-family Perisphinctida.



Text-fig. 2. Suture-lines of *Garniericeras catenulatum*, Fischer sp. (a-f) and *G. subcatenulatum*, Milachewitsch sp. (*g, h*) from the Upper Volgian, near Moscow, Russia. (*a*). Copy from Sayn, 1902, p. 15, fig. 7, enlarged × 4.5. (*b*). Complete suture-line of a specimen in the writer's collection at about 30 mm diameter (enlarged × 4.25) with earlier stage (*d*) at 6 mm diameter. (*c*). From a small specimen (B. M. No. C. 20*b*) enlarged × 5. (*e, f*). From two specimens (B. M. No. C. 2421 and C. 20*a*) at diameters of 85 and 50 mm respectively (natural size). (*g*). From a specimen (B. M. No. C. 25141) at 60 mm (natural size) and (*h*) copy from Nikitin, 1884, pl. II, fig. 14.

Burckhardt[1]) thus put some Kimmeridgian and Portlandian forms from Mexico and the Argentine Andes in the genus *Craspedites* and even thought it probable that it originated in Central America. In the case of *Craspedites mazapilensis* and *C. praecursor* (referred to the genus *Involuticeras* by Salfeld[2]) and other species from the Kimmeridgian

[1]) Etude synthétique sur le Mésozoique mexicain. Mém. Soc. pal. Suisse, XLIX—L, 1930, p. 110.

[2]) *Op. cit.* (Monographie der Gattung *Ringsteadia*, gen. nov.), 1917, p. 74.

Idoceras beds, comparison with the true *Craspedites* seems to me inapt, although previously[1]) I expressed the opinion that *Epicephalites* (i. e. the group of *Macrocephalites epigonus*, Burckhardt[2]) and *Subneumayria* (group of *Neumayria ordonezi*, Burckhardt[3]) might be related to the Portlandian Craspeditids. But the Tithonian *C. limitis*, Burckhardt sp. (originally described by that author[4]) as *Perisphinctes* aff. *erinus*, d'Orbigny sp.) morphologically represents a type of shell that could have given rise to Craspeditids, by simplification of the suture-line. It was, indeed, described as being close to *Craspedites subditus* (Trautschold); and the Portlandian *C. africanus*, Zwierzycki[5]), is another isolated form that might belong to some incompletely known southern group ancestral to the boreal *Craspedites*.

The modification of characters, notably the suture-line (with increase in the number of elements but simplification of the whole line) necessary to change a Perisphinctid (Pavlovid) stock like *Dorsoplanites* or *Laugeites* (olim *Kochina*) into *Craspedites* seems to me slight, but until such transformation is actually observed in some suitable deposit, it seems best not to be too dogmatic concerning the ancestry of the Craspeditids. For those who consider the family heterogeneous, however, I may mention that Zittel[6]) already associated "*Neumayria*" with *Craspedites* (as subgenus of *Olcostephanus*) and included both in the family Stephanoceratidae, so that the classification here adopted is by no means revolutionary.

There are, however, various difficulties and uncertainties which have not been touched upon. I may say at once that I do not seriously consider the question whether *Garniericeras* has any connexion with the Liassic genus *Oxynoticeras*, Hyatt, or whether it is related either to the Cardioceratidae or the Barremian family Pulchellidae. What similarities there are in the suture-lines are easily explained by similarity of whorl-

[1]) Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch). Mem. Geol. Surv. India, Pal. Indica, N. S., vol. IX, No. 2, pt. 3, 1928, p. 175.

[2]) La Fauna jurassique de Mazapil. Bol. Inst. Geol. Mexico, No. 23, 1906, p. 20, pl. III, figs. 6—11.

[3]) *Ibid.*, p. 11, pl. I, figs. 4, 6, 7.

[4]) Beiträge zur Kenntniss der Jura- und Kreideformation der Cordillere. Palaeontogr., vol. 50, 1903, p. 52, pl. IX, figs. 1—2.

[5]) Die Cephalopoden-Fauna der Tendaguru-Schichten in Deutsch Ost-Afrika. Wiss. Ergeb. Tendaguru Exp. 1909—12, Archiv f. Biontol., vol. III, Heft 4, 1914, p. 59, pl. VII, fig. 9.

[6]) See e. g. Grundzüge, vol. I, fifth ed. (by Broili), 1921, pp. 566—7. In 1884 (Handbuch, I, 2, III, p. 452) Zittel had included "*Neumayria*" in the Amaltheidae, but the reference (in 1921) of *Amm. catenulatus* to *Platylenticeras* and the family Pulchellidae makes it doubtful what is meant by *Neumayria* (on p. 567).

[7]) See Sayn: Les Ammonites pyriteuses des marnes valanginiennes du S. E. de la France. Mém. Soc. géol. France, Paléont., mém. 23, vol. IX. 1901, p. 14.

shape and a glance at Text-fig. 2 will show that symmetry or asymmetry of the principal (first lateral) lobe is one of the less constant features, at least in *Garniericeras*. Far more important seems to me the fact that Nikitin[1]) already had noticed the resemblance between his genus "*Neumayria*" and certain forms of *Oppelia* and *Haploceras*; and I considered it very significant that Burckhardt[2]) included in the same boreal genus, "*Neumayria*", not only his own Cordilleran species *N. zitteli*[3]), but also the typical Mediterranean *Haploceras rasile* (Oppel), var. *planiuscula*, Zittel[4]) (found in the Argentine as well as at Rogoznik in the Carpathians). When separating "*N*". *zitteli* therefore as *Pseudolissoceras* in 1925[5]), I thought that it led to Craspeditids, with similarly simplified suture-lines; for not only was its Middle Tithonian age[6]) suggestive, but I then favoured (and still do favour) the derivation of the ephemeral ornamented stocks of the more northern seas from the persistent, and originally smooth, fundamental stocks of the Tethys and its extensions.

The smooth *Kachpurites fulgens* (Trautschold), already cited, differs from *Pseudolissoceras zitteli* (Burckhardt) chiefly in its less close coiling, less lateral angularity of the biconcave lines of growth, and a lower external lobe. These differences seemed unimportant, considering the widespread simplification of characters in the Jurassic and especially Cretaceous ammonites, to which I have repeatedly drawn attention. Even the curious similarity in ornamentation between *Hectoroceras*, here described, and the New Zealand *Uhligites hectori* or the Mexican genus *Mazapilites* might be held to support the Oppelid or Haploceratid origin of the Craspeditids, not to mention a certain parallelism in the development of another degenerate Oppelid, namely *Clydoniceras discus* (Sowerby) with *Garniericeras* and its presumed successors of the lowest Neocomian.

Against these theoretical considerations we can set the practical fact that, as is generally agreed, *Craspedites okensis* (d'Orbigny), through *C. fragilis* (Trautschold), is directly connected with *C. subditus* (Trautschold), and the last leads by many intermediaries to the tuberculate and inflated forms of the group of *C. nodiger* (Eichwald), *C. kaschpuricus*

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[1]) *Loc. cit.* (Mém. Acad. Imp. Sci., St. Pétersb., ser. VII, vol. XXVIII, No. 5), 1881, p. 61.

[2]) *Loc. cit.* (Palaeontogr., vol. 50), 1903, p. 54.

[3]) *Ibid.*, p. 55, pl. x, figs. 6—8 (lectotype), 1—5.

[4]) Die Fauna der älteren Cephalopoden-führenden Tithonbildungen. Palaeontogr., Suppl. 1870, p. 57, pl. xxviii, figs. 3a-c.

[5]) Spath: Ammonites and Aptychi. Pt. VII of: On the Collection of Fossils and Rocks from Somaliland, made by Messrs. Wyllie and Smellie. Monogr. Hunter. Mus. Glasgow, vol. I, 1925, p. 113.

[6]) See in Weaver: Palaeontology of the Jurassic and Cretaceous of West Central Argentina. Mem. Univ. Washington, vol. I, 1931, p. 46.

(Trautschold), and *C. milkovensis* (Stremooukhoff). There appears to be little doubt that this continuous lineage can have no affinity with any known Oppelid (or Haploceratid) stock; instead it resembles offshoots of the Perisphinctids (or Stephanoceratids) at earlier levels in the Jurassic. But it could be held that, as both the dominant ammonite stocks of the Upper Jurassic, namely Perisphinctids as well as Oppelids (and Haploceratids) could have produced more or less smooth end-forms, with a similar type of suture-line, the family Craspeditidae is diphyletic:— one section, comprising *Kachpurites*, *Garniericeras* and *Hectoroceras* being derived from *Pseudolissoceras* and thence the Haploceratidae, while *Craspedites* itself, with *Subcraspedites* and other offshoots and transitions to the Polyptychitidae represent the perisphinctid branch.

If I do not now accept this interpretation, it is because, as already mentioned, *Kachpurites* and *Garniericeras* are as intimately connected with *Craspedites okensis* and its allies of the lowest Upper Volgian zone of *C. okensis* and *Kachpurites fulgens*, as are the ribbed and tuberculated species of *Craspedites* of the higher zones, above mentioned. The apparent difficulties may be explained if we assume *Kachpurites* to represent a very plastic stock, producing innumerable transitions to the ribbed *Craspedites* on the one hand, and to the oxycone *Garniericeras* on the other, but showing its ancestry in occasional fine ribbing of the type of that of *Laugeites stchurowskii* (Nikitin[1])), or the bundled costation of one extreme example of *K. fulgens* figured by the same author[2]). The prolific Perisphinctids, in any case, are known to have persisted in the boreal seas, whereas Oppelids and Haploceratids are unknown even from the English Kimmeridgian and Portlandian. I may add that thin sections of the innermost whorls of *Craspedites* and *Garniericeras* revealed no obvious difference in the position of the siphuncle which does not become external until the second or third whorl.

With regard to the degenerate oxycones of the Lower Neocomian and their derivation from *Garniericeras*, there is still considerable difference of opinion. Entirely miscarried seems to me to have been Hyatt's[3]) attempt to put two such related species as *Amm.* (*Amaltheus*) *heteropleurus*, Neumayr and Uhlig[4]) and *Amm. marcousanus*, d'Orbigny[5]) into two widely distinct families, the former (as *Platylenticeras*) into Coilopoceratidae, and the latter (as *Tolypeceras*) into Cosmoceratida.

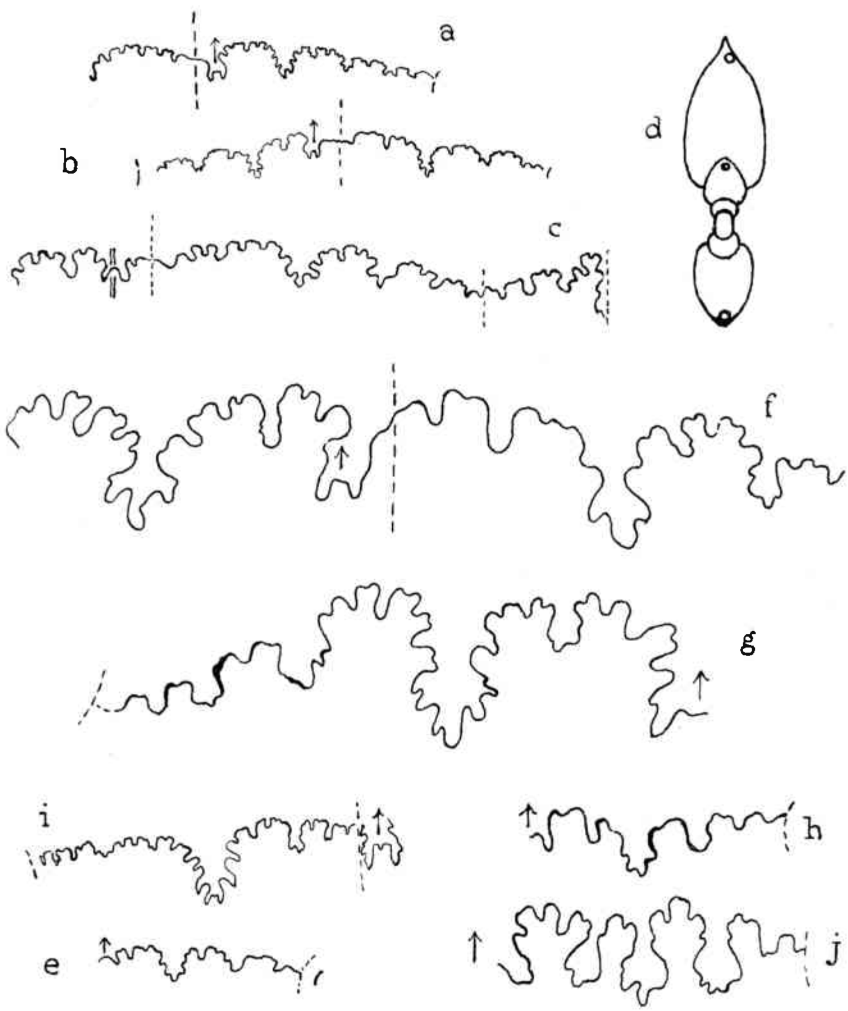
[1]) *Loc. cit.* (Mém. Acad. Imp. Sci., St. Pétersb., ser. VII, vol. XXVIII, No. 5), 1881, p. 83, pl. VII, figs. 53—56.

[2]) *Ibid.*, pl. VI, fig. 48.

[3]) Pseudoceratites of the Cretaceous. Monogr. U. S. Geol. Surv., vol. XLIV, 1903, pp. 88, 103.

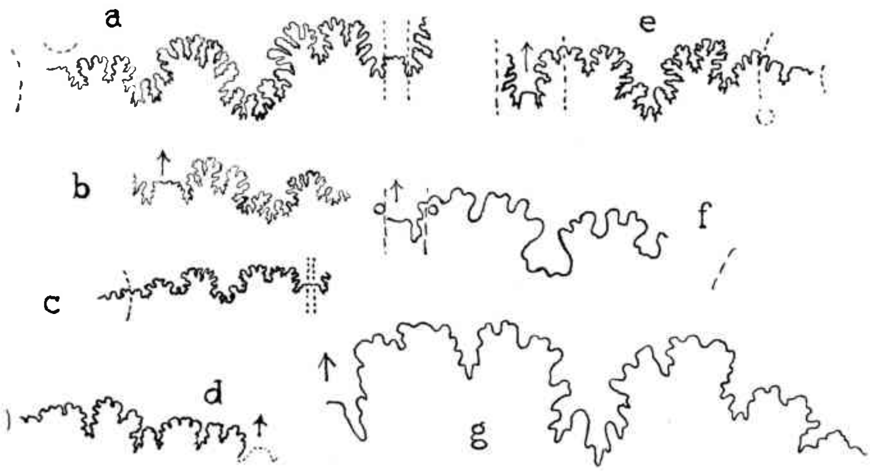
[4]) Über Ammonitiden aus den Hilsbildungen Norddeutschlands. Palaeontogr., vol. XXVII, 1881, p. 135, pl. XV, figs. 1—2.

[5]) See in Pictet and Campiche (Ste. Croix, vol. I, 1860), p. 169, pl. XXI, figs. 1—2.



Text-fig. 3. Suture-lines of *Platylenticeras* (*a-h*), *Tolypeceras* (*i*), and *Paquiericeras* (*j*). (*a*). ***Platylenticeras heteropleurum*** (Neumayr & Uhlig). Slightly enlarged, at diameter = 45 mm (B. M. No. C. 13351). (*b*). ***P. latum***, v. Koenen (1902, pl. I, figs. 1—2). (*c-e*). ***P. heteropleurum*** (Neumayr & Uhlig). Enlarged suture-line at diameter = 35 mm (*c*) and at 18 mm (*e*), with cross-section at diameter = 19 mm, enlarged × 2 (B. M. No. C. 13346). All from Lower Valanginian of Gronau, Westphalia. (*f*). ***P. occidentalis***, Sayn sp. (1901, fig. 8 on p. 17, enlarged × 4.5). (*g*). ***P. cardioceroides***, Sayn sp. (1901, fig. 11 on p. 20, enlarged × 4.5). (*h*). ***P. nicolasi***, Sayn sp. (1901, fig. 12 on p. 22, enlarged × 4.5). Valanginian of S. E. France. (*i*). ***Tolypeceras*** ("***Platylenticeras***") ***cuneiforme***, v. Koenen sp. (1902, pl. XVI, figs. 4—5). Lower Valanginian, Gronau, Westphalia. (*j*). ***Paquiericeras paradoxum***, Sayn (1901, fig. 15, p. 26, enlarged × 4.5), for comparison with *h*. Valanginian, S. E. France.

The fact that this super-family actually became extinct in the Middle Oxfordian (Divesian), while the super-family Mammitida, which was made to include the Coilopoceratidae, is really of Turonian age, makes Hyatt's classification particularly inapt. Unfortunately there is little more concrete knowledge of the exact ranges of the early Cretaceous oxycones than when Sayn wrote, but it seems to me not impossible that the peculiar suture-lines of *Platylenticeras*, *Tolypeceras* and the extreme offshoot *Paquiericeras* (see Text-fig. 3) or the rather distinct *Pseudo-*



Text-fig. 4. Suture-lines of *Pseudogarnieria* (*a-d*), *Proleopoldia* (*e*), *Delphinites* (*f*), and *Neocomites* (*g*). (*a*). *Pseudogarnieria* sp. nov. (*Oxynoticeras marcoui*, Stchirowsky, *non* d'Orbigny, 1894, pl. xv, fig. 4c). (*b*). *P. undulato-plicatile*, Stchirowsky sp. (*ibid.*, fig. 3c). (*c*). *P.* sp. nov.? (*Oxynoticeras gevrili*, Stchirowsky sp. (*ibid.*, fig. 1*c*). (*d*) *P. tuberculiferum*, Stchirowsky sp. (*ibid.*, fig. 2a, from specimen, with external lobe doubtful). (*e*). *Proleopoldia kurmyschensis*, Stchirowsky sp. (*ibid.*, pl. xvi, fig. 2c). Lower Cretaceous, Alatyr, Simbirsk, Russia. (*f*). *Delphinites ritteri*, Sayn (1901, fig. 14, p. 23, enlarged × 4.5). (*g*). *Neocomites* ("*Leopoldia*") *aenigmaticus*, Sayn sp. (1907, fig. 24, p. 55, enlarged × 5, reversed for comparison with *f*). Valanginian, S. E. France.

garnieria (Text-fig. 4) were directly evolved from those of the Jurassic *Garniericeras*.

The time-gap, separating these stocks, of course, may be far more considerable than we think. *Garniericeras toliense* apparently was found associated with *Craspedites okensis*, while *G. catenulatum* and *G. subcatenulatum* occur in the higher zones of the Upper Volgian; but there is nothing known from the highest Jurassic (*Riasanites* beds or *privasensis* zone of the Tithonian) and the lowermost Cretaceous (Spiticeratan age) that would bridge the gap between *Garniericeras* and the Cretaceous oxycones. Again, although *Pseudogarnieria* was said to occur together with *Subcraspedites stenomphalus* (Pavlow), a form of the Spilsby Sand-

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stone and presumably of very early Cretaceous age, its suture-line shows a suspicious resemblance to that of *Proleopoldia*, Spath (see Text-fig. 4*e*) and it may well be entirely distinct from *Garniericeras*. It may also be recalled in this connexion that *Platylenticeras* was made to include (even by Hyatt) a form ("*Oxynoticeras*" *pseudograsianum*, Uhlig)[1]) which has a rounded venter and could thus represent a derivative of the persisting Haploceratidae (*Neolissoceras* or group of *H. grasianum*, d'Orbigny sp. of the same deposit). In view of all these doubts it seems advisable to include the four Cretaceous oxycone genera here discussed in a separate group, *Incertae Sedis*, provisionally attached to the Craspeditidae, for there is certainly not the least evidence for referring them to the much later family Pulchellidae, suggested perhaps by the superficial resemblance of the suture-line of a reduced Neocomitid (*Delphinites*, Sayn)[2]) to that of *Platylenticeras*[3]).

Hectoroceras, gen. nov.

Genotype:— *Hectoroceras kochi*, sp. nov. (Plate I, figs. 2*a*, *b*).

Diagnosis:— Narrowly umbilicated platycones, with elliptical to compressed, occasionally almost oxynote, whorl-section, and narrow, smooth venter. Ribbing flexuous, with long primaries which branch (generally by bifurcation) above the middle of the flat whorl-side. Secondary ribs terminate when reaching smooth siphonal area, except towards the end of the body-chamber where they may be continuous across the periphery with a fairly pronounced forward sweep. Ribbing also declines near end where all the costae appear to be equally long or disappear almost completely. Umbilical wall high, but sloping and with rounded edge. Aperture sigmoidal, with slight rostrum; body-chamber nearly three-quarters of a whorl, becoming smooth and rounded ventrally in large forms. Suture-line fairly simple, but with numerous elements (fig. 5).

Remarks:— This genus, at first, seemed so entirely different from any known Jurassic or Cretaceous stock, except possibly *Mazapilites*, that I could not place it, either biologically or in its stratigraphical position. As regards the peculiar subdivision of the ribs, a New Zealand ammonite from Kawhia, figured by Hector[4]) and renamed by

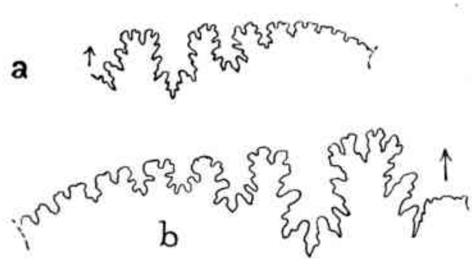
[1]) Über die Cephalopoden-Fauna der Teschener- und Grodischter Schichten. Denkschr. k. Akad. Wiss., Wien, vol. LXXII, 1901, p. 25, pl. II, figs. 1a-c.

[2]) *Loc. cit.* (Mém. Soc. geol. France, Paléont., mém. 23, vol. IX, 1901), p. 23, pl. II, fig. 12.

[3]) See Roman: Les Ammonites jurassiques et crétacécs. 1938, p. 463.

[4]) 'Outline of the Geology of New Zealand'. Ind. & Colon. Exhib. London, N. Z. Court, Catal. & Guide to Geol. Exhibits, 1886, p. 68, text-fig. 33, 2.

myself [1]) *Uhligites hectori* appeared to be very similar, and it was similarly associated with "*Aucella*", but the very complicated suture-line of that Oppelid genus, of course, is entirely against closer comparison. *Oxynoticeras toliense* (Nikitin) which, as mentioned above, is perhaps the closest relation of this genus, seems to differ chiefly in its less specialised ribbing. It is left in *Garniericeras*, however, because it is still close to *G. catenulatum*; and, according to Nikitin [2]), its suture-line, quite wrongly figured by Eichwald, is similar to that of the typical *G. catenulatum*. The great differences in the suture-line between *Garniericeras* (see Text-fig. 2, p. 14) and *Hectoroceras* (Text-fig. 5) alone are sufficient for generic



Text-fig. 5. *Hectoroceras kochi*, sp. nov. Suture-lines of holotype (*a*), natural size and of specimen figured in Plate II, fig. 1 (*b*), enlarged × 2. (Locs. 313 and 306).

separation, and they may not be of even approximately the same date; but it is interesting to note that *G. toliense* shows not only distinct dichotomy of the ribs in the adult, but also returns to a rounded periphery on the body-chamber. In the largest of the many examples of *G. catenulatum* before me (B. M. No. C. 2421), with about three-quarters of the outer whorl belonging to the body-chamber (at 118 mm diameter), the periphery is still almost as sharp as in the younger stages.

The resemblance of the young examples of *Hectoroceras* here figured to similarly immature specimens of the Desmoceratid genus *Saynella* of the Hauterivian must be superficial since the suture-lines are so different.

Hectoroceras kochi, sp. nov.

(Plate I, figs. 1—5; Plate II, figs. 1—4; Plate III, fig. 1).

Holotype:— The original of Plate I, fig. 2, from locality 313.

Diagnosis:— *Hectoroceras* with typically about twenty-eight irregular primary ribs at ordinary sizes, but more in the var. *tenuicostata*

[1]) Ammonites from New Zealand. Quart. Journ. Geol. Soc., vol. LXXIX, 1925, p. 298.

[2]) *Loc. cit.* (Mém. Imp. Acad. Sci., St. Pétersb., sér. VII, vol. XXVIII, No. 5), 1881, p. 150.

(Pl. I, fig. 1) and fewer in the var. *magna* (Pl. II, fig. 3). Maximum size about 160 mm; body-chamber nearly three-quarters of the outer whorl. Aperture (Pl. II, fig. 3) with slight, ventral rostrum.

Measurements:—

	Diameter	Whorl-height	Thickness	Umbilicus
Holotype (Pl. I, fig. 2)	74 mm	51 %	? 18 %	12 %
Plate I, fig. 4	17 -	53 -	30 -	15 -
— I, - 5	27 -	54 -	28 -	11 -
— II, - 1	52 -	54 -	24 -	10 -
— I, - 1 (var. *tenuicostata*)	87 -	55 -	21 -	10 -
— II, - 3 (var. *magna*)	160 -	50 -	(?) -	14 -

Remarks:— These measurements indicate that the umbilicus which is comparatively open in the young (Plate I, fig. 4*c*) but then becomes narrow, opens out again at larger sizes. Most of the sixty specimens available are slightly crushed or otherwise imperfect, but the originals of Plate I, figs. 4—5 and Plate II, fig. 1 show the true whorl-thickness. In the holotype this thickness probably amounted to about 21 %, as in the fairly well-preserved original of Plate I, fig. 1, but it is probable that at larger diameters the thickness became less, in proportion.

There are slight differences in costation, especially when this becomes modified near the aperture as in the var. *tenuicostata*, nov. (Plate I, fig. 1) and in the var. *magna*, nov. (Plate II, fig. 3). The greater prominence of some of the ribs is particularly noticeable in the original of Plate II, fig. 1. The presence of a long, single, anterior branch on two of the bifurcating ribs, shown in the plaster-cast of an impression (plate III, fig. 1), is reminiscent of *Thurmannites* and allied Eocretaceous genera.

The fragment figured in Plate IV, fig. 6 represents the arched periphery of a large body-chamber. There are merely faint traces of ribbing and the lines of growth are scarcely projected across the venter, so that there is little resemblance between this ammonite and typical examples of the form here described. Yet it is probable that it belonged to a large body-chamber specimen like that figured in Plate II, fig. 3; for it is known that the periphery became arched towards the end and the ribbing tended to be lost. Of course, large, smooth *Craspedites* may have a similar ventral aspect, but it must be remembered that *Hectoroceras* is undoubtedly the dominant ammonite in the rock that yielded the fragment under discussion.

The Wollaston Foreland specimen figured in Plate III, fig. 2, at first sight, seems to have a larger umbilicus and more projected ribbing than the species here described. The projection, however, is only slightly more pronounced than in the specimen of *H. kochi*, figured in Plate II, fig. 2; and since the umbilicus of the Wollaston Foreland specimen is small on the inner whorls and shows the characteristic rounded edge, it is clear that the last half-whorl was broken in the crushing. The example may thus be thought to be comparable to *H. kochi*, yet it cannot be identified with it. Not only is there a subtle difference in the ribbing, but periphery and suture-line, which cannot be seen, may be rather different.

Localities:— 304 (4); 305 (10); 306 (9); 307 (2); 308 (10); 309 (5); 311 (3); 312 (5); 313 (11); 314 (1); 315 (1); 316 (1); 318 (4).

Genus *Subcraspedites*, Spath.

1924. On the Blake Collection of Ammonites from Kachh, India. Mem. Geol. Surv. India. Pal. Indica, N. S., vol. IX, No. 1, p. 17.

Genotype:— *Ammonites plicomphalus*, J. Sowerby *pars*; Mineral Conchology, vol. IV, 1823, p. 145, pl. 404 (B. M. No. 43892 *b*), pl. 359?

Diagnosis:— More or less evolute shells with compressed elliptical to circular whorl-section and evenly arched venter. Ribs in the young perisphinctoid, bi- or tri-furcating, rather blunt and with various irregularities, projected peripherally and tending to differentiate at varying diameters into primary stems or bundles and an increasing number of secondaries. Adult whorls with faint or strong, irregular inner bulges and fine or obsolescent peripheral ribs and finally smooth venter. Aperture plain, with ventral lappet. Suture-line with low external lobe, fairly large first lateral lobe, but shorter second lateral and auxiliary lobes, often ascending towards umbilicus.

Remarks:— This genus was first mentioned in 1923[1]) when I referred to it the Spilsby Sandstone forms of the group of *S. plicomphalus* (J. Sowerby) and *S. stenomphalus* (Pavlow)[2]), also three apparently distinct forms from the Knoxville Beds which had been described by Stanton[3]) as a single species, '*Olcostephanus*' *mutabilis*. In 1924[4]), I added several other species, including *S. ptychomphalus*, Brown[5]) sp., but a nomen-

[1]) Spath, *loc. cit.* (Quart. Journ. Geol. Soc. vol. LXXIX), pp. 306—308.

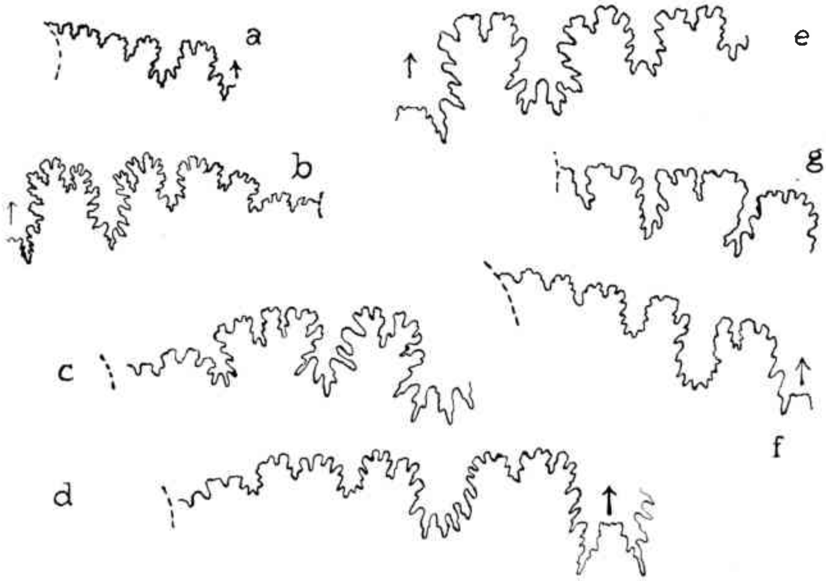
[2]) Etudes sur les couches jurassiques et crétacés de la Russie, pt. 1. Bull. Soc. Imp. Nat. Moscou, 1889, No. 1, p. 59, pl. III, figs. 1 (lectotype) and 10 (*Olcostephanus*).

[3]) The Fauna of the Knoxville Beds. Contrib. Cret. Pal. Pacif. Coast, Bull. U. S. Geol. Surv. No. 133, 1895, p. 77, pl. XV, figs. 1—5 (issued 1896).

[4]) On the Ammonites of the Speeton Clay and the Subdivisions of the Neocomian. Geol. Mag. vol. LXI, 1924, pp. 78—79.

[5]) Illustrations Fossil Conchology, 1837, p. 17, pl. XIII, fig. 2 (= Amm. *plicomphalus*, Sowerby, Min. Conchol., vol. IV, 1822, p. 82, pl. 359).

clatorial irregularity affecting this species passed unnoticed; for since J. Sowerby's species was created in 1822 on the basis of the single specimen figured in his pl. 359, this must be the holotype. But Brown's name was meant for the same form and not for the second specimen figured by J. de C. Sowerby a year later (pl. 404). The two specimens are in the British Museum (Nat. Hist.) and I can only endorse Brown's



Text-fig. 6. Suture-lines of *Subcraspedites*. (*a*). *S. stenomphalus*, Pavlow sp. (After Pavlow, 1889, pl. III, fig. 10c, Simbirsk, Cent. Russia. (*b*). *S. undulatus*, Swinnerton (1935, pl. II, fig. 3B, completed from other, uncrushed side. Spilsby Sandstone, B. M. No. 36352). (*c*, *d*). *S. primitivus*, Swinnerton (at diameters of about 85 and 115 mm. Same bed, Bros. Wright Coll.). (*e*). *S. lamplughi*, Spath (*Craspedites subditus*, Pavlow, 1892, pl. XIII, fig. 5, B. M. No. C. 34981, Spilsby Sandstone, composite and enlarged about × 2). (*f*). *S.* sp. nov. (between *S. primitivus*, Swinnerton and *S. lamplughi*, Spath. Spilsby Sandstone, B. M. No. C. 996a. Enlarged × 1$^1/_2$). (*g*). *S.* (?) *mutabilis*, Stanton (1895, pl. XV, fig. 2). Knoxville Beds, California (enlarged portion of suture-line).

opinion that they are specifically different. I definitely designated the genotype, however, as Sowerby's pl. 404 i. e. the finely ribbed form which may have to be renamed since it does not seem to represent the inner whorls of *S. plicomphalus* as restricted to the more coarsely ornamented types that somewhat resemble *Craspedites nodiger* (Eichwald).

Other species included in *Subcraspedites* were *S.* sp. nov. (= *Craspedites subditus*, Pavlow[1]) *non* Trautschold sp.) which I renamed *S.*

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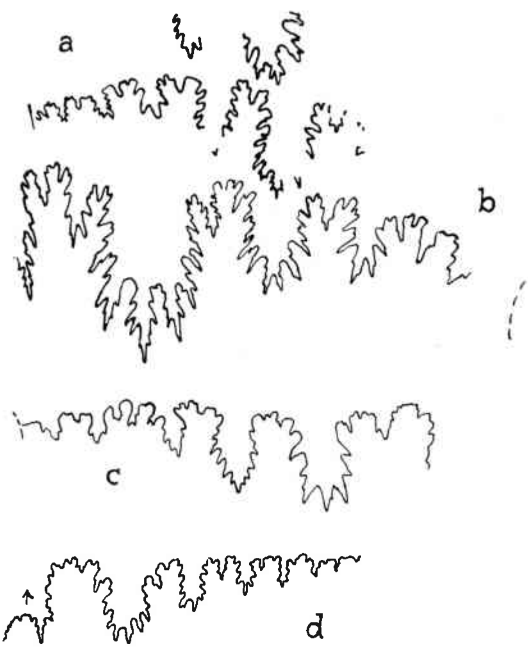
[1]) In Pavlow and Lamplugh; Argiles de Speeton, 1892, p. 116, pl. XIII, (vi), fig. 5.

lamplughi in 1936[1]); *Craspedites* cf. *nodiger*, Pringle[2]), *non* Eichwald, which was later included by Swinnerton[3]) in his *S. cristatus*; also *Olcostephanus pressulus* and *O. subpressulus*, Bogoslowski[4]) and *O. spasskensis*, Nikitin[5]). To these Swinnerton added *S. primitivus*, *S. precristatus*, *S. subundulatus*, *S. undulatus*, *S. parundulatus* and *S. preplicomphalus*, Swinnerton, while Riasan forms like *Olcostephanus supra-*



Text-fig. 7. Suture-lines of (*a, b*) *Tollia* and (*c, d*) *Subcraspedites*. (*a*). *Tollia tolli*, Pavlow (Copy of Pavlow, 1914, pl. xii, fig. 2c). Infra-Valanginian of N. Siberia. (*b*). *Tollia latelobata*, Pavlow (*ibid.*, pl. xiii, fig. 2). Same beds (Drawn from side-view of specimen and external saddle, therefore distorted). (*c*). *Subcraspedites suprasubditus*, Bogoslowski sp. (1897, pl. i, fig. 2d). Riasan beds of Central Russia. (*d*). *S. spasskensis*, Nikitin sp. (1888, pl. i, fig. 11). Staraia Riasan, Spassk., Russia.

subditus, Bogoslowski[6]), may also be included in *Subcraspedites* in spite of certain differences in the suture-lines.

[1]) *Loc. cit.* (Medd. om Grønl.), vol. 99, No. 3, 1936, pp. 81, 180.

[2]) Palaeontological Notes on the Donnington Borehole of 1917. Summ. Progress Geol. Surv. Gr. Br. for 1918 (1919), p. 50.

[3]) Rocks below the Red Chalk of Lincolnshire and their Cephalopod Faunas. Quart. Journ. Geol. Soc., vol. XCI, 1935, p. 33.

[4]) Der Rjasan Horizont. Mat. Geol. Russl., vol. XVIII, 1897, pp. 68—72, 142, pl. iv, figs. 2—4.

[5]) Les Vestiges de la période crétacée dans la Russie centrale. Mém. Com. géol., vol. V, No. 2, 1888, p. 95, pl. i, figs. 9—11.

[6]) *Op. cit.* (1897), pp. 47—50, 140, pl. i, figs. 1—4.

The forms so far mentioned, with others from the Riasan Beds of Central Russia, are intimately allied with the more coarsely ribbed *Paracraspedites*, recently separated from *Subcraspedites* by Swinnerton[1]), with *P.* aff. *stenomphaloides*, Swinnerton[2]), as the most characteristic form. It is as yet doubtful whether such species as *S. stenomphalus* and *S. spasskensis* referred to above, should be transferred to the genus *Paracraspedites*, perhaps also species like *Olcostephanus kozakowianus* and *O. tzikwinianus*, Bogoslowski[3]); others are still more doubtful. In fact, Swinnerton's own type material, with the exception of *P.* aff. *stenomphaloides*, already mentioned, on account of its poor preservation and the absence of suture-lines, is difficult to appraise. For example his *P. bifurcatus*[4]) may belong to quite a different stock, since the ribbing becomes closer at the end, instead of more distant, and since it is without peripheral projection. The holotype of *P.* (?) *trifurcatus*, Swinnerton[5]), again is so worn that the reconstruction may be entirely wrong. Moreover, since derived Portlandian ammonites (*Crendonites*, *Kerberites*) have now been found in the basement bed (with phosphatic nodules) of the Spilsby Sandstone at Nettleton Mine, Caistor, Lincs. (Bros. Wright Coll.) the resemblance of some of these *Paracraspedites* to Portlandian Perisphinctids may be significant. That is to say, while they are not referable to species known from the Portland Stone and quite different from the derived Portlandian ammonites of Caistor, it is possible that the basement bed of the Spilsby Sandstone which yielded the *Paracraspedites* fauna, includes fossils derived from various post-Portlandian horizons that are not known to occur *in situ* at the present day.

While *S. suprasubditus*, Bogoslowski, already cited, appears to connect the genus *Subcraspedites* with the earlier true *Craspedites*, *Tollia*, Pavlow[6]) and *Nikitinoceras*, Sokolow[7]) (= *Temnoptychites*, Pavlow[8])) are transitional to the Polyptychitidae. The last two genera have not only more advanced dichotomous or bidichotomous ribbing, but slightly different suture-lines. That of *Tollia* (see Text-figs. 7 *a*, *b*) has long saddles and a high external lobe; in *Nikitinoceras*, according to a

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[1]) *Op. cit.* (1935), p. 38.

[2]) *Ibid.*, p. 39, pl. IV, fig. 2.

[3]) *Op. cit.* (Der Rjasan Horizont), 1897, p. 141, pl. II, figs. 2 (3—5) and 6.

[4]) *Loc. cit.* (Quart. Journ. Geol. Soc., vol. XCI), 1935, p. 39, pl. IV, fig. 3.

[5]) *Ibid.*, p. 39, text-fig. 5 on p. 40.

[6]) Céphalopodes Sibérie septentrionale. Result. scientif. Exp. polaire russe, 1900—03. Section C. Géol. & Paléont. livr. 4 (Mém. Acad. Imp. Sci., St. Pétersb., ser. VIII, vol. XXI, No. 4), 1914, p. 38.

[7]) Sur les fossiles des blocs erratiques de Novaja Zemlia. Trav. Mus. Géol. Pierre le Grand, vol. VII, 1913, p. 80 (restricted to the group of *Olcostephanus hoplitoides*, Nikitin).

[8]) *Loc. cit.* (1914), p. 44.

specimen of N. *Igowense*, Nikitin sp.[1]) before me (B. M. No. C. 39878) the suture-line is strongly inverse (i. e. ascending towards the umbilicus) and the internal portion shows a corresponding decline towards the dorsal lobe, but the saddles and lobes also are comparatively long and slender.

Subcraspedites (?) sp. nov. (?).

Plate IV, figs. 1a, b.

The crushed fragment figured in Plate IV, fig. 1 is the final portion of the body-chamber, intact at the apertural end; its opposite side is seen in fig. 1*a*, together with the impression of some of the earlier parts of the same ammonite. In spite of the crushing and distortion, it can be seen that the umbilicus was fairly open; otherwise the form seemed to resemble some ammonites from California, described by Stanton[2]) as *Olcostephanus mutabilis.* Stanton's description seems to have been based on an examination of about forty specimens, all more or less distorted, and I have previously[3]) expressed the opinion that even the three figured specimens may represent three distinct species of *Subcraspedites.* Anderson's[4]) more recent work makes it doubtful whether that identification can be upheld. The description was necessarily somewhat comprehensive and the periodic constrictions of the internal casts as well as the suture-line (see Text-fig. 6*g*, p. 24) make it difficult to say whether '*O.*' *mutabilis* is as close to *Subcraspedites* as appeared at first sight. The suture-line certainly seems peculiar; if only the external lobe is missing, as Stanton says, the suture-line is rather different from that of any other form of *Subcraspedites* so far known. But it would agree with the other suture-lines here figured, if the broad, bifid, median saddle shown in fig. 6*g* were the second lateral saddle, On the other hand, the suture-line shows even less resemblance to that of *Simbirskites*, and, if correctly drawn, it also does not support the reference of Stanton's form or forms to the genus *Dichotomites*[5]).

[1]) *Op. cit.* (Vestiges de la période crétacée), 1888, p. 98, pl. II, figs. 6—7.

[2]) *Op. cit.* (Fauna of the Knoxville Beds), 1896, p. 77, pl. XV, figs. 1—5.

[3]) Spath, *loc. cit.* (Quart. Journ. Geol. Soc., vol. LXXIX), 1923, p. 306.

[4]) Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Report XXVIII, State Mineralogist California (1933), p. 322. Also: Knoxville-Shasta Succession in California. Bull. Geol. Soc. America, vol. 44, 1933, p. 1259; and: Lower Cretaceous Deposits in California and Oregon. Geol. Soc. Am. Special Paper No. 16, 1938, p. 160.

[5]) Anderson compared '*D.*' *mutabilis* to *D. fragilis*, Pavlow, *non* Trautschold, but he may have overlooked the fact that the Speeton form, cited by myself (1924, p. 75), has nothing to do with the original of Pavlow's fig. 3 which is a true Russian *Craspedites* of the Upper Volgian and probably identical with Trautschold's original *Amm. fragilis.* If Stanton's drawings are anything like the type-specimens, their development from coarse to fine (as regards ribbing) is not in favour of Anderson's identification.

The Jameson Land form, however, is not "involute", having an umbilicus of possibly 40 %, or twice that of Stanton's *O. mutabilis*, as lectotype of which Anderson chose the original of fig. 1. There are about four to five secondary ribs to each primary, but these are sharp, not blunt, as in most *Subcraspedites*. Even '*S.*' *primitivus*, Swinnerton[1]), with somewhat similar ribbing, has much more regular costation and more closely set primary ribs, but this is probably a form of *Tollia*.

If such young examples as those figured in Plate IV, figs. 11 and 12 are referable to the same form as the example so far discussed, which seems probable, then the ribs in the young were very irregular at an early stage, and the secondaries much longer than in the typical *Subcraspedites*, so far as the young of this genus are known. The two impressions figured in figs. 2 and 13 of the same plate, unfortunately, are even less well preserved, and the fragment figured in Plate I, fig. 6 may owe its slightly different aspect to the crushing, the inner half of the side of the outer whorl-portion being missing. None of the East Greenland examples shows traces of a suture-line.

The fragment recorded below from Locality 314 is a very poor impression of part of a larger whorl, and, although it is almost unrecognisable, it shows the long, medium, and short ribs so characteristic of many Infra-Valanginian ammonites.

Localities:— 305 (1); 314 (1?); 318 (many young?).

Subcraspedites (? *Paracraspedites*) sp. ind.

(Plate II, fig. 5).

The fragmentary ammonite represented in Plate II, fig. 5 has slightly coarser ornamentation than the examples described under the last heading. The ribbing is equally irregular, with long and short secondaries, but there is at least one bidichotomous rib with associated constriction, and three more, thickened ribs, at intervals, also have faint constrictions. The latter may be following the thickened rib or lie in between two strong ribs, but owing to the crushing and generally poor preservation, it is difficult to see the constrictions. Like the ribs, they are most conspicuous on the periphery where they all form a distinct sinus, directed forwards. It is possible that the fragment figured in Plate IV, fig. 14 belonged to another example of the same form, but its inner whorls are finely and closely ribbed, more so than those of the larger specimen.

The form here described may be compared to *Olcostephanus* sp. ind. A of Bogoslowski[2]) from the Riasan beds, since this also has bidichoto-

[1]) *Loc. cit.* (Quart. Journ. Geol. Soc., vol. XCI), 1935, p. 32, pl. II, figs. 1a-c.
[2]) *Loc. cit.* (Mat. Geol. Russl., vol. XVIII), 1895, p. 142, pl. IV, figs. 6a, b.

mous ribs and constrictions, but difference in size, unfortunately, prevents closer comparison.

Localities:— 303 (4); 308 (2); 318 (many).

b. Order *BELEMNOIDEA.*

Family *BELEMNITIDAE.*

Sub-family *Cylindroteuthinae.*

Genus *ACROTEUTHIS*, Stolley, 1911.

Acroteuthis sp. ind.

(Plate V, figs. 13, 14).

Among the few belemnite remains from the *Hectoroceras* beds there is the guard figured in Plate V, fig. 13 which has a ventro-dorsal and lateral diameter of 31 mm at the middle (i. e. in the stem-region) at an actual length of 127 mm (estimated length of complete guard about 180 mm). The restoration of the alveolar or anterior end shows that there was no rapid increase of the lateral, as compared with the ventro-dorsal diameter (32 mm), at any stage. The alveolar cavity must have been over half the length of the (complete) guard; the angle is about 17 ° (15 ° in the doubtful smaller fragment, figured in fig. 14, and 22 ° (?) in an isolated phagmocone, No. 316). The ventral side is distinctly flattened and has a short and shallow groove, not reaching to the apex. There is little lateral flattening, but the sides are largely covered by firmly adhering matrix. The posterior end is compressed laterally and distinctly excentric, the apex pointing towards the ventral side far more conspicuously than in the otherwise similar but more compressed *Belemnites panderi*, d'Orbigny[1]).

It is probably impossible to assign a definite specific name to the single individual figured in Plate V, fig. 13, considering the large number of very similar species of *Pachyteuthis* and *Acroteuthis* that have actually been named, and the incompleteness of the specimen; but it may be mentioned that *A. partneyi*, Swinnerton[2]), from the basement beds of the Spilsby Sandstone, has a similar shape, though apparently a deeper ventral groove and probably more conspicuous lateral grooves. *A. subquadratus* (Roemer) from King Charles Islands, as figured by Blüthgen[3]) also seems comparable, except in its longer ventral groove

[1]) In Murchison, Verneuil & Keyserling, *op. cit.*, 1845, pl. xxx, figs. 1—2, 6, 12—13.

[2]) A Monograph of British Cretaceous Belemnites. Pal. Soc., vol. for 1935 (1936), p. 12, pl. v, figs. 1a, b.

[3]) Die Fauna und Stratigraphie des Oberjura und der Unterkreide von König Karl Land. 1936, p. 29, pl. iv, figs. 4—6.

and depressed section; but according to Stolley[1]) the identification is erroneous; and Roemer's species, in any case, is said to be a form of the *Neocomites* beds of the basal Hauterivian. Some forms of *Acroteuthis* before me from Kuhn Island and other localities in the northern part of East Greenland also all seem to have a more rectangular section, and in the Speeton forms of *Acroteuthis* I collected (from the D beds) the ventral flattening is generally very conspicuous. The Jameson Land example thus might well be referred to *Pachyteuthis* and not to *Acroteuthis*. According to Stolley[2]) there is a gradual change in the cross-section of the rostrum from compressed (characteristic of the earlier forms of *Pachyteuthis*) to depressed (distinguishing the later *Acroteuthis*); and if there are no fundamental differences between the two genera except that one is supposed to be Jurassic and the other Cretaceous, it is comprehensible that Naef[3]) put *Belemnites subquadratus*, Roemer, the genotype of *Acroteuthis*, into the older genus *Pachyteuthis*, Bayle, 1878.

In any case, the Jameson Land form is now referred to *Acroteuthis* because it is slightly different from the many well preserved forms of *Pachyteuthis* from the pre-Portlandian beds of East Greenland and because it also does not agree with the Upper Volgian species like *P. corpulentus*, Nikitin[4]), available for comparison. But the reference to *Acroteuthis* must not be taken to imply that the belemnite is recognisable off-hand as a Cretaceous rather than a Jurassic form.

Localities:— 306 (2); 308 (1); 311 (2); 312 (1); 313 (1); 316 (3).

2. Class *GASTROPODA*.

A. Sub-class *Streptoneura*.

a. Order *ASPIDOBRANCHIATA*.

Family *VANIKORIDAE*.

Genus *VANIKORO*, Quoy & Gaimard 1832.

Vanikoro sp. nov.?

(Pl. V, fig. 17).

1936. *Vanikoro* sp. nov. (?) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), p. 93, pl 40, figs. 1a, b.

A rough sandstone cast seems to differ from the form previously described from Milne Land merely in being about half its size. It has

[1]) Zur Kenntnis der arktischen Belemniten von König-Karls-Land. Zentralbl. f. Min. etc. 1938, B., p. 25.

[2]) Die Systematik der Belemniten. XI. Jahresb. Niedersächs. Geol. Ver., Hanover, 1919, p. 55.

[3]) Die fossilien Tintenfische. Jena, 1922, p. 244.

[4]) *Loc. cit.* (Verh. Kais. Min. Ges., 1884), p. 66, pl. VIII, figs. 34—36. Included in *Acroteuthis* by Bülow-Trummer (Fossilium Catalogus, I, pars 11, 1920, p. 207) together with many other Jurassic species.

similar traces of spiral ribbing and a flat spire (damaged), but the preservation is altogether too defective for accurate determination.

Locality:— 308 (1).

b. Order *CTENOBRANCHIATA.*

Family *NATICIDAE.*

Genus *NATICA*, Adamson in Scopoli, 1777.

Natica (?) sp. ind.

(Plate I, figs. 7, 8).

Four sandstone casts show a shape apparently like that of English examples of the Portlandian "*N.*" *elegans*, J. de C. Sowerby in Fitton[1]), but the upper margin is much sharper in the Greenland forms; what little remains of the test cannot be described as "very thin". Since the casts are not only small but incomplete, comparison with similar Upper Jurassic or Lower Cretaceous species is not really helpful, especially as the ranges of the species are mostly conjectural; but *N. georgeana*, d'Orbigny[2]) seems to represent another comparable type of shell.

Localities:— 306 (1); 308 (2); 313 (1).

B. Sub-class *Euthyneura.*

Order *TECTIBRANCHIATA.*

Family *ACTAEONIDAE.*

Genus *ACTAEONINA*, d'Orbigny, 1850.

Sub-genus *OVACTAEONINA*, Cossmann, 1895

Actaeonina (*Ovactaeonina*) sp. ind.

(Plate III, fig. 6).

The only example available fortunately retains part of the thick test, showing extremely fine, spiral lineation. The shape, so far as can be seen, is that of *A.* (*O.*) *groenlandica*, Spath[3]) from the Portlandian of Milne Land or of *A.* (*O.*) *peroskiana* (d'Orbigny)[4]) from the Lower

1) Observations on some of the Strata below the Chalk &c. Trans. Geol. Soc. 2nd. ser., vol. IV, 1836, p. 347, pl. XXIII, fig. 3. Examples with the test are different. See Cox: The Fauna of the Basal Shell-Bed of the Portland Stone, Isle of Portland. Proc. Dorset Field Club, vol. XLVI, 1925, p. 49.

2) Pal. Française, Terr. Jurass. vol. II, 1852, p. 214, pl. 298, figs. 2—3.

3) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 96, pl. 40, figs. 2a-e.

4) In Murchison, Verneuil & Keyserling, *op. cit.*, 1845, p. 449, pl. XXXVII, figs. 12—14.

Volgian (and Lower Cretaceous) of Russia, but the size is larger. Whether this difference and the thickness of the test indicate another species, is difficult to say; and since the aperture is crushed the shape may not be too safe a guide to identification. This may also be responsible for the apparent difference between the Jameson Land example and the similarly lineate *Actaeon peroskianus*, d'Orbigny var., figured by Keyserling[1]) from the River Taymir, East Siberia. In the circumstances, no specific determination is attempted, for there may be a varied congeries of forms among the assemblage referred by Eichwald[2]) to his '*Globiconcha perowskiana*'. The Cretaceous *Actaeon petshorae*, Keyserling[3]), however, is not closely comparable to the Greenland example, either in shape or ornamentation.

Locality:— 313 (1).

3. Class *SCAPHOPODA*.

Family *DENTALIIDAE*.

Genus *DENTALIUM*, Linnaeus, 1740.

Dentalium sp. cf. *moreanum*, d'Orbigny.

1845. *Dentalium moreanum*, d'Orbigny, in Murchison, Verneuil & Keyserling, *op. cit.*, p. 454, pl. xxxviii, fig. 10.

A small fragment of a *Dentalium*, showing a slight curvature and a perfectly circular section, agrees with d'Orbigny's figure and description, but the Donetz form probably comes from a much earlier horizon. The test is as smooth as the cast and since this type of *Dentalium* has a very long range, it is of little importance stratigraphically.

A fragment embedded in the rock that also includes *Entolium nummularis*, Fischer sp. (figured in Plate V, fig. 6) suggests that *Ditrupa*, comparable to a supposed Lower Volgian form from Spitsbergen figured by Frebold[4]), may be represented in the *Hectoroceras* Beds, in addition to *Dentalium*. The identification of the small pieces available is thus very uncertain.

Locality:— 311 (1).

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[1]) Fossile Mollusken; in Middendorf's Reise in den äussersten Norden und Osten Sibiriens. Vol. I, pt. 1, p. 254, pl. iv, fig. 10.

[2]) *Op. cit.* (Lethaea rossica), 1868, p. 1288.

[3]) *Op. cit.* (Wiss. Beobacht. Reise Petschora Land), 1846, p. 320, pl. xviii, figs. 22—23 (*A. petschorae*, on plate). The author (p. 319) also cites *A. perofskianus* [*sic*] from the Petchora Land, i. e. from a presumably Cretaceous deposit.

[4]) *Loc. cit.* (Skrifter om Svalbard, No. 31), 1930, p. 40, pl. xiv, fig. 4.

4. Class *PELECYPODA.*

A. Sub-class *Anisomyaria.*

Family *PTERIDAE.*

Genus *OXYTOMA*, Meek, 1864.

Oxytoma sp. ind. cf. *semiradiata* (Fischer).

(Plate V, figs. 16a, b).

This form is not readily distinguishable from some of the small examples from Milne Land, previously[1]) included in *O. expansa* (Phillips), but the present species is probably closer to *O. semiradiata* (Fischer)[2]). The posterior wing is larger in the Greenland form, but as d'Orbigny's drawing is enlarged and based on a very small specimen, it is doubtful whether this difference is of significance. There are about fourteen primary ribs, but the intermediate secondary ribs are rather irregular, long or short and occasionally even duplicated. The granulation is not nearly so conspicuous as in d'Orbigny's figure. The posterior wing bears fine striae, but only near the hinge-line, and where the convex area begins to become ribbed.

Avicula macroptera, Roemer[3]) is possibly also allied to the species here discussed, but the Koldewey Ø form figured by Ravn[4]) as *Oxytoma inaequivalvis* (Sowerby) var. *macroptera*, Roemer, has a more oblique shape and the posterior wing is uniformly striate. If *O. macroptera*, moreover, is identical with *Pteria* (*Oxytoma*) *cornueliana* (d'Orbigny) and if the Speeton Clay forms figured by Woods[5]) represent that species, then the Greenland examples are undoubtedly distinct. Bogoslowsky[6]), it may be noted, recorded both these species, namely *O. semiradiata* (as *Avicula russiensis*) and *O. cornueliana*, from the Riasan beds.

Localities:— 309 (1); 311 (1).

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[1]) Spath; *loc. cit.* (Medd. om Grønl., 99, 3), 1936, p. 97.

[2]) See d'Orbigny, in Murchison, Verneuil & Keyserling, *op. cit.*, 1845, p. 474, pl. XLII, figs. 35—36 (needlessly renamed *Avicula russiensis* in Prodrome, vol. I, 1850, p. 372, No. 413).

[3]) Die Versteinerungen des norddeutschen Oolithen-Gebirges, 1836, p. 86, pl. IV, fig. 5.

[4]) On Jurassic and Cretaceous Fossils from N. E. Greenland. Medd. om Grønl., vol. XLV, 1912, p. 454, pl. XXXII, fig. 1.

[5]) Monograph Cretaceous Lamellibranchia of England. Pal. Soc., vol. II, pt. 2, p. 57, pl. VIII, figs. 1—7.

[6]) *Loc. cit.* (Mat. Geol. Russl., vol. XVIII), 1897, p. 107.

Family *MYALINIDAE.*

Genus *BUCHIA*, Rouillier, 1845.

Buchia volgensis (Lahusen).

Plate I, fig. 9; Plate III, fig. 5; Plate IV, fig. 8, 9; Plate V, figs. 1—2.

1888. *Aucella volgensis*, Lahusen; Über die russischen Aucellen. Mém. Com. Géol., vol. VIII, No. 1, p. 38, pl. III, figs. 1—17.

1905. — — — Woods: Monograph Cretaceous Lamellibranchia of England. Pal. Soc., vol. II, pt. 2, p. 69, pl. X, figs. 1—2.

1907. — — — Pavlow: Enchaînement des Aucelles. Nouv. Mém. Soc. Imp. Nat. Moscou, vol. XVII, No. 1, p. 27, pl. II, figs. 10a-c.

1931. — — — Sokolov & Bodylevsky: Jura- und Kreide-Faunen von Spitzbergen. Skrifter om Svalbard og Ishavet, No. 35, p. 38, pl. I, figs. 4—5.

1935. — — — Aldinger, *op. cit.* (Medd. om Grønl., vol. 99, No. 1), p. 38.

There are numerous valves of this form, both left and right, and those here figured are representative of the various changes in ornamentation which may be found, especially on the left valves, in this large species-group. The right valves also show variation in ribbing; they may be fairly smooth (Plate IV, fig. 9) or coarsely ribbed (Plate III, fig. 5), but the thin test is only rarely preserved. There is a unique but fragmentary left valve in which the ribbing is very coarse, as in some of the rugose species of *Buchia* (e. g. *B. fischeri*, Lahusen sp.) but it does not seem advisable to record this ill-preserved example as a distinct species.

According to Pavlow this form is chiefly of Infra-Valanginian age, but appears already in the Upper Volgian. Woods figured it from the Spilsby Sandstone, where, however, it does not seem to be common.

Localities:— 303 (?); 306, 308—9, 311—13, 315, 318 (many specimens).

Buchia cf. *terebratuloides* (Lahusen).

Plate II, figs. 7—8.

1888. *Aucella terebratuloides*, Lahusen; *loc. cit.* (Mém. Com. Géol., vol. VIII, No. 1), p. 39, pl. IV, figs. 1—11.

1907. — — — Pavlow, *loc. cit.* (Nouv. Mém. Soc. Imp. Nat., Moscou, vol. XVII, No. 1), p. 60, pl. V, figs. 4—9, 11—12.

1931. — — — Sokolov & Bodylevsky, *loc. cit.* (Skrifter om Svalbard, No. 35), p. 41, pl. II, figs. 1—2.

1935 (?) — cf. — — Bodylevsky: On some Faunas from the Cretaceous of Kolyma Land and Kamchatka. "Dal' stroi", ser. I, vol. V, p. 52.

The two left valves here figured are somewhat imperfect, the larger being broken posteriorly and the smaller being incomplete at the lower half of the anterior border. The outline thus may appear unduly elongated, and it is possible that these valves belong to the rather narrow var. *regularis* of Pavlow. The much larger right valve figured in Plate IV, fig. 8 has a straighter posterior margin than corresponding valves of *B. volgensis* and may, therefore, also be referred to the present form, though with doubt, since the many large left valves in the same bed all belong to *B. volgensis.* It is possible that a condensed deposit like the Riasan beds contains a number of heterochronous species of *Buchia*, lying side by side, but a uniform assemblage like that of the *Hectoroceras* beds is not likely to include individuals of many species, so that perhaps even the forms here referred to *B. terebratuloides* are merely extremes of the *volgensis* stock.

Localities:— 306 (? 1); 311 (1); 313 (1).

Family *PERNIDAE.*

Genus *INOCERAMUS* (J. Sowerby) Parkinson, 1819.

Inoceramus sp. ind.

(Plate V, fig. 3).

The unique sandstone cast here discussed is smaller than the impression which it left in the rock from which it was detached, so that the photograph was taken from a plasticine-squeeze of that impression. The long axis is approximately 40 mm and there are about six strong concentric ridges, but these are not sharp, as in Crickmay's[1] *Aucella canadiana.* That author's fig. 5, it is true, also shows fairly blunt ridges, but the convexity is entirely against closer comparison of the two forms, the Jameson Land valve showing a maximum thickness of perhaps not more than 12 mm.

This form shows a certain resemblance to *I. propinquus*, Eichwald[2]), which comes from the Upper Volgian beds with *Garniericeras catenulatum* of Khoroshovo, near Moscow. It has the same shape and wide and deep concentric pleats, without intermediate striae, also a similar convexity, but in view of the unfavourable preservation of the Greenland cast, and the absence of the umbonal and hinge areas, it is impossible definitely to identify it. *I. retrorsus*, Keyserling, and *I. spitzbergensis*,

[1]) Fossils from Harrison Lake Area, British Columbia. Nat. Mus. Canada Bull. No. 63, 1930, p. 47, pl. x, figs. 3—5.

[2]) *Loc. cit.* (Lethaea rossica), 1868, p. 487, pl. xxi, figs. 5a, b.

Stolley, which have been recorded by Girmounsky[1]) from the "Middle Aquilonian" of Spitsbergen, are less closely comparable. The former was recorded[2]) by myself from the *Cranocephalites* Beds (Bathonian) of Jameson Land and, if correctly identified, has a much more oblique shape and less regular concentric folds than the form here described. *I. spitzbergensis*, Stolley[3]) has less prominent and less regular concentric ridges; moreover Bodylevsky[4]) who re-examined Girmounsky's Spitsbergen form, thought that it belonged to a species of "*Aucella*".

I. neocomiensis, d'Orbigny, which had been doubtfully recorded[5]) from the Spilsby Sandstone, is much more closely ribbed than the present form; according to Woods[6]), the specimens of *Inoceramus* found both in the Speeton Clay and the Infra-Valanginian Spilsby Sandstone are not sufficiently perfect for description.

Locality:— 312 (1).

Family *OSTREIDAE*.

Genus *EXOGYRA*, Say, 1819.

Exogyra cf. *contorta*, Eichwald.

(Plate V, fig. 17).

1868. *Exogyra contorta*, Eichwald, *op. cit.* (Lethaea rossica), vol. II, p. 406, pl. XIX, figs. 9a-c.

The smooth cast of a very thick-shelled mollusc, apparently coiled in a helicoid spiral, though rather unsymmetrical, at first sight was taken to be a gastropod, but the remains of test are lamellar and quite unlike the shell of an ordinary gastropod. Moreover, the cast shows what must have been a contracted or bent "aperture"; and the coarse, spiral pleats of the thick test appeared suddenly and quite near the end, as in Eichwald's form. The earlier part of the "spire" is broken off, which enhances the gastropod aspect, but as the preservation is altogether defective, the identification with the Russian species can only be tentative. A

[1]) La faune du Jurassique supérieur et du Crétacé inférieur de Spitzberg. Berichte des Wissenschaftl. Meeres-Instituts; vol. II, Lief 3, Moscow, 1927, p. 104.

[2]) The Invertebrate Faunas of the Bathonian-Callovian Deposits of Jameson Land. Medd. om Grønl., vol. 87, No. 7, 1932, p. 110, text-fig. 8 on p. 111.

[3]) Über Kreideformation und ihre Fossilien auf Spitzbergen. K. Svenska Vetensk. Handl., vol. 47, No. 11, 1912, p. 20, pl. I, figs. 5—6.

[4]) In Sokolow and Bodylevsky: Jura- und Kreide-Faunen von Spitzbergen. Skrifter om Svalbard og Ishavet, No. 35, 1931, p. 47.

[5]) The Geology of Part of East Lincolnshire. Mem. Geol. Surv., Sheet 84, 1887, p. 140.

[6]) Monograph Cretaceous Lamellibranchia of England. Pal. Soc., vol. II, pt. 7, 1911, p. 263.

second example is still more doubtful, but the smooth internal cast shows the same irregular outline that does not seem to agree with a normal, helicoid spiral.

Localities:— 306 (1); 308 (1).

Family *PECTINIDAE.*

Genus *ENTOLIUM*, Meek, 1865.

Entolium nummularis (Fischer).

(Plate V, figs. 5—6, 9).

1936. *Entolium nummularis* (Fischer) Spath, *loc cit.* (Medd. om Grønl., vol. 99 No. 3), p. 103, pl. 41, figs. 9, 10; pl. 42, fig. 11.

The examples from the *Hectoroceras* Beds do not seem to differ from those previously described from the Portlandian of Milne Land, or of examples in the matrix of Upper Volgian *Craspedites* from the neighbourhood of Moscow, except perhaps in having the concentric lamellae rather distantly spaced, in some examples even quite near the umbo. As will be seen from the largest example cited in the synonymy (pl 42, fig. 11) the Milne Land form generally has the concentric ridges closer and closer the nearer they are to the umbo, and the figured examples of the present form thus are much more like d'Orbigny's[1]) original drawing. On the other hand, the external cast here figured (fig. 6) shows that the wings had sloping and curved, not perpendicular, sides, so that d'Orbigny's drawing is possibly rather diagrammatic. The test is perfectly circular and very thin, with a smooth inner surface.

Since it has been stated that the Jurassic *E. nummularis* shows great resemblance to the Cretaceous *E. orbicularis* (Sowerby)[2]), which also shows characteristic, concentric ornamentation on one (right) valve, I may add that in at least one Valanginian example of Sowerby's species[3]), the concentric ridges are far more closely spaced than in *E. nummularis.* On the other hand, Woods's[4]) figured examples (e. g. fig. 1) do not seem to differ from the form here discussed, while others (e. g. figs. 6, 9) are much like the larger Milne Land specimen figured in 1936. If I now

[1]) See in Murchison, Verneuil and Keyserling, *op. cit.*, 1845, p. 475, pl. XLI, fig. 2.

[2]) Recorded (doubtfully) from the Infra-Valanginian Spilsby Sandstone by Jukes-Browne (Geology of Part of East Lincolnshire. Mem. Geol. Survey, Sheet 84, 1887, p. 140), and (definitely) by Woods (Monograph Cretaceous Lamellibranchia of England. Pal. Soc., pt. IV, 1902, pp. 45 etc.).

[3]) See in Kitchin: The Invertebrate Fauna and Palaeontological Relations of the Uitenhage Series. Ann. S. Afr. Mus., vol. VII, pt. 2, 1908, p. 65, pl. II, figs. 2—3 (as *Pecten* [*Syncyclonema*]).

[4]) *Loc. cit.* (1902), pl. XXVII, figs. 1—9.

refer the Jameson Land examples to *E. nummularis* rather than to *E. orbicularis* it is done chiefly because Sowerby's[1]) type of the latter species has close concentric lamellae and comes from a much later bed, namely the Upper Albian (Malmstone) of Devizes. The Spilsby Sandstone examples referred to this species by Woods and the present form may perhaps represent passage-forms between the two species, provided they are really distinct, for it has been stated[2]) that the species of *Entolium* throughout the Jurassic and Cretaceous remain extraordinarily constant.

The very flat valve figured in Plate V, fig. 5 may perhaps be only provisionally included in this species, since it seems to have a rather thick lamellar test which shows concentric ribbing only on a part where the outer, smooth layers have been removed by exfoliation. Since in the rather thick-shelled Milne Land forms, previously described, the flat (right) valve is concentrically ribbed, whereas the more convex left valve is smooth, or at least shows only very fine lines of growth, it is probable that the mode of preservation is responsible for the different aspect of this second example. The more convex smooth casts which occur in the *Hectoroceras* beds and suggest the presence of still other species of *Pecten*, may then represent merely casts of left valves of *E. nummularis*, but others belong to the form of *Camptonectes* described below.

Localities:— 306, 308—13 (many specimens).

Genus *CAMPTONECTES*, Meek, 1864.

Camptonectes sp. ind.

(Plate V, fig. 7).

The large anterior auricle and traces of the radial striation of the test make it probable that the cast here figured belonged to a form of *Camptonectes*, not strikingly different from *C. morini* (P. de Loriol), previously[3]) recorded from a presumably lower horizon (Portlandian) of Milne Land. In most of the smaller smooth casts which abound in the *Hectoroceras* beds the preservation of the auricles is such that reference either to the present form or to *Entolium*, described above, is impossible (see Pl. V, fig. 4).

Localities:— 306, 308—09, 312—13 (many specimens).

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[1]) Mineral Conchology, vol. II, 1817, p. 193, pl. CLXXXVI.

[2]) Benecke: Die Versteinerungen der Eisenerzformation von Deutsch-Lothringen und Luxemburg. Abh. Geol. Spez. Karte v. Els.-Lothr., N. F. Heft VI, 1905, p. 97.

[3]) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 105, pl. 41, figs. 5—6.

Family *LIMIDAE.*

Genus *LIMA*, Bruguière, 1792.

Lima (*Limatula* ?, *Pseudolimea* ?) sp. ind.

(Plate II, fig. 6).

Some external casts of a *Lima* have the general aspect of the Volgian *L. consobrina*, d'Orbigny[1]), but they are ornamented with eighteen or twenty instead of sixteen ribs; the squeezes of two of these casts are here figured (Plate II, fig. 6). It also resembles the Portlandian *L.* (*Pseudolimea*) aff. *blakei*, Cox, previously[2]) figured from Milne Land, and *L. coodei*, Morris and Lycett, in Damon[3]), from the Portland Stone, but the state of preservation does not admit of closer comparison. Since the same type of *Lima* passes up into the Cretaceous[4]), it is clearly of little use for exact dating. Moreover, these forms also seem to have a great horizontal range. *L. consobrina*, for example, occurring in the Lower and Upper Volgian and in the uppermost Jurassic *Riasanites* beds[5]), has been recorded not only from the Oxfordian of France, but also from as far afield as the Moghara Range (North Sinai)[6]) and from Juba Land (East Africa)[7]), the latter occurrence being dated as Corallian-Kimmeridgian.

Localities:— 304 (6); 308 (1).

B. Sub-class *Isomyaria.*

a. Order *TAXODONTA.*

Family *ARCIDAE.*

Genus *CUCULLAEA*, Lamarck, 1801.

Sub-genus *DICRANODONTA*, Woods, 1899.

Dicranodonta cf. *groenlandica* (Rosenkrantz MS.) Spath.

(Plate III, figs. 3a-d; Plate IV, fig. 5).

1936. *Dicranodonta groenlandica* (Rosenkrantz MS.) Spath, *loc. cit.*, Medd. om Grønl., vol. 99, no. 3, p. 177, pl. 41, figs. 11a-d.

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1) In Murchison, Verneuil & Keyserling, *op. cit.*, 1845, p. 477, pl. XLII, figs. 5—7.

2) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 107, pl. 45, figs. 7a, b.

3) Geology of Weymouth & c., 1860, p. 172, fig. 36, p. 79. Included by Cox (Fauna of the Basal Shell-Bed of the Portland Stone, Isle of Portland. Proc. Dorset Field Club, vol. XLVI, 1925, p. 139) in *Lima* (*Plagiostoma*) *rustica* (J. de C. Sowerby).

4) Compare *Lima* (*Mantellum*) *parallela*, Sowerby; Woods: Monograph Cretaceous Lamellibranchia of England. Pal. Soc., vol. II, pt. 1., 1904, pp. 28 &c., pls. V, VI.

5) Nikitin: Vestiges de la Période Crétacée dans la Russie centrale. Mém. Com. Géol., vol. V, No. 2, 1888, pp. 87—89.

6) H. Douvillé: Les Terrains Secondaires dans le Massif du Moghara. Mém. Acad. Sci. Paris, vol. LIV, 2nd. ser., 1916, p. 76.

7) Weir: Jurassic Fossils from Jubaland. Monog. Hunter. Mus. Glasgow, vol. III, 1929, p. 28.

A number of examples, unfortunately, are in a scarcely more favourable state of preservation than the Aucella River specimens previously figured, but they do not seem to be distinguishable specifically. What little can be stated to make this species more than a name, may therefore be acceptable, but there is a possibility that the Aucella River examples and those from the *Hectoroceras* beds are of rather different ages. The peculiarities of the ornamentation can be seen in the enlarged fig. 11*d*, given in 1936, which shows the stronger principal ribs (about 30 at the average size) superimposed on a large number of very fine radial lines, both crossed by concentric striae at irregular intervals. The taxodont hinge has already been stated to be of *Cucullaea* pattern, but the new material does not include any examples in which the hinge plate and central and lateral teeth are exposed. The height is 15—20 mm where the length is 20—25 mm and the thickness (of the single valve) is about 6 mm. The general shape is best shown in the example figured in fig. 11*b* (pl. 41). It is rather equilateral, with a prominent umbo which, however, is not so broad as that of the more subquadrate, massive *Cucullaea* (*Dicranodonta*) *donningtonensis*, Keeping[1]). There seems to be considerable variability in outline and inflation in the Greenland as in the English examples.

Less closely comparable is *Pectunculus petschorae*, Keyserling[2]), first described from a single, imperfect individual found in the Drift of Northern Siberia, but later described by Schmidt[3]) on the basis of numerous, well preserved examples. *D.* cf. *pectunculoides* (Trautschold) recorded by Frebold[4]) from Kuhn Island is apparently a much less convex form.

A small sandstone-cast from Loc. 306 is a trifle longer than it is high, almost equilateral, and the very prominent umbo surmounts a large triangular cardinal area, almost as conspicuous as in *Stringocephalus*. The cast, however, is weathered to such an extent that the present shape and smoothness have nothing to do with the original appearance which is believed to have been that of the normal, unweathered examples.

Localities:— 306 (3); 308 (2); 309 (8); 311 (2).

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[1]) See in Woods, *op. cit.* (vol. I, pt. 1, 1899), p. 54, pl. x, figs. 11—14, pl. xi, figs. 1—2.

[2]) Reise in das Petschora Land, 1846, p. 306, pl. xvii, figs. 5—6.

[3]) Wissenschaftliche Resultate Mammuth-Cadaver Expedition, Mém. Acad. Imp. Sci., St. Pétersb., ser. VII, vol. XVIII, No. 1, 1872, p. 151, pl. i, figs. 14a-d, pl. iiia, fig. 17.

[4]) *Loc. cit.* (Medd. om Grønl., vol. 94, No. 1), 1933, p. 31, pl. iii, fig. 26.

b. Order *SCHIZODONTA.*

Family *TRIGONIIDAE.*

Genus *TRIGONIA*, Bruguière, 1789.

Trigonia sp. ind.

Two smooth, internal casts of a *Trigonia* indicate a slightly more elongated form than that previously[1]) figured from the Aucella River, with a more prominent umbo. The length is about 82 mm in one and 67 mm in the other; the height is 60 mm and 45 mm respectively. The thickness of the larger (right) valve is 22 mm (without test); in the smaller left valve it is about 15 mm. The casts are not referable to the Portlandian *T. incurva*, Benett[2]), which has a still more elongated shape and a different anterior edge; but as only a little of the test is preserved (in the form of an impression of a third specimen) comparison is impossible with the numerous species of *Trigonia* recorded for example from the English Portlandian[3]). The few forms found in the Upper Volgian and the Riasan Beds are incompletely known; and among the species from the Spilsby Sandstone[4]), there is none that has a comparable shape.

Localities:— 306 (2); 309 (1).

c. Order *HETERODONTA.*

Family *ASTARTIDAE.*

Genus *ASTARTE*, J. Sowerby, 1816.

Astarte cf. *saemanni*, P. de Loriol.

(Plate IV, figs. 3—4).

1936. *Astarte* aff. *saemanni*, P. de Loriol; Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3,) p. 115 (*partim*).

The form here figured may well be compared to the Portlandian Milne Land and Aucella River specimens previously recorded, but the ribbing is less conspicuous and less regular. In this respect, the Green-

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1) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 113, pl. 41, fig. 7.

2) See J. de C. Sowerby in Fitton, *loc. cit.* (Trans. Geol. Soc., 2nd. ser., vol. IV), 1836, p. 347, pl. XXII, fig. 14.

3) Cox: Synopsis of the Lamellibranchia and Gastropoda of the Portland Beds of England. I. Lamellibranchia. Proc. Dorset Field Club, vol. 50, 1929, pp. 151—161.

4) See Woods: Monograph Cretaceous Lamellibranchia of England, vol. I, pt. 2, 1900, pp. 75—79 (*Trigonia ingens*, Lycett, *T. keepingi*, Lycett, *T. tealbyensis*, Lycett).

land form under discussion perhaps resembles the Cretaceous *A.* (*Eriphyla*) *laevis* (Phillips)[1]), especially a Claxby Ironstone (Valanginian) example figured by Woods[2]), but the convexity of the valves in that species is greater. Woods already pointed out that *A. saemanni* and *A. leavis* were allied and that in some cases the resemblance was very close; transitional forms between the two species at intermediate horizons may thus, perhaps, be expected to occur.

While *A. panderi*, Rouillier, or at least the smooth form I figured in 1936[3]) is more oblique, *A. duboisiana*, d'Orbigny[4]) is not only more strongly costate, but has a less circular shape. In the internal cast figured by d'Orbigny in fig. 16, the height is less than four-fifths of the length; the internal cast of the right valve figured in Plate IV, fig. 4 on the other hand, has the umbonal portion even more elongated and pointed than the corresponding cast figured in 1936 (pl. 47, fig. 4). Since this difference, however, is due largely to the indifferent photograph and does not appear to exist on comparison of actual specimens, I am provisionally leaving the present form in *A. saemanni.*

Localities:— 306, 308—09, 311, 313 (many specimens).

Astarte cf. *polymorpha* (Contejean).

(Plate IV, fig. 7; Plate V, figs. 8—9).

This small form shows four conspicuous steps caused by temporary arrest of growth, and the test thus appears to consist of five different shells, overlapping one another. It is smooth at the umbo, but most of the rest of the shell has very fine concentric lines of growth. The hinge is not exposed, but the general shape is that of *A.* cf. *saemanni*, P. de Loriol, above described. *A. curvirostris*, Roemer[5]), or at least the English Corallian examples figured by Arkell[6]) and doubtfully attached to Roemer's species, show similar growth-halts, but only three not four, and the shape is much more oblique. The Kimmeridgian *A. polymorpha*, Contejean[7]) is decidedly closer to the present species, but not the

[1]) Geology of Yorkshire, 1829, p. 122, pl. II, fig. 19 (? fig. 18) as *Cassina laevis.*

[2]) *Loc. cit.* (Pal. Soc. Monogr., vol. II, pt. 3), 1906, p. 115, pl. XVI, figs. 5a, b.

[3]) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 116, pl. 47, fig. 7.

[4]) In Murchison, Verneuil & Keyserling, *op. cit.*, 1845, p. 455, pl. XXXVIII, figs. 14—17.

[5]) Versteinerungen des norddeutschen Oolithengebirges. 1836, p. 114, pl. VI, fig. 30.

[6]) Monograph of British Corallian Lamellibranchia. Pal. Soc., pt. 6, 1932, p. 244, pl. XXXI, fig. 2, pl. XXXIV, figs. 15—20.

[7]) Etude de l'étage Kimmeridgien dans les environs de Montbéliard. 1860, p. 266, pl. XI, figs. 13—15.

Danish Drift specimens referred to the French form by Skeat and Madsen[1]).

Locality:— 313 (3).

Astarte sp. ind.

There is apparently a third form of *Astarte* in the *Hectoroceras* Beds, in shape like *A. saemanni*, but smooth, except for the lines of growth. It is, however, represented by only two small examples; they cannot be the young of *A. saemanni* because they are devoid of the conspicuous corrugations. What larger specimens there may be are too badly preserved to be definitely identified, or else are internal casts. There are no growth-halts, as in *A.* cf. *polymorpha*, but separation from the young of the form of *Lucina*, described below, may be more difficult. Among the Milne Land forms previously described[2]), *A.* sp. cf. *panderi*, Rouillier, is perhaps the most closely comparable, but the shape is rather more oblique and more triangular.

Locality:— 306 (2).

Family LUCINIDAE.

Genus *LUCINA*, Bruguière, 1797.

Lucina aff. *fischeriana*, d'Orbigny.

(Plate III, fig. 7; Plate V, fig. 12).

1845. *Lucina fischeriana*, d'Orbigny; in Murchison, Verneuil & Keyserling, *op. cit.*, p. 458, pl. xxxviii, figs. 31—32.

1897. *Lucina fischeri*, d'Orbigny; Bogoslowsky, *loc. cit.* (Mat. Geol. Russl., vol. xviii), p. 109.

The small double-valved specimen here figured (Plate V, fig. 12) is indistinguishable from d'Orbigny's equal-sized holotype, except in being more inflated, the thickness of both valves being 14.5 mm at a length of 34 mm, i. e. 43 $^0/_0$ instead of 34 $^0/_0$. The larger figure (Plate III, fig. 7) is of a plaster cast of an impression in the rock which only indicates the general shape and the fine irregular lines of growth. These are in agreement with the corresponding features in the smaller example, but in the absence of any other character, identification cannot be more than tentative. *L. crassa*, J. de C. Sowerby[3]), from the Spilsby Sandstone has a circular outline, but inflation and thick test seem to be similar to those of the Greenland form. *L. lirata*, (Phillips) was quoted by

[1]) On Jurassic, Neocomian and Gault Boulders found in Denmark. Danm. geol. Undersg., vol. II, No. 8, 1898, p. 127, pl. iv, figs. 14—15.

[2]) *Loc. cit.*, (Medd. om Grønl., vol. 99, No. 3), 1936, p. 116, pl. 47, fig. 7.

[3]) Mineral Conchology, vol. VI, 1827, p. 108, pl. 557, fig. 3.

Jukes-Browne[1]) from the same deposit and was said to be indistinguishable from the Oxfordian original; presumably that name was applied to a more rugose form than the present, with raised, concentric lamellae in addition to the growth-lines[2]).

Examples from West and East Spitsbergen, referred by Sokolov and Bodylevsky[3]) and by Weir[4]) to the present species are from doubtful deposits, the age of which will be discussed when the *Hectoroceras* fauna is compared with the assemblages known from Spitsbergen.

Localities:— 306 (5); 308 (1); 309 (1); 311 (1); 313 (1).

Family *ARCTICIDAE*.

Genus *ARCTICA*, Schumacher, 1817.

Arctica ("*Cyprina*") sp. nov.?

The internal cast of a left valve, 67 mm long and 45 mm high, probably belonged to the same elongate, triangular form as a fragmentary external cast, which shows that the shell was smooth. The shape seems to be roughly similar to that of an internal cast of *Cyprina cancriniana* figured by Rouillier[5]); but it is more elongate and more triangular. If d'Orbigny [6]), however, has correctly interpreted Rouillier's species, then the Greenland form is rather different, as the dimensions alone indicate.

Localities:— 311 (1); 312 (1).

Arctica ? ("*Cyprina*") sp. ind.

A fragmentary example of a right valve of apparently a more rounded form of "*Cyprina*" shows a height of just under 70 mm. In the absence of the hinge or other diagnostic feature, however, even the generic identification is doubtful; and a smooth *Eocallista*, for example, might show a similar rounded outline.

Locality:— 308 (1).

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[1]) *Loc. cit.* (Mem. Geol. Survey, Sheet 84), 1887, p. 140.

[2]) See Arkell, *op. cit.* (Monogr. Pal. Soc., pt. VII, 1934), p. 278, pl. xli, figs. 1—3, 7.

[3]) *Loc. cit.* (Skrifter om Svalbard, No. 35), 1931, p. 74.

[4]) In Tyrrell, Stratigraphical Observations in the Stor Fjord Region of Spitsbergen. Appendix. Trans. Roy. Soc. Edinb., vol. LVII, pt. 3, 1933, p. 694, pl. i, fig. 19.

[5]) Explication de la coupe géologique des environs de Moscou. Bull. Soc. Imp. Nat., Moscou, vol. XIX, 1846, pl. E, fig. 8d (*Lucina*).

[6]) In Murchison, Verneuil & Keyserling, *op. cit.*, 1845, p. 457, pl. xxxviii, figs. 26—27.

Family *TANCREDIDAE.*

Genus *CORBICELLA*, Morris & Lycett, 1854.

Corbicella (?) sp. ind.

A doubtful example of some elongated, triangular shell, with a length of 46 mm and a height of 31 mm, has approximately the dimensions of the doubtful *Corbicella* recorded in 1936[1]). There is a suggestion of a posterior ridge and though the hinge is not preserved, its apparent arrangement was such that it excludes comparison with *Pleuromya* which the faint concentric ribbing might suggest. A rough sandstone cast of a second example agrees with the first in shape, but, of course, is quite indeterminable.

Localities:— 309 (1); 312 (1).

Phylum *BRACHIOPODA.*

Order *NEOTREMATA.*

Family *DISCINIDAE.*

Genus *ORBICULOIDEA*, d'Orbigny, 1847.

Orbiculoidea sp. ind.

(Plate V, fig. 15).

There is only a single, defective sandstone cast, but the comparatively high conical shape suggests that the form may have been the same as *O.* aff. *latissima* (J. Sowerby) previously[2]) figured and described from Milne Land and from the Aucella River in Jameson Land, the latter possibly of post-Portlandian date. Since the rock is a similar micaceous sandstone and the facies identical with that of the uppermost Jurassic deposits of East Greenland, the form just mentioned may be presumed to have had a long range and to have persisted into the Cretaceous. On the other hand, the example here discussed seems to have a very symmetrical shape, with the pointed umbo exactly central, and since there is no trace of the test, it is even possible that it may have belonged to a radially striate from like *O. maeotis* (Eichwald)[3]). The latter species, recorded by Rosanow[4]) from beds with *Zaraiskites* (Lower Volgian)

[1]) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 121.

[2]) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 137, pl. 44, fig. 3.

[3]) Urwelt Russlands, I, 1840, p. 98, pl. IV, figs. 5—6 (as *Orbicula*). *Op. cit.* (Lethaea rossica, II), 1868, p. 350, pl. XVIII, fig. 31 (as *Discina*).

[4]) Sur la division zonale du Volgien inférieur du gouv. de Simbirsk. Bull. Com. géol., Moscou, I (1919) 1923, p. 194.

also seems to have a long range. *O. laevigata* (Deshayes)[1]), from the Middle Neocomian of the Aube (France) has a very excentric apex and is more depressed.

It is clearly useless to look for comparable species in Lower Cretaceous deposits of a differing facies, such as the limestones of the *boissieri* zone of south-eastern France; and I do not know of species of *Orbiculoidea* recorded from the Spilsby Sandstone or the Upper Volgian and Lower Neocomian deposits of Russia.

Locality:— 309 (1).

Phylum *ECHINODERMATA*

Sub-phylum *Asterozoa.*

Class *ASTEROIDEA.*

Genus *ASTROPECTEN*, Blainville, 1830.

Astropecten (?) sp. ind.

The very fragmentary remains of a typical five-armed starfish are yet sufficiently distinct to show that the arms were about 60 mm long and 20 mm broad near the central disc. Only portions of two of the arms remain, with the marginalia reduced to amorphous plates of calcite (by solution) but the total diameter was apparently about 140 mm. Since even the Asteroids from the English Chalk have a Mesozoic aspect, and are, on the whole, quite distinct from the Tertiary and especially Recent forms, it is clear that the assignment of the Greenland example to the living genus *Astropecten* is provisional. There is resemblance to an example of *Astropecten rectus*, McCoy, from the Corallian of Yorkshire in the British Museum, but the comparatively large marginals which are so conspicuous in that form are scarcely comparable with the weathered remains of these plates in the Greenland specimen under discussion. A second example consisting of scattered small plates is still more weathered and it is perhaps not even certain that it belonged to an Asteroid rather than an Ophiuroid.

Localities:— 312 (1); 314 (1).

[1]) Leymerie: Memoire sur le terrain Crétacé du Departement de l'Aube. II. Mém. Soc. géol. France, vol. V, 1842, p. 11, pl. xv, figs. 1a, b.

Sub-phylum *Pelmatozoa.*

Class *CRINOIDEA.*

Family *PENTACRINIDAE.*

Genus *Pentacrinus*, Miller, 1821.

Pentacrinus cf. *tenellus*, Eichwald.

(Plate V, fig. 10, 11).

(?) 1868. *Pentacrinus tenellus*, Eichwald, *op. cit.* (Lethaea rossica, vol. II) p. 225, pl. XVI, fig. 1.

1935. Crinoidenstielglieder. Aldinger, *loc. cit.* (Medd. om Grønl., vol. 99, No. 1), p. 41, text-fig. 10.

Most of the slabs, like that figured by Dr. Aldinger and the smaller piece represented in Plate V, fig. 10, have been affected by weathering, and in consequence the ossicles are almost regular pentagons in some stem-fragments, whilst others show a more sharply defined, more star-shaped cross-section. The petals of the articulating surfaces have not been preserved, so far as can be seen. At 2 mm diameter, the thickness of the ossicles is just under $^3/_4$ mm, so that a fragment 12 mm in length has about 17 ossicles. The exterior seems to be quite plain.

The reference to Eichwald's species from the Volgian is, of course, tentative; and it is, perhaps, open to criticism if a fragment figured by Rouillier[1]) is correctly identified with *P. tenellus.* Since the cross-section of the latter species is pentagonal, with almost convex sides, the present form is probably closer to Rouillier's *P. basaltiformis* (*pars*, *non* Miller)[2]) or to *P. scalaris* (Goldfuss)[3]), both Liassic species, but quoted from the Russian Oxfordian. *P. annulatus*, Roemer, which occurs in the Speeton Clay[4]), has a less angular cross-section, with curved, not straight, sides to the five edges, but *P. sigmaringensis*, Quenstedt[5]), to which a presumably Volgian form from Spitsbergen has been compared[6]), again seems closer to *P. tenellus* and to the Greenland species here described.

In addition to the slabs with remains of the stems, there are several heads of which one is represented in Plate V, fig. 11, together with a piece of fossil wood (partly carbonised). It is possible that still other crinoids are present among these, but the weathering has altered the appearance of the plates so much that identification is probably impossible.

Localities:— 312 (many); 314 (1).

[1]) *Loc. cit.* (Bull. Soc. Imp. Nat., Moscou, 1864), pl. c, fig. 9.

[2]) *Ibid.*, figs. 10—11.

[3]) See in Quenstedt; Der Jura, 1858, p. 111, pl. XIII, figs. 49—57.

[4]) See Lamplugh: On the Subdivisions of the Speeton Clay. Quart. Journ. Geol. Soc., vol. XLV, 1889, p. 616.

[5]) Der Jura, 1858, p. 721, pl. 88, fig. 1.

[6]) See Sokolov and Bodylevsky, *loc. cit.* (Skrifter om Svalbard, No. 35), p. 28.

C. THE LOCALITIES AND THEIR FAUNAS

The material described in the foregoing pages, as already mentioned, comes from a number of localities in the neighbourhood of the Horse-, Mussel-, and Rauk Rivers, as indicated on Dr. Aldinger's map[1]). Without repeating his stratigraphical details I may mention that he recognised an upper cross-bedded 'Sandstone Series' (over 100 m or 333 feet thick), becoming coarse in the lowest part and having a 'Shell-Bed' at the base. The great majority of the fossils and especially those in the most favourable state of preservation come from this Shell-Bed. It is underlain by a 'Marl and Shale Series' (about 150 m or 500 feet thick) which, at the top, has very large concretions containing Crinoids, Asteroids, ammonites and fossil wood. The sandy shales, however, also yielded ammonites, partly in concretions, but mostly in thin sandstone slabs at a lower level, i. e. below the top; but the pyritic concretions in the basal beds, mentioned by Dr. Aldinger, are without fossils. The sequence is summarised in the following diagram (Text-fig. 8), which is intended merely to show the relative position of the *Hectoroceras* Beds.

The localities have been referred to by numbers, in order to avoid repetition; but they are here listed, together with observations on the nature of the matrix or the state of preservation.

303. Hill 66, on Horse River, near confluence with Straight River and Rauk River (Lower Marl and Shale Series, level unspecified). The ammonite impressions, presumably of *Subcraspedites*, are very poorly preserved and associated on the thin sandstone-slabs with unrecognisable pelecypods (including probably *Buchia volgensis*) and carbonised plant remains.

304. Mussel River, south-south-west of P. 155 and north of P. 101 (Lower Marl and Shale Series, level unspecified). The examples of *Hectoroceras* are compressed in a soft, micaceous sandy shale and they are accompanied by impressions of a *Lima*, but no other fossils.

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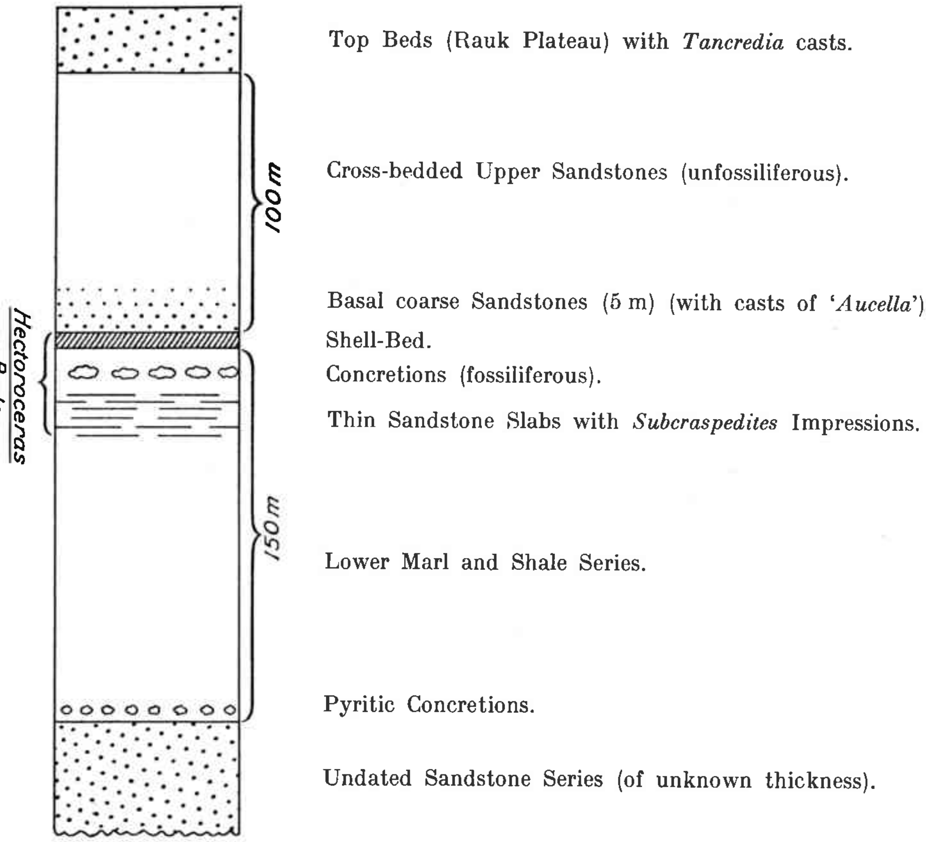
[1]) The north-south direction, not marked on that map, is roughly parallel to the line of Neill's Cliff.



Text-fig. 8.

305. Same as last, but without *Lima* and, instead, unrecognisable crushed pelecypods and a *Subcraspedites* (?).

306. Same as 304 and 305, but, judging by the abundance of fossils, from the concretions near the top of the Lower Marl and Shale Series. Very micaceous sandy shale matrix.

307. Mussel River, south-west of P. 101. Same dark micaceous shale as 304—06, with crushed *Hectoroceras*, but otherwise apparently barren.

308. Slopes of the Mussel River, south of Crinoid Mtn. From the Shell-Bed, indicated on Dr. Aldinger's map by a dark green line, west of P. 101. Numerous fossils, but not all in the characteristic light yellowish-grey, sandy micaceous matrix of the Shell-Bed.

309. Same as last, probably also from the Shell-Bed. Many of the shells have a rough, white, coating due to weathering of the test.

311. Horse River, east of P. 66. Many fossils. Dark micaceous matrix;

probably from concretions near the top of the Lower Marl and Shale Series.

312. Summit of Crinoid Mtn. (P. 245). From the Shell-Bed. (See Aldinger, 1935, p. 42).

313. Same as 308. The fossils are from the Shell-Bed, but some pyritic concretions (without fossils and also numbered 313) are apparently from the base of the Lower Marl and Shale Series.

314. West slope of Basalt Mtn. (P. 210), between Horse River and Mussel River. Judging by the presence of Crinoid and Asteroid fragments, from the concretions below the Shell-Bed.

315. Same as 314. Shell-Bed, but represented only by two specimens.

316. Depression (P. 121) about 2 km. south-west of last locality. Only *Hectoroceras* and small belemnite fragments were collected.

318. South-west of Mosquito Ridge, apparently from the Lower Marl and Shale Series. Thin sandstone slabs, with impressions of *Subcraspedites*, but also typical *Hectoroceras*.

The distibution of the fossils collected at each of these localities is indicated in Table 1 and it will be seen that at thirteen out of the fourteen localities typical examples of *Hectoroceras* have been found. The one exception (Loc. 303), however, has yielded impressions of *Subcraspedites* ?, so similar to those collected at Loc. 318 that the beds are not likely to be of greatly different age from those at the other localities. Dr. Aldinger thought it probable that this was the lowest level yielding ammonites in the Marl and Shale Series. In the discussion of the presumable date of the *Hectoroceras*-fauna it will thus be assumed that there is no essential difference between the assemblages from the Shell-Bed and those from the upper part of the Marl and Shale Series, just below, or from the concretions.

The Upper Sandstone Series, according to Dr. Aldinger, includes casts of "*Aucella*" in the coarse lower part, above the Shell-Bed, but I have not seen these. The series, higher up, soon becomes unfossiliferous; and it terminates above with sandstone beds, exposed at the top of Rauk Plateau. These sandstones have yielded only two small casts of a *Tancredia* (one of them figured in Plate IV, fig. 10) and crinoid stems (not forwarded to me). It is perhaps impossible to express an opinion on the age of these, and, pending the discovery of more material and the exploration of the areas farther west, I am not in a position to question Dr. Aldinger's contention that these top beds belong to the same stage as the Shell-Bed and the beds above and below the latter. I have before me, however, from the same part of south-west Jameson

Table 1. The Distribution of Species at Localities in S. W. Jameson Land.

		303	304	305	306	307	308	309	311	312	313	314	315	316	318
1.	*Hectoroceras kochi*, sp. nov.		×	×	×	×	×	×	×	×	×	×	×	×	×
2.	*Subcraspedites* (?) sp. nov.?	..	..	×	..	..	..	..	..	..	..	×	..	..	×
3.	— (? *Paracraspedites*) sp. ind.	×	..	..	..	..	×	..	..	..	..	..	..	..	×
4.	*Acroteuthis* sp. ind.	..	..	..	×	..	×	..	×	×	×	..	..	×	..
5.	*Vanikoro* sp. nov.?	..	..	..	..	..	×	..	..	..	..	..	..	..	..
6.	*Natica* (?) sp. ind.	..	..	..	×	..	×	..	..	..	×	..	..	..	..
7.	*Actaeonina* (*Ovactaeonina*) sp. ind.	..	..	..	..	..	..	..	..	..	×	..	..	..	..
8.	*Dentalium* sp. cf. *moreanum*, d'Orbigny	..	..	..	..	..	..	..	×	..	×	..	..	..	..
9.	*Oxytoma* sp. ind. cf. *semiradiata* (Fischer)	..	..	..	..	..	..	×	×	..	..	..	..	..	..
10.	*Buchia volgensis* (Lahusen)	?×	..	..	×	..	×	×	×	×	×	..	×	..	×
11.	— cf. *terebratuloides* (Lahusen)	..	..	..	×	..	..	..	×	..	×	..	..	..	..
12.	*Inoceramus* sp. ind.	..	..	..	..	..	..	..	..	×	..	..	..	..	..
13.	*Exogyra* cf. *contorta*, Eichwald	..	..	..	×	..	×	..	..	..	..	..	..	..	..
14.	*Entolium nummularis* (Fischer)	..	..	..	×	..	×	×	×	×	×	..	..	..	..
15.	*Camptonectes* sp. ind.	..	..	..	×	..	×	×	..	×	×	..	..	..	×
16.	*Lima* (*Limatula*?, *Pseudolimea*?) sp. ind.	..	×	..	..	..	×	..	..	..	..	..	..	..	..
17.	*Dicranodonta* cf. *groenlandica* (Rosenkrantz MS.) Spath	..	..	..	×	..	×	×	×	..	..	..	..	..	..
18.	*Trigonia* sp. ind.	..	..	..	×	..	..	×	..	..	..	..	..	..	..
19.	*Astarte* cf. *saemanni*, P. de Loriol	..	..	..	×	..	×	×	×	..	×	..	..	..	..
20.	— cf. *polymorpha* (Contejean)	..	..	..	..	..	..	..	..	..	×	..	..	..	..
21.	— sp.	..	..	..	×	..	..	..	..	..	..	..	..	..	..
22.	*Lucina* aff. *fischeriana*, d'Orbigny	..	..	..	×	..	×	×	×	..	×	..	..	..	..
23.	*Arctica* ("*Cyprina*") sp. nov.?	..	..	..	..	..	..	..	×	×	..	..	..	..	..
24.	— — sp. ind.	..	..	..	..	..	×	..	..	..	..	..	..	..	..
25.	*Corbicella* (?) sp. ind.	..	..	..	..	..	..	×	..	×	..	..	..	..	..
26.	*Orbiculoidea* sp. ind.	..	..	..	..	..	..	×	..	..	..	..	..	..	..
27.	*Astropecten* (?) sp. ind.	..	..	..	..	..	..	..	..	×	..	×	..	..	..
28.	*Pentacrinus* cf. *tenellus*, Eichwald	..	..	..	..	..	..	..	..	×	..	×	..	..	..

Land (Signal Post 2 of Säve-Söderbergh = Pt. 182 on Rauk Plateau) some blocks of a light grey, very coarse sandstone which includes a large number of identical yellow casts of *Tancredia*[1]), associated with a few other fossils, namely two more individuals of pelecypods (unrecognisable), two gastropod casts, and the periphery of an ammonite. The last is, of course, the most important; and therefore deserves closer investigation.

The fragment is only about 40 mm long and 30 mm wide and represents the periphery of a broadly-arched Desmoceratid of perhaps about 80 or 90 mm diameter. There is no trace of a suture-line or the

[1]) The *Tancredia* casts (see Plate IV, fig. 10) may be described as miniature reproductions of the large *T. jarneri* figured by Ravn (Medd. om Grønl., vol. XLV, No. 10, 1912, pl. xxxv, fig. 3) but identity is not suggested.

test, but the ornamentation seems characteristic. It consists of fine and coarse ribs, passing over the wide and rounded periphery with a strong forward projection. It is possible that the ribs are slightly attenuated in the median (siphonal) line and there are three intermediate finer ribs between a pair of the blunt, principal ribs. Since only one half of one side is preserved and since the cast is in a rather coarse grit, little can be added about the lateral aspect, but it appears that while the fine intermediate ribs combine to form a blunt lateral rib, the coarse peripheral ribs become obsolescent on the side. This type of ornament was not produced, so far as I know, in the Infra-Valanginian or the Valanginian, but occurred in various Desmoceratids and their offshoots, e. g. Pachydiscids, in the higher beds of the Lower and in the Upper Cretaceous.

The resemblance is probably general rather than specific, for I cannot think of a single form of Desmoceratidae[1]) that could be cited as showing an identical periphery. There also is no resemblance between the fragment under discussion and any of the Cretaceous ammonites so far collected in East Greenland; and though the *Tancredia* Sandstone probably represents a later Cretaceous deposit than the underlying Infra-Valanginian series, it cannot at present be dated.

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[1]) Except, possibly, some of the Aptian forms recently described by Anderson (Lower Cretaceous Deposits in California and Oregon. Geol. Soc. Amer., Spec. Pap. No. 16, 1938), e. g. the less inflated *Beudanticeras breweri*, Gabb sp. (p. 189, pl. 44, fig. 2).

D. STRATIGRAPHICAL AND PALAEONTOLOGICAL CONCLUSIONS

a) The Age of the *Hectoroceras* Fauna.

The *Hectoroceras* Fauna, as here understood, includes the fossils from the Shell-Bed as well as those from the upper part of the underlying Lower Marl and Shale Series; for, as has already been mentioned, at at least one locality (318) *Hectoroceras* (characteristic of the Shell-Bed) and numerous *Subcraspedites* (occurring in the lowest fossiliferous beds) have been found together. The fauna may thus well be treated as a homogeneous assemblage; and in attempting to determine its exact date of existence, the ammonites will naturally receive attention before the other fossils.

The tentative dating of the fauna in question as ? Infra-Valanginian was largely based on a presumed resemblance between the bad impressions of *Subcraspedites* (? *Paracraspedites*) from Greenland on the one hand and the Perisphinctoids of the Riasan Beds of Russia and the forms of *Subcraspedites* from the Spilsby Sandstone on the other. For, *Hectoroceras* being entirely new, and impossible to place at first sight, it was useless, stratigraphically, in spite of the fact that there were over sixty examples, some rather well preserved and several showing the suture-line. Now this is a point of considerable general interest to stratigraphers as well as to palaeontologists. It has to be admitted that a new ammonite is no better as a time-index than a fossil *Trigonia* or other highly ornamented, and therefore, presumably, short-lived, invertebrate whose range is unknown; and any attempt to deduce its exact age from the character of its suture-line or other evolutionary feature or developmental facies is doomed to fail. There are various other examples to illustrate this difficulty of dating a new ammonite. I have before me some Callovian Oppelids from Madagascar, oxycones with a reduced suture-line, which, if found without other ammonites, would have been taken to be examples of the Lower Bathonian genus *Clydoniceras*, Blake. An entirely new ammonite fauna from Asia Minor, also awaiting description, consists of elements which, though in their assemblage pointing to a Tithonian age, could not have been dated individually. Again, the Hoplitid ammonites from the Abur Group of Rajputana, discussed in 1933[1]) and stated to be almost identical with certain Canadian forms, have now been discovered in Madagascar, associated with Lower Albian ammonites, so that their dating as Aptian, on the strength of a general resemblance to the Barremian-Aptian genus *Pseudohaploceras*, was erroneous.

It is thus impossible to date a new stock like *Hectoroceras* from a study of its morphological characters; but even its assumed resemblance to the only known ammonite of somewhat similar aspect proves to be of little assistance in our present enquiry because opinions differ not only as to its exact age, but as to whether it is Jurassic or Cretaceous. This ammonite (*Garniericeras toliense*, Nikitin sp., discussed on p. 21) was apparently associated with *Craspedites okensis* (d'Orbigny) of the lowest (*fulgens*) zone of the Upper Volgian, and has therefore always been taken to be of that age. Yet Bodylevsky[2]) now "conjectures that the sandstones with *G. toliense* are to be attributed to the very lowest Neocomian". To appreciate the difference involved in this change of opinion, we may first list the zones which in the North European and Boreal Province characterise the uppermost Jurassic and lowest Cretaceous:—

	Stages	Ages	Zones
Cretaceous	Valanginian (*pars*)	Platylenticeratan	. . . .
		Subcraspeditan	*stenomphalus*
			spasskensis
	Infra-Valanginian		
		. . . .	. . . .
Jurassic	Tithonian	Berriasellidan	*riasanensis*
			. . . .
	Upper Volgian	Craspeditan	*nodiger*
			subditus
			fulgens

The dotted lines indicate what I take to be gaps in the succession (or in our knowledge), but even if the zones were consecutive, the *fulgens* zone would not be at the top of the Jurassic, but well down. I have already expressed the opinion[3]) that the Lower Volgian is of post-

[1]) Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch). Mem. Geol. Survey India, Pal. Indica, New Series, vol. IX, Mem. 2, pt. VI, 1933, p. 801.

[2]) Concerning Traces of the Upper Volgian Stage in the West Siberian Lowlands. C. R. (Doklady) Acad. Sci. U.S.S.R., 1936, vol. I (X), No. 1 (78), p. 32.

[3]) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, pp. 168, 172.

Portlandian date, but unfortunately there is no sequence known (except possibly that of Hartz Mtn. on Milne Land) where corresponding strata could actually be seen in their relative positions.

Whether Bodylevsky was right in considering *G. toliense* to be of lowest Cretaceous age, or whether it belongs to the *fulgens* zone, as assumed by Nikitin, does not really affect the question of the age of *Hectoroceras*, since the two ammonites are considered to be generically different. The association of *Hectoroceras* with the presumed *Subcraspedites* (?), thus, is of particular interest, though here again we are confronted with great difficulties, chiefly because the comparable forms found in the condensed Riasan Beds include both Jurassic and Cretaceous elements. To the former probably belongs the Berriasellid genus *Riasanites* which was at one time believed to have been rediscovered in the Upper Tithonian (Lower Berriasian) of the South of France, although Kilian[1]) later expressed doubts about the identification. It is possible that as Bogoslowsky[2]) held, *Hoplites mendozanus*, Behrendsen[3]), is closer to *Riasanites* than is the Mediterranean group of *Berriasella privasensis* (Pictet) which Kilian had in mind; and I have previously listed *Berriasella mendozana* as a zonal (or sub-zonal) index of the Tithonian, but not the highest beds[4]). Burckhardt[5]) also figured a Riasan ammonite which is very close to, if not identical with, his Argentine *Hoplites peregrinus*, from the border-beds between the Jurassic and Cretaceous. The *Blanfordiceras* faunas of the Salt Range and Madagascar are probably equivalents though they include nothing like the true *Riasanites*.

The forms that characterise the uppermost part of the Riasan Beds, according to Bogoslowsky, are species like '*Olcostephanus*' *tzikwinianus*, '*O.*' *clementianus*, '*O.*' *subtzikwinianus* and '*O.*' *pressulus*, Bogoslowsky. The last is a *Subcraspedites*; the first two seem to belong to *Paracraspedites*, and they are comparable to forms known from the base of the Spilsby Sandstone of Lincolnshire. I am in agreement with Bogoslowsky in putting this fauna above the line, rather than below, but it is possible that the Perisphinctid ancestors of these *Subcraspedites* and *Paracraspedites* in the uppermost Jurassic were essentially similar in all characters. Apart from the form here described as resembling *Olcostephanus mutabilis*, Stanton, the poor impressions of *Subcraspedites* (or

[1]) In Lethaea geognostica. II. Mesozoicum. 3. Kreide, fasc. 1, 1907, p. 24. (footnote 2).

[2]) Materialien zur Kenntniss der untercretacischen Ammoniten-Fauna von Central- und Nord-Russland. Mém. Com. Geol. N. S. 2, 1902, p. 155.

[3]) Zur Geologie des Ostabhanges der argentinischen Cordillere. Zeit. Deutsch. Geol. Ges., vol. XLIII (1891), p. 399, pl. xxv, figs. 2a-c.

[4]) *Loc. cit.* (Pal. Indica, N. S., vol. IX, No. 2, pt. 6), 1933, p. 865 (Table I).

[5]) *Loc. cit.* (Palaeontogr., vol. 50), 1903, p. 63, pl. xi, figs. 5—8.

Paracraspedites) are thus insufficient to give a decisive verdict on the exact age; and if I prefer to date them as (?) Infra-Valanginian and not as Jurassic, it is largely a matter of personal opinion. It is based on my experience with Upper Jurassic Perisphinctids from other deposits; for while I can see no resemblance between the Riasan and Greenland forms on the one hand and those of the Upper Tithonian of the *Blanfordiceras* Beds on the other, and only a distant similarity to *Epivirgatites* (*nikitini* group) of the Lower Volgian, there is far greater agreement with members of the Craspeditidae and especially their Cretaceous derivatives, the Polyptychitidae, at least in the low branching of the ribbing.

The other mollusca here recorded from the *Hectoroceras* Beds are still less helpful for fixing the date of the deposit. The impressions and casts of "*Aucella*" in the gritty basal beds of the Upper Sandstone Series, just above the Shell-Bed, do not seem to have been brought back by Dr. Aldinger, or at least they are not in the material before me. The remains of *Buchia* from the lowest slabs (with *Subcraspedites* ?) are unrecognisable, so that only the forms from the Shell-Bed can be considered in this connexion. Unfortunately, the range of *B. volgensis* (Lahusen), with the associated *B. terebratuloides* (Lahusen), is not limited to one zone or even one ammonite age or a single stage; and it is only the fact that *B. volgensis* has its maximum development in the Infra-Valanginian (zone of '*Craspedites*' *spasskensis*, in Sokolow and Bodylevsky) that supports the conclusions already arrived at from a review of the ammonites.

As regards the remaining fossils, the belemnites are even less important than the forms of *Buchia*, not only because they are so scant and badly preserved, but because, as mentioned in the specific descriptions, the Jurassic *Pachyteuthis* and the Cretaceous *Acroteuthis* are not essentially distinct. It is generally possible to distinguish the Upper Oxfordian and Kimmeridgian forms from those of the Polyptychitan age of the Valanginian, but it seems to me very doubtful whether the many species of the *Craspedites* Beds and the Infra-Valanginian can be separated generically with equal confidence, even when their horizons are known. In any case, the single defective guard in the present collection to which a specific name could possibly be attached, is here considered to fit in well with the evidence of the ammonites and the forms of *Buchia*.

Of the other mollusca, one or two gastropods and a few pelecypods have been compared or identified with species previously described by the writer from Milne Land; but as the higher beds of the Hartzfjæld Sandstone are as yet insufficiently known, it can only be stated that the *Hectoroceras* Beds are devoid of elements that could be called typically Portlandian. The position in the stratigraphical scale of the new

Craspedites, described from the Hartzfjæld Sandstone, is as yet unknown; and *Subcraspedites groenlandicus*, referred to as "Cretaceous" (but possibly a *Tollia* of a higher horizon than the *Hectoroceras* fauna), may be much later than the fossils from apparently contiguous beds within the Hartzfjæld Sandstone.

There still remains over half of the fauna and most of these represent isolated examples of long-ranged pelecypods, often almost unrecognisable sandstone casts that cannot affect the question of age of the Shell-Bed. Specific names have been attached to some of the species, chiefly names of Russian forms, described by Fischer, d'Orbigny and Eichwald, but that is probably because the prolific and beautifully preserved fauna of the Upper Volgian deposits has long been figured and described. Again, whilst the invertebrates of the Tithonian and Infra-Valanginian deposits of the Mediterranean Province mainly belong to different types, corresponding faunas of Boreal regions are almost unknown, except some pelecypods from the Spilsby Sandstone.

The date of the fauna, first announced with some hesitation, as being probably Infra-Valanginian has, then, on the whole been confirmed by the present, more detailed, investigation. Although there is still a possibility that future discoveries may cause us to put the fauna below the Jurasso-Cretaceous border-line rather than above, the single Wollaston Foreland ammonite figured in Plate III, fig. 2 and doubtfully attached to *Hectoroceras*, suggests that an Infra-Valanginian age is more probable for the fauna here described.

b. Comparison with Other Faunas.

1. East Greenland.

After what has already been said in connection with the identification of the poorly preserved or long-ranged elements in the present fauna it will be clear that the accidental majority, in numbers, of pre-Cretaceous and especially Volgian species in the *Hectoroceras* fauna does not necessarily indicate that the fossils have more affinity with those from the Upper Jurassic of Russia than with the faunas of supposed similar or later date from other areas. This apparent resemblance is largely due to the fact that few late Jurassic faunas of non-Mediterranean facies have been described or figured from outside Russia, while early Eo-Cretaceous deposits from anywhere else in the Boreal Province have been almost unknown until the last few years. When I described the fauna of the Hartzfjæld Sandstone in Milne Land, I suggested that this deposit did not represent a homogeneous formation because of the occurrence of a *Subcraspedites* (or *Tollia*) of Cretaceous aspect (at the

87 m horizon of Aldinger)[1]) almost immediately above what appeared to be Portlandian ammonites (80 m). Unfortunately the upper 100 m of the Hartzfjæld Sandstone are without marine fossils and I can add nothing to what Dr. Aldinger has written about the presumable date of that deposit.

The only other area in East Greenland so far known where lowest Cretaceous deposits occur is in Kuhn Island and the neighbouring northern part of Wollaston Foreland. Since the fossils from that area will be described in the present series, it must suffice to say that the unique example of *Hectoroceras* figured in Plate III, fig. 2 was found by Dr. Wolf Maync in a bed which is younger than a new assemblage including *Subcraspedites*, also derived *Laugeites* (?), and unnamed ammonites of Portlandian aspect (? *Paracraspedites* or *Dorsoplanites* = *Perisphinctes* [*Pavlovia* ?] sp. indet. aff. *panderi*, Michalski, of Frebold)[2]) associated with *Buchia* of predominantly Cretaceous affinities (although including *B. mosquensis* in Frebold)[3]). Whatever the age of this rock, which as Frebold already stated is full of forms of *Buchia* and fragments of ammonites but contains no other fossils, it denotes the incoming of a new series of deposits with the great Cretaceous transgression. The beds with *Tollia* which succeed the *Hectoroceras* horizon also contain no fossils except ammonite impressions and crushed examples of *Buchia*. The *Polyptychites* fauna known from elsewhere on Kuhn Island and Wollaston Foreland has not been found in the same section (on Mt. Bütler), but the top beds, at 560 m above the base, have yielded an example of the Valanginian genus *Lyticoceras*. It seems probable that the whole of this uniform sandstone series which according to Dr. Wolf Maync includes *Buchia* of the *keyserlingi* type throughout its enormous thickness of 1867 feet, belongs to the Infra-Valanginian and Valanginian; and as far as *Hectoroceras* is concerned, it certainly supports its attribution to the Cretaceous rather than the Jurassic.

2. Spitsbergen.

Of all the other faunas with which the East Greenland assemblage here described may be compared, those from Spitsbergen undoubtedly claim our first attention. Spitsbergen has been held to have a fairly continuous sequence from the Jurassic into the Cretaceous (e. g. at Cape Fastness, Green Harbour, Ice Fjord), and might therefore be thought to show a somewhat similar fauna near the border-line of the two systems. Yet it has almost only the two species of *Buchia* in common with the Jameson Land fauna here discussed. For the occurrence of an

[1]) *Loc. cit.* (Medd. om Grønl., vol. 99, No. 1), 1935, p. 68.

[2]) Untersuchungen über die Verbreitung, Lagerungsverhältnisse und Fauna des oberen Jura von Ostgrönland. Medd. om Grønl., vol. 94, No. 1, 1933, p. 31.

[3]) *Ibid.*, p. 32.

isolated *Pentacrinus* fragment, an *Oxytoma* or a *Corbicella* is valueless for the present purpose, and even the record[1]) of *Pecten* (*Entolium*) *nummularis* from Spitsbergen (as from Andö)[2]) is of no significance since there the species is associated with forms of apparently Lower Kimmeridgian age. Beds 20 and especially 21 of the Fastness section, which seem to be the strata with faunas most comparable to that of the *Hectoroceras* Beds, according to Frebold[3]) consist of rather different elements; and if it is held that bed 21 is essentially a *Buchia* bed, like the shell bed of Jameson Land, and that it includes the same two species, *B. volgensis* and *B. terebratuloides*, it must be pointed out that these are already associated with *B. keyserlingi* (Lahusen) which occurs in its typical form only in the Valanginian. But there are other difficulties in correlation.

I am not at all satisfied that accurate dating of the many post-Kimmeridgian and pre-Valanginian ammonites collected in Spitsbergen can be attempted in the present state of our knowledge. I referred forms like a *Perisphinctes* sp., with smooth outer whorl, figured by Sokolow and Bodylevsky[4]) from bed 18, to the Lower Kimmeridgian genus *Pictonia*, but these authors suggested an Upper Kimmeridgian or Portlandian date for the Perisphinctids from beds 17 and 18 of the Fastness section. Frebold[5]), before them, had correlated bed 17 with the Lower Portlandian, on the strength of a supposed *Virgatites*, and beds 18 and 19 with the Upper Portlandian because they contained Perisphinctids which he considered related to or identical with *Epivirgatites nikitini* (Michalski). I myself had recorded these groups already in 1921[6]) and thus possibly influenced my successors' determinations; but I now believe that the resemblance is only general and that the Spitsbergen forms described as *Perisphinctes* cf. *panderi* and *P.* cf. *nikitini* are largely new species of unknown and possibly post-Portlandian and post-Volgian age, and that some might even be Cretaceous *Subcraspedites*.

The Spitsbergen sequence consisting largely of black shales with impressions of *Buchia* is almost certainly as fragmentary as the Upper

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[1]) Stoll, in Frebold & Stoll: Das Festungsprofil auf Spitsbergen. III. Stratigraphie und Fauna des Jura und der Unterkreide. Skrifter om Svalbard, No. 68, 1937, p. 33.

[2]) Sokolow: Fauna der mesozoischen Ablagerungen von Andö. Skrifter Videnskap. Kristiania, I (1912), No. 61, p. 4.

[3]) In Frebold and Stoll, *op. cit.* (1937), pp. 50—51. See also Hoel and Orvin: Das Festungsprofil auf Spitzbergen: Karbon-Kreide. I. Vermessungsresultate. Skrifter om Svalbard, No. 18, 1937, p. 24.

[4]) *Loc. cit.* (Skrifter om Svalbard, No. 35), 1931, p. 93, pl. IX, fig. 5.

[5]) Das Festungsprofil auf Spitzbergen. Jura und Kreide. II. Die Stratigraphie. Skrifter om Svalbard, No. 19, 1928, pp. 12—13.

[6]) Spath: On Ammonites from Spitsbergen. Geol. Mag., vol. LVIII, 1921, pp. 351 &c.

Jurassic of all other areas, even in the supposed geosynclines. The thickness of the deposits of the Fastness section is considerable but not impressive. For example, from horizon 7 (presumed top of the Oxfordian) to horizon 16 (base of the supposed *Virgatites*-bearing beds) there is a thickness of about 145 m or 485 feet, of which the lower 46 m or 150 ft. (beds 7—13) are Eo-Kimmeridgian. Unfortunately there are no ammonites in beds 14—16 that would enable us to date the next higher 99 m or 335 feet of deposits (originally dated as Sequanian by Sokolow)[1], but in Dorset the post-Eo-Kimmeridgian *Aulacostephanus* and *Gravesia* Shales alone are of 190 feet thickness and they are succeeded by no less than 625 feet of shales and clays of Upper Kimmeridgian age, underlying the true Portlandian[2]. The resemblance between some Perisphinctids of beds 18 and 19[3]) to forms of *Subplanites* from the lower part of the Upper Kimmeridgian could thus well be taken to indicate a similar date of existence. But it seems to me that the resemblance may be superficial because these ammonites are associated with other Perisphinctids[4] that are unknown from any Upper Kimmeridgian or Portlandian horizon in England or Milne Land. I have certainly seen nothing from Spitsbergen that points to the presence of the Lower Volgian, although I have myself recorded "*Virgatites*" in 1921, that is at a time when (after Salfeld) we included in that genus the crushed *Subplanites* from the Bituminous Shales of Dorset, again discussed on a recent occasion[5]. There are no true *Virgatites* either in the Upper Kimmeridgian or in the Portlandian of Dorset; and the resemblance between the Spitsbergen forms that have been assigned to that genus and the typical Russian forms is in my opinion similarly due to the misidentification of more or less heterochronous homoeomorphs.

It is not at all certain that bed 20 marks the top of the Jurassic as has been stated, and that bed 21 is the base of the Cretaceous in the Fastness Section; for the evidence is far from satisfactory. It has been seen that there is little doubt about the occurrence of Eo-Kimmeridgian Ammonites (*Amoeboceras*)[6], but that nothing from Spitsbergen can be

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[1]) Trav. Mus. géol. minéral. Pierre-le-Grand, Ac. Sci. Petrograd, vol. III (1917—18), 1922, pp. 124—26.

[2]) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, pp. 162—63.

[3]) See e. g. in Frebold, *loc. cit.* (Skrifter om Svalbard, No. 19), 1928, pl. I, figs. 3—4 (as *Perisphinctes* cf. *polygyratus*, Pavlow, *non* Trautschold).

[4]) E. g. the forms which, in 1921, on account of the smooth outer whorl I took to be examples of the Lower Kimmeridgian genus *Pictonia*.

[5]) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 172.

[6]) *Pictonia*, recorded by myself in 1921 (Geol. Mag., p. 351) has already been stated to be probably based on a misidentification; and the three examples of *Rasenia* (B. M. Nos. C. 26971—73) are now believed to be crushed Polyptychitids, comparable to *P.* aff. *quadrifidus*, v. Koenen (Sokolov and Bodylevsky, *op. cit.*, 1931, pl. x, fig. 1).

definitely identified with any Upper Kimmeridgian, Portlandian and Lower or Upper Volgian ammonite known from elsewhere, except, possibly the *Dorsoplanites* to which I referred in 1936[1]). The most convincing of these (*Perisphinctes* cf. *panderi* [Michalski ?] Frebold)[2]), however, is not from the Fastness Section, and the provisional identification of, for example, the almost unrecognisable *P.* cf. *panderi* figured by Sokolow and Bodylevsky[3]) with *Dorsoplanites* does not date bed 18 as Portlandian. Conversely the "*Craspedites*" recorded by Frebold and Stoll from bed 20 are said to be comparable to "*C.*" *subpressulus* of the Upper Riasan Beds and therefore of Cretaceous age. I myself recorded *Craspedites* in 1921; and in 1924[4]) I listed them as of Subcraspeditan (*spasskensis*) age. Although these are preserved in limestone and thus probably come from a higher bed than No. 20 it is certain that a considerable thickness of strata between bed 22 (put into the zone of *Tollia stenomphala* by Sokolow and Bodylevsky) and bed 23 (327 m or 1090 feet higher) with *Polyptychites* is very incompletely known. Since Frebold[5]) listed *Polyptychites* aff. *quadrifidus*, v. Koenen, from both beds 22 and 22a, this great thickness, however, seems to be entirely within the Valanginian and therefore later than the *Hectoroceras* fauna, and is as little comparable as the presumed "Portlandian" fauna of beds 17—20. If the *Hectoroceras* fauna occurs in Spitsbergen it has not up to the present been recognised.

3. King Charles Islands.

In the neighbouring King Charles Islands, the succession seems to be similar to (but perhaps still less representative than) that of Spitsbergen. There is some Eo-Kimmeridgian, followed by beds that have been referred to the Lower Volgian (lowest and perhaps middle parts) on the strength of the forms of *Buchia*, and these are succeeded by some Valanginian deposits. Blüthgen[6]) in his recent account of the fauna and stratigraphy of the Upper Jurassic and Lower Cretaceous of the King Charles Islands, thought that on the basis of the forms of *Buchia* ("*Aucella*") it could not be established with certainty whether the Riasan horizon also was represented, for *B. terebratuloides* (here recorded from Jameson Land) had too great a vertical range and no other species of *Buchia* of that horizon were before him. Likewise Blüthgen thought that the presence of the zone of *Polyptychites keyserlingi* (Neumayr &

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[1]) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, pp. 170—71.
[2]) *Loc. cit.* (Skrifter om Svalbard, No. 31), 1930, pl. XI, fig. 1.
[3]) *Loc. cit.* (Skrifter om Svalbard, No. 35), 1931, pl. VIII, fig. 2.
[4]) *Loc. cit.* (Geol. Mag., vol. LXI), 1924, table to p. 80.
[5]) In Frebold & Stoll, *loc. cit.* (Skrifter om Svalbard, No. 68), 1937, p. 51.
[6]) *Op. cit.* (1936), p. 55.

Uhlig) was not absolutely proved, though it was probable that the zone of "*Tollia*" *stenomphala* was developed. But in the absence of ammonites that author had to rely on the forms of *Buchia* and rightly considered that the belemnites were not suitable for dating the deposits because their vertical ranges were probably too great. Stolley[1]) in a characteristic criticism of Blüthgen's work attempted to defend the value of the belemnites; but the repeated pronouncement that he had for some years recognised the high Jurassic to low Neocomian age of the belemnite beds of the King Charles Islands, is as vague as is the evidence of the belemnites in general, if unsupported by that of other fossils. What is more important from a stratigraphical point of view is the recognition by Blüthgen of the fact that the Kimmeridgian and presumed Volgian deposits are shales, often paper shales and highly bituminous, with their fossils crushed, indicating tranquil but not deep waters, but that the facies of the Cretaceous deposits was quite different. These are somewhat coarser, marly sediments, non-bituminous, with the fossils never flattened by pressure, and they clearly form a distinct set of strata from those below. Unfortunately the uppermost Jurassic and the Infra-Valanginian faunas that might have been comparable are apparently missing and the East Greenland succession is much more complete.

4. Andö.

The deposits on Andö (Lofoden Islands) must be very similar to those of Spitsbergen, for following on the supposed Portlandian and Aquilonian "Middle Beds" with crushed ammonites similar to those above discussed, there are the *Buchia*-bearing Upper Beds which are undoubtedly Cretaceous, but contain few other fossils. I may mention in this connection that the fauna of the uppermost beds (of 125 m thickness) was stated by Sokolow[2]) to be unexplored; but they have probably yielded a '*Crioceras*', apparently of Speeton Clay facies, which was brought to the British Museum some years ago and submitted to me for identification.

5. England.

The Spilsby Sandstone of Lincolnshire represents a deposit of particular interest in our present survey; for not only is there often extraordinary lithological resemblance, especially in the more gritty types of matrix, with East Greenland rocks (e. g. the sandstones of

[1]) *Loc. cit.* (Zentralbl. f. Min., &c. 1938 B), pp. 19—28. The contention that *Hibolites* is an immigrant from the Arctic can be maintained as little as that *Olcostephanus* came from the north; both suggestions are entirely against all the evidence of Indian or African faunas of the late Jurassic and early Cretaceous.

[2]) *Op. cit.* (Vidensk. Skrifter, Kristiania, I), 1912, p. 13.

Haakon's Hut, Kuhn Island, above referred to) but the forms of *Subcraspedites* are apparently similar in the two areas. Unfortunately, the Lincolnshire Lower Cretaceous, on account of the infrequency of the inland exposures, has never attracted much attention; and, as Jukes-Browne[1]) stated over 50 years ago, the fossils of the Spilsby Sandstone are incompletely known and form a somewhat peculiar assemblage. He rightly thought that if they corresponded to any part of the Speeton Clay it would seem to be the lowest part of the lower stage. Later I showed that the Spilsby Sandstone was of even earlier age than the lowest part of the Speeton Clay, but Swinnerton[2]) has since suggested, on the (unconvincing) evidence of the belemnites, that the lowest few feet of clay at Speeton (which I had queried) may be of pre-Polyptychitan age though not so old as the lowest part of the Spilsby Sandstone. There can be no question about the stratigraphical position of the Spilsby Sandstone or the rolled and transported nature of the fossil contents of the nodule bed at its base; Jukes-Browne considered the rolled casts to have been derived chiefly from the Portlandian and the Kimmeridge Clay, but later Lamplugh[3]) not only correlated the nodule bed at the base of the Spilsby Sandstone with the heterochronous Coprolite bed *E* at Speeton, but favoured the view that instead of marking a great (and visible) unconformity between the Jurassic and Cretaceous, the deposit in question indicated a gradual passage from one system into the other. The magnitude of the gap was not understood at the time and Lamplugh may have been influenced by Pavlow's identification of a Spilsby ammonite as a *Craspedites* of the Upper Volgian, but the determination was wrong and the form probably did not even come from the lower part of the Spilsby Sandstone.

More recently, Swinnerton[4]) described ammonites from two fossiliferous horizons (*C* and *D*), just above the base of the Spilsby Sandstone, and he showed that the two assemblages of ammonites presented a remarkable general resemblance to that described by Bogoslovsky from the (condensed) Riasan Beds of Russia. Specific identity was limited to one species, *Subcraspedites subpressulus*, but an approach to specific similarity seemed to be manifested also by *S. preplicomphalus* (resembling *S. spasskensis*, Nikitin sp., Bogoslovsky) and by *S. stenomphaloides* (resembling *S. stenomphalus*, Pavlow sp. and, in the case of a variety, *S. subtzikiwinianus*, Bogoslovsky sp.). Swinnerton concluded that the Lincolnshire and Riasan areas evidently derived their faunas from the

[1]) *Loc. cit.* (Mem. Geol. Survey, Sheet 84), 1887, p. 14.

[2]) *Loc. cit.* Monog. British Cretaceous Belemnites, pt. 2, Pal. Soc., 1938, xxvii.

[3]) On the Speeton Series in Yorkshire and Lincolnshire. Quart. Journ. Geol. Soc., vol. LII, 1896, pp. 195 &c.

[4]) *Loc. cit.* (Quart. Journ. Geol. Soc., vol. XCI), 1935, p. 40.

same northern source, but were not themselves directly connected with one another.

Since Swinnerton wrote, ammonite fragments have been collected by Messrs. C. W. and E. V. Wright from the basal phosphate bed at the Mine (in the Claxby Ironstone) at Nettleton Top, near Caistor, i. e. farther north than Donington, and I have recognised among the nodules fragments of the Portland Stone genera *Crendonites* and *Kerberites*. The Coprolite bed *E* at Speeton, on the other hand, has yielded derived Kimmeridgian ammonites of pre-*rotunda* age, i. e. not of the uppermost Kimmeridgian, and as I have stated before[1]) there is at Speeton a complete absence of the uppermost Kimmeridgian, the whole of the Portlandian, the Tithonian (Purbeckian or Aquilonian), and probably most of the Infra-Valanginian (= Upper Berriasian). In Lincolnshire, the gap was evidently not so enormous. Whatever happened to Aquilonian or Volgian deposits, if such were ever laid down, before the deposition of the littoral Spilsby Sandstone, some Portland Stone equivalent must certainly have been present in North Lincolnshire; and it is even possible that the execrably preserved *Paracraspedites* (?) *trifurcatus*, Swinnerton[2]), from bed *C* at Donington, is a derived Portlandian or post-Portlandian element. But since *Subcraspedites*, the dominant ammonite stock of the Spilsby Sandstone, occurs already in the basal bed *C* (with predominant *Paracraspedites*) it is clear that the deposit as a whole is Cretaceous and that it is separated by considerable gaps from the beds below (the Kimmeridge Clay) and above (the Claxby Ironstone or Hundleby Clay). That is to say the Spilsby Sandstone, like the *Hectoroceras* Beds of Jameson Land, represents merely one horizon within a very long Infra-Valanginian period and it is not yet possible to assign to either its correct place in the sequence.

As regards the fossils other than ammonites it is interesting to note that there are also at least eight genera of pelecypods common to the Spilsby Sandstone and the *Hectoroceras* Beds. Woods, in his great Monograph of the Cretaceous Lamellibranchia of England[3]) recorded fourteen species (two doubtful) belonging to eleven (or twelve) genera; and although the list of Jameson Land forms on p. 51 contains only a single species (*Buchia volgensis*) described by Woods as occurring also in the Spilsby Sandstone, the agreement is much closer than appears at first sight, as mentioned in the specific descriptions. As regards the belem-

[1]) *Loc. cit.* (Geol. Mag., vol. LXI), 1924, p. 80.

[2]) *Loc. cit* (Qurat. Journ. Geol. Soc., vol. XCI), 1935, p. 39, text-fig. 5, p. 40.

[3]) Woods's list is probably rather incomplete, for it does not include *Lucina crassa*, Sowerby, or the *Pinna* and *Lima*, recorded by Jukes-Browne and Lamplugh. Gastropods, like *Trochus* and *Pleurotomaria*, listed by Jukes-Browne, also occur, but like the rest of the fauna, have not been described in detail.

nites recently described by Swinnerton, two forms of *Acroteuthis* (one of them resembling the Jameson Land species here described) occur in the Basement Beds of the Spilsby Sandstone and five more are common to that deposit and the Speeton Clay or Claxby Ironstone, while eight species are of later age than the Spilsby Sandstone or at least have not been found in it. Swinnerton concludes that the study of the belemnites completes the destruction of the case for regarding any portion of either the Speeton Clay or the Spilsby Sandstone as of Jurassic age.

6. Russia.

While the Spilsby Sandstone fauna thus is decidedly more comparable to the Jameson Land assemblage here discussed than are the faunas of Spitsbergen, the King Charles Islands, or Andö, the frequent reference in the foregoing pages to forms from the Russian Riasan Beds and the Upper Volgian suggests that these also show great affinity with the East Greenland fauna. With regard to the *Craspedites* Beds of Russia, I have already shown that their relegation to the Upper Kimmeridgian in 1923[1]) was prompted by Salfeld's misidentification of supposed "*Virgatites*" and the presumed co-existence of *Virgatites* and *Craspedites* in the Kachpur Section. Judging by the Blake Collection in the British Museum (Natural History), *Epivirgatites nikitini* (Michalski) and *Kachpurites fulgens* (Trautschold) are certainly associated in one section (No. 3A) and accompanied by *Craspedites okensis* (d'Orbigny) in another (No. 2); but though they are preserved in the same light matrix, quite distinct from the blackish-green matrix of the true *Virgatites* that are also labelled No. 2, the forms of the *nikitini* zone (upper zone of the Lower Volgian) and of the *okensis-fulgens* zone (lowest zone of the Upper Volgian) are not actually preserved together in the same hand-specimens. Since in the Kachpur sections published by Nikitin[2]) as well as by Pavlow[3]) the *okensis-fulgens* zone is distinctly separated from the underlying Lower Volgian, I take it that there has been some error in Blake's numbering or collecting. What is more important is that there is probably no great time-gap between the two zones; and I also agree with Bogoslovsky[4]) that the true *Craspedites* and their successors in the Riasan Beds are closely connected by many

[1]) Spath: Ammonites from New Zealand. Quart. Journ. Geol. Soc., vol. LXXIX, 1923, p. 306. Swinnerton has recently (Monograph British Cretaceous Belemnites, Pal. Soc., pt. 2, Oct. 1937, p. XXVIII) perpetuated this error, not having noticed the corrections made in my later papers.

[2]) De Moscou à Oufa. Guide Excurs. VII. Congrès géol. internat., St. Pétersb., 1897, No. II, p. 16.

[3]) Voyage géologique par la Volga de Kazan à Tsaritsyn. *Ibid.*, No. XX, p. 25.

[4]) *Op. cit.* (Der Rjasan Horizont), 1897, p. 145.

features (characters of the inner whorls, type of suture-line, modification of whorl-shape, and of ornamentation with increase in size). I have therefore more recently[1]) favoured the view that the Lower Volgian as well as the Upper Volgian is of post-Portlandian age. That is to say I maintain that the Tithonian, the Volgian, and the Portlandian are three successive periods but the order is now changed. This view receives some support not only from the discovery of *Laugeites stschurovskii* or allies in the post-Portlandian *Lingula* Bed of Hartz Mtn. (Milne Land), but from the peculiarities of the branching of the ribs which, as Bogoslowsky[2]) has pointed out, affect so many different ammonite stocks at the end of the Jurassic and beginning of the Cretaceous, but of which there is as yet scarcely a sign in the Kimmeridgian and closely allied Portlandian Perisphinctids.

It may be admitted, then, that the pelecypod fauna of the Upper Volgian, though Jurassic and very much older, does not appear to be very different from that of the Spilsby Sandstone and the *Hectoroceras* Beds. Moreover, it is not certain that '*Oxynoticeras*' *toliense*, Nikitin, which has some resemblance to *Hectoroceras* and which was at first ascribed to the Upper Volgian, is really of Lower Cretaceous age, as Bodylevsky now holds. Since the young of *Craspedites* of the *fragilis* type, however, show ribbing that is far more regular, less deeply branched, and altogether rather different from that of the forms of *Subcraspedites* here described from the *Hectoroceras* Beds, it is of little significance that most of the genera and sometimes species of pelecypods known to occur in the Spilsby Sandstone and the Jameson Land deposits in question can be matched by forms from the *Craspedites* Beds of Russia. The prevalence of glauconitic sandstones in the uppermost Jurassic as well as in the lowest Cretaceous, would alone account for a great similarity in the pelecypod fauna.

The Riasan Beds represent a condensed deposit of special interest in so far as it contains both Mediterranean types of Berriasellids and boreal Craspeditids. It is customary to distinguish a Jurassic lower portion, characterised by *Riasanites riasanensis* and a Cretaceous upper part (zone of "*Craspedites*" *spasskensis*), but since the greatest thickness, on the River Oka, is only 2 m (elsewhere it is 2 feet or less), the doubts that have been expressed by Bogoslovsky[3]) concerning the divisibility of the Riasan Beds into distinct zones may not be unfounded. On the other hand, it appears probable that as this phosphatic and glauconitic deposit is condensed and was undoubtedly accumulated at a very slow rate, it includes elements derived from different horizons,

[1]) Spath, *loc. cit.* (Medd. om Grønl., vol. 99, No. 3), 1936, p. 168.
[2]) *Op. cit.* (Mém. Com. géol., N. S. No. 2), 1902, p. 114 (footnote 2).
[3]) *Loc. cit.* (Mater. Geol. Russl., vol. XVIII), 1897, p. 149.

especially if the extent of the gap between the lowest portion of the Riasan Beds and the underlying Upper Volgian varies from place to place. At all localities the sudden change in the fauna is most striking. The occurrence of *Buchia volgensis* and *B. terebratuloides* in both the Riasan Beds and in the *Hectoroceras* fauna of Jameson Land thus means little; for these two species probably occur throughout those undifferentiated horizons of the uppermost Jurassic and lowest Cretaceous that may have contributed elements to the composite Riasan fauna. Since the doubtful *Subcraspedites* also do not include a single example that could even provisionally be referred to a Riasan species, it is clear that exact comparison with the *Hectoroceras* fauna is as little fruitful in the present state of our knowledge, as comparison with those scanty deposits (mostly without ammonites) that have so far been recorded from western and northern Siberia[1]).

7. North America.

Comparison of the assemblage here discussed with Upper Jurassic and Lower Cretaceous faunas from North America is difficult since our knowledge is even more fragmentary than in the case of the deposits already reviewed. The evidence of the forms of *Buchia* is unsatisfactory; the record of *B. terebratuloides*, for example, or close allies, from Alaska, British Columbia and California is of little significance since so-called Sequanian, Portlandian and Neocomian forms of *Buchia* have long been known to occur in those areas. Pavlow[2]), who took White's[3]) "*Aucella*" *concentrica*, Fischer, var. to include *B. terebratuloides*, thought that one of the forms at least (fig. 2) could be Jurassic. He was even less certain about the "*Aucellae*" of the Knoxville Beds of California, stating that while those of the Upper Series (2000 feet) were Cretaceous, those of the Lower Series were Portlandian and Aquilonian, though the latter was more doubtful. Recently Anderson[4]) has shown that there is evidence of an unconformity between the Knoxville (Upper Jurassic) and the Shasta (Lower Cretaceous) Series, denoting an interval of disturbance and of erosion which seemed to have extended along the Pacific Coast from California to Alaska, and far beyond. Separation of the Infra-Valanginian elements, thus, would seem easy, but I am not at all satis-

[1]) Concerning Traces of the Upper Volgian Stage in the West Siberian Lowlands. C. R. (Doklady) Acad. Sci. USSR., vol. I (X), No. 1 (78), 1936, p. 31. See also Obrutschew: Die Geologie von Sibirien. Fortschr. Geol. Pal. (Soergel), Heft 15, 1926, pp. 293—301, 335—348.

[2]) *Loc. cit.* (Nouv. Mem. Soc. Imp. Nat. Moscou, vol. XVII), 1907, p. 81.

[3]) On a Small Collection of Mesozoic Fossils collected in Alaska by Mr. Dall. Bull. U. S. Geol. Surv. No. 4, p. 13, pl. vi, figs. 2—5.

[4]) *Loc. cit.* (Geol. Soc. Am. Special Paper No. 16), 1938, pp. 40 &c.

fied that those fossils from the Sandy Shales which Anderson[1]) attributed to the Lower Paskenta Group (Lower Shasta Series) are correctly identified, and that they are really referable to the Infra-Valanginian. It has been mentioned (p. 27) that Stanton's '*Olcostephanus*' *mutabilis* does not look like a *Dichotomites* and its comparison with a Volgian *Craspedites* does not support a Valanginian age. Conversely, the supposed Tithonian fauna from Middle California described by Crickmay[2]), with *Protothurmannia*, *Berriasella*, and *Buchia terebratuloides* may well be either latest Tithonian or already Infra-Valanginian. It therefore appears that neither the late Jurassic (Knoxville) nor the early Cretaceous (Infra-Valanginian part of the Paskenta Series) is known in anything like a complete chronological sequence; and in spite of the enormous thickness of the deposits in California, they have yielded so far a less satisfactory record of the faunas existing during those critical times than various localities in Central and South America.

Anderson thought the Californian faunas largely Indo-Pacific in character, but the presence of Polyptychitids and the continuity of the succession of '*Aucella*' faunas in Alaska[3]) make it probable that what I called the Mackenzie Strait across the Yukon kept the Arctic and Pacific Basins in continuous communication, as indicated on Crickmay's[4]) map of North America in Early Lower Cretaceous (*crassicollis*) times. He himself[5]) drew attention to the mixing of Berriasellids and genuine Russian '*Aucella*' (*Buchia terebratuloides*) in California, as in the Russian Riasan Beds, but Bodylevsky[6]) recently offered a different explanation to account for the affinity between the Upper Volgian *Buchia* faunas of Novaya Zemlya on the one hand, and the Upper Knoxville Series of California on the other. He pointed to the absence of marine deposits of that date in Greenland, Spitsbergen, northern and eastern Siberia and Alaska, i. e. the whole of the Arctic region, and therefore suggested connexion through the sub-Arctic (or subpolar)[7]) areas, which I take to mean inter-communication by some more southerly

1) *Ibid.*, p. 38 (Table I).

2) A New Jurassic Ammonite from the Coast Ranges of California. Amer. Midland Naturalist, Notre Dame, Indiana, vol. XIII, No. 1, Jan. 1932, pp. 1—11.

3) Crickmay: Jurassic History of North America. Proc. Amer. Philos. Soc., vol. LXX, No. 1, 1931, p. 62.

4) *Ibid.*, p. 93.

5) *Loc. cit.* (Amer. Midl. Natural.), 1932, p. 5.

6) On the Jurassic and Lower Cretaceous Fossils from the Collection of A. Petrenko from Novaya Zemlya. Trans. Arct. Instit. Leningrad, vol. XLIX, 1936, pp. 110—12; The Upper Volgian Fauna of Novaya Zemlya. *Ibid.*, pp. 113—36, pls. I—II.

7) MS. correction in the author's copy of Bodylevsky's paper kindly sent to the writer.

route (Central Siberia?). The discovery of the *Hectoroceras* fauna in Jameson Land and of marine pre-Valanginian deposits on Kuhn Island confirms the view that the sea in Jurassic and Cretaceous times was always just on or just off the East Greenland Coast; and the stratigraphical record at the different localities, when fully known and pieced together, may well excel in completeness that of many of the more classical successions here reviewed.

E. SUMMARY OF RESULTS

1. The fossils here described come from a restricted horizon within a thick series of sediments. These are underlain first by unfossiliferous sandstones of unknown extent and then by undoubted Upper Jurassic strata. They are succeeded above, after an interval of unfossiliferous sediments, by rocks of presumably much later (? Aptian) age.
2. The assemblage of fossils is called the *Hectoroceras* fauna because that ammonite genus (with one species and its varieties) has been collected at thirteen out of fourteen localities.
3. *Hectoroceras* being new, the dating of the fauna as Infra-Valanginian is provisional and based on impressions of perisphinctoid ammonites resembling *Subcraspedites* from the Lincolnshire Spilsby Sandstone and from the Riasan Beds of Central Russia.
4. The other elements of the fauna are plentiful pelecypods, especially examples of *Buchia* (= '*Aucella*'), but there are only a few belemnites, gastropods, a brachiopod, starfishes and crinoids. Their evidence supports the attribution of the fauna to a very low horizon in the Cretaceous.
5. Comparison with other assemblages of similar, sandy, shallow water facies in the Boreal Province (e. g. on Kuhn Island or in northern or western Siberia) is limited by the incompleteness of our knowledge, and there are almost no species in common with presumably Infra-Valanginian deposits known from Alaska, British Columbia or California. Difference of facies prevents comparison with Spitsbergen almost as much as with more southern faunas of Infra-Valanginian date.
6. Direct marine connexion between East Greenland, England, Russia and Siberia must have existed as in Callovian, Oxfordian and Kimmeridgian times.

Færdig fra Trykkeriet den 27. Oktober 1947.

Plate I.

Figs. 1-5. *Hectoroceras kochi*, sp. nov. Holotype (2*a*, *b*) from Locality 313; paratype (3) from 308; var. *tenuicostata*, nov. (1*a*, *b*) from 315; and two small examples (4*a*, *b* and, same enlarged × 2, *c*, *d*) from 313 and (5*a*, *b*) from 306. 21

\- 6. *Subcraspedites* (? *Paracraspedites*) sp. ind. Crushed body-chamber fragment. Loc. 318 28

\- 7, 8. *Natica* (?) sp. ind. Two internal casts. Locs. 308 and 306 31

\- 9. *Buchia volgensis* (Lahusen). Small right valve. Loc. 306 34

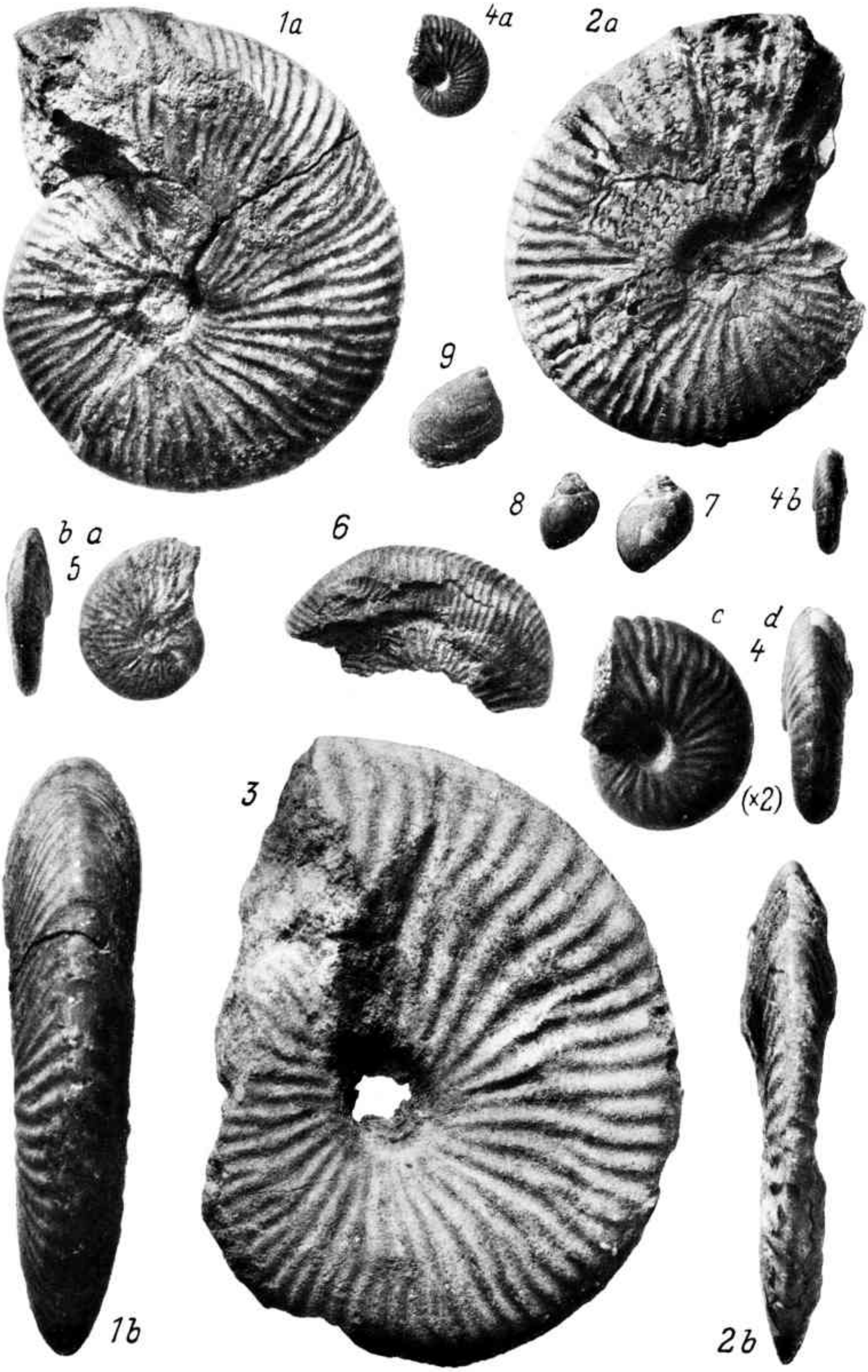
1a
4a
2a
9
8
7
4b
b a
5
6
c d
4
(×2)
3
1b
2b

Plate II.

Fig. 1. *Hectoroceras kochi*, sp. nov. Small imperfect, but uncrushed example. Loc. 306 21

- 2a, b. *Hectoroceras kochi*, sp. nov. Transition to var. *tenuicostata*, nov. Loc. 313 (Side-view slightly reduced) 21

- 3. *Hectoroceras kochi*, sp. nov., var. *magna*, nov. Plaster cast of an impression (external mould). Loc. 307 21

- 4a, b. *Hectoroceras kochi*, sp. nov. Inner whorls. Loc. 306 21

- 5a, b. *Subcraspedites* (? *Paracraspedites*) sp. ind. Side- and peripheral views of a crushed example. Loc. 308 28

- 6a, b. *Lima* (*Limatula* ?, *Pseudolimea* ?) sp. ind. Squeezes of two external moulds. Loc. 304 39

- 7, 8. *Buchia* cf. *terebratuloides* (Lahusen). Two left valves. Locs. 311 and 313 34

PLATE 2.

Plate III.

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- 7.	*Lucina* aff. *fischeriana* (d'Orbigny). Plaster cast of a doubtful external mould. Loc. 309	43

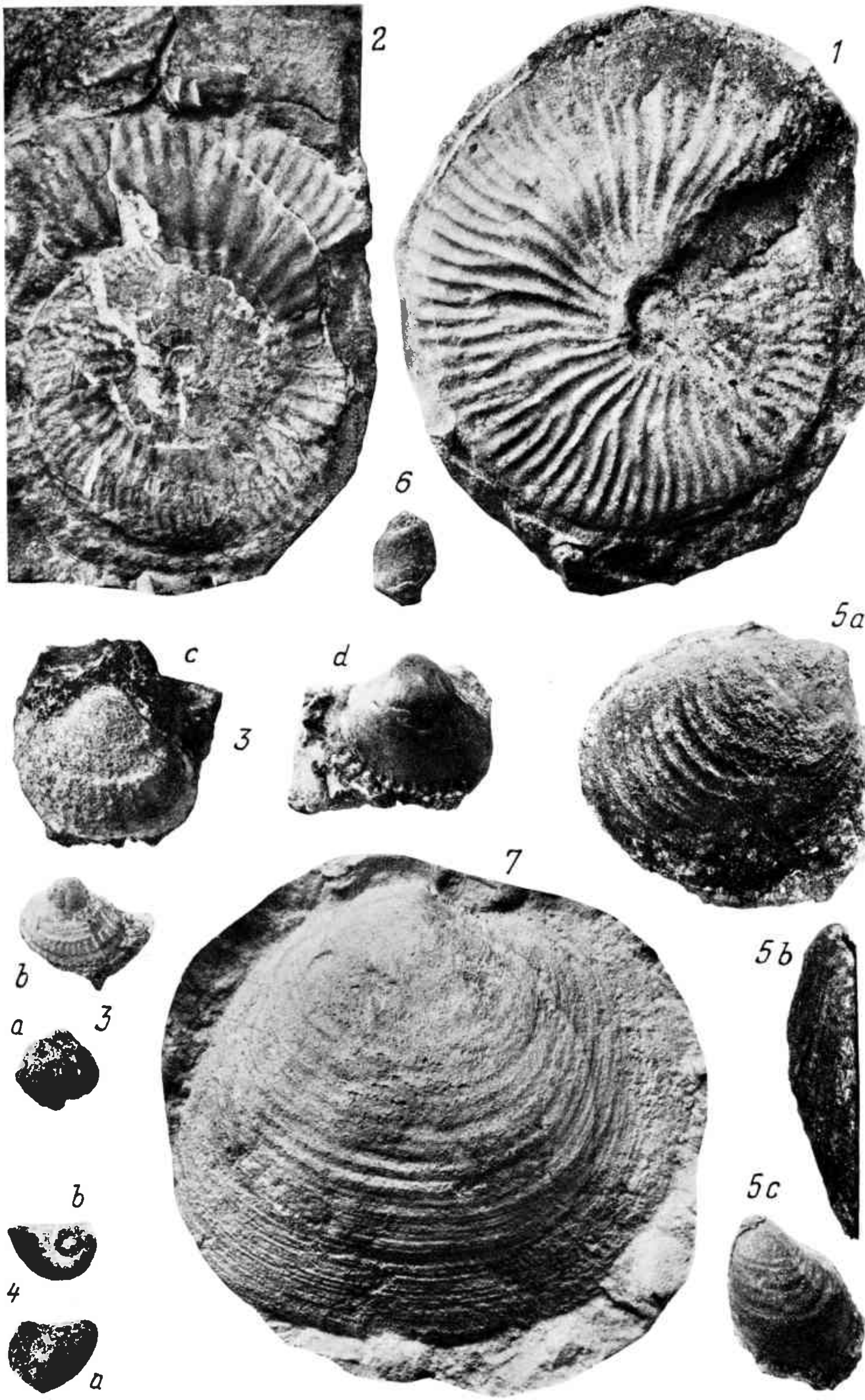
2
1
6
c
d
3
5a
7
b
5b
a
3
b
5c
4
a

Plate IV.

Figs.	1a, b.	*Subcraspedites* (?) sp. nov. (?). Crushed outer whorl, with impression of earlier whorls (*a*) and opposite side of final portion (*b*). Loc. 305	27
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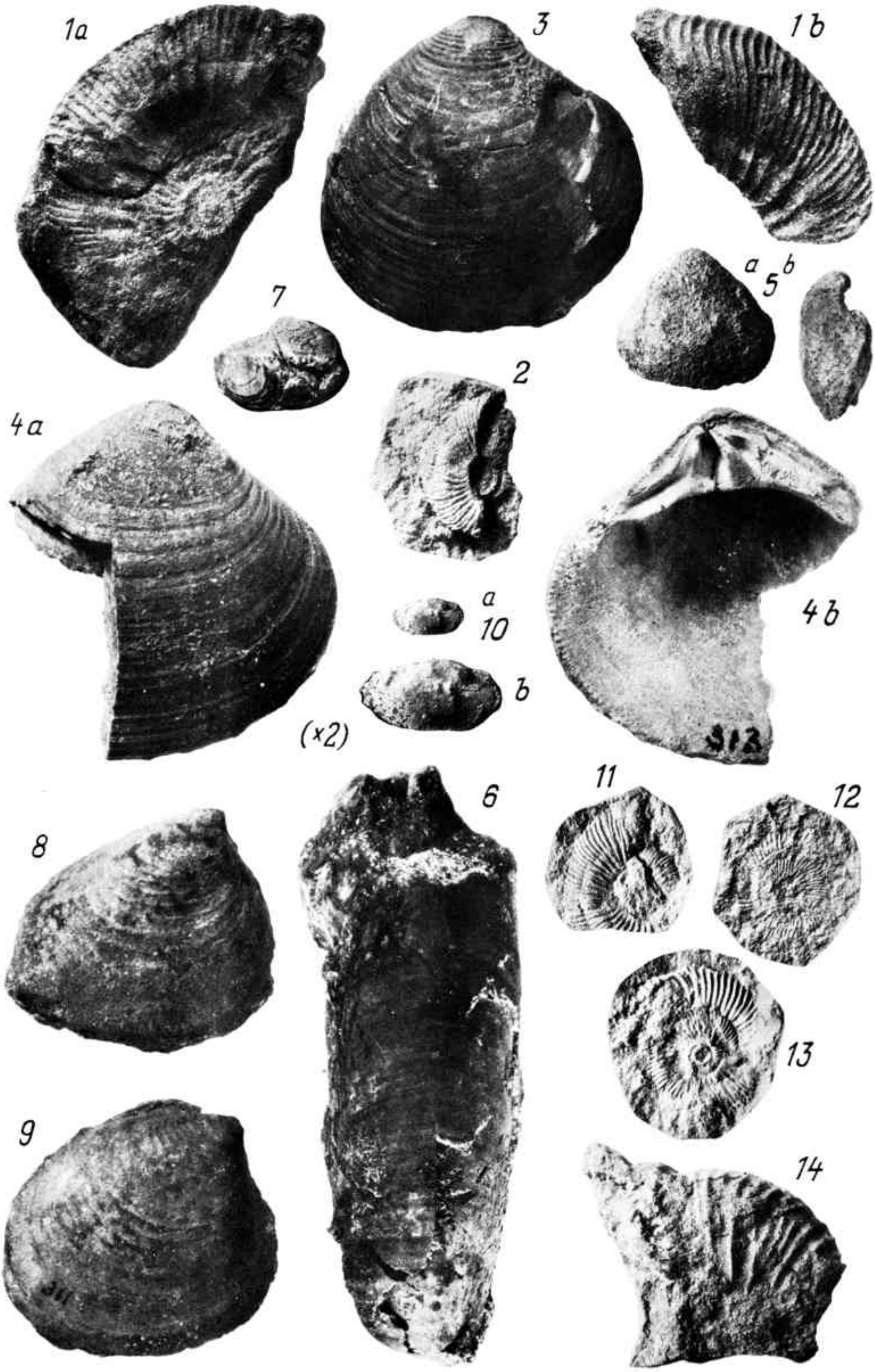
1a
3
1b
a 5 b
7
2
4a
a
10
b
(×2)
4b
6
11
12
8
13
9
14

Plate V.

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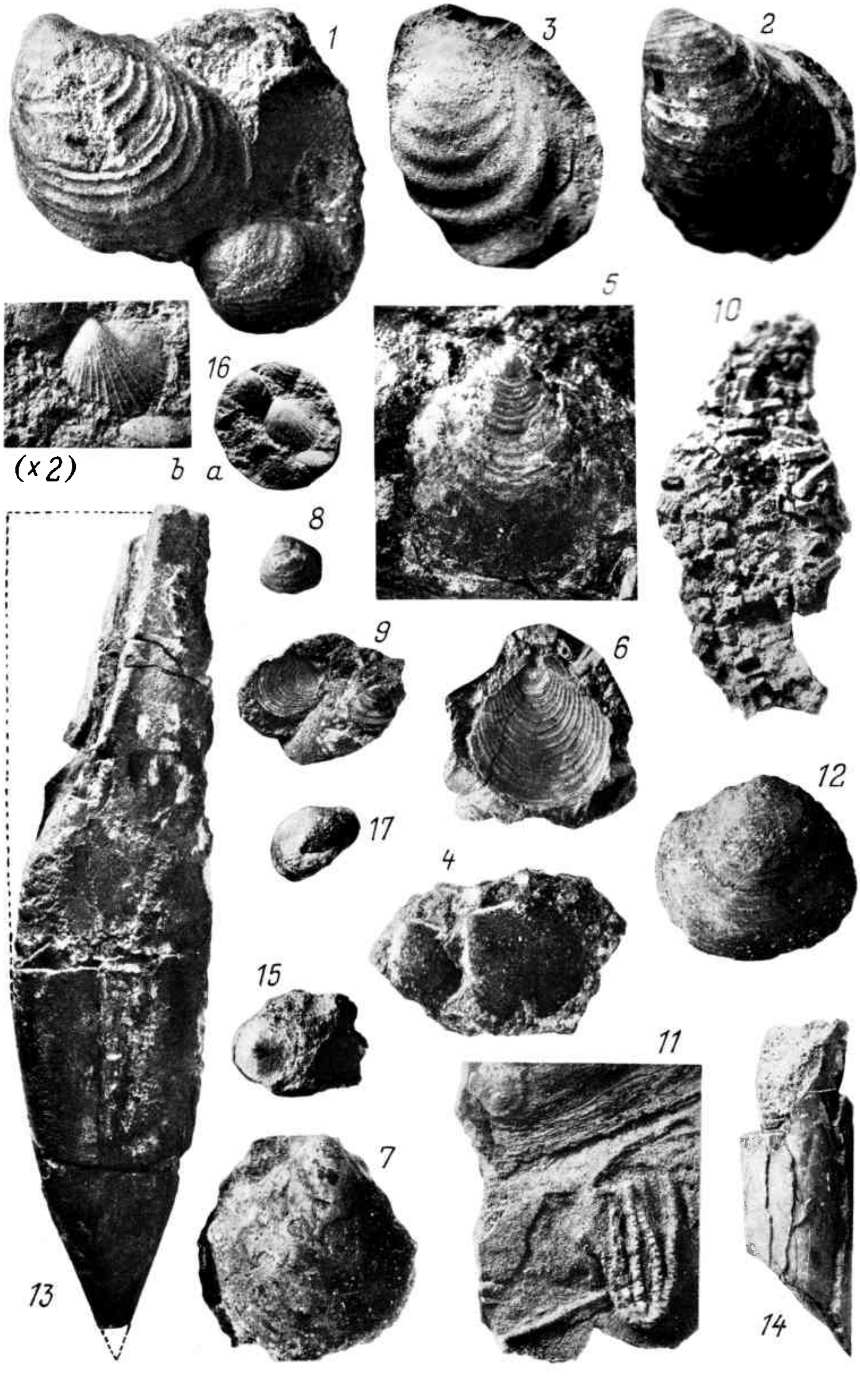
1
3
2
5
10
16
(x2)
b
a
8
9
6
17
12
4
15
11
7
13
14