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Under Ledelse af Lauge Koch

THE UPPER JURASSIC INVERTEBRATE FAUNAS OF CAPE LESLIE, MILNE LAND

I. OXFORDIAN AND LOWER KIMMERIDGIAN

BY

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WITH 15 PLATES

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I. INTRODUCTION

Recent expeditions to East Greenland, under the leadership of Dr. Lauge Koch, have succeeded in bringing back collections of the greatest importance from many localities and from many formations; but, at least in so far as the invertebrate remains are concerned, there are few to rival in interest and beauty of preservation the Upper Jurassic ammonite faunas of Cape Leslie. The first of the assemblages now before me was collected by A. Rosenkrantz as member of the 1926—27 expedition which had its headquarters in Scoresby Sound. A preliminary account of the Cape Leslie Formation and its fossils was published by Rosenkrantz in Lauge Koch's 'Geology of East Greenland'[1]), but, as in the case of V. Madsen's fossils from the *Aucella* River in Jameson Land on the opposite side of the Sound, the identifications not only stressed the affinity with Russian (Volgian) faunas, but the determination of their age as "Portlandian" was rather indefinite. It was while Mr. Rosenkrantz was working out his fossils from Scoresby Sound in the British Museum (Natural History) in the summer of 1932 that he kindly handed over to me the ammonites and belemnites of the Cape Leslie Formation. But before venturing on their description I found it necessary to review the standard succession in Dorset; for there is still the greatest confusion in geological literature as regards the use of the terms Kimmeridgian and Portlandian, not to mention their relations to the Volgian and Tithonian. It is clearly insufficient to describe the Cape Leslie Formation as Portlandian, if this term is interpreted differently by almost every author. I hope that the new information incorporated in the stratigraphical account in a later chapter will help towards a better understanding of the type succession and that it may justify the inclusion in the plates of some new British ammonites that are necessary to substantiate the sequences and opinions here put forward.

Matters were greatly complicated by the publication of Parat and

[1]) Medd. om Grønl. vol. LXXIII, 2, 1929, p. 147. Also: Das Mesozoikum Ostgrönlands. Geol. Rundschau, vol. XXI, 1929, Heft 5, pp. 341—343.

Drach's note on the Portlandian of Cape Leslie[1]). It was seen at once that the ammonites there listed could not possibly occur in the order given, and it was out of the question to reconcile Parat's sequence with Rosenkrantz's collection and the stratigraphical information he had been good enough to give me. I was very glad therefore to receive through the kindness of Dr. Lauge Koch the very fine collections made by Dr. H. Aldinger during a month's stay in 1931 at Cape Leslie. And I may say at once that they confirmed the general accuracy of Rosenkrantz's observations, although the latter, like Parat, collected mostly at places on Hartz Mtn., where the beds are greatly disturbed by faults, so that, according to Dr. Aldinger, on ascending this mountain certain horizons are met with repeatedly.

After the ammonites from these two collections had been worked out, in the autumn of 1934, I received the remainder of the invertebrates collected by Mr. Rosenkrantz, also some Cardioceratids from Wollaston Foreland, collected by him in 1929. Some of the pelecypods of the later beds had already been determined by Rosenkrantz, as mentioned in the descriptions, and he also kindly sent me some photographs, including fig. 9 of Plate 15 and some others which I am incorporating in the next part.

Further, Rosenkrantz forwarded to me some Cardioceratids (and ammonites of the Vardekløft Formation) collected by Dr. Bütler in Jameson Land which had been sent to him (Rosenkrantz) together with some Liassic fossils; and among collections made in southern Jameson Land by Dr. Aldinger and Mr. Säve-Söderbergh, there were also found a few Cardioceratids, together with Bathonian-Callovian and Cretaceous invertebrates. The apparent absence from Jameson Land of the Corallian-Kimmeridgian *Amoeboceras* faunas to which I previously referred[2]), is thus disproved.

All the Cardioceratids will be referred to in the present account, because the Cape Leslie material is in a better state of preservation and more varied. The Cretaceous ammonites and those from the Vardekløft Formation will be dealt with in separate papers, as the material is far more extensive. I may, however, already at this stage mention that there is nothing strikingly new among the Bathonian-Callovian material and that no fresh light can be thrown on the real nature of those crushed *Cadoceras?* collected by Nordenskjøld, which had been identified by Pompeckj as *Simbirskites?*[3]).

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[1]) Le Portlandien du Cap Leslie dans le Scoresby Sound (Groenland). C. R. séances Acad. Sci. Paris, t. 196, p. 1909 (19 juin, 1933).

[2]) Spath: The Invertebrate Faunas of the Bathonian-Callovian Deposits of Jameson Land. Medd. om Grønl., vol. LXXXVII, no. 7, 1932, p. 132.

[3]) See *ibid.*, p. 131.

Merely for convenience and in view of the large number of plates required I am dividing this account into two parts. The first, dealing with the fossils from the Oxfordian and Lower Kimmeridgian, is an account of the fauna of what has been called the 'Kløft I Formation' (Lauge Koch, 1929), previously known from Kuhn Island. The second part, dealing with the Upper Kimmeridgian, Portlandian and higher Jurassic invertebrates, includes the fauna of the 'Cape Leslie Formation' of Rosenkrantz. But the evidence as to whether these two formations are separated by a stratigraphical gap, is as yet doubtful, as mentioned in a later chapter (p. 73).

It is a pleasure again to thank Dr. Lauge Koch for enabling me to study these fine collections obtained under his leadership, and the various members of his expeditions, especially Mr. A. Rosenkrantz and Dr. H. Aldinger, for sending me the necessary stratigraphical information. My thanks are also due to the Keeper of the Geology Department of the British Museum (Natural History) for giving me all facilities in connection with the storing and preparation of the collections and the use of material for comparison.

February, 1935.

II. SPECIFIC DESCRIPTIONS

PHYLUM MOLLUSCA.

A. Class *Cephalopoda.*

a. Order *AMMONOIDEA.*

SUPER-FAMILY *STEPHANOCERATIDA.*

Family *Cardioceratidae*, Hyatt 1892, emend.

Sub-family *Cardioceratinae*, emend.

When in 1932[1]) I suggested that it was advisable to split up the original family Cardioceratidae into sub-families, I defined the Cardioceratinae as including those post-*Quenstedioceras* developments in which a cordate whorl-section and a serrated keel were conspicuous at all stages. The sub-family is very homogeneous and corresponds merely to the old genus *Cardioceras sensu lato*, as understood by authors like R. Douvillé[2]). The separation by Hyatt[3]), in 1900, of *Amoeboceras* (for the forms of the *alternans* group) was justified, and accepted for example by Reeside[4]); but Salfeld[5]), in 1915, rejected this name because, according to him, many younger Cardiocerates (his *bauhini*, *kitchini* and *anglicum* groups) were derived from certain late members of the *cordatum* group (*Cardioceras* s. s.) that co-existed with the *alternans* group and therefore would also require separate sub-generic names. But I can see no objection to using *Amoeboceras* for all these younger Cardiocerates; for the origin of *Cardioceras* itself (in *Quenstedioceras*) is polyphyletic. As is generally the case when one group of ammonites is replaced by another, there are transitions in many directions, according to whether any one character is more or less developed in different individuals; and since the new characters first appear in the young or adolescent stages and since

[1]) Medd. om Grønland, vol. LXXXVII, no. 7, p. 47.

[2]) Études sur les Cardioceratidés de Dives &c. Mém. Soc. géol. France, Paléont. no. 45, vol. XIX, pt. 2, 1912.

[3]) In Zittel's Text-Book of Paleontology (1st English edition), p. 580.

[4]) Some American Jurassic Ammonites of the Genera *Quenstedticeras*, *Cardioceras* and *Amoeboceras* &c. U. S. Geol. Surv. Prof. Paper 118, 1919, p. 13.

[5]) Monographie der Gattung *Cardioceras*. I. Die Cardioceraten des Oberen Oxford und Kimmeridge. Zeit. Deutsch. Geol. Ges., vol. LXVII (1915), Abh., Heft 3.

it is the adult and not the inner whorls that show most resemblance to the ancestral form, the ontogenetic evidence on which Salfeld relied is to me valueless. Thus the genus *Sagitticeras*, Buckman, 1921 is in my opinion merely a heterogeneous mixture of transitional *Quenstedioceras* (*Vertumniceras*) e. g. *S. sagitta* and *S. fastigatum* and more or less similar *Cardioceras* (*Vertebriceras*), e. g. *S. moderatum* and *S. carinaeferum*, S. Buckman[1]). Another transitional type is *Goliathiceras*, S. Buckman, 1919[2]) (for often gigantic forms in which the keel may be only in the *Quenstedioceras* stage, in spite of their late age); and I have already pointed out that the inclusion of this genus (with its synonyms *Hortoniceras* and *Korythoceras*, Buckman 1922[3]) in Cardioceratinae rather than Cadoceratinae is arbitrary. *Goliathiceras* is now used as a subgenus of *Cardioceras* for the inflated forms, as *Vertebriceras* and *Scarburgiceras*, Buckman may be used for the quadrate-whorled and untuberculate, discoidal, species respectively; but there are many transitions to *Cardioceras* s. s. (with the synonyms *Paracardioceras*, *Pachycardioceras*, *Galecardioceras*, *Miticardioceras* and *Anacardioceras*, Buckman, also probably the unknown quantity "*Chalcedoniceras*"). Likewise the smooth and discoidal forms (*Scoticardioceras*) are intimately related to the typical, tuberculate, *Cardioceras*, although they also include derivatives of *Scarburgiceras*, with smooth outer-whorls; and Buckman himself included some of the smooth forms in *Anacardioceras*[4]), the tuberculate genotype of which (*A. cordatiforme*), however, was apparently separated from the typical *C. cardia* merely on a presumed difference in age. Unlike *Cawtoniceras*, Buckman[5]), which is later in date than the typical *cordatum* group and may, perhaps, be found to be separable generically, the three groups above discussed are morphological units, i. e. developments more or less parallel with the typical *Cardioceras* s. s. and without time significance. The subdivisions of Buckman's Cardioceratan age[6]) are as misleading as his dating of the Ampthill Clay[7]); he not only inverted the well-known stratigraphical position of some, like *C. excavatum* (*Scoticardioceras*) and *C. vertebrale* (*Vertebriceras*), but included in this age three hemerae (*praecordatum*, *vernoni* and *oculatum*) which are each more or less equivalent to the *renggeri* zone of his Ver-

[1]) Type Ammonites, vol. III (1921), pl. CCLX; vol. IV (1922), pl. CCLXXX; vol. VI (1925—26), pls. DC and DCXXVII.

[2]) *Ibid.*, pl. CXXXII a-c.

[3]) Type Ammonites, vol. IV, pls. CCXCVI and CCCLXI.

[4]) E. g. *A. delicatum* (vol. VI, pl. DCXXX). Since all large examples of *Cardioceras* become smooth, there will generally be considerable practical difficulty in separating *Scoticardioceras* from *Cardioceras* s. s.

[5]) Type Ammonites, vol. V, 1923, pl. CDLIV.

[6]) *Ibid.*, vol. VII, parts 71—72 (A. Morley Davies), 1930, pp. 26—27.

[7]) *Ibid.*, vol. VI, 1927, p. 49.

tumniceratan age. With regard to *Plasmatoceras* (and "*Plasmatites*") which also deserves subgeneric rank within *Cardioceras* (for the finely-ribbed extreme offshoots of the *praecordatum* group = *Scarburgiceras*) it may be mentioned that at Wootton Bassett, *C.* (*P.*) *plastum*, Buckman, (which is very close to *C.* (*P.*) *tenuicostatum*, Nikitin, and *C.* (*P.*) *tenuistriatum*, Borissjak) is associated with a *Vertebriceras* (B. M., no. 37429) so that it is of Upper Oxford Clay (*cardia-vertebrale*) age.

The genera *Prionodoceras*, Buckman, 1920 (for the *serratum*-group) and *Amoebites*, 1925 (for the *kitchini*-group) are justified, in my opinion, but in view of the polyphyletic character of the later Cardiocerates, they are again taken to be merely sub-genera of *Amoeboceras*, Hyatt. The inclusion, by Salfeld, in his one "Group 3" of such diverse elements as *A. alternans*, *A. serratum* and *A. transversum* shows that they are all closely allied, and the *A. bauhini* group of the same author was made to include *Amm. kapfi*, Oppel, a species almost indistinguishable from *Cardioceras* (*Plasmatoceras*) *plastum*, above referred to, of Upper Oxford Clay (i. e. pre-*alternans*) age. Even the tuberculate *Amoebites* is only a morphological unit; and Salfeld[1]) himself significantly pointed out that inner whorls of his *C. praebauhini* could scarcely be separated from a form of the late *anglicum* group.

The younger East Greenland Cardiocerates here described do not include forms of the restricted *alternans* group; but there are some typical *Prionodoceras* and *Amoebites*. On the other hand there are two groups that require new names, namely the *nathorsti-robustum-sokolovi* group (*Euprionoceras* gen. nov.) and the trituberculate *Hoplocardioceras* nov. The first may be defined as comprising those large boreal forms that have young stages like species of the earlier genus *Prionodoceras*, but that remain evolute and ornamented instead of becoming involute and smooth.

There are many incompletely-known forms of *Amoeboceras* in geological literature that are difficult to assign to either *Prionodoceras* or to *Euprionoceras*, at the size represented by the original figures; and for this reason alone it is preferable to retain *Amoeboceras* as a collective name for all the younger Cardiocerates. But the smooth body-chambers of e. g. *A.* (*Prionodoceras*) *excentricum*, Buckman[2]) and the costate final stages of the evolute *A.* (*E.*) *sokolovi* (Bodylevsky)[3]) or of the form here figured as *A.* (*E.*) *kochi* (Plate 5, fig. 2a) are so entirely different that sub-generic separation seems well justified. *Euprionoceras* occurs in Scot-

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[1]) *Op. cit.* (Monogr. *Cardioceras*), 1915, p. 198.

[2]) Type Ammonites, vol. v, 1924, pl. CDLXIV.

[3]) In Sokolov and Bodylevsky: "Jura- und Kreide-Faunen von Spitzbergen". Skrifter om Svalbard og Ishavet, no. 35, 1931, p. 86, pl. VI, fig. 1.

land (Culgower) as well as in North America, Greenland and Spitsbergen, but has not been definitely identified from Russia.

The second new sub-genus *Hoplocardioceras* with its three rows of prominent spines is characterised by its Aspidoceratid aspect which in the case of some badly preserved examples from Kuhn Island has indeed caused them to be attributed to the genus *Aspidoceras*, hitherto unknown from the Arctic regions.

Finally there is the *anglicum* group of Salfeld which includes dwarf-forms that reduce the keel until there is an almost rounded venter and no rostrum. The forms of this latest group of Amoeborates clearly cannot be attached to the extreme *Amoebites* or *Hoplocardioceras* and even if they should turn out to be merely endforms of the large *Euprionoceras*, they are distinct enough for sub-generic separation (= *Nannocardioceras*, nov.).

The Cardioceratinae, then, include the following genera and sub-genera:—

Genus *CARDIOCERAS*, Neumayr and Uhlig 1881.
Genotype: *C. cardia*, Buckman (= *C. cordatum*, Sowerby, partim).
Sub-genus *Goliathiceras*, Buckman 1919.
Sub-genotype: *G. ammonoides* (Young & Bird).
Sub-genus *Scarburgiceras*, Buckman 1924.
Sub-genotype: *S. scarburgense* (Young & Bird).
Sub-genus *Vertebriceras*, Buckman 1920.
Sub-genotype: *V. dorsale*, Buckman.
Sub-genus *Scoticardioceras*, Buckman 1925.
Sub-genotype: *S. scoticum*, Buckman.
Sub-genus *Plasmatoceras*, Buckman 1925.
Sub-genotype: *P. plastum*, Buckman.
Sub-genus *Cawtoniceras*, Buckman 1923.
Sub-genotype: *C. cawtonense* (Blake & Hudleston).

Genus *AMOEBOCERAS*, Hyatt 1900.
Genotype: *A. alternans* (v. Buch).
Sub-genus *Prionodoceras*, Buckman 1920.
Sub-genotype: *P. prionodes*, Buckman.
Sub-genus *Amoebites*, Buckman 1925.
Sub-genotype: *A. akanthophorus*, Buckman.
Sub-genus *Euprionoceras*, nov.
Sub-genotype: *E. kochi*, nov.
Sub-genus *Hoplocardioceras*, nov.
Sub-genotype: *H. decipiens* nov.
Sub-genus *Nannocardioceras*, nov.
Sub-genotype: *N. anglicum* (Salfeld).

Genus *CARDIOCERAS*, Neumayr et Uhlig 1881.

Cardioceras aff. *zenaïdae*, Ilovaïsky.

(Plate 2, figs. 3 a—c).

1904. *Cardioceras zenaïdae*, Ilovaïsky. "L'Oxfordien et le Sequanien des gouvernements de Moscou et de Riasan"; Bull. Soc. Imp. Nat. Moscou, N. S., vol. XVII (1903), p. 269, pl. x, figs. 33—36.

The fragment of a body-chamber here figured is perhaps too incomplete to allow of specific identification, but as it is the only fossil before me from the lowest beds, i. e. the concretions in the sandy micaceous clays and marls between the *Pecten* Sandstone and the basal Charcot Bay Sandstone, it merits careful examination. The last two suture-lines are partly visible at the smaller end, especially the external saddle of the last and the first lateral lobe of the penultimate suture-line. These, however, are not distinctive, and a similar suture-line has been figured, for example by Reeside[1]) for *C.* (*Scarburgiceras*) *martini*, although this is entirely different externally. In view of the small value of the suture-line, it is then necessary to rely on ornamentation and whorl-shape. The latter is subhexagonal (fig. 3c), with the greatest thickness at the lateral tubercle, and a high and perpendicular umbilical wall. The high, thin, keel is accompanied by concave lateral areas, but there are no grooves; the crenulations are sharp and directed forwards, as in typical *Cardioceras*. Each lateral tubercle, connected with the umbilical slope by a sharp rib, gives rise to two smaller costae, which in their turn, at elongated tubercles situated at the ventro-lateral edges, branch into two, still weaker, and strongly projected ribs that each correspond to one tooth in the carina. This is the type of ribbing shown in Ilovaïsky's fig. 34, but there are individuals of the common *C. cordatum* (J. Sowerby) or of the almost identical *C. caelatum*, Pavlow[2]) that could well yield a similar whorl-fragment. A fragment of the last species from Jameson Land is figured in Plate 15, fig. 3; it differs from the common *C. cordatum* merely in its less closely-spaced primary ribs.

The American *C. canadense*, Whiteaves[3]) is not very close to the present form, judging by the original figure; but Reeside's[4]) larger Wyoming specimen and the same author's *C. whiteavesi*[5]) are, perhaps,

[1]) *Loc. cit.* (U. S. Geol. Surv., Prof. Paper 118), 1919, pl. IX, fig. 8.

[2]) "Jurassic and Lower Cretaceous Cephalopoda of N. Siberia", in Résultats scientif. Expéd. polaire russe, 1900—1903. Sect. C. livr. 4, Mém. Acad. Imp. Sci. St. Pétersb., sér. VIII, vol. XXI, no. 4 (1914), p. 49, pl. XIV, figs. 6—7.

[3]) "Description of a Species of *Cardioceras* from the Crows Nest Coal Fields". Ottawa Naturalist, vol. XVII, 1903, pp. 65—67.

[4]) *Loc. cit.* (U. S. Geol. Surv., Prof. Paper 118), 1919, p. 20, pl. XVII, figs. 5—8.

[5]) *Ibid.*, p. 33, pl. XVII, figs. 1—4.

comparable to *C.* aff. *zenaïdae*. I have before me, however, casts of the holotype of *C. whiteavesi* (B. M., No. C 36497a, b), also a well-preserved example labelled *C. canadense* from the Cold Bay Region af Alaska (B. M., No. C 36496); and they are both referable to the sub-genus *Vertebriceras*, having broad, square venters. The Russian species, therefore, is probably most closely comparable to the fragment here figured, but *C.* (*Cawtoniceras*) *cawtonense*, Blake and Hudleston sp.[1]) and *C.* (*C.*) *maltonense* (Young and Bird)[2]) are also similar, though with less regular bidichotomy of the ribs. It is interesting, therefore, to note that *C. zenaïdae* was stated to characterise the upper beds of the *cordatus* zone, i. e. Ilovaïsky's horizons A_2 and B. Externally similar forms of *Cardioceras* from the lower *cordatum* zone, like *C. cardia*, Buckman[3]) (= *C. subcordatum*, Pavlow[4]), *non* d'Orbigny) are distinguishable by their more costate secondaries or the number of the outer ribs, but since the ventrolateral tubercles in the fragment here described are broken off, the side-view (fig. 3a) does not sufficiently emphasise this difference.

Horizon. *Cardioceras* Beds. Neoxfordian (Argovian), probably *perarmatum* zone. It is to be noted, however, that P. Dorn[5]), from corresponding beds in the Franconian Jura (his *biarmatum* and *transversarius* zones), records only *Prionodoceras* (*Amoeboceras* [*P.*] ***franconicum***, n. n. [= *Cardioceras excavatum*, P. Dorn[6]) *non* Sowerby] and *C.* [*P.*] *neischli*, C. Dorn) so that the lower part of the *perarmatum* zone is indicated. At Ardassie Point in Sutherland, similar forms occur, but the *cordatum* zone is also represented there. Buckman's[7]) '*zenaïdae* hemera' and its placing below "*suessi*" (which in vol. VII, p. 26 is put near the base of the Cardioceratan age) cannot be accepted, for the Cardiocerates listed by him on p. 48 are almost certainly misidentified and no Upper Argovian forms comparable to those figured in P. de Loriol's pl. II (1902) could occur below equivalents of the Red Beds (*vertebrale-cardia* zone) of Weymouth.

Locality:— 800 m from Ravine "2 W." (No. 255), at 316 m.

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[1]) See Buckman, Type Ammonites, vol. V, 1923, pl. CDLIV.

[2]) Geological Survey of the Yorkshire Coast, 1822, pl. XII, fig. 10 (e. g. B. M., No. 39571, from Malton, ex Bean Collection).

[3]) Type Ammonites, vol. III, 1920, pp. 10, 15 (See Pal. Universalis, 1905, pl. 94, figs. P_4, P_{4a}, P_{4b}).

[4]) *Loc. cit.* (Mém. Acad. Imp. Sci. St. Pétersb. [VIII] XXI), 1914, p. 48, pl. XIV, figs. 5a, b.

[5]) Die Ammoniten-Fauna des Untersten Malm der Frankenalb. II. Palaeontogr., vol. LXXIV, 1931, p. 77.

[6]) *Ibid.*, p. 77, pl. XIX, figs. 2a, b (holotype).

[7]) Type Ammonites, vol. V, 1925, p. 49.

Cardioceras (?) sp. juv. ind.

(Plate 9, figs. 5a—i).

The three examples here figured are too small for definite identification, the largest being only 11 mm in diameter. They are all perfectly smooth, with the periphery becoming angular at 6—7 mm and finely crenulate at about 10 mm. The whorl-section is higher than wide and more compressed than in *C. zieteni* (Rouiller), even the examples figured and described by Ilovaïsky[1]), or in *C. tenuiserratum* (Oppel) as illustrated by Bruder[2]). Moreover, both the forms just cited have the lateral folds already developed at the size of the example here figured in fig. 5a, as have some Popilany specimens of the same group, now before me (B. M., no. C 7869b, c). They may be only the young of *C. schellwieni*, Boden[3]), although Pakuckas[4]) has now also recorded *C.* sp. ind. aff. *zieteni* from Popilany; but *C. kokeni*, Boden[5]), with smooth inner whorls to a diameter of 14 mm, is perhaps also comparable to the Greenland examples here described.

There are, however, still more closely comparable forms of *Cardioceras* in the English Elsworth Rock, including the new and quite smooth species I recorded in 1933[6]) and immature *Cawtoniceras* of the type of Blake's smaller example of *C.* (*C.*) *cawtonense*[7]). In a Drift nodule, again, presumably from the overlying Ampthill Clay, there was found the example figured in Plate 13, fig. 4, as *Cardioceras* (*Cawtoniceras*) ***blakei*** sp. nov. which also has entirely smooth inner whorls and which differs from *C. kokeni*, already cited, by acquiring robust ornamentation on the body-chamber. There are still other undescribed species of the same group, and it is probable that the three Greenland specimens here figured are inner whorls of the same type as the species just discussed, especially as *C.* aff. *zenaïdae*, described above, has been found in beds of perhaps the same age.

Among the American species of *Cardioceras*, *C. canadense*, Whiteaves, already cited, has the earlier whorls smooth; but according to Reeside[8]),

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[1]) *Loc. cit.* (Bull. Soc. Imp. Nat. Moscou), 1904, p. 271, pl. XI, figs. 3—4.

[2]) "Fauna der Jura-Ablagerungen von Hohnstein in Sachsen". Denkschr. K. Akad. Wiss. Wien, vol. 50, 1885, p. 262, pl. I, figs. 1a—c.

[3]) "Die Fauna des Unteren Oxford von Popilany in Litauen". Geol. Pal. Abh., N. F., vol. X, 1911, p. 158, pl. XXI, figs. 3, 3a, b.

[4]) "Die Ammoniten-Fauna des Oxford und Kelloway von Papilé". Mém. Fac. Sci. Univ. Vytautas-le-Grand, vol. VI, 1932, p. 72.

[5]) *Loc. cit.* (Geol. Pal. Abhandl., X), 1911, p. 159, pl. XX, figs. 9—10.

[6]) Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch). Pal. Indica, N. S., vol. IX, no. 2, pt. VI, 1933, p. 866.

[7]) Corallian Rocks of England. Q. J. G. S., vol. XXXIII, 1877, pl. XIII, fig. 2a.

[8]) *Loc. cit.* (U. S. Geol. Surv., Prof. Paper 118), 1919, p. 21.

distinct ribs show on the venter where the diameter is more than 8 mm, while the present form is perfectly smooth still at 11 mm.

The specimens could, of course, also be the young of forms of *Amoeboceras* (*Prionodoceras*) since the inner whorls are smooth in species like *A.* (*P.*) ***marchense*** sp. nov.[1]) or *A.* (*P.*) ***ravni***, sp. nov. (Plate 4, fig. 4, see p. 37).

Horizon:— *Cardioceras* Beds(?) or *Pecten* Sandstone, Section IV of Rosenkrantz, from sandy concretions with numerous pelecypods and many belemnites. Neoxfordian (Argovian), probably *perarmatus* zone, corresponding to zone B of Ilovaïsky (with *C. zenaïdae* and *C.* cf. *zieteni*), but perhaps higher.

Locality:— North of northernmost 'basalt' dyke, east coast of Milne Land, at 25 m.

Genus *AMOEBOCERAS*, Hyatt 1900.

Sub-genus *Prionodoceras*, Buckman 1920 emend.

Amoeboceras (*Prionodoceras*) *transitorium*, sp. nov.

(Plate 1, figs. 8a, b).

Diagnosis:— Rather high whorls (subplatygyral), probably rather inflated (subpachygyral); comparatively narrow umbilicus (subangustumbilicate). Whorl-section subcordate, with greatest thickness at lateral tubercle; umbilical wall high, with rounded edge; ventral area with high, median keel, but only slight depressions on each side. Keel with numerous, transverse, notches, at least three to each peripheral rib; forward prolongation of the latter towards the keel strongly marked. Ribs at first more or less uniform, long and straight, as in *Prionodoceras*; later a lateral tubercle is developed and the ribs are more or less irregularly bifurcate, with the two secondary branches strongly curved forward and becoming almost tuberculate. Inner whorls and suture-line unknown.

Measurements:—

Diameter (in mm)	90
Height of the outer whorl (in % of diameter	47
Thickness of the outer whorl (in % of diameter)	34?
Umbilicus (in % of diameter)	27

Remarks. The thickness was determined from the reconstruction of the whorl-section, given in fig. 8b, but since the specimen is largely crushed, the measurements can only be taken to be approximate. This

[1]) Based on *Cardioceras* aff. *excavato* (J. Sowerby) Crick: On the Muscular Attachment of the Animal to its Shell in Some Fossil Cephalopoda (Ammonoidea). Trans. Linn. Soc. London (2nd ser.) vol. VII, pt. 4, 1898, p. 86, pl. XVIII, figs. 9—10.

whorl-section as well as the finely serrated keel suggest comparison with *A.* (*Prionodoceras*) *ogivale*, S. S. Buckman[1]), which was correctly identified as a *Prionodoceras* and not a *Cardioceras* s. s., and which must have the costate *alternoides* stage ending at a much smaller diameter than in the present species or even in *A.* (*P.*) *serratum* (Sowerby)[2]) or *A.* (*P.*) *shuravskii*, Sokolov sp.[3]).

The largest example of '*Ammonites cordatus*' figured in d'Orbigny's[4]) Plate CXCIV is also comparable to the present species, but only as regards the earlier whorls; and since the figure is not reduced, this ammonite must belong to the earlier *cordatum* group. Siemiradzki[5]) included d'Orbigny's figure in his *C. suessi*, based on an unrecognisable illustration in Pusch[6]). Douvillé[7]) almost certainly misinterpreted this species in making it a variety of *C. cordatum*, transitional to *C.* (*Scarburgiceras*) *praecordatum*, and I can see no resemblance between d'Orbigny's ammonite and for example the "*C. suessi*" (probably a *Scarburgiceras*) figured by Roemer[8]).

It is to be noted, however, that in d'Orbigny's figure, the outer whorl shows reduction of the ornament, whereas in the species here described the last half whorl probably formed the (temporary) body-chamber and the strength of the ribbing increases throughout. It, therefore, is a species of *Prionodoceras*, more coarsely ornamented than any yet described; and it must have reached a comparatively enormous size. The single, almost rectiradiate, ribbing of the earlier whorls suggests comparison of these with the form described below as *A. aldingeri*, and it definitely separates the present form from *Cardioceras*; but identification with any known form is out of the question. It may be added that among the large English, American and Siberian species of *Cardioceras* described by Buckman (1919—1926), Reeside (1919) and Pavlow (1914) there also is nothing comparable to *C. transitorium*. In the large *Cardioceras* showing the final stage, figured by P. de Loriol[9]),

[1]) Type Ammonites, vol. IV, 1923, pl. CDXXI. A specimen in the Sowerby Collection (No. C. 36503) is apparently from the same bed as *A.* (*P.*) *marstonense* (Plate 4, fig. 5).

[2]) See Salfeld: *op. cit.* (Monogr. *Cardioceras*), 1915, pl. XVIII, fig. 1a (= *P. prionodes*, S. Buckman).

[3]) "Zur Ammoniten-Fauna des Petschoraschen Jura". Mém. Com. géol. St. Pétersbourg, N. S., livr. 76, 1912, p. 60.

[4]) Paléont. Française, Terr. Jurass., vol. I, 1849.

[5]) "Fauna Kopalna &c." Pamietnika. Wydz. mat. przyr. Akad., Krakowie, vol. XVIII, 1891, p. 28.

[6]) Polen's Palæontologie, 1837, pl. XIV, fig. 4.

[7]) *Loc. cit.* (Mém. Soc. géol. France, Paléont. no. 45, XIX, pt. 2), 1912, p. 64.

[8]) As *Amm. cordatus*. Geologie von Oberschlesien, 1870, pl. XXIV, fig. 2.

[9]) Étude sur les mollusques et brachiopodes de l'Oxfordien supérieur et moyen du Jura lédonien. Mém. Soc. Pal. Suisse, vol. XXIX, 1902, pl. II, fig. 7.

the coarsely crenulated keel is entirely against comparison with the present species.

Embedded in the same piece of sandstone as the holotype of the present species was the fragment illustrated in Plate 1, fig. 5. It shows only a few single and bifurcating ribs and cannot be definitely attached either to *A*(*P.*). *transitorium* or to a form like *A.* (*P.*) aff. *alternoides*, figured in Plate 1, fig. 4, but it supports the reference of the present species, with perhaps more finely costate inner whorls, to *Prionodoceras* rather than to *Cardioceras*; for it is comparable to the *Prionodoceras* figured by Sokolov[1]) as *C.* cf. *quadratoides* (*non* Nikitin) and correctly placed with *C.* (*P.*) *shuravskii*, Sokolov sp., already referred to.

Horizon:— *Cardioceras* Beds, a few metres below *Pecten* Sandstone. Neoxfordian (Upper Argovian-Rauracian). The age is probably about the same as that of the Port-an-Righ beds (with *Prionodoceras ogivale* and '*Pictonia* cf. *parva*', Tornquist[2]), erroneously attributed to the Kimmeridgian; and in view of the ammonites found in the overlying *Pecten* Sandstone, the present form cannot be even uppermost Neoxfordian.

Locality:— About 500 m north of III (between *Cardioceras* Ravine and Section IV of Rosenkrantz). No. 231.

Amoeboceras (*Prionodoceras*) aff. *pseudocaelatum*, nom. nov.

(Plate 2, fig. 4).

1904. *Cardioceras* cfr. *alternans* (Buch); Ilovaïsky, *loc. cit.* (Bull. Soc. Imp. Nat. Moscou, N. S., vol. XVII), p. 272, pl. XI, fig. 6 only.

1915. *Cardioceras* aff. *cordatum* (Sowerby); Salfeld: "Monographie der Gattung *Cardioceras*". Part I. Zeitschr. deutsch. geol. Ges., vol. LXVII, Abh.; Heft 3, p. 165.

The new name is intended for the Russian form figured by Ilovaïsky, and on account of its small size, the Greenland specimen here discussed can only be doubtfully included with this species. It shows, however, the characteristic features of this distinctive form, namely the small tubercles at the middle of the whorl-sides, about twice as many secondary ribs as primaries, and very strong projection of the former, also a very high keel. Since the Greenland specimen is crushed, the slight differences that are noticeable between it and Ilovaïsky's figure are not taken to be significant. Thus, it could be held that the lateral tubercles are scarcely

[1]) *Loc. cit.* (Mém. Com. géol. St. Pétersb., N. S., 76), 1912, pl. II, figs. 7—9.

[2]) See "The Geology of the Country around Golspie &c." Mem. Geol. Surv. Scotland, 1925, p. 114.

prominent enough in the example here figured and the peripheral projection of the secondary ribs seems less pronounced, at least on the figured side. Both these features, however, may be explained by the compression.

Salfeld, who discussed Ilovaïsky's form in considerable detail, thought that it was certainly very closely allied to *C. cordatum*. I do not agree, and consider the resemblance to certain forms of the *cordatum* group to be superficial and due partly to similar projection of the ribbing which, however, is of a different type. On the other hand, there is close affinity between *C. pseudocaelatum* and the new Marston species figured in Plate 4, figs. 5 a, b as *A.* (*P.*) ***marstonense***, sp. nov. This interesting species differs from the present form merely in its less fine and close ribbing, but it shows the suture-line which is unknown in *C. pseudocaelatum*. It is characterised by a high external lobe and the broad and low saddles of *Prionodoceras*; and it indicates the taxonomic position of the two species. Moreover, it enables us to place correctly a number of forms of *Cardioceras* figured by P. de Loriol[1]) and wrongly referred to *C. cordatum* or to *A. alternans*. Thus, while the passage-form depicted in de Loriol's fig. 13 differs from enodate varieties of the present species chiefly in its earlier whorls, the originals of the same author's figs. 11, 14, 15 and 16 are merely the young of forms of *Prionodoceras* of the *serratum-alternoides* group, comparable to those figured by Nikitin[2]). An evolute variety of the present species, without lateral nodes and therefore showing resemblance to the form figured in de Loriol's fig. 10, was recorded by Blake[3]) (as *Amm. alternans* = *serratus*) from the Upper Calcareous Grit of Nunnington. The resemblance of de Loriol's form to *C.* (*Plasmatoceras*) *plastum* is interesting in view of the polyphyletic origin of *Amoeboceras*, here claimed, as against the single lineage postulated by Nikitin[4]).

A. (*P.*) *alternoides*, Nikitin, sp. discussed below, has less close ribbing, while in *Amoeboceras alternans* and *A. ovale* the ribbing appears reclined rather than projected, at least in side-views.

Horizon:— *Cardioceras* beds, several metres below *Pecten* Sandstone. Neoxfordian (Upper Argovian-Rauracian), *transversarius* or *bimammatum* zones. The position in the former zone of *A. pseudocaelatum* (= *A.* cf. *alternans* of Ilovaïsky's bed D_1) in my Correlation Table II[5])

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[1]) *Loc. cit.* (Mém. Soc. pal. Suisse, vol. XXIX), 1902, pl. I.

[2]) Die Cephalopoden des Moskauer Jura. I. Mém. Com. géol. St. Pétersb., N. S., no. 70, 1916, pl. I.

[3]) Corallian Rocks of England. Quart. Journ. Geol. Soc., vol. XXXIII, 1877, p. 360.

[4]) *Op. cit.*, (1916), p. 39.

[5]) *Loc. cit.* (Pal. Indica, N. S., vol. IX No. 2), pt. VI, 1933, p. 872.

may be too low; for the allied *A. marstonense* is probably from the *Ringsteadia* beds and the evolute variety of *A. pseudocaelatum*, above referred to, from Nunnington, is from the Upper Calcareous Grit.

Locality:— 300—400 metres north of III (between *Cardioceras* Ravine and Rosenkrantz's Section IV). No. 232.

Amoeboceras (*Prionodoceras*) aff. *alternoides* (Nikitin).

(Plate 1, figs. 4a, b).

1878. *Amaltheus alternoides*, Nikitin. "Ammonites of the Group of *Amaltheus funiferus*, Phillips" (in Russian). Bull. Soc. Imp. Nat. Moscou, vol. LIII, 2, p. 147, pl. I, figs. 14—15.

1904. *Cardioceras alternoides* (Nikitin) Ilovaïsky, *Op. cit.*, (Oxfordien et Sequanien de Moscou et de Riasan), p. 273.

1912. *Cardioceras alternoides* (Nikitin) Sokolov, *Op. cit.*, (Zur Amm.-Fauna des Petschoraschen Jura), pp. 41, 61, pl. III, fig. 1.

1916. *Cardioceras alternoides* (Nikitin) Nikitin: *Op. cit.*, (Cephalop. des Moskauer Jura), p. 6, pl. I, fig. 1.

(?)1931. *Cardioceras alternoides* (Nikitin) Sokolov and Bodylevsky, *Op. cit.* (Jura-Kreide Faunen von Spitzbergen), p. 83, pl. VIII, fig. 4.

1932. *Cardioceras alternoides* (Nikitin) Pakuckas: Die Ammoniten-Fauna des Oxford und Kelloway von Papilé. Mém. Fac. Sci. Univ. Vytautas-le-Grand, vol. VI (1931—1932), pp. 19 & 71, pl. I, fig. 1.

The example here figured is rather too small for definite identification, and it seems to be not only more involute than the excellent figure in Nikitin's posthumous work (1916), but to have the keel more definitely separated from the periphery, as in the *serratum* group. The dimensions are not so very different from those of Nikitin's 1916 example (at 50 mm diameter) but disagree with those given in Nikitin's text, both in 1878 and in 1916:—

	Plate 1, fig. 4	Nikitin, 1916
Diameter (in mm)	40	50
Height of last whorl (in % of diameter)	45	42
Thickness (in % of diameter)	31	29
Umbilicus (in % of diameter)	25	29

In *A.* (*P.*) *serratum* (J. Sowerby) which Nikitin (in 1878) aptly thought to be possibly the same as his species, the whorls are more

quadrate at the same diameter, with sharp ventro-lateral shoulders, and there is a distinct median tubercle on the ribs. There are many intermediate forms, however, between *A.* (*P.*) *alternoides* and the less highly ornamented species of *Prionodoceras*, such as *A.* (*P.*) *excentricum*, Buckman (L. F. S., no. 82) and *A.* (*P.*) *prionodes*, Buckman (L. F. S., no. 81), although these soon become smooth, whereas *A. alternoides* at over 80 mm diameter merely loses the regularity of the ribbing (L.F.S., no. 83). Another slightly different English specimen of *A.* (*P.*) *alternoides* (no. 84) associated with *A. marchense* sp. nov. (= *Cardioceras* aff. *excavato*, Crick[1]) = *C. ovale*, Quenstedt in Salfeld) differs from the Greenland example in having fewer single ribs. The latter form thus also comes close to ***A. leucum*** sp. nov. (Plate 5, figs. 3a, b)[2]) which I take to include (as an evolute variety?) the original of Ilovaïsky's[3]) pl. XI, fig. 2 (*C.* cfr *bauhini*, Oppel). This was doubtfully left by Salfeld[4]) in *C. bauhini*, but it is a form of the *alternoides* group and var. *e* of *C. alternans* (v. Buch) in Nikitin[5]) may represent its inner whorls. The latter author's *C. bauhini*[6]) which also has nothing to do with Oppel's species, is another allied species and may be renamed *A.* (*P.*) ***simplex,*** nom. nov.

The Greenland example, with its rather numerous single ribs may also be compared to the Novaya Zemlya forms that were described by Frebold[7]) as of Lower Oxfordian age and referred to Pavlow's *C. excavatum*, var. *arctica*. I may say at once that this identification is erroneous; and in my opinion the assemblage belongs to the Upper, not the Lower, Oxfordian, as held already by Tullberg and Ravn, the ammonite being even generically different from Pavlow's Siberian form. I would not insist on the resemblance of Frebold's figs. 2 and 3 (pl. XXIV) to *C. grumanticum*, Sokolov and Bodylevsky[8]), because that species is based on a mere fragment; and if Frebold's fig. 4 represent the same form as his

[1]) On the Muscular Attachment of the Animal to its Shell in some Fossil Cephalopoda (Ammonoidea), Trans. Linn. Soc. London, ser. II, vol. VII, pt. 4, 1898, p. 86, pl. XVIII, figs. 9—10, (B. M. no. 50098).

[2]) Diagnosis:— Like *A. alternoides*, (Nikitin), but with parallel whorl-sides, square venter, and all the ribs tending to become single. Suture-line very simple, with second lateral lobe scarcely more individualised than the two auxiliary notches. This species may include *Amm. alternans* var. *ovalis* of Rouiller (1846, Bull. Soc. Imp. Nat., Moscou, pl. A, fig. 3).

[3]) *Loc. cit.* (Bull. Soc. Imp. Nat. Moscou), 1904.

[4]) *Loc. cit.* (Zeitschr. deutsch. geol. Ges.), 1915, p. 180.

[5]) *Loc. cit.* (Mém. Com. géol. St. Pétersb.), 1916, pl. I, fig. 4. But note the resemblance of some of these young forms, wrongly referred to *A. alternans*, to species like *A.* (*P.*) *shuravskii* Sokolov sp.

[6]) *Ibid.*, p. 40, pl. I, fig. 8.

[7]) Verbreitung und Ausbildung des Mesozoikums in Spitzbergen. Skrifter om Svalbard etc., No. 31, 1930, p. 72, pls. XXIV—XXV.

[8]) *Loc. cit.* (Skrifter om Svalbard, 35), 1931, p. 87, pl. VI, fig. 4.

figs. 2 and 3 then the two species develop along different lines at larger diameters. But Frebold's fig. 5 depicts a form of the *serratum* group and his largest example (pl. xxv) is probably also a *Prionodoceras*, judging by the keel and umbilicus, and it is interesting to recall in this connection that in England *A.* (*P.*) *serratum* had always been mistaken for *C.* (*Scoticardioceras*) *excavatum*[1]), on account of its undercut umbilicus. The original of Frebold's fig. 4 probably belongs to the same group as *A.* (*P.*) *simplex*, nom. nov. (= *C. bauhini*, Nikitin non Oppel) which has only single ribs but is connected by transitions with what the same author described as *C. alternans*, i. e. young *Prionodoceras* with more bifurcating than single ribs.

Horizon:— *Pecten* Sandstone. Neoxfordian (Rauracian). Sokolov stated that *A. alternoides*, together with *Cardioceras zenaïdae*, characterised the highest bed of the Orenburg Oxfordian; but I do not know of any species of *Cardioceras*, with resemblance to *C. zenaïdae*, occurring so high in the sequence. The species occurs in the English Ampthill Clay which includes the Rauracian and part of the Argovian.

Locality:— L (West River), No. 206.

Amoeboceras (*Prionodoceras*) aff. *superstes* (Phillips).

(Plate 1, figs. 2a, b).

1871. *Ammonites superstes*, Phillips. Geology of Oxford, p. 332, pl. xv, fig. 21.

1923. *Prionodoceras superstes* (Phillips) Buckman: Type Ammonites, vol. iv, pl. cdxxii.

1927. *Prionodoceras superstes* (Phillips) Buckman: *ibid.*, vol. vi, p. 49.

Since Phillips's original sketch, showing merely two bifurcating ribs, is entirely inadequate to define this species, Buckman's illustration is taken as representative, but in the absence of a description and in view of the defective preservation of both the English and the Greenland examples, the identification can only be approximate. The fragment here figured is characterised by flat sides and a compressed whorl-section, with a rectangular venter, surmounted by a high keel. The ribs are indistinct, but the elongated inner nodes, near the umbilical edge, the small median tubercles and the angular and projected outer nodes are conspicuous. The ornamentation altogether resembles that of a small example of a "variety of *C. cordatum*" figured by P. de Loriol[2]). This I consider to belong to the sub-genus *Cawtoniceras*; its keel is that of a *Cardioceras*, not of a *Prionodoceras*. In the present form the typical,

[1]) See Salfeld "Die Gliederung des oberen Jura in Nordwest-Europa &c.". N. Jahrb. f. Min. &c., Beil. Bd., xxxvii, 1913, p. 196.

[2]) *Loc. cit.* (Mém. Soc. pal. Suisse, vol. xxix), 1902, pl. ii, fig. 9.

transverse *Amoeboceras* crenulations number at least three to each outer tubercle. Moreover, the periphery is almost carinati-sulcate in the Greenland form, and the inner nodes are short and confined to the umbilical edge, while the lateral nodes are not only placed nearer the outer row than in *Cawtoniceras*, but are at first only faint ribs. Their number is only slightly smaller than that of the outer row. There is no trace of a suture-line.

A. (*P.*) *serratum* (J. Sowerby)[1]) at a comparable diameter has pronounced primary ribs of which the median tubercles form the terminations. It is also far less compressed, but it is uncertain whether the Greenland example here described has been crushed in the rock (a micaceous, hard, sandstone).

Horizon:— *Pecten* Band, 11 m above base of *Pecten* Sandstone. Neoxfordian (Rauracian). Buckman[2]) put *A. superstes*, from the Brill Serpulite Bed, in a separate zone above his *serratum* hemera; not only is there no evidence for a difference in age, but Buckman mistook the whole stratigraphical position of *Prionodoceras* in placing it above *Ringsteadia* instead of below, i. e. in the Kimmeridgian instead of the Oxfordian.

Locality:— III (between *Cardioceras* Ravine and Section IV of Rosenkrantz). No. 233.

Amoeboceras (*Prionodoceras?*) *prorsum*, sp. nov.
(Plate 5, fig. 5).

Diagnosis:— Whorls rather high (subplatygyral), probably rather compressed (subleptogyral); rather narrowly umbilicate (subangustumbilicate). Whorl-section with rather flattened sides, rounded umbilical wall and carinatisulcate periphery with high median keel, smooth below the crenulations. Ribs reclined on umbilical wall, then straight up to middle of side where they bear small nodes. After slight weakening they are pronounced again near ventro-lateral shoulders, and like the occasional intercalated secondary ribs form strongly projected hooks that unite in continuous lateral keels, much lower than median keel. Secondary ribs less frequent than single costae; about 11 outer to 8 inner. Suture-line unknown.

Measurements:—

Diameter	44 mm
Height	41 %
Thickness	?
Umbilicus	32 %

[1]) Mineral Conchology, vol. I, 1812, p. 65, pl. XXIV, *non* Salfeld, *loc. cit.* (1915), pl. XVIII, figs. 1a—c, 2 (= *P. prionodes* and *P. excentricum*, Buckman).

[2]) Type Ammonites, vol. IV, 1923, p. 37, vol. VII, 1930 (p. 25).

Remarks:— This form shows resemblance to *A.* (*Prionodoceras*) *pseudocaelatum*, above discussed (p. 19) as well as to *A.* (*P.*) *alternoides* (Nikitin), but it is distinguished from the former by being less closely ribbed at the same diameter, in having a wider umbilicus, and in having the keel much more definitely separated from the ventro-lateral shoulders. *A.* (*P.*) *alternoides*, with a similarly different periphery and narrower umbilicus, is also more finely ornamented on the inner whorls.

The only available example, unfortunately, is crushed and it is impossible to state whether it includes part of the body-chamber. But it is clearly different for example from any of the forms of *Prionodoceras* figured by Nikitin[1]) as "*Cardioceras alternans*" and since it is known to be from a high horizon, it is possible that *A. prorsum* is connected with the forms here referred to *Euprionoceras* rather than with *Prionodoceras*, that is to say, it may not acquire a smooth body-chamber. In the somewhat comparable *A. falcarius* (Quenstedt)[2]) there is half a whorl of body-chamber and the ribs have all become single and are crowded towards the end, so that comparison is difficult.

The species described below as *A.* (*E.?*) *aldingeri* has a different type of ribbing and a more coarsely crenulated keel. *A.* ***nigrum***, nom. nov. (based on one of Frebold's examples of *Cardioceras* cf. *nathorsti*, var. *robusta*, Pompeckj)[3]) to judge by a Van Keulen's Bay example in the Reynolds Collection (B. M., no. C 22018)[4]) is more rectiradiate at all diameters and more distinctly tuberculate at the ventro-lateral shoulders, as are the inner whorls of the more closely ribbed *A.* (*E.*) *sokolovi*, Bodylevsky, at the same diameter. The Novaya Zemlya ammonites figured by Frebold[5]) as *Cardioceras* cf. *nathorsti* are less closely comparable, being *Prionodoceras* of the typical *serratum-prionodes* group.

Horizon:— *Amoebites* Clays, layer of large concretions (δ), 19 m above *Pecten* Sandstone. Lower Kimmeridgian, *cymadoce* zone, accompanied by *Rasenia orbignyi*.

Locality:— *Cardioceras* Ravine (F), at 102 metres. No. 186 (pars).

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[1]) *Loc. cit.* (Mém. Com. géol. St. Pétersb., N. S., livr. 70), 1916, pl. I.

[2]) Ammoniten des Schwäbischen Jura, III, 1887, p. 825, pl. XCI, fig. 8 only.

[3]) Verbreitung und Ausbildung des Mesozoikums in Spitzbergen. Skrifter om Svalbard &c., 31, 1930, p. 34, pl. VIII, fig. 2 only (non fig. 1 = *A. sokolovi*, Bodylevsky).

[4]) Most of the examples of *A.* cf. *nathorsti* recorded by myself in 1921 (Ammonites from Spitsbergen. Geol. Mag., vol. LVIII, p. 351) are referable to *A. sokolovi*, Bodylevsky, 1931.

[5]) *Loc. cit.* (1930), pl. XXVI, figs. 3 (and 1—2) = *A.* (*P.*) ***regulare***, nom. nov. and fig. 4 = *A.* (*P.*) ***freboldi***, nom. nov. Comparable examples from the English Ampthill Clay (B. M., nos. 19536a, 37786 and 20899) develop smooth body-chambers. *A.* ***rosenkrantzi***, sp. nov. (Plate 12, fig. 4; Plate 13, fig. 5) has a smaller umbilicus and a more finely crenulated keel.

Sub-genus *Euprionoceras*, nov.

Amoeboceras (*Euprionoceras*) *kochi*, sp. nov.

(Plate 5, figs. 2a, b).

Diagnosis:— Whorls rather high (subplatygyral), rather narrowly umbilicate (subangustumbilicate); whorl-section unknown, probably considerably compressed and apparently with carinati-sulcate venter. Keel prominent and provided with numerous, fine, transverse teeth. Ribs close and fine, mostly single and strongly bent forward at outer termination. Occasionally a bifurcating rib or conversely, two ribs uniting near the periphery. Suture-line unknown.

Measurements:—

Diameter	106 mm
Height	41 %
Thickness	?
Umbilicus	31 %

Remarks:— The holotype is crushed and it is impossible to state whether it included part of the body-chamber, but near the end the ribbing becomes fine, degenerate, and irregular which may indicate the proximity of the mouth-border. Approximation of the ribbing near the end is shown in *A. sokolovi* (Bodylevsky)[1]) which may reach a still larger size, but its costation is much more distant and coarser than that of the present species, especially on the septate whorls. *A. sokolovi* includes some of the Spitsbergen forms that I had previously[2]) referred to *A.* cf. *nathorsti* (Lundgren), e. g. B.M., nos. C 26957—8 and some figured by Frebold as *Cardioceras* cf. *nathorsti*, var. *robusta*[3]), but unfortunately they are too crushed for comparison of any feature but the spacing of the ribs. In the fragment of *A. kochi* figured in Plate 5, fig. 2b, (in a gypsiferous matrix) it can be seen that the ventro-lateral keels, formed by the continous line of the projected rib-endings, are separated from the median, toothed, keel by well-marked, smooth grooves, which causes a ventral aspect rather different from that illustrated in Sokolov and Bodylevsky's fig. 2 (pl. VI); but there are about 6 primary costae to 12 crenulations in the carina in both species.

The finely-ribbed inner whorls of the present species might be held to be identical with *A. nathorsti* (Lundgren)[4]) which has been so widely

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[1]) Sokolov and Bodylevsky: *loc. cit.* (Skrifter om Svalbard, 35), 1931, p. 86, pl. VI, fig. 1.

[2]) *Loc. cit.* (Geol. Mag.), 1921, p. 351.

[3]) *Loc. cit.* (Skrifter om Svalbard, 31), 1930, pl. VIII, fig. 1.

[4]) "Bemerkungen über die von der Schwedischen Expedition nach Spitzbergen 1882 gesammelten Jura- und Trias-Fossilien". Bihang till K. Svenska Vet. Akad. Handl., vol. VIII, no. 12, 1883, p. 6, pl. I, figs. 1, 2.

quoted, but is still incompletely known. The two examples originally figured by Lundgren are here taken to represent the inner and outer whorls respectively of one and the same species, in spite of apparent differences. The ribbing is first fine and close but later more widely spaced and the furcation of those ribs that are not single takes place at about the middle of the side. The small umbilicus is another important diagnostic feature; and this alone distinguishes *A. nathorsti* from *A. kochi*. The same feature also shows that Salfeld[1]) completely misunderstood this species when he compared it to *A. ovale* (Salfeld *non* Quenstedt), a species that was made to include for example *Cardioceras bauhini* of Sokolov[2]), an Oxfordian *Prionodoceras*, common also in the English Ampthill Clay, together with a more evolute species[3]). The Greenland *C. nathorsti* figured by Ravn[4]), and definitely included by Salfeld in his *C. ovale*, is rather too small for satisfactory identification, since there are so many species that might yield similar inner whorls. But of all the Cardiocerates I have examined, there is only one Kimmeridgian species associated with *Rasenia* which seems to me to represent the true *A. nathorsti*. I am now figuring (Plate 4, fig. 8) part of a slab of carbonaceous shale covered with impressions of this species (a, b) as well as of other forms. Some of these are passage-forms, perhaps referable to the var. *robusta* of Pompeckj, and one of Frebold's Spitsbergen examples may belong to this variety; but there are various other species of *Amoeboceras* in these slabs (e. g. forms of the *beaugrandi-kitchini* group) which are similarly finely ribbed in the young.

Since the most characteristic feature of *A. kochi* is the projected, falcoid ribbing, comparison may be made with *A. volgae* (Pavlow)[5]) which, however, is known only in very small examples. The innermost whorls of the present species are neither so finely ribbed (nor are the ribs so strongly bent) as those of *A. volgae*, nor is there any sign of the peculiar, intercalated secondaries that do not reach to the ventral edge. Other such related small species as *A. subtilicostatum* (Pavlow)[6]) or *A. krausei* (Salfeld)[7]) are still less closely comparable and with

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[1]) *Op. cit.* (Monogr. *Cardioceras*), 1915, p. 168.

[2]) *Loc. cit.* (Mém. Com. géol. St. Pétersb., N.S., 76), 1912, p. 64, pl. III, figs. 9—10.

[3]) Figured in Crick: "On the Muscular Attachment of the Animal to its Shell in some Fossil Cephalopoda (Ammonoidea")", Trans. Linn. Soc. (2nd. ser.), vol. VII, pt. 4, 1898, pl. XVIII, fig. 9 (as *Cardioceras* aff. *excavato*, J. Sowerby sp.) here renamed *Amoeboceras* (*Prionodoceras*) *marchense*, nom. nov. (pp. 17 & 22).

[4]) On Jurassic and Cretaceous Fossils from North-East Greenland. Medd. om Grønl., vol. XLV, 1911, p. 487, pl. XXXV, fig. 10.

[5]) Les Ammonites de la zone à *Aspidoceras acanthicum* de l'Est de la Russie. Mém. Com. géol. St. Pétersb., vol. II, no. 3, 1886, p. 86, pl. VIII, figs. 5a—c.

[6]) *Ibid.*, p. 86, pl. VIII, fig. 4.

[7]) *Loc. cit.* (Monographie *Cardioceras*), 1915, p. 201, pl. XX, figs. 6—10.

A. anglicum (Salfeld) belong to a separate dwarf-offshoot (*Nannocardioceras*).

Horizon:— *Amoebites* shales, about 30—40 m above layer of concretions (δ). Kimmeridgian, probably *mutabilis* zone.

Localities:— Camp I (on shore below Hartz Mtn.) at 20 m (No. 237) and locality K (Hill 295 near West River) marked 350 m (No. 208).

Amoeboceras (*Euprionoceras?*) *aldingeri*, sp. nov.

(Plate 2, figs. 6a, b).

Diagnosis:— Whorls rather high (subplatygyral), probably rather compressed (subleptogyral), rather narrowly umbilicate (subangustumbilicate). Whorl-section probably rectangular, with squarish, carinatisulcate periphery and rounded umbilical walls. Coarsely crenulated carina, with about 10 teeth to six ribs. Costae subfalcoid, comparatively sharp and concave forward at umbilical end, fainter and convex forward at middle of side and more pronounced and projected again at ventrolateral shoulders. Only about three intercalated secondary ribs in 24 (fig. 6b); approximation of last few ribs (fig. 6a) showing proximity of mouth-border. Body-chamber just over half a whorl in length. Suture-line unknown.

Measurements:—

Diameter	48 mm
Height	42 %
Thickness	?
Umbilicus	49 %

Remarks:— The outer endings of the ribs are apparently faint but the only typical example available is crushed. The projected terminations of the ribs form continuous, entire, lateral keels which must have been separated from the thick and coarsely-toothed median keel by distinct grooves. This species is probably close to *A. subcordatum* (d'Orbigny)[1]), which seems to differ merely in the rib-curve (if d'Orbigny's idealised illustration be accepted as correct) and in the earlier whorls. But the Russian species has always been misinterpreted; and even after Douvillé's[2]) refiguration of d'Orbigny's types it was still considered a synonym of *A. alternans*, for example by Nikitin[3]). Yet

[1]) In Murchison, Verneuil and Keyserling: Géologie de la Russie &c., vol. II, pt. 3, 1845, pl. XXXIV, figs. 6—7, non *Cardioceras subcordatum* Pavlow, *loc. cit.* (Mém. Acad. Imp. Sci. St. Pétersb., VIII, vol. XXI, No. 4), p. 48 = *C. cardia*, Buckman, 1920.

[2]) Paléont. Universalis, 1911, no. 212.

[3]) *Loc. cit.* (Mém. Com. géol. St. Pétersb., N. S., no. 70), 1916, pl. I.

the larger of the syntypes figured by Douvillé shows one pair of ribs uniting in an outer tubercle, a curious feature which, in addition to the broad keel, stamps d'Orbigny's form as a member of the *kitchini* group. Moreover, the smaller syntype of *A. subcordatum* is very much like some young Market Rasen (*uralensis* zone) examples in the British Museum (nos. C 7699) labelled by Salfeld himself "*C. kitchini*". They are however, more finely and closely ribbed than the type of *A. kitchini*[1]) or the largest example figured by Salfeld (pl. xx, fig. 16). As already mentioned, Salfeld was only incompletely acquainted with his species or he[2]) would not have contended that the "*Cardioceras*" *bauhini* (*non* Oppel) figured by Nikitin[3]) was perfectly like larger English specimens of *C. kitchini.*

Unfortunately the inner whorls of the holotype of the Greenland form now discussed are not preserved, and the young example figured in Plate 1, fig. 7, can only doubtfully be attached to the present species, although it seems to be connected with it by a larger (unfigured) fragment, in which the last few ribs have already become single. But it would be inadvisable to identify it with *A. subcordatum* merely because of its resemblance to d'Orbigny's idealised figure and in order to avoid giving a new name. The identification might be suggested, in spite of the absence of a ventro-lateral auricle, on the strength of the Market Rasen species of the very variable *kitchini*-group which is figured in Plate 1, fig. 6, as *A.* (*A.*) ***rasenense,*** sp. nov. The holotype of this form is complete to the ventral rostrum of the mouth-border (the body-chamber being over half of the outer whorl) and after an early stage resembling that of *A. kitchini* or *A. subcordatum* it develops rather coarse, almost straight, ribs, ending in elongated outer tubercles. These are greatly produced on the periphery in the form of fine striae, leading up to the transverse ridges of the keel, far in advance of the corresponding ribs; but near the end there is again reduction in the ribbing, as in the form described below as *A.* (*A.*) *irregulare.* These forms show that the presence of pairs of ribs uniting at the peripheral tubercle (sometimes only on one side) is rather too variable a character in the individuals to be of more than specific importance; but *A. aldingeri* and *A. subcordatum* will probably have to be looked upon as passage-forms from *Amoeboceras* s. s. to *Euprionoceras* and *Amoebites.*

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[1]) In P. de Loriol: Monographie paléontologique des couches de la zone à *Ammonites tenuilobatus* de Baden (Argovie). Mém. Soc. pal. Suisse, vol. III, pt. 1, 1876, pl. I, figs. 17, 17a, b.

[2]) *Op. cit.* (Monographie *Cardioceras*), 1915, p. 191.

[3]) "Die Jura-Ablagerungen zwischen Rybinsk, Mologa und Myschkin etc.". Mém. Acad. Imp. Sci. St. Pétersb., (ser. VII), vol. XXVIII, no. 5, 1881, pl. V, fig. 40.

The *Cardioceras subcordatum* (*non* d'Orbigny) figured by P. Dorn[1]) from the Oxfordian ("*hypselum* zone") belongs to the true *Amoeboceras* (*alternans* group) and has nothing in common with the form here described. Those Spitsbergen Cardiocerates that have been recorded under various names but are probably the inner whorls of *A. sokolovi*, referred to above, are distinguished from the form here discussed by their straighter and sharper ribbing, but it is to be noted that the small, crushed, fragment figured by Sokolov and Bodylevsky[2]) also shows great peripheral projection of the ribs. These authors' *C. grumanticum*, already referred to, may, however, also be allied to *A. aldingeri* and differs chiefly in having a more finely crenulated keel.

Horizon:— *Amoebites* shales, layer of large concretions (δ) 19 m above *Pecten* Sandstone. Lower Kimmeridgian, associated with *Rasenia orbignyi*.

Locality:— *Cardioceras* Ravine, at 149 m (No. 249).

Sub-genus *Amoebites*, Buckman, 1925.

Amoeboceras (*Amoebites*) *subkitchini*, sp. nov.

(Plate 1, figs. 3a, b).

Diagnosis:— Like *A. kitchini*, Salfeld[3]), but with slightly larger umbilicus and therefore smaller whorl-height, much closer and finer ribbing on the inner whorls, and with a more finely denticulated keel. Suture-line unknown, probably similar to that of *A. kitchini* (Plate 6, fig. 2).

Measurements:—

Diameter	38 mm
Height	38 %
Thickness	30? %
Umbilicus	34 %

Remarks:— The holotype being crushed, the thickness cannot be measured, but it may be assumed to be about 30—33 % of the diameter, as in *A. kitchini* (Salfeld) and *A. beaugrandi* (Sauvage). Since Salfeld figured and described only the inner whorls of the former species, this was not easy to recognise; and even his largest example (Plate xx, fig. 16) has the outer whorl crushed, so that Salfeld himself was not aware of the curious change in ornamentation. I am therefore now figuring a typical Cromarty specimen (B.M., no. 89062) which is complete to the end and shows exactly the same hoplitid uniting of the ribs

[1]) Ammonitenfauna des untersten Malm der Frankenalb. Palaeontogr., vol. LXXIV, 1931, p. 79, pl. XIX, figs. 6, 7a, b.

[2]) *Loc. cit.* (Skrifter om Svalbard &c., no. 35), 1931, pl. VI, fig. 2.

[3]) *Op. cit.* (Monographie *Cardioceras*, I), 1915, p. 189, pl. XX, fig. 16 only.

in the ventro-lateral tubercles as the Greenland form. This example is scarcely separable from *A. akanthophorum* (Buckman) already referred to, which is not even a distinct variety; but whether these all belong to the same species as P. de Loriol's small Baden example (on which the present species was originally based)[1]) is doubtful. In 1915 Salfeld himself queried the identification; but since de Loriol's original could not be found, and since the interpretation of the figure is difficult, as shown by Salfeld, I am taking the original of this author's fig. 16 (pl. xx) as the neotype (B.M., no. C 13312). *A. beaugrandi* (Sauvage) is more distantly ribbed at the same diameter (Plate 5, fig. 4), but has a less coarse auriculate stage than *A. subkitchini* in the adult (45 mm diameter).

A. irregulare, described below, has far more coarsely ribbed inner whorls, while *A. pingue* (Salfeld)[2]) and *A.* ***salfeldi***, nom. nov.[3]) are even more robust and more involute than *A. kitchini*. The West Garty (Sutherland) fragment figured in Plate 2, figs. 5a, b, from the *eudoxus* zone, is also comparable, since it shows some auriculate ribs. But the earlier whorls of this species are far more distantly ribbed than those of *A. subkitchini* and some examples (e. g., B. M., no. C 13281) were indeed mistaken by Salfeld[4]) for *A. lorioli* (Oppenheimer)[5]), a species of the much earlier *alternans* group. One large fragment from the same rock, with very pronounced peripheral grooves and a keel as broad as that of a fragment ("*Cardioceras* cf. *kitchini*") figured by Sokolov and Bodylevsky[6]), indicates that there are yet several undescribed species of *Amoebites* in the *eudoxus* zone, i. e. higher than *Nannocardioceras anglicum*; and such Spitsbergen *Cardioceras* cf. *kitchini* or *C.* sp. indet. aff. *cricki* (Salfeld) as those figured by Weir[7]) and Frebold[8]), may belong to these species. The *Cardioceras* cf. *kitchini* figured by Frebold[9]) from

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[1]) Salfeld: "Die Gliederung des oberen Jura in Nordwesteuropa &c.". N. Jb. f. Min. &c., Beil. Bd. xxxvii, 1913, p. 129.

[2]) *Loc. cit.* (Monographie *Cardioceras*, I), 1915, p. 193, pl. xix, fig. 1.

[3]) *Ibid.*, pl. xx, fig. 14 only. This has 3—4 smooth whorls and distant, strong costae appear suddenly at a size almost that of the holotype of *A. pingue* (Salfeld's pl. xix, fig. 1).

[4]) *Loc. cit.* (Monographie *Cardioceras*, I), 1915, p. 170.

[5]) "Malm der Schwedenschanze bei Brünn". Beitr. Pal. Geol. Österr.-Ung., vol. xx, 1907, p. 239, pl. xxi, fig. 3.

[6]) *Loc. cit.* (Skrifter om Svalbard, no. 35), 1911, pl. vii, fig. 2.

[7]) Mesozoic Fossils from Spitsbergen. Appendix to Tyrrell: Stratigraphical Observations in the Stor Fjord Region of Spitsbergen, Trans. Roy. Soc. Edinburgh, vol. lvii, pt. iii, No. 27, 1933, pl. lvii, fig. 15 (as *Amoeboceras*).

[8]) *Loc. cit.* (Skrifter om Svalbard, no. 31), 1930, pl. ix, figs. 1—2.

[9]) Untersuchungen über die Verbreitung, Lagerungsverhältnisse und Fauna des Oberen Jura von Ostgrönland. Medd. om Grønl., vol. 94, no. 1, 1933, p. 16, pl. i, fig. 9.

Kuhn Island, however, is probably even less closely related to the present group.

Horizon:— *Amoebites* Shales, layer of large concretions (δ) 19 m above *Pecten* Sandstone. Lower Kimmeridgian, associated with *Rasenia orbignyi*.

Locality:— *Cardioceras* Ravine, at 149 m (No. 249).

Amoeboceras (*Amoebites*) *irregulare*, sp. nov.
(Plate 1, figs. 1a, b).

Diagnosis:— Rather high whorls (subplatygyral), probably rather compressed in body-chamber stage (subleptogyral); comparatively narrow umbilicus (subangustumbilicate). Whorl-section more or less rectangular, first subquadrate, later more compressed, with prominent keel, well separated from ventro-lateral shoulders; rounded umbilical slope. Ribs first as in *A. kitchini* but coarser already at 15 mm diameter; later auriculate, with about 10 ribs to 7 peripheral clavi; on last half whorl degeneration of ribbing to irregular falcoid costae and striae, strongly projected peripherally, and with rarely two joining in an outer thickening. Suture-line unknown.

Measurements:—

Diameter	39 mm
Height	38 %
Thickness	?
Umbilicus	29 %

Remarks:— This species differs from *A. kitchini*, Salfeld, above referred to, in acquiring the auriculate stage at a much smaller diameter and in showing considerable decline of the ribbing which also has no median tubercle at any stage. In *A. subkitchini* the earlier whorls are far more closely and finely ribbed. *A. subcordatum*, discussed on p. 28, also is probably less coarsely ornamented at the same diameter, while *A. pingue*, Salfeld[1]) and especially *A. salfeldi* sp. nov. (= *A. pingue*, Salfeld, partim)[2]) is much more robust and more distantly ribbed. *A. rasenense*, nov. (Plate 1, fig. 6) has no auriculate stage, but the West Garty form (see Plate 2, fig. 5) confused by Salfeld[3]) with *C. lorioli* and already referred to, is somewhat similar, but probably does not belong to the present species. It comes from a sandstone that has yielded various species of *Aulacostephanus*[4]) and is therefore higher in the Kimmeridgian

[1]) *Op. cit.* (Monographie *Cardioceras*), 1915, p. 193, pl. XIX, fig. 1. (lectotype).

[2]) *Ibid.*, p. 194, pl. XX, fig. 14 only.

[3]) *Ibid.*, p. 170.

[4]) See Spath: *op. cit.* (Revision of the Jurassic Cephalopod Fauna of Kachh), pt. VI, 1933, p. 871. Also Bailey and Weir: "Submarine Faulting in Kimmeridgian Times: East Sutherland". Trans. Roy. Soc. Edinb., vol. LVII, pt. II, no. 14, 1932, pp. 463—464.

succession than the *Rasenia orbignyi* assemblage of East Greenland. The species described below as *A. elegans* and *A. pseudacanthophorum* are less closely comparable, being too regularly ribbed and, especially in the case of the second form, far more coarsely ornamented.

Horizon:— *Amoebites* Shales, layer of large concretions δ, 19 m above *Pecten* Sandstone. Lower Kimmeridgian, "*cymadoce* zone", accompanied by *Rasenia orbignyi.*

Locality:— *Cardioceras* Ravine (F), at 102 metres.

Amoeboceras (Amoebites) elegans, sp. nov.

(Plate 4, figs. 1, 2).

Diagnosis:— Whorls rather high (subplatygyral), probably compressed (subleptogyral); with rather wide umbilicus (sublatumbilicate). Section unknown, probably between that of *A. kitchini* (Plate 1, fig. 9) and *A. beaugrandi* Sauvage sp. (Plate 5, fig. 4)[1]). Umbilical wall rounded, ventro-lateral edges distinct, probably with ventral grooves on each side of the median keel, as in *A. pseudacanthophorum.* Ribs evenly and rather closely spaced, consisting of long primaries and short, intercalated or irregularly-branching secondaries in the proportion of nine umbilical to 12 outer ribs. In adult some of the rib-pairs unite in an outer clavus which (in crushed specimens) projects beyond the keel. Final stage characterised by ribbing becoming closer again, single, and irregular. Suture-line unknown.

Measurements:—	Holotype (Pl. 4, fig. 2)	Paratype (Pl. 4, fig. 1)	Variety (Pl. 4, fig. 3)
Diameter	46	40	50 mm
Height	40	40	42 %
Thickness	?	?	?
Umbilicus	35	34	34 %

Remarks:— The example figured in Plate 4, fig. 3, is somewhat transitional to *A. pseudacanthophorum* in having the ribbing slightly less closely spaced than in the holotype. It is probably incomplete, but if the ornamentation should be found to continue to be coarse and distantly spaced, then this example could equally well be attached to

[1]) See: P. de Loriol and Pellat: Monographie pal. & géol. des étages supérieurs de la formation jurassique des environs de Boulogne-sur-Mer. I. 1874, pl. II, fig. 4c. The example here figured (Plate 5, figs. 4a, b) has the lateral tubercle slightly less conspicuous, but comes from a rock in which there are various young Amoebocerates of the same group, all slightly different, so that *A. beaugrandi* is a rather variable species. In the adult it is very similar to *A. subkitchini*, sp. nov. (e. g. B. M. no. C. 36474).

the next species. It is preserved on a slab of black, micaceous, shale that bears two more impressions which seem to be identical with those on the piece of shale figured in Plate 3, fig. 1. The innermost whorls of these impressions (see Plate 5, figs. 1 and 6), after the smooth stage, are rather distantly ribbed, as in *A. dubium* (Hyatt)[1]), but at about 12 mm diameter, there are regularly two short secondaries to each primary, generally separated by a smooth zone; and there are about 14 teeth in the prominent keel to ten of the outer ribs. But this type of ribbing continues to a considerable diameter and at the size of the impression figured in Plate 5, fig. 1, there are still too many bifurcating ribs to allow of identification with Hyatt's species. The four syntypes from among Hyatt's originals, figured by Reeside[1]), may not all belong to the same species and fig. 7 seems to show closer ribbing than the inner whorls of fig. 5, which appears to be the most suitable to choose as the lectotype.

Whether the doubtful impressions just discussed belong to the present species or to *A. dubium*, the holotype of the former, figured in Plate 4, fig. 2, at any rate, has more closely and more regularly-spaced ribs round the umbilical border than either of Reeside's figs. 5 or 6. Hyatt[2]) stated that in his species the costae disappeared occasionally "on the sides just before reaching the geniculae", which suggests reference to *Amoebites*. The flared auriculae are particularly well seen in the transitional example figured in Plate 4, fig. 3, but the approximation of the ribbing towards the end of the holotype shows that at the diameter of the example of *A. pseudacanthophorum* figured in Plate 5, fig. 8, the present form has become not only closely but singly ribbed.

A. elegans may also be compared to the var. *robusta* of *A. nathorsti*, referred to on p. 26 to which may belong the Spitsbergen example figured by Frebold in 1928[3]) and perhaps some of his *Cardioceras* sp. aff. *kitchini* of 1929[4]) (compare Plate 5, fig. 8). There is no indication, however, in *A. elegans* of the rather low branching of some of the ribs of *A. nathorsti* and the inner whorls of *A. sokolovi*, Sokolov and Bodylevsky, also never have auriculate ribbing.

The West Garty fragment figured in Plate 2, fig. 5, and already discussed in connection with *A. irregulare* (p. 32) and *A. subkitchini*

[1]) See Reeside, *loc. cit.* (U.S. Geol. Surv. Prof. Paper 118), 1919, p. 38, pl. XXIV, figs. 5—8.

[2]) Trias and Jura in the Western States. Bull. Geol. Soc. America, vol. V, 1894, p. 420.

[3]) Das Festungsprofil auf Spitzbergen: Jura und Kreide. Skrifter om Svalbard, No. 19, 1928, p. 10, pl. I, fig. 2.

[4]) Die Schichtenfolge des Jura und der Unterkreide an der Ostküste Südwest-Spitzbergens. Abh. Naturwiss. Ver. Hamburg, vol. XXII, 1929, p. 267, pl. III, fig. 10.

(p. 31) may also be compared to the present species, especially as it is from the *eudoxus* zone.

Horizon:— *Amoebites* Shales, between nodule bed γ and Oil Shales. Eo-Kimmeridgian, *mutabilis* zone? The absence of any species of *Aulacostephanus* from the collections before me may not be of significance, but the lower horizon is suggested by the association of *A. elegans* with the form described below as *A.* (*A.*) *pseudacanthophorum.*

Locality:— J = Valley of South River (upper part, at Hill 144 m). No. 203 (pars).

Amoeboceras (*Amoebites*) *pseudacanthophorum*, sp. nov.

(Plate 5, figs. 7—8).

Diagnosis:— Like last (*A. elegans*) but with much coarser ribbing, spaced more distantly, and apparently more quadrate whorl-section. Straight, single ribs; more swollen below outer auricles, than in *A. akanthophorum* (Buckman)[1]). Ventral sulci each side of high keel well marked. Suture-line unknown.

Measurements:—

Diameter	45 mm
Height	39 %
Thickness	?
Umbilicus	38 %

Remarks:— This species is also close to *A. kitchini* and differs merely in its coarser early (costate) stage. In the auriculate stage (Plate 5, fig. 8) the peripheral grooves are also more distinctly developed and although the denticulations are not preserved and cannot therefore be compared with the coarse, transverse ridges of *A. kitchini*, the keel of *A. pseudacanthophorum* must have been higher, judging by its smooth base, visible in the original of Plate 5, fig. 8. *A. pingue* (Salfeld) and especially *A. salfeldi*, nov.[2]) already referred to, have very prominent lateral spines in the younger stages and *A. akanthophorum* (Buckman), mentioned above, is not specifically distinct from *A. kitchini* (Salfeld), and scarcely a variety, with the lateral tubercle rather faint.

The Spitsbergen *Cardioceras* cf. *kitchini* figured by Sokolov and Bodylevsky[3]) may be somewhat intermediate between the Greenland form (Plate 5, fig. 7) and the original of Plate 1, fig. 9, but they are

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[1]) Type Ammonites, vol. v, 1925, pl. DL. It has already been mentioned (p. 31) that this is scarcely separable as a variety from the true *A. kitchini* (Salfeld) as interpreted by that author's form figured in pl. xx, fig. 16.

[2]) See supra, pp. 31—32.

[3]) *Loc. cit.* (Skrifter om Svalbard, no. 35), 1931, pl. VII, fig. 1.

badly crushed. The small and perhaps somewhat different *A.* cf. *kitchini* recorded by myself from Spitsbergen has the lateral tubercles of the inner whorls of Salfeld's largest specimen (Pl. xx, fig. 16) in the British Museum (No. C 13312), but it also is crushed, in a black shale.

Horizon:— *Amoebites* clays, between nodule bed γ and Oil Shales. Eo-Kimmeridgian, *mutabilis* zone ? (suggested by resemblance to *A. kitchini*).

Locality:— J = Valley of South River (upper part, at Hill 144 m). No. 203 (pars).

Sub-genus *Hoplocardioceras*, nov.

Amoeboceras (*Hoplocardioceras*) *decipiens*, sp. nov.

(Plate 2, figs. 1, 2; Plate 3, fig. 2; Plate 4, fig. 7).

1933. *Aspidoceras* sp. indet. Frebold, *loc. cit.* (Medd. om Grønland, vol. 94, no. 1), p. 12, pl. 1, figs. 1-4.

Diagnosis:— Whorls rather high (subplatygyral), especially in young, probably rather inflated (subpachygyral), at least in the earlier stages; with rather narrow umbilicus (subangustumbilicate) which, however, widens with increase in size. Whorl-section probably similar to that of *A. salfeldi* (Plate 2, fig. 7) but with inner (umbilical) tubercle more prominent. Umbilical slope high but rounded; broad venter, apparently with grooves on each side of prominent keel, but becoming more acute at larger sizes. Ribs in young distant, as in *A. salfeldi*, with lateral spine. Umbilical tubercle appears at about 12—15 mm and secondaries become nodate at < 30 mm but still outnumber lateral tubercles by 4 : 3 throughout septate stage. Ribs then almost suppressed; occasionally striation between. Body-chamber with considerably reduced ornamentation and aperture with ventral lappet. Suture-line unknown.

Measurements:—	Holotype (Pl. 3, fig. 2)	Paratype I (Pl. 2, fig. 1)	Paratype II (Pl. 2, fig. 2)
Diameter	140	83	42 mm
Height	38	40	44 %
Thickness	?	?	?
Umbilicus	34	31	26 %

Remarks:— Six examples of this interesting form are now figured, but their preservation is only little better than that of the Kuhn Island specimens figured by Frebold. The smallest (Plate 4, fig. 7, left centre) is like *A. salfeldi*, a species that has the innermost 3—4 whorls perfectly smooth, and then suddenly develops strong ribs, whereas *A. kitchini* and *A. subcordatum* have a much shorter smooth stage and gradually

develop their fine ribbing. The next larger specimen (Plate 4, fig. 7, right centre) has already the Aspidoceratid aspect of Frebold's fig. 2, but the crenulated keel can be seen in at least one place. The rostrum of the complete example figured in Plate 2, fig. 1, leaves no doubt as to the true affinities of this species.

The presence of three rows of tubercles in *A. decipiens* suggests comparison with the *Cardioceras* sp. from Koldewey Island, figured by Ravn[1]). The inner whorls of this form are apparently smooth, but this is partly due to the defective preservation and in any case the ammonite was compared to Ilovaïsky's *C.* cf. *alternans*, here renamed *A. pseudocaelatum* (see p. 19), a distinctly costate form. It seems to me that Ravn's Greenland specimen belongs to the same form as the Scottish example figured in Plate 4, fig. 4 as *Amoeboceras* (*Prionodoceras*) *ravni*, sp. nov. But this form is of earlier age than *A. decipiens*, judging by its association (in the same block) with a large *Prionodoceras* fragment and specimens of the *ovale* group; and the strong median tubercle decreases again in size towards the end, so that *A. ravni* is closer to *A. superstes*, i. e. to *Prionodoceras*, than to the trituberculate species here described.

The inner tubercle is as yet scarcely developed in *A. salfeldi*, but there is a specimen of a black shale from Culgower in the British Museum (Nat. Hist.) (No. C 13205) which, in addition to crushed fragments of *Rasenia*, bears a portion of a large *Amoeboceras* with prominent outer and median tubercles. The umbilical edge is missing, so that it is impossible to state whether this form has a third tubercle. The ribs are also too continuous for this fragment to be identified with the new species here described, but it clearly forms a connecting link between *Hoplocardioceras* and the tuberculate species of *Amoebites* above discussed.

Horizon:—*Amoebites* Shales, probably a little higher than 237 (which is 30—40 m above the nodule bed γ) Kimmeridgian, *mutabilis* zone?

Locality:— Reptile locality, *Pinna* Valley, Hartz Mtn. Nos. 243 and 251.

Family *Perisphinctidae.*

Sub-family *Pictoninae,* Spath.[2])

Perisphinctids, by common consent, are one of the most difficult (and largest) of ammonite groups to classify. The reason for this is that they include so many diverse elements, some stable, others extremely unstable. The stable, unspecialised, forms I take to have persisted in

[1]) *Loc. cit.*, (Medd. om Grønl., vol. XLV), 1911, p. 488, pl. XXXV, fig. 11.

[2]) On the Blake Collection of Ammonites from Kachh, India. Pal. Indica, N. S., vol. IX, no. 1, 1924, p. 13, as a family.

all the Upper Jurassic seas, especially the Tethys; but being comparatively small and not very distinctive, they have been generally neglected. On the other hand the more spectacular, but unstable, extreme offshoots of the neritic, marginal areas have been given distinctive names from the time of the early investigators, at an ever increasing pace. On account of the vastness of the group, Perisphinctids have nearly always been studied from too local a point of view. There are excellent works on the degenerate Perisphinctids of the Kimmeridgian of Le Havre, on the genus *Rasenia* in the Suabian Jura, on the Perisphinctids of the English Upper Kimmeridge Clay, and so forth. But since Siemiradzki's time (1899) few have attempted to survey the family as a whole. Now there is a multitude of genera or sub-genera of Perisphinctids, all more or less disconnected, and their relations to the stable and fundamental Mediterranean forms (that carried on the *Perisphinctes* stock), are uncertain. Those who only work on local faunas are apt to get lost in studying details of little or no significance. But their nomenclature remains to complicate matters. There are so many transitions between all these different groups of Perisphinctids that only an elastic classification will be practicable. I have on more than one occasion expressed doubt about the benefit to palaeontology of the modern craze for "accuracy"; and in view of the admitted persistence, in southern seas, of such stocks as the Oppelids, not to mention the smooth Phylloceratids and Lytoceratids, I think there is still need for a comprehensive genus *Perisphinctes sensu lato* (Waagen), or perhaps preferably *Biplices*, Siemiradzki, besides a *Perisphinctes sensu stricto* (Buckman).

The "Rasenids" are no exception among the Perisphinctid derivatives and they have also been studied from different angles. For the reasons already given, I am in sympathy with Beurlen's[1]) account; for he not only stressed the difficulties of getting a general view of the complex totality of Perisphinctids in the lower and middle White Jura, but rightly considered the Perisphinctids that gave rise to the more specialised offshoots as a 'genetic unity'. Schindewolf[2]) objected to the provisional "group of *Perisphinctes plicatilis*" from which Beurlen derived all the forms of the Middle White Jura and I also do not consider the name well chosen, since *P. plicatilis* (= *Dichotomosphinctes*) does not belong either to *Biplices* or to the group of *Ammonites convolutus impressae*, Quenstedt[3]) (= *Properisphinctes*) which Beurlen considered the root-stock. But in my opinion the unity of the fundamental stock is

[1]) "Zur Systematik der Perisphincten". Centralbl. f. Min. &c. (1926) B., no. 3, pp. 78—95.

[2]) Zur Systematik der Perisphincten. N. Jahrb. f. Min. etc., Beil. Bd., LV, B, 1926, p. 499.

[3]) "Ammoniten des Schwäbischen Jura". III. 1887, pl. XCIV, figs. 11—15.

not necessarily deceptive, even if this stock includes the beginnings of various lateral offshoots, as yet scarcely distinctive. Very few genera of ammonites are strictly monophyletic and Beurlen's "provisional" group of *Perisphinctes plicatilis* is no less homogeneous than many a genus universally accepted.

But in deriving *Rasenia* from "*R.*" *prostephanoides*, Beurlen, or from *Prorasenia* (*witteanus* group), both Beurlen and Schindewolf lost sight of the fact that *Rasenia* is essentially a genus of northern affinities and that it only occurs as an accessory element in more southern faunas. Salfeld[1]) recognised an early (*cymadoce*) group with smooth body-chambers and a later (*uralensis*) group with strong, single ribs on the outer whorls; and the former is so close to the genus *Pictonia* that for a long time authors were unable to separate *Rasenia cymadoce* from *Pictonia cymadoce*. Again the evolute species of *Ringsteadia* (with *Balticeras*) and *Vineta* are very intimately allied to *Pictonia* and the group of *Rasenia trimera* in Dohm's interpretation. Now this homogeneous group of genera had produced gigantic smooth forms already in the uppermost Argovian, some of them characterised by degeneration of the suture-line. But even in *Ringsteadia* some species have olcostephanid inner whorls (Plate 15, fig. 4) while others are perisphinctid (Plate 12, fig. 3); and Tornquist[2]) was probably right in deriving his species of *Pictonia* from various Perisphinctid sources, among them *P.* (*Biplices*) *colubrinus*, which is a well-known representative of what I consider the persisting root-stock. It thus seems preferable to consider with Dohm[3]) all these genera as branches of the great *Perisphinctes* main stock, without attempting to attach each of these typically northern genera to definite species of the South German White Jura. Although it is possible to establish a series from *Rasenia fascigera* through the *striolaris* group to *Involuticeras* and *Pararasenia* and although *R. prostephanoides* may connect up directly with *R. stephanoides* and *Gravesia*, these series are only morphological, not genetic, series, as is proved by the still closer affinity of the true *Rasenia* ("*cymadoce*" group) with *Pictonia* and *Ringsteadia* and normal Perisphinctids.

Since forms like *Rasenia trimera* (Quenstedt) and *R. perisphinctoides* (Wegele) also appear only towards the end of the Upper Oxfordian, it is even possible that "*R.*" *prostephanoides* of the White Jura *α* is not so close to the Kimmeridgian *Rasenia* as Beurlen held. In any case

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[1]) "Certain Upper Jurassic Strata of England". Quart. Journ. Geol. Soc., vol. LXIX, 1913, p. 429.

[2]) "Die degenerierten Perisphinctiden des Kimmeridge von Le Havre. Abh. Schweiz. pal. Ges., vol. XXIII, 1896, p. 9.

[3]) "Ueber den Oberen Jura von Zarnglaff i. P. und seine Ammoniten-Fauna". Abh. geol. pal. Inst. Univ. Greifswald, vol. IV, 1925, p. 38.

Rasenoides fasciger (Quenstedt) leads to the *striolaris* group and to *Involuticeras*, but *Prorasenia* (*witteanus* group) might equally well be the immediate ancestor of *Rasenia*. I previously thought that if it were, as Schindewolf held, the direct root-form of *Rasenia* and its allies, then it would be justifiable to separate them in a distinct sub-family *Raseninae*, Schindewolf. But the older name *Pictoninae*, is now used for all except the aulacostephanid forms[1]), i. e. in addition to the genera *Pictonia*, *Rasenia* and *Gravesia*, formerly cited[2]) there are included here the genera *Ringsteadia* Salfeld, *Vineta* and *Balticeras*, Dohm, *Rasenioides*, and *Prorasenia*, Schindewolf. They are all offshoots of the Perisphinctid main stock, and it seems to me preferable to have a polyphyletic family *Pictoninae* than to split up the *Raseninae* alone into three branches again, derived respectively from "*Rasenia*" *prostephanoides*, *Rasenioides fasciger*, and *Prorasenia witteana*, none of which may lead to the true Market Rasen forms of *Rasenia*. Since these are as yet very incompletely known, I am taking this opportunity of figuring a few, but there is a great wealth of undescribed species awaiting monographic treatment. Most of these can certainly be derived from *Prorasenia triplicata*, J. Sowerby sp. (Plate 12, fig. 2, Plate 14, fig. 5) and *P.* ***hardyi*** sp. nov. (Plate 15, fig. 5) more naturally than from any other forms, but *Rasenia evoluta* (Plate 10, fig. 5) also connects up directly, by way of the coarse variety (*P. emancipata*, Fontannes sp. 1879) figured by Dumortier and Fontannes[3]), with the typical *Pararasenia desmonota* (Oppel)[4]) of the next higher (*mutabilis*) zone.

Genus *RINGSTEADIA*, Salfeld, 1913.

Ringsteadia sp. ind.

(Plate 9, fig. 2).

The crushed fragment here figured shows rather irregular ribbing, bifurcating, or with intercalated secondaries, and there are two deep constrictions, preceded in each case by strengthened ribs and succeeded by a collar, followed by a smooth interval. The preservation suggests that the fragment represents a body-chamber, broken off at the last septum. Constrictions and ribs are merely curved forward. This unusual curve probably is partly due to the crushing, as it is not the same on

[1]) I. e. the subfamily Aulacostephaninae, Spath, including the genera *Aulacostephanus* (v. Sutner and Pompeckj in Tornquist), *Involuticeras*, Salfeld, *Pararasenia*, Spath.

[2]) Spath, *op. cit.* (Blake Collection), 1924, p. 13; also *op. cit.* (Revision of the Jurassic Cephalopod Fauna of Kachh), pt. IV, 1931, p. 469.

[3]) Description des Ammonites de la zone à *Ammonites tenuilobatus* de Crussol (Ardèche), 1876, p. 110, pl. XIV, fig. 4. See also: Description des Ammonites des Calcaires du Château de Crussol, 1879, p. 77, pl. XI, fig. 8.

[4]) Pal. Mitteil. III, 1863, p. 241, pl. LXVII, figs. 1a, b.

the opposite side. The ribbing is continuous across, and strongest on, the venter which must originally have been evenly arched.

The low point of branching of the ribs prevents comparison of the fragment here discussed with the normal Perisphinctids of the Upper Oxfordian and suggests reference to some early member of the Pictoninae. There is some resemblance to *Rasenia perisphinctoides*, Wegele[1]), but the oblique and merely curved constrictions are found in young *Ringsteadia* (see Plate 15, fig. 4) rather than in young *Pictonia* (Plate 8, fig. 4) or the true *Rasenia* (Plate 10, fig. 5). The Greenland example, in fact, is halfway between *R. marstonensis* (Salfeld)[2]) and such more finely-ribbed species as *R. frequens* (Salfeld), but in the absence of the smooth, later stages or of the suture-line, it is impossible to put forward this identification with certainty. The inner whorls of *Ringsteadia anglica*, Salfeld[3]), however, visible in that author's fig. 3a, also differ from the fragment here described merely in their less projected ribbing. The specimen is before me (B. M., no. 50768) and the agreement is so perfect that the generic identification in any case is definite, however, unlikely it may appear at first sight. It is confirmed by the age of the Cardiocerates in the same bed, and the impossibility of accomodating the Greenland form in one of those Upper Oxfordian groups discussed above that foreshadow the true Kimmeridgian *Rasenia*.

Horizon:— *Cardioceras* Beds, a few metres below *Pecten* Sandstone. Upper Argovian. Associated with *Amoeboceras* (*Prionodoceras*) *transitorium*, sp. nov. (p. 17).

Locality:— 500 metres north of III (between *Cardioceras* Ravine and Section IV of Rosenkrantz). No. 231.

Genus *PICTONIA*, Bayle, 1878.

Pictonia sp. ind.

(Plate 14, fig. 4).

The example here figured includes half a whorl of body-chamber but the crushed inner whorls are scarcely recognisable. The impression, however, shows them to have been perisphinctoid, with closely-spaced primary ribs, not bullae. On the earlier part of the outer whorl the ribbing is that of *Pictonia normandiana* (Tornquist)[4]), but later the

[1]) "Stratigraphische und faunistische Untersuchungen im Oberoxford und Unterkimmeridge Mittelfrankens. Palaeontogr., vol. LXXII, 1929, pt. 2, p. 81 (175), pl. X (XIV), fig. 2.

[2]) Monographie der Gattung *Ringsteadia* (gen. nov.). Palaeontographica, vol. LXII, 1917, p. 83, pl. XI, fig. 1 (*non* fig. 2 = *R.* ***bassettensis,*** nom. nov.; see Plate 12, fig. 3).

[3]) *Ibid.*, pl. VIII, fig. 3a.

[4]) *Loc. cit.* (Abh. Schweiz. pal. Ges., vol. XXIII) 1896, pl. VI, fig. 2, as represented by e. g. B. M., no. 23885.

primary costae disappear and only the secondaries remain, which is just the reverse of what takes place in a larger example figured by Tornquist[1]). This is no essential difference, however, for in an English (Marston) specimen of a *Pictonia* aff. *costigera*, Buckman[2]) (B. M., no. 88665) which is much closer to *P. normandiana* than to *P. baylei*, Salfeld[3]), the ribbing is identical with that of the Greenland example. Moreover, even in an example of "*Pictonia cymadoce*, d'Orbigny" thus labelled by Salfeld (B. M., no. 89665a) which, however, I would refer to the var. *evoluta* of Tornquist[4]), there is similar persistence of the secondary costation after the primary has disappeared. In an unstable group like *Pictonia* no two individuals are alike[5]), but if I do not identify the Greenland example with any particular species, it is done only on account of the absence of recognisable earlier whorls.

The forms of *Pictonia* described by Dohm[6]) retain the primary ribs till the end and since there is no degeneration of the suture-line they are distinct and probably early species; his *P. baylei* certainly is not identical with the French ammonite (e. g., B. M., no. 24087). In the Westbury iron-ore, where *Pictonia* also occurs associated with *Ringsteadia* (and gigantic *Perisphinctes*) the species of the former are similarly ribbed to a larger diameter, and have a less degenerate suture-line so that Dohm's *baylei-Ringsteadia* zone may well be uppermost Oxfordian. The occurrence, in the basal Kimmeridge Clay of Westbury, of dwarf *Pictonia*[7]) associated with *Prorasenia* aff. *hardyi*, sp. nov., and allies is therefore of considerable stratigraphical interest. At Wootton Bassett a similar fauna occurs in beautiful preservation, apparently above *Pictonia baylei*, since Salfeld[8]) recorded that species from the ironshot limestone of the basal Kimmeridge Clay, which does not yield these irridescent ammonites[9]), but includes *Ringsteadia*.

Horizon:— *Amoebites* Shales, concretionary layer δ, Lower Kim-

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[1]) *Loc. cit.* (Abh. Schweiz. pal. Ges., vol. XXIII) 1896, pl. V, fig. 1.

[2]) Type Ammonites, vol. VI, 1927, pl. DCCXVI.

[3]) Based on *Pictonia cymadoce*, Bayle (*non* d'Orbigny): Atlas to "Fossiles Principaux des Terrains". I. Explic. Carte géol. dét. France, vol. IV, 1878, pl. LXIV, fig. 1.

[4]) *Loc. cit.* (Abh. Schweiz. pal. Ges., vol. XXIII) 1896, pl. V, fig. 2.

[5]) See Spath: "Notes on Ammonites", Geol. Mag., Dec. VI, vol. VI, 1919, p. 32. For this reason I am referring the original of Plate 8, fig. 4, one of many dissimilar young examples from Wootton Bassett, to *P. baylei* rather than to *P. densicostata* (see Buckman, Type Ammonites, vol. V, 1924, pl. DXXXIII.

[6]) "Ueber den Oberen Jura von Zarnglaff i. P. und seine Ammoniten-Fauna. Abh. geol. pal. Inst. Univ. Greifswald, vol. IV, 1925, p. 31.

[7]) See Spath, *loc. cit.* (Pal. Indica, N. S., vol. IX, no. 2), pt. VI, 1933, p. 867.

[8]) "Gliederung des oberen Jura in Nordwesteuropa &c.". N. Jahrb. f. Min. etc., Beil. Bd. XXXVII, 1913, p. 196.

[9]) See H. B. Woodward: Jurassic Rocks of Britain, vol. V, 1895, p. 164.

meridgian, "*cymadoce* zone". The association with *Amoebites subkitchini* and *Rasenia* of the *cymadoce* group is probably of more importance than the resemblance of the present form to *Pictonia* of the "*baylei* zone", if this zone has any real existence.

Locality:— *Cardioceras* Ravine, at 149 m (No. 249).

Pictonia sp. juv.

(Plate 8, figs. 5a, b).

Like the fragment last described, this is probably a body-chamber, broken off at the last septum, and it also has two deep constrictions. These, however, are succeeded by thickened, bifurcating ribs, as in typical young examples of *Pictonia* from the lowest Kimmeridgian clays of Wiltshire (see Plate 8, fig. 4). The straight ribs, in between, are bi- or trifurcating; the primary stems are sharper than the blunt secondaries, most of which are intercalated. The specimen is slightly crushed, obliquely, but the whorl-section is still almost circular, with rounded umbilical slopes and an evenly arched venter.

Rasenia trimera (Quenstedt)[1]) also seems to have somewhat similar inner whorls, but more in the diagrammatic fig. 4s than in actual examples. If it were not for the very strong *Pictonia*-like constrictions shown by the Greenland fragment, it might also be compared to those small forms of *Prorasenia* that are common in the lowest Kimmeridgian, as mentioned under the last species, but that are difficult to identify at small diameters. The specimen of the *witteanus* group, figured in Plate 14, fig. 3 as *P.* ***bowerbanki***, sp. nov., is probably complete, and it is seen that the body-chamber has only biplicate ribbing. The constrictions in these dwarf-forms, however, are much less conspicuous than those of the Greenland example; and by direct comparison with a young *Pictonia* from Wootton Bassett (B. M., no. 24710d, labelled by Salfeld "*P. cymadoce*, d'Orbigny juv.") the generic identification cannot be doubted.

Horizon: *Amoebites* Shales, concretionary horizon δ, or just below. Lower Kimmeridgian, "*cymadoce* (or *baylei?*) zone".

Locality:— West River, L, at 312 m, loose (No. 207).

Genus *RASENIA*, Salfeld, 1913.

Rasenia orbignyi (Tornquist).

(Plate 8, figs. 1, 2; Pl. 9, figs. 1, 3, 4; Pl. 10, figs. 1—3; Pl. 11, fig. 1; Pl. 12, fig. 1).

1850. *Ammonites cymadoce*, d'Orbigny: (pars) Pal. Française, Terr. Jurass., I, p. 534, pl. CCII, figs. 1—2, pl. CCIII, fig. 1 (Dated "1847").

[1]) Ammoniten des Schwäbischen Jura. III, 1887, pl. CVII, figs. 4, 5.

1896. *Pictonia orbignyi*, Tornquist: *loc. cit.* (Abhandl. Schweiz. pal. Ges., vol. XXIII), p. 29.
1904. *Pictonia cymadoce* (d'Orbigny) Lemoine: Pal. Universalis, pls. lv a, b.
1913. *Rasenia cymadoce* (d'Orbigny) Salfeld: *loc. cit.* (N. Jahrb. f. Min. etc. Beil.-Bd. XXXVII), p. 129.

A number of Greenland examples are figured because they are all slightly different, partly no doubt on account of defective preservation. The smallest specimen (Plate 10, fig. 3) seems to agree with the inner whorls of typical examples (Plate 10, fig. 2; Plate 12, fig. 1) but it might perhaps belong to one of the other forms of *Rasenia* here described; since the earlier volutions of most of the larger specimens are lost or corroded, direct comparison is almost impossible.

The different appearance of the three examples figured in Plate 9, fig. 3 and 4, and Plate 10, fig. 2, is due to crushing in different directions. No peripheral views are therefore now given, even the larger examples being all compressed laterally.

The originals of Plate 11, fig. 1, and Plate 10, fig. 1, remain ornamented to a larger diameter than the most typical example (Plate 8, fig. 1, Plate 12, fig. 1), i. e. to about 120 mm instead of 90, but the proportions are the same (height = 35 %; umbilicus = 38 %). They may be separated as a var. ***ornata***, nov. since they show resemblance to *R. cymadoce* (d'Orbigny emend. Tornquist), which, however, has less coronate, i. e. less true *Rasenia*-like inner whorls. In this var. *ornata* the secondaries remain for a quarter of a whorl or so after the umbilical bullae have disappeared; in the example figured in Plate 12, fig. 1, both types of ribs are lost at the same time.

The large example figured in Plate 9, fig. 1, also does not seem to be separable from d'Orbigny's form, but at 174 mm diameter it has a whorl-height of 31 % and an umbilical width of 50 %. The ornamentation preserved on the opposite side is the same as in the var. *ornata*, i. e. it persists to a diameter of about 120 mm. Reduction, then, is rapid, the faint ribs of the periphery having already disappeared before the last few umbilical bullae, another feature distinctive of this form as compared with the typical examples and the var. *ornata*. On account of the differences in dimensions, this evolute variety may also be separated with a distinct name (var. ***aperta***, nov.). The length of the body-chamber is almost a whole whorl and the fine lineation is well shown in the figure.

There is still another variety (var. ***suburalensis***, nov., Plate 8, fig. 2) which has slightly more closely-spaced ribbing, the swollen primaries numbering 14 (as against 9 in the var. *ornata*). They also degenerate at an earlier stage. The proportions are slightly different

from those of the typical form and the var. *ornata*. The example figured in Plate 8, fig. 2, at a diameter of 114 mm has a whorl-height of 32 % and an umbilicus of 42 %, as compared with 32 % and 45 % in d'Orbigny's *R. cymadoce* (diameter = 83 mm). The side not figured, at the diameter of d'Orbigny's smaller example (as represented in Pal. Universalis), shows such close resemblance that identification of this variety with *P. cymadoce* could be suggested. If I do not unite them, however, it is only because there is no evidence that the next half-whorl of d'Orbigny's form would have shown the degenerate ribbing of the Greenland variety. Since Lemoine thought *P. cymadoce* and *P. orbignyi* to be the same species, it appears probable that the ribbing declined at an earlier stage and more suddenly.

Some of the examples of *R. trimera* (*non* Oppel) figured by Dohm[1]) show resemblance to the Greenland form, e. g. to the original of Plate 10, fig. 2, but others have more distantly spaced primaries (e. g. his pl. VI, fig. 2). In the absence of the originals it is difficult to appraise the Pomeranian forms which, however, do not seem to agree with either Oppel's or Quenstedt's *R. trimera*. Dohm's *R. electra*[2]), which probably should be referred to *Ringsteadia*, is not so closely comparable.

Horizon:— *Amoebites* Shales, concretionary layer δ, 19 m above *Pecten* Sandstone. Lower Kimmeridgian, "*cymadoce* zone" (18 examples and fragments).

Locality:— *Cardioceras* Ravine, loc. F (nos. 186, 187, 188, 189, 190, 191, 222, 249).

Rasenia inconstans, sp. nov.

(Plate 8, figs. 7, 8; Plate 10, fig. 6).

Diagnosis:— Rather high-whorled (subplatygyral) with rather wide umbilicus (sublatumbilicate). Whorl-section probably slightly compressed and altogether similar to *R. trimera*, as generally understood, but costation very irregular. Strong single ribs and pseudo-constrictions, alternating with trifurcating ribs and occasional intercalated secondaries, so that there are about 35 peripheral ribs to 7 umbilical bullae. Ornament apparently weakening at larger diameters. Suture-line unknown.

Measurements:—	Pl. 10, fig. 6.	Pl. 8, fig. 7.	Pl. 8, fig. 8.
Diameter	(at) 80	96	90 mm
Height	36	35	38 %
Thickness	?	?	?
Umbilicus	38	36	34 %

[1]) *Loc. cit.* (Abh. geol. pal. Inst. Univ. Greifswald) IV, 1925, e. g., pl. I, fig. 3.
[2]) *Ibid.*, p. 29, pl. II, figs. 1, 2.

Remarks:— The holotype (Plate 10, fig. 6) with badly preserved inner whorls, and the two body-chamber fragments here figured may not be considered worthy of a distinct name, but it seems to me still more objectionable to refer them to a known species and suggest a spurious relationship to some distant fauna.

R. trimera (Oppel)[1]) has a smaller umbilicus and appears to retain more regular ribbing even on body-chambers, although Favre's[2]) Swiss example loses the primary ribs on the last half whorl. *Ammonites trimerus* (Quenstedt[3]), *non* Oppel) also is more involute, especially the original of Quenstedt's fig. 5. The Pomeranian forms figured by Dohm[4]) as *R. trimera*, also with a fairly complex suture-line, are somewhat comparable to the species here described, but also are not identical, at least in so far as the smaller examples cited below[4]) are concerned.

R. orbignyi (Tornquist), discussed above, is less closely ribbed, as is *R. cymadoce* (d'Orbigny) in the restricted sense. *Triozites seminudatus*, Buckman[5]) may have inner whorls like the present form, but it is difficult to compare on account of its large size. Since the group of *R. cymadoce* (to which Buckman's form evidently belongs, judging by its simplified suture-line), is characterised by its smooth outer whorls, and since *R. cymadoce* itself is the genotype of *Rasenia*, there is no need for the separate generic name *Triozites*; and even the *uralensis* group, with coarsely ornamented body-chambers, is too intimately connected with the *cymadoce* group for subgeneric separation.

A species of the English Kimmeridge Clay with great resemblance to the form here described is (partly) figured in Plate 14, fig. 2 as *R.* ***similis*** sp. nov. At a diameter of 110 mm (still septate) it has scarcely changed its aspect; there are still about 25 primary ribs, but they become increasingly less tuberculate, so that at larger diameters the species resembles *Pictonia* more than *Rasenia*. It is an important transitional form between the *cymadoce* and *uralensis* groups. In *R. inconstans*, the primaries are shorter and the bullae at the umbilical end are more conspicuous, but as the holotype (Plate 10, fig. 6) is crushed, the differences in proportions between *R. inconstans* and *R. similis* appear negligible. In reality the latter species has a slightly larger umbilicus (40 %) than the original of Plate 8, fig. 7 (also crushed); but it enables

[1]) Ueber jurassische Cephalopoden. III. Pal. Mitteilungen, 1863, p. 240, pl. LXVI, figs. 2a, b.

[2]) La Zone à *Ammonites acanthicus* etc.". Mém. Soc. pal. Suisse, vol. IV, 1877, pl. III, fig. 8.

[3]) *Op. cit.* (Ammoniten des Schwäbischen Jura, III), 1887, p. 965, pl. CVII, figs. 4—5.

[4]) *Loc. cit.* (Abh. geol. pal. Inst. Univ. Greifswald, IV), 1925, p. 30, pl. I, figs. 1, 3; pl. VI, fig. 2.

[5]) Type Ammonites, vol. V, 1924, pl. CDXCIV.

us to suggest that the whorl-thickness was probably originally equal to the whorl-height (35 %).

The holotype (Plate 10, fig. 6) seems to show some resemblance to the Kuhn Island example figured by Frebold[1]) as *Rasenia* (?) sp. indet. aff. *groenlandica* (Ravn), but the preservation of this ammonite, as of the other *Ammonites* (*Rasenia*?) sp. indet. of the same author[2]), from Hochstetter Foreland, is too poor even for correct generic identification. The former, in any case, seems to have nothing whatever to do with either Ravn's species or the Spitsbergen forms of *Rasenia* figured by Frebold[3]) in 1930 and discussed under *R. polaris*.

Rasenia variocostata, Wegele[4]) is also comparable to the species here described in having irregular costation, but the ribs are less bullate on the inner whorls, as they are in the same author's *R. perisphinctoides*[5]). Since these two species, however, are undoubtedly very closely allied to the Greenland form, it is important to note that the second came from Wegele's *planula* zone (equivalent to the "*baylei* zone" in more northern successions), while *R. variocostata* occurred as high as the *suberinum* zone (= *mutabilis* zone). In placing the present species in the "*cymadoce* zone", I am guided by the presence in the same beds of *Amoebites subkitchini* etc.

Horizon:— *Amoebites* shales, concretionary layer δ, 19 m above *Pecten* Sandstone. Lower Kimmeridgian, "*cymadoce* zone".

Locality:— *Cardioceras* River, F. (nos. 186, 249).

Rasenia sp. ind.

(Plate 13, figs. 1a, b).

The example here figured consists of the body-chamber, over half a whorl in length, and with the mouth-border complete, also a portion of the septate part (about six camerae). It is characterised by the latter being almost smooth, with only one or two indistinct ribs, and by the body-chamber acquiring renewed costation, with conspicuous umbilical bullae. The ribs or rather folds on this part are very blunt and distantly spaced and they die out near the venter, while near the anterior end there are only sigmoidal striae. The inner whorls appear to have been ornamented, as in *R. orbignyi*, but the whorl-height (31 %) and the width of the umbilicus (44 % at 160 mm diameter) link the present form with the var. *aperta*, above discussed (Plate 9, fig. 1).

The suture-line is well displayed (Plate 13, fig. 1b) and shows

[1]) *Loc. cit.* (Medd. om Grønl., vol. 94, no. 1), 1933, p. 19, pl. II, fig. 13.

[2]) *Ibid.*, p. 35, pl. III, fig. 31.

[3]) *Loc. cit.* (Skrifter om Svalbard, no. 31), 1930, p. 20, pl. IX, fig. 4; p. 62, pl. XXII, fig. 2.

[4]) *Loc. cit.* (Palaeontographica, vol. LXXII), 1929, p. 85 (179), pl. X (XIV), fig. 6.

[5]) *Ibid.*, p. 81 (175), pl. X (XIV), figs. 2a, b.

resemblance to that of *Pictonia cymadoce*, figured by Tornquist[1]), but it is more reduced than that of a fragment of a large *Rasenia* from Market Rasen, figured in Plate 13, fig. 2 which, again, is more degenerate or less perisphinctoid than the suture-line of an example of *Pictonia baylei* before me (B. M., no. 24087), agreeing with Bayle's[2]) figure. Among the many undescribed species of *Rasenia* found at Market Rasen (associated with *R. uralensis*, d'Orbigny sp., *R. involuta*, *R. evoluta*, Salfeld MS.[3]) etc.) there are some perfectly smooth, others resembling the form here described and a majority more like *R. polaris* described below. In the absence of the inner whorls, it is impossible to identify the Greenland form with any of the Market Rasen species, but it may be stated that those body-chambers that come closest to the Greenland example here figured have inner whorls resembling *R. uralensis* (d'Orbigny)[4]), a form that was wrongly referred by R. Douvillé[5]) to the much earlier genus *Kepplerites*.

Horizon:— *Amoebites* shales, concretionary layer δ, 19 m above *Pecten* Sandstone. Lower Kimmeridgian, "*cymadoce* zone".

Locality:— *Cardioceras* River, F. (No. 186 only).

Rasenia borealis sp. nov.

(Plate 6, fig. 1; Plate 7).

Diagnosis:— Rather low-whorled (substenogyral), at least on the earlier whorls, and evolute (latumbilicate). Whorl-section probably rounded, with evenly arched venter and rounded umbilical slope. Inner whorls with typical *Rasenia* ornamentation, namely primary tubercles or bullae and about 4 or 5 secondary ribs to each. At over 50 mm diameter primaries become more elongated and strongly bent forwards, and secondaries are gradually being lost. At 160 mm shell is perfectly smooth, but on large body-chambers coarse and blunt, almost straight, single ribs reappear, some of them short, all continuous across the periphery. Suture-line unknown.

Measurements:—	Pl 6, fig. 1.		Pl. 7.
Diameter	(at) 260	(at) 160	(at) 170 mm
Height	30	33	32 %
Thickness	?	?	?
Umbilicus	48	48	45 %

[1]) *Loc. cit.* (Abh. Schweiz. pal. Ges., vol. XXIII), 1896, pl. IV, fig. 1.

[2]) *Loc. cit.* (Atlas), 1878, pl. LXVI, fig. 1.

[3]) Small, inner whorls are figured in Plate 10, fig. 5, and Plate 14, fig. 6 but there is an endless variety of differing body-chambers; and the difficulties of identification are increased by the frequent changes in ornament, before the final rejuvenation of the single ribbing on the body-chamber.

[4]) In Murchison, Verneuil and Keyserling: "Géologie de la Russie &c.". II, Pal., 1845, p. 429, pl. XXXII, figs. 6—7 only.

[5]) Pal. Universalis, 1911, pl. 210 and 210a.

Remarks:— As holotype may be chosen the example (partly) figured in Plate 7, which is crushed, in an enormous concretion, but which does not show the body-chamber so well as the similarly compressed specimen figured in Plate 6, fig. 1. The inner whorls of the latter are almost unrecognisable. In the holotype they are seen to be equally evolute and loosely coiled, but the typical *Rasenia* ornamentation is preserved, as on the inner whorls of similarly large Market Rasen examples of *Rasenia* in the British Museum, some of which had been photographed by Salfeld for his projected monograph. In the Greenland form, however, the primary bullae are comparatively closely spaced and strongly inclined forwards after the early coronate stage and then follows a whorl of almost complete smoothness until the rejuvenated single ribbing of the body-chamber appears.

There are evolute forms of *Rasenia*, like an example figured by Quenstedt[1]), but the inner whorls of the present species are different from anything recorded in geological literature, so far as I know, except two Spitsbergen forms figured by Frebold and discussed under *R. inconstans* (p. 47). Whether their comparison to Ravn's *Aulacostephanus*(?) *groenlandicus*[2]) was justified, however, seems to me very doubtful. I do not see why the Koldewey Island form should not be left in *Aulacostephanus* rather than transferred to *Rasenia*, considering its long ribs, short umbilical bullae, and suggestion of a ventral sulcus. In any case the Spitsbergen examples seem to be much closer to *R. polaris*, with its distinct ribbing, and there can be no question about this being quite different from any form of *Aulacostephanus*. On the other hand, the extreme evolution of the inner whorls of *R. polaris*, seen also in a very large (unfigured) third example, is reminiscent of certain Scottish (Culgower) forms of *Aulacostephanus* that have been referred to *A. autissiodorensis*, Cotteau sp. (B. M., no. C. 13216). As that rare species is very incompletely known, I am figuring a young Culgower example (Plate 13, fig. 8) which is even more transitional to *Rasenia* than *Aulacostephanus*(?) *groelandicus*, Ravn; but the inner whorls of the present species at a similar diameter, are too poorly preserved for exact comparison.

Horizon:— *Amoebites* shales, nodule bed γ, 49 m above *Pecten* Sandstone. Lower Kimmeridgian, *cymadoce* zone?

Locality:— Grey Ravine (loc. G), at 85 m (Nos. 194, 250).

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[1]) *Loc. cit.* (Ammoniten des Schwäbischen Jura, III, 1887, pl. CVII, fig. 24 (*Ammonites* cf. *trifurcatus*). This is probably identical with *R. evoluta* (Salfeld, MS., see Plate 14, fig. 6) in which the tubercles remain well inside the umbilical suture to a very large diameter.

[2]) *Loc. cit.* (Medd. om Grønland, vol. XLV), 1911, p. 492, pl. XXXVII, figs. 3a—c.

b. Order *Belemnoidea.*

Family *Belemnitidae.*

Sub-family *Cylindroteuthinae.*

Genus *CYLINDROTEUTHIS*, Bayle, 1878.

Cylindroteuthis sp. nov.? ind.

(Plate 6, figs. 3—4; Plate 15, figs. 2a, b).

The largest example (Plate 15, figs. 2a, b), the deformation of which is accidental, shows distinctly flattened sides, especially on the less cylindrical lower two-thirds (but not near the apex), whereas the section at the alveolar end is more nearly oval. The ventral groove or depression is short and already at a distance of 20 mm from the apex (as restored) the ventral side is flat; the sides, however, are still convex. The alveolus is about a third of the length of the guard; and the excentric apical line, at 20 mm from the apex, is only a quarter of the diameter away from the ventral side. The alveolar angle is about 21°.

A second specimen (Plate 6, figs. 4a-—d) is not so complete as the first, but its ventral side is free from matrix and also shows very distinct flattening. Although the dorsum is more convex, the cross-section almost throughout is thus subquadrate, with the ventro-dorsal diameter slightly in excess of the lateral. The smallest specimen figured (Plate 6, figs. 3a—c) shows the same characters and the apical groove disappearing at over 25 mm length, but the section is more rounded.

This species probably requires a new name when more material is available; it seems to be a member of the group of *C. puzosiana* (d'Orbigny)[1]) which according to Pavlow[2]) ranges up into the Kimmeridgian. But this species itself has an alveolus of not more than a quarter of the length of the guard, also a far more cylindrical shape. *C. extensa* (Trautschold) Sintzow sp.[3]) which had been included by Pavlow in the synonymy of *C. puzosiana* shows the subrectangular section of the Greenland form, but also has a shorter alveolus; in *Pachyteuthis miatschkoviensis* Ilovaïsky sp.[4]) which differs from *P. panderi* merely in having the transverse diameter equal to the dorso-ventral[5]), the alveolus is half the length of the guard.

Of the various forms ascribed to *C. trosloyana* (d'Orbigny) and

[1]) Pal. Française, Terr. Jurass., I, 1843, p. 117, pl. XVI, figs. 1—6.

[2]) In Pavlow and Lamplugh: Argiles de Speeton, Moscou, 1892, p. 39.

[3]) Aperçu géologique du gouvernement de Saratow. Bull. Soc. Min. St. Pétersb., (2), vol. v, 1870, p. 161, pl. VI, figs. 2—4 only.

[4]) *Loc. cit.* (Bull. Soc. Imp. Nat. Moscou, N. S., vol. XVII, 1903), 1904, p. 283, pl. XII, figs. 8—9.

[5]) This feature may be taken to justify the reference of *P. miatschkoviensis* to *Acroteuthis* (see Bülow-Trummer: Fossilium Catalogus, I, pars 11, 1920, p. 209) but it cannot apply to the compressed *C. puzosiana.*

C. "nitida" (Dollfus) there are some that come close to the form here described, especially since according to Pavlow[1]) the length of the alveolus is $^1/_3$ to $^1/_4$ that of the guard. Blake[2]) already recorded this Kimmeridgian species from the uppermost "Corallian" and noted the existence of unnamed belemnites, intermediate between the stout *Pachyteuthis abbreviata* of the *cordatus* beds and the late and slender *C. "nitida"*, in the intervening beds.

There are many fragments in the blocks with *Parallelodon keyserlingi* and they nearly all seem to belong to the present form; but since the young of the species described below as *Pachyteuthis* cf. *panderiana* were also slender, it is probably only their fragmentary condition that prevents a more satisfactory differentiation of the two species.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?). Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV).

Genus *PACHYTEUTHIS*, Bayle 1878.

Pachyteuthis aff. *panderiana* (d'Orbigny).

(Plate 10, figs. 7a—c; Plate 14, figs. 1a, b; Plate 15, fig. 1).

1920. *Pachyteuthis panderiana* (d'Orbigny) Bülow-Trummer: Fossilium Catalogus, I, 11, p. 204 (see there for synonymy).

The example figured in Plate 15, fig. 1 shows much better agreement with the Russian form and with Boden's[3]) *P. panderi* than with d'Orbigny's[4]) figure of *P. excentrica* (Blainville), which Pavlow[5]) included in *P. panderi*[6]). It seems to me that *P. panderi* has a less excentric apex, in side-view, than *P. excentrica*, and the Greenland example figured in Plate 15, fig. 1 is also slightly more conical than a typical specimen of *P. excentrica* (commonly called *Bel. abbreviatus*) from the English Corallian (L. F. S., 731). The same characters are seen in another large (unfigured) example and they are conspicuous on direct comparison with *P. excentrica* from Traekpasset on Koldeway Island (A. Rosenkrantz coll.). The small *P. panderi* from the same island figured by Ravn[7]) is also very symmetrical.

[1]) In Pavlow and Lamplugh, *loc. cit.* (1892), p. 63.

[2]) In Blake and Hudleston: Corallian Rocks of England. Quart. Journ. Geol. Soc., vol. XXXIII, 1877, p. 391.

[3]) *Loc. cit.* (Pal. Abhandl., vol. XIV), 1911, p. 33, pl. XX, fig. 1.

[4]) Pal. Française, Terr. Jurass., vol. I, 1843, pl. XVII, fig. 3.

[5]) In Pavlow and Lamplugh, *loc. cit.*, (1892), p. 66.

[6]) If *Bel. panderi* and *Bel. excentricus* prove to be identical, the latter name, of course, must be used, being the older of the two.

[7]) *Loc. cit.* (Medd. om Grønl., vol. XLV, no. 10), 1911, p. 494, pl. XXXVII, figs. 2a—c.

The largest example (Plate 14, fig. 1) I was at first inclined to attach to *P. kirghisensis* (d'Orbigny), as it seemed to agree with Pavlow's description; but since d'Orbigny particularly pointed out that his species differed from *P. panderi* merely in its quadrate section and since in the large Greenland example the dorso-ventral diameter (34 mm) exceeds the transverse (32 mm), there is no reason for separating it from the examples of *P.* aff. *panderi*, just discussed, although it comes from a higher horizon, i. e. the *Rasenia* beds. The apical end was not found till after the photograph had been taken, but the restoration is based on the actual fragment, showing an almost symmetrical shape, in side-view.

The smallest example (Plate 10, figs. 7a—c) is attached to the present form with some doubt. The young of *P. panderi* is slender, as shown in Boden's fig. 2, but unfortunately there is nothing to connect this single, small, belemnite with the more typical, larger, examples.

Stout belemnites from a much higher level in the Portlandian (Rosenkrantz's section I, 165 m), to be dealt with in the next part, do not seem to differ from the form here described.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?). Upper Oxfordian. Also concretionary layer δ in *Rasenia* clays, above *Pecten* Sandstone. Lower Kimmeridgian (No. 193).

Localities:— Near northernmost dyke (Rosenkrantz's section IV); also *Cardioceras* Ravine, locality F. (No. 193).

B. Class *Pelecypoda.*

a. ORDER *ANISOMYARIA.*

Family *Aviculidae.*

Genus *PSEUDOMONOTIS*, Beyrich, 1862.

Pseudomonotis sp. ind.

A rather strongly convex left valve of the general aspect of a form of the group of *P. ovalis* (Phillips)[1] is too small to be described in detail. It is only about 9 mm high and 8.5 mm in length and the anterior and posterior wings are almost equally large, as in the two left valves figured by Arkell[2]. The ornament, however, may be slightly coarser, although, since the example is only a sandstone cast, this character also makes a definite identification inadvisable.

The impression of the inside of a less convex right valve and its counterpart in the same piece of rock, showing (through the transparent test) the fine ornamentation of *P. ovalis*, were labelled *Placunopsis*?

[1]) Geology of Yorkshire, 1829, pl. III, fig. 36.

[2]) Monograph of the British Corallian Lamellibranchia (Pal. Soc.) pt. v, 1933, p. 198, pl. XXVII, figs. 6, 8.

There is some resemblance to a form like *Ostrea unguis* (Merian MS) de Loriol[1]), except for the byssal notch, but the shape is not that of *P. ovalis*, allowing for the obvious difference between the right and left valves.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?). Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

Family *Myalinidae.*

Genus *BUCHIA*, Rouiller, 1845.
(= "*Aucella*", Keyserling, 1846).
Buchia aff. *bronni* (Rouiller).
(Plate 3, fig. 2; Plate 8, fig. 3).

1911. *Aucella bronni*, Lahusen: Ravn, *loc. cit.* (Medd. om Grønl., vol. XLV), p. 455, pl. XXXII, fig. 5.
1933. — var. *lata*, Lahusen: Weir, *loc. cit.* (Trans. Roy. Soc. Edinb., vol. LVII, pt. III), pl. I, fig. 9.

The example here figured in Plate 8, fig. 3 is one of the best, but others are crushed in different directions (see Plate 3, fig. 2) and are less closely comparable to the Spitsbergen specimen figured by Sokolov and Bodylevsky[2]). Among the Spitsbergen material discussed in 1921[3]), the slabs bearing crushed examples of *Amoeboceras* (*Euprionoceras*) *sokolovi* (previously *C. nathorsti*) also contain similar specimens of '*Aucella*', but their state of preservation prevents definite identification either with *B. bronni* and its var. *lata* (Trautschold) or *B. spitzbergensis* and *B. reticulata* of Lundgren[4]), the latter of which, in any case, was considered by Lahusen[5]) to be a synonym of Rouiller's (1848) species.

Ravn recorded *Aucella kirghisensis*, Sokolov, and *A. sinzowi*, Pavlow, from Koldewey Island, in association with the present species, and it is, of course, possible that these species are also represented among the crushed material here discussed.

Horizon:— *Amoebites* shales (with *Hoplocardioceras*) Lower Kimmeridgian, *mutabilis* zone?

Locality:— Reptile locality, *Pinna* Valley, Hartz Mtn. (Nos. 243, 251); also upper course of South River, western shore (height 144 m); No. 203.

[1]) *Loc. cit.* (Mém. Soc. pal. Suisse, vol. XXI), 1904, pl. XXVI, figs. 10—12.
[2]) *Loc. cit.* (Skrifter om Svalbard &c., No. 35), 1931, pl. V, fig. 5.
[3]) Spath, *loc. cit.* (Geol. Mag., 1921), p. 352.
[4]) "Jura- und Trias-Fossilien etc." Bihang till K. Svenska Vet.-Akad. Handl., vol. VIII, no. 12, 1883, pp. 15—16, pl. I, figs. 5—7.
[5]) "Ueber die russischen Aucellen". Mém. com. géol. St. Pétersb., vol. VIII, no. 1, 1888, p. 6.

Family *Pinnidae.*

Genus *PINNA*, Linnaeus, 1758.

Pinna aff. *lanceolata* (J. Sowerby).

1933—34. *Pinna lanceolata*, J. Sowerby; Arkell: Monograph British Corallian Lamellibranchia, *loc. cit.*, pt. V, p. 219, pl. XXVIII, fig. 5; pt. VI, pl. XXIX, figs. 1—3.

I am provisionally including the single fragment from Cape Leslie in Sowerby's species, because it is too incomplete for a discussion of its real affinities with the various species hitherto described. Its longitudinal striations are slightly less closely spaced than those of the early Callovian *P. sublanceolata*, Eichwald, which I[1]) recorded from Jameson Land, or those of one species of *Pinna* from the higher beds of the Cape Leslie Formation to be figured in part 2 of this memoir. Parat and Drach[2]) have already recorded *Pinna constantini*, de Loriol, but the new Portlandian material before me includes at least two species.

The fragment is comparable to Ilovaïsky's[3]) smaller example, but even shorter; and as it is uncrushed, the cross-section resembles that of the same author's fig. 1.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?). Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

Family *Ostreidae.*

Genus *OSTREA*, Linnaeus, 1758.

Ostrea sp. ind.

(Plate 9, fig. 6; Plate 10, fig. 4).

The two examples here figured were attached to specimens of *Rasenia* and they seem to differ from *O. bononiae*, Sauvage and Rigaux[4]) merely in their smaller size. They are internal casts, with the comparatively thin, brown, test preserved in a few places, and there is no sign of radial striation, as in '*Ostrea*' *laeviuscula*, Phillips[5]). The smaller example covered the umbilicus of the ammonite figured in Plate 9, fig. 4 and has

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[1]) Spath, *loc. cit.* (Medd. om Grønl., vol. 87, no. 7), 1932, p. 108, pl. XVII, fig. 4.

[2]) *Loc. cit.* (C. R. Acad. Sci. Paris, vol. 196), 1933, p. 1909.

[3]) *Loc. cit.* (Bull. Soc. Imp. Nat. Moscou, N. S., vol. XVII), 1904, p. 253, pl. IX, fig. 2 (*Pinna* cf. *lanceolata*, Sowerby; Lahusen).

[4]) Description d'espèces nouvelles des terrains jurassiques de Boulogne-sur-Mer (Pas-de-Calais). Journ. Conchyl., vol. XX, 1872, no. 17, pl. X, fig. 8.

[5]) Geology of Yorkshire, 1829, pl. IV, fig. 1 (reduced $\times$ $^2/_3$), apparently a *Placunopsis*.

likewise suffered from mechanical deformation in the rock. It shows no resemblance to the form I[1]) recorded as *Liostrea*? sp. ind. from the Callovian of Jameson Land, that form being unattached and thus not reproducing the costation of an ammonite.

Horizon:— *Amoebites* shales, concretionary layer δ, 19 m above *Pecten* Sandstone, Lower Kimmeridgian, "*cymadoce* zone".

Locality:— *Cardioceras* River, locality F. (Nos. 186, 222).

Sub-genus *Liostrea*, Douvillé, 1904.

Ostrea (*Liostrea*?) sp. ind.

In the many blocks crowded with valves of *Parallelodon keyserlingi* and other pelecypods (but only very few small casts of *Cardioceras*) there occur impressions and fragments of an oyster that probably belonged to the group of *O. delta*, Smith[2]). It is listed here chiefly because it is obviously a different species from that discussed above as *Ostrea* sp. ind., not because it is of earlier age.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?). Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

Genus *EXOGYRA*, Say, 1819.

Exogyra nana (J. Sowerby).

1932. *Exogyra nana* (J. Sowerby) Arkell: Monograph British Corallian Lamellibranchia, pt. IV, *loc. cit.*, p. 175 (Some errors in synonymy).

On a slab of sandstone, next to the ammonite figured in Plate 1, fig. 8, but only partly visible in the photograph, there is imbedded an example that seems to agree best with the flat originals of Arkell's figs. 7—9 (pl. XVIII) or with one of de Loriol's examples of his *E.* "*roederi*"[3]). The preservation, however, is very poor.

Horizon:— *Cardioceras* beds, a few metres below *Pecten* Sandstone. Neoxfordian (see p. 19).

Locality:— About 500 m north of III (between *Cardioceras* Ravine and Section IV of Rosenkrantz). No. 231.

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[1]) Medd. om Grønl., vol. 87, no. 7 (1932), p. 114.

[2]) Strata Identified by Organized Fossils, 1817, p. 18, fig. 6 of corresponding (Oak Tree Clay) plate (unnumbered).

[3]) *Loc. cit.* (Mém. Soc. pal. Suisse, vol. XXXI), 1904, pl. XXV, fig. 20.

Family *Pectinidae.*

Genus *PECTEN*, Osbeck, 1765.

Sub-genus *Entolium*, Meek, 1864.

Pecten (*Entolium*) cf. *demissus*, Phillips.

1911. *Pecten* (*Entolium*) *demissus*, Bean; Phillips; Ravn, *loc. cit.* (Medd. om Grønl., vol. XLV), p. 463, pl. XXXIII, fig. 8.

1932. *Entolium demissum* (Phillips) Spath, *loc. cit.* (Medd. om Grønl., vol. 87, no. 7), p. 112, pl. XXVI, fig. 2.

No complete examples of this species appear to have been collected, but there are various fragments attached to other fossils or occurring in slabs of rock, from a number of horizons. In these circumstances, it is impossible to suggest a definite identification and I am attaching the fragments to Phillips' species merely because this is the commonest of the smooth Pectens of the Neoxfordian.

Horizon:— *Pecten* Sandstone and *Cardioceras* shales below, and *Amoebites* Shales above, up to nodule bed *δ*.

Locality:— North of III (Nos. 231 and 232) and *Cardioceras* Ravine, locality F. (Nos. 191 and 222).

Sub-genus *Camptonectes*, Meek, 1864.

Pecten (*Camptonectes*) aff. *lens*, J. Sowerby.

1930. *Camptonectes lens* (J. Sowerby) Arkell: Monograph British Corallian Lamellibranchia, pt. II, *loc.* cit., p. 94, pl. VII, fig. 1.

A fragmentary example well shows the ornamentation of the test, as in the topotype recently figured by Arkell. Since the shape cannot now be ascertained and in the absence of the wings, the identification cannot be considered definite and it is possible that the present form belongs to that new species, allied to *P. lens*, which was recorded by Ravn[1]) from Koldewey Island.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?). Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

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[1]) *Loc. cit.* (Medd. om Grønl., vol. XLV), 1911, p. 466.

Family *Limidae.*

Genus *LIMA*, Bruguière, 1792.

Sub-genus *Plagiostoma*, J. Sowerby, 1814.

Lima (*Plagiostoma*) cf. *mutabilis*, Arkell.

1931. *Lima* (*Plagiostoma*) *mutabilis*, Arkell, Monograph British Corallian Lamellibranchia, pt. III, *loc. cit.*, p. 130, pl. XII, fig. 4.

An impression of a large *Lima* (in a rock crowded with *Parallelodon keyserlingi*) has the general aspect of the holotype of *L. mutabilis*. The costae are flat, but the grooves in between are generally divided by a fine, radial, line although a few have a flat base and at least one bears a double line. The base of the groove, however, at each side of the thin median ridge, is punctate. This is different from the ornamentation of *L. mutabilis* or any of the species figured by Goldfuss[1]), while Roemer's unfigured *L. tumida*[2]) has much narrower punctate grooves, compared with the flat interspaces. *L. boidini* (Sauvage)[3]) which has been stated to be one of the closest figured allies of *L. mutabilis*, also has narrower grooves, without the fine lines of the present form.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

Lima (*Plagiostoma*) sp. ind.

Unlike the species last described, this has broad, flat, radial ribs, and there are no lines in the grooves between; the larger part of the valve also is almost smooth. Since the only example available is not only incomplete but also crushed it must suffice to record it as a second species of *Lima*. It is probably a form of the *laeviuscula* group.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

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[1]) Petrefacta Germaniae etc., II, 1836, pl. CII, etc.

[2]) Die Versteinerungen des norddeutschen Oolithen-Gebirges, 1836, p. 77.

[3]) Description d'éspèces nouvelles des terrains Jurassiques de Boulogne-sur-Mer. Journ. Conchyl., vol. XX, 1872, no. 22, pl. XII, fig. 4.

b. ORDER *HOMOMYARIA.*

Family *Arcidae.*

Genus *PARALLELODON*, Meek and Worthen, 1866.

Parallelodon keyserlingi (d'Orbigny).

(Plate 15, fig. 7).

1911. *Macrodon keyserlingii* (d'Orbigny) Ravn: *loc. cit.* (Medd. om Grønl., vol. XLV), p. 469.

1933. *Parallelodon* (*Benshausenia*) *keyserlingii* (d'Orbigny) Arkell: Jurassic System in Britain, p. 413.

1933. *Macrodon keyserlingi* (d'Orbigny) Frebold, *loc. cit.* (Medd. om Grønl., vol. 94, no. 1), p. 25, pl. II, fig. 21; pp. 21, 26.

This well-known Russian species is extremely common in the blocks of sandstone from Rosenkrantz's locality IV, but the specimens are generally crushed or deformed in the rock, so that it is difficult to verify the agreement of the dimensions with those of the poorly-preserved Elsworth Rock example figured by Arkell[1]) or the far better illustrations given by Borissjak[2]) and Boden[3]). The former figured this species from various horizons, between the Middle Callovian and the Sequanian and Arkell included only the two Oxfordian examples in the synonymy of this species, but Rosenkrantz determined as *P.* cf. *keyserlingi* some very similar forms from the Portlandian of Cape Leslie. These will be figured in the next part and they come from beds above those in which *P. schourovskii* (Rouiller)[4]) occurs in rather well preserved examples, together with Pavlovids. The range of this species thus may be very considerable, but Frebold's Fligely Fjord specimens were also associated with Neoxfordian Cardiocerates.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's Section IV), at 25 m.

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[1]) Monograph of the British Corallian Lamellibranchia, pt. I, Pal. Soc., 1929, p. 38, pl. I, figs. 6, 6a.

[2]) Pelecypoden der Jura-Ablagerungen im europäischen Russland II. Mém. Com. Géol. St. Pétersb., N. S., livr. XIX, 1905, p. 42, pl. I, figs. 5—7, etc.

[3]) *Loc. cit.* (Geol. Pal. Abhandl., vol. XIV), 1911, p. 188, pl. XXVI, fig. 9.

[4]) See Borissjak, *loc. cit.* (1905), p. 48, pl. II, figs. 10—12.

Family *Lucinidae*.

Genus *LUCINA*, Bruguière, 1792.

Lucina? sp. ind.

(Plate 2, fig. 2).

The slabs with *Hoplocardioceras* bear numerous crushed pelecypods in addition to rather more favourably preserved valves of *Buchia* (see e. g. Plate 3, fig. 2). The test, preserved in brown calcite is very thin and there are fine concentric striae of growth. The shape agrees with that of various forms of *Astarte* as well as species of *Lucina*. I at first compared this form to the similarly crushed *Lucina* of the type of *L. minuscula*, Blake, which are so common in the English Kimmeridge Clay and which have been discussed in some detail by Kitchin[1]). Mr. C. P. Chatwin, however, kindly informs me that even the genus (*Lucina*) must be considered doubtful.

Horizon:— *Amoebites* Shales (with *Hoplocardioceras*). Lower Kimmeridgian, *mutabilis* zone?

Localities:— Reptile locality, *Pinna* Valley, Hartz Mtn. (Nos. 243, 251); also upper course of South River, western shore (height 144 m); No. 203. Doubtfully from Camp I, below Hartz Mtn. (No. 237), see Plate 3, fig. 1.

Family *Astartidae*.

Genus *ASTARTE*, J. Sowerby, 1817.

Astarte extensa (Phillips).

1933. *Astarte extensa* (Phillips): Arkell, Monograph British Corallian Lamellibranchia, *loc. cit.*, pt. VI, p. 237, pl. xxxiv, figs. 21—30.

The impression of a right valve, only 6 mm in length bears about ten pronounced ridges; and although not resembling Phillips's[2]) original sketch, may be compared to the English Corallian examples lately figured by Arkell. The young *A. lituanica*, represented in Boden's[3]) fig. 23 is also very similar, while *A. depressoides* (Lahusen)[4]) is more finely ribbed.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

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[1]) In Lamplugh and Kitchin: On the Mesozoic Rocks in some of the Coal Explorations in Kent. Mem. Geol. Surv. 1911, pp. 157, 159; also Lamplugh, Kitchin and Pringle: "The Concealed Mesozoic Rocks in Kent". *Ibid.*, 1923, pl. ii to p. 224.

[2]) Geology of Yorkshire, 1829, pl. iii, fig. 21 (*"Crassina"*).

[3]) *Loc. cit.* (Pal. Geol. Abhandl., vol. xiv), 1911, pl. xxv.

[4]) See especially Ilovaïsky, *loc. cit.* (Bull. Soc. Imp. Nat. Moscou, N. S., vol. xvii, 1904), p. 256, pl. ix, figs. 12—22.

Astarte? sp. ind.

Some fragments of a thick-shelled form with fine and sharp concentric ornamentation resemble the figures of various species of *Astarte* as well as those of other Pelecypods (e. g. *Lucina*) and they are doubtfully attached to this genus merely because of the robust test and the general resemblance to *A. subdepressa*, Blake and Hudleston[1]), from the English Corallian.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

Family *Arcticidae.*

Genus *ARCTICA*, Schumacher, 1817.

Arctica(?) sp. ind.

There are some fragmentary examples and impressions of a large "*Cyprina*", but in the absence of the hinge or other characteristic feature, the resemblance to such a similar, large *Astarte* as *A. matheyi*, P. de Loriol[2]) cannot be dismissed as merely superficial. The shell margin is not crenulate and the largest example had been labelled "*Cyprina*" by Mr. Rosenkrantz.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

Genus *ANISOCARDIA*, Munier-Chalmas, 1863.

Anisocardia(?) sp. ind.

A smooth internal cast with the two asymmetrical umbones broken off, resembles the figure of *A. choffati*, P. de Loriol[3]), but the anterior side is less indented and the thickness is less[4]). The cast, however, is only half the size of de Loriol's figure.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

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[1]) *Loc. cit.* (Quart. Journ. Geol. Soc., vol. XXXIII), 1877, pl. XIV, fig. 10.

[2]) Couches coralligènes inférieures du Jura bernois. Mém. Soc. pal. Suisse, vol. XVIII, 1891, p. 232, pl. XXVI, fig. 1.

[3]) *Loc. cit.* (Mém. Soc. pal. Suisse, vol. XXXI), 1904, pl. XX, fig. 8 only.

[4]) Length = 15 m; thickness = 11 mm; as against 21.5 : 19 in de Loriol's figure.

Family *Pleuromyacidae.*

Genus *PLEUROMYA*, Agassiz, 1842.

Pleuromya cf. *tellina* (Agassiz).

Two small internal casts of right valves, with the shape of *P. securiformis* (Phillips) previously[1]) recorded from the Callovian of Jameson Land, are distinguished from the widely distributed *P. tellina* Agassiz[2]) by the absence of the characteristic depression. Since, however, this depression may be very faint even at a much larger size, it seems permissible to attach the Greenland forms provisionally to Agassiz's species. *P. peregrina*, d'Orbigny sp., cited by Ravn[3]) from Koldewey Island, is also very similar.

A larger but crushed cast of a *Pleuromya?* with a more central umbo cannot be definitely identified with the two small examples.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

2. *PHYLUM VERMES.*

Class *Annelida.*

Sub-Order *TUBICOLA.*

Genus *SERPULA*, Linnaeus, 1758.

Serpula cf. *lacerata* (Williamson MS) Phillips.

(Plate 8, figs. 6a, b).

1835. *Serpula lacerata*, Phillips: Geology of Yorkshire, vol. I (second edition), p. 169, pl. IV, fig. 35 (*S. lacerata*, Williamson on p. 180).

The fragmentary tube is broken off at both ends so that it is impossible to determine whether it had a spiral apex like *S. volubilis*, Münster[4]) or a gently tapering beginning like *S. flagellum*, Münster[5]). While the specimen thus cannot be definitely identified with these or allied, smooth, *Serpula* tubes, the reference to Phillips's incompletely known form may seem still less justified. It is not intended to convey more than a general resemblance, in spite of the difference in shape and size.

Horizon:— *Cardioceras* beds, just below *Pecten* Sandstone.

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[1]) Spath, *loc. cit.* (Medd. om Grønland, vol. 87, no. 7), 1932, p. 118.

[2]) See in Boden, *loc. cit.* (Pal. Geol. Abhandl., vol. XIV), 1911, p. 181.

[3]) *Loc. cit.* (Medd. om Grønland, vol. XLV), 1911, p. 480.

[4]) In Goldfuss: Petrefacta Germaniae &c., I, pl. LXIX, figs. 2a, b.

[5]) *Ibid.*, figs. 5a, b.

Locality:— 500 m north of III (between *Cardioceras* Valley and Rosenkrantz's Section IV). No. 231.

Serpula sp. ind.

Another species of *Serpula*, occurring in the rocks with *Parallelodon keyserlingi*, shows resemblance to *S. intestinalis*, Phillips[1]), which has been recorded from beds between the Oxford Clay and Kimmeridge Clay[2]). It is preserved as part of the smooth internal cast of a large "*Cyprina*", having apparently been attached to the inside of the valve, and there are many similar casts of species of *Lima* in the English Coral Rag.

Horizon:— Sandy concretions (in shales below *Pecten* Sandstone?), Upper Oxfordian.

Locality:— Near northernmost dyke (Rosenkrantz's section IV), at 25 m.

3. *PHYLUM ECHINODERMATA.*

Class *Ophiuroidea.*

Genus *OPHIURITES*, Schlotheim, 1820..

Ophiurites sp. ind.

(Plate 11, fig. 2).

The absence of the central portions makes it inadvisable to attach the specimen to a recent genus, such as *Ophiecten* etc. and I am using the term *Ophiurites* in a broad sense, as suggested by Clark[3]). The dorsal surface of the arms is rather well preserved if slightly corroded, but an attempt (kindly made by Mr. T. H. Withers) to expose the central disc was not successful. The specimen is now figured, because ophiuroid remains are not very common, even in well-searched areas.

Horizon:— *Pecten* Sandstone (Neoxfordian).

Locality:— 1 km south of 11 m (No. 257).

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[1]) Geology of Yorkshire, 1829, p. 138, pl. v, fig. 21.

[2]) Damon: Supplement to the Geology of Weymouth, 1888, pl. ix, fig. 8.

[3]) In Eastman-Zittel: "Text-Book of Palaeontology", vol. i, second English edition, 1927, p. 257.

III. LOCALITIES AND FAUNAL ASSEMBLAGES

The localities from which nearly all the fossils here described were obtained are in Milne Land, chiefly on the East Coast, between Cape Leslie and Charcot Bay, the central part of this nine-mile strip of coast being dominated by Hartz Mtn. A number of sections, giving the evidence for the generalised scheme set out below, were measured by Dr. Aldinger and will no doubt be discussed in his stratigraphical account. Here it may suffice to state that the most complete section is in *Cardioceras* Valley and along the coast to the north of it, up to Rosenkrantz's locality IV, referred to below, while Gray- and Kiderlen Ravines, and *Pinna*-, *Astarte*-, and Crab Valleys, also on the eastern flanks of Hartz Mtn., are the principal remaining fossil localities. The Ravine 2 W (Charcot Bay), the South and West Rivers, mentioned in the text, have yielded only a few isolated fossils; and since they will appear on Dr. Aldinger's map, they need not now be considered in detail. For the present purpose it is sufficient to mention that the formations mentioned below appear to be continuous over the whole area and to be fairly uniformly developed, although the fossiliferous bands collected from at the different localities may not always be on exactly the same levels.

From Dr. Aldinger's stratigraphical account it will be seen that the lowest sedimentary formation is his Charcot Bay Sandstone which rests directly on Caledonian granite. Beginning with a coarse conglomerate, this gritty sandstone, of a yellowish to whitish colour and about 200 m in thickness, is entirely unfossiliferous. Its age thus is unknown. It is succeeded by another 200 m of sandy, micaceous, dark shales, with several layers of large concretions, enclosing rare and badly preserved Cardioceratids, belemnites, pelecypods, and plant remains. Unfortunately, Dr. Aldinger's collection includes only a single fragment of a *Cardioceras* from these lower shales, and that from an isolated exposure; but all the fossils from Rosenkrantz's Section IV may perhaps have come from concretions in these *Cardioceras* Shales. The section is described as follows:—

IV. Section near northernmost basic dyke, east coast of Milne Land.

30 m. Blue, shaly, calcareous concretions without fossils.

25 m. Sandy concretions with numerous pelecypods and belemnites and some small ammonites.

Rosenkrantz described the pelecypods as similar to those of the much later 100 m horizon in his section I at Cape Leslie to the south and thus missed the presence of Oxfordian beds, as Parat and Drach, after him, did not discover the pre-"Portlandian" part of the succession.

The only fossil described from the *Cardioceras* shales is:—

Cardioceras aff. *zenaïdae*, Ilovaïsky.

In view of what is said below about the resemblance of the fossils from Rosenkrantz's section IV to those from the higher *Pecten* Sandstone, I am listing this assemblage separately. It consists of[1]):—

Cardioceras sp. juv. ind.
Cylindroteuthis sp. nov.? ind.
Pachyteuthis aff. *panderiana* (d'Orbigny).
Pseudomonotis sp. ind.
Pinna aff. *lanceolata* (J. Sowerby).
Ostrea (*Liostrea?*) sp. ind.
Pecten (*Entolium*) cf. *demissus*, Phillips.
Pecten (*Camptonectes*) aff. *lens*, J. Sowerby.
Lima (*Plagiostoma*) cf. *mutabilis* (Arkell).
Lima (*Plagiostoma*) sp. ind.
Parallelodon keyserlingi (d'Orbigny).
Astarte extensa (Phillips).
Astarte? sp. ind.
Arctica? sp. ind.
Pleuromya cf. *tellina* (Agassiz).
Mactromya sp. (*fide* Rosenkrantz).
Serpula sp. ind.

Towards the top of the *Cardioceras* Shales and only a few metres below the overlying *Pecten* Sandstone an assemblage of Cardioceratids, with a few other fossils, was collected, but again at isolated localities (231 and 232) so that no section can be given. The assemblage includes:—

Amoeboceras (*Prionodoceras*) *transitorium*, sp. nov.
Amoeboceras (*Prionodoceras*) aff. *pseudocaelatum*, nom. nov.
Ringsteadia sp. ind.

[1]) Among others. The pelecypods are badly preserved (see Plate 15, fig. 7) but there is no doubt that if it be considered worth while at some future date to break up the blocks more thoroughly, a number of additional (though perhaps equally indifferent) species may be obtained.

Exogyra nana (J. Sowerby).
Pecten (*Entolium*) cf. *demissus*, Phillips.
Serpula cf. *lacerata* (Williamson MS) Phillips.

The next higher *Pecten* Sandstone, of about 70 m thickness, includes a bed, at 11 m above the base, which is stated by Dr. Aldinger to contain countless examples of a large species of *Pecten*, *Dentalium*, and rare *Cardioceras*. Unfortunately only one fragmentary Cardioceratid (Plate 1, fig. 2) was brought back from this *Pecten* band and the remains of a *Pecten* in its matrix are unrecognisable. The matrix of the only other fossils from the *Pecten* Sandstone, the Cardioceratid figured in Plate 1, fig. 4, and the brittle-star represented in Plate 11, fig. 2, does not even include *Pecten* fragments. The assemblage from the *Pecten* Sandstone Formation thus makes a meagre list:—

Amoeboceras (*Prionodoceras*) aff. *alternoides* (Nikitin).
Amoeboceras (*Prionodoceras*) aff. *superstes* (Phillips).
[*Dentalium* sp., many *Ditrupa*].
Pecten sp.
Ophiurites sp.

It has already been mentioned, however, that the longer list from Rosenkrantz's Section IV may have to be added to the fauna of the *Pecten* Sandstone rather than to that of the *Cardioceras* Shales.

The *Pecten* Sandstone is succeeded by about 240—250 m or over 800 feet of dark shales and marls, sandy and rich in mica (like all the Greenland sediments), and including several harder layers. At a height of 19 m above the *Pecten* Sandstone, there is a layer of large concretions (horizon δ) containing the *Rasenia* assemblage listed below, but some fossils from immediately below δ are also included:—

Amoeboceras (*Prionodoceras?*) *prorsum*, sp. nov.
Amoeboceras (*Amoebites*) *subkitchini*, sp. nov.
Amoeboceras (*Amoebites*) *irregulare*, sp. nov.
Amoeboceras (*Euprionoceras?*) *aldingeri*, sp. nov.
Pictonia sp. ind.
Pictonia sp. juv.
Rasenia orbignyi (Tornquist).
Rasenia inconstans, sp. nov.
Rasenia sp. ind.
Pachyteuthis aff. *panderiana* (d'Orbigny).
Ostrea sp. ind.
Pecten (*Entolium*) cf. *demissus*, Phillips.
"*Onychites*" sp.

About 30 m higher or about 50 m above the *Pecten* Sandstone there is a second layer of concretions (horizon γ) which has yielded the large:—

Rasenia borealis

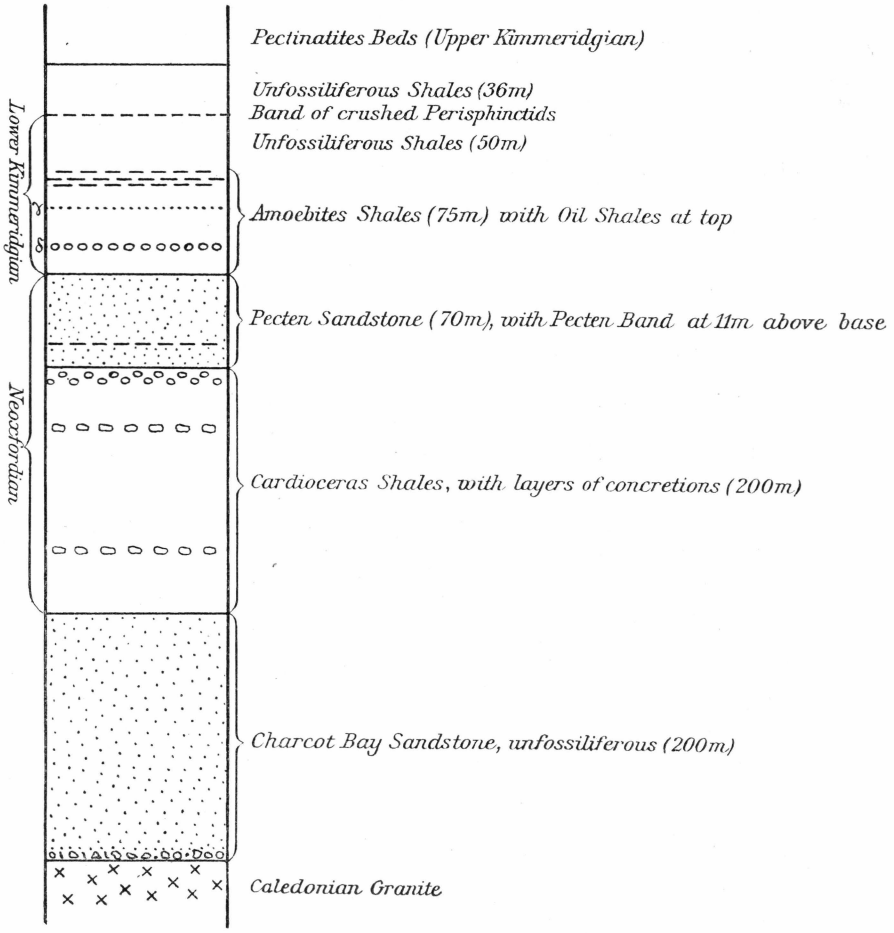
figured in Plates 6 and 7. Higher again (30—40 m above γ on the labels but only 20 m according to Dr. Aldinger's latest information) shales with *Amoeboceras* (*Euprionoceras*) *kochi* follow and probably only a few metres higher still the harder slabs with the crushed examples of *Hoplocardioceras*, here figured. Together with fossils from presumably about the same level but not definitely zoned, the forms just mentioned are part of the following assemblage:—

Amoeboceras (*Amoebites*) *elegans*, sp. nov.
Amoeboceras (*Amoebites*) *pseudacanthophorum*, sp. nov.
Amoeboceras (*Euprionoceras*) *kochi*, sp. nov.
Amoeboceras (*Hoplocardioceras*) *decipiens*, sp. nov.
Rasenia? sp. ind.
Buchia bronni, Rouiller.
Lucina? sp. ind.

These shales, at about 70—80 m above the *Pecten* Sandstone, having the appearance of oil shales and including (rare) remains of fishes and plesiosaurs, pass up into unfossiliferous beds, about 50 m thick, but no line of division of any kind could be detected by Dr. Aldinger that would serve as a natural boundary between the Oxfordian—Lower Kimmeridgian series (Kløft I Formation), described in the present part, and the Upper Kimmeridgian and later deposits (Cape Leslie Formation) to be dealt with in the next part.

About 125 m above the *Pecten* Sandstone or at the middle of this shale series, there is a horizon with very badly crushed Perisphinctids. Although they are here considered to be more closely allied to Upper Kimmeridgian ammonites than to Lower (and therefore figured in the next part), they are still preserved in black shales, like those from the *Hoplocardioceras*- and other low levels; and the first recognisable Upper Kimmeridgian ammonite (of the *pectinatus* zone) does not occur till 36 m higher, after another series of barren, black shales. There are thus altogether about 80—90 m or 300 feet of almost unfossiliferous passage shales between the Upper and the Lower Kimmeridgian series.

The succession may then be summarised in the following diagrammatic column:—



Part of the Upper Jurassic succession on Milne Land, showing the Neoxfordian-Eo-kimmeridgian portion.
(From information kindly supplied by Dr. H. Aldinger).

IV. STRATIGRAPHICAL AND PALAEONTOLOGICAL CONCLUSIONS

(a). The Age of the Faunas.

The determination of the exact age of even those portions of the succession that have yielded ammonites offers some difficulty. The earliest ammonite is a *Cardioceras*, the Neoxfordian age of which is established beyond doubt. The form was compared to a Russian species (*C. zenaïdae*, Ilovaïsky) which, in a previous correlation-table, I[1]) considered the equivalent of the upper part of the *cordatum* zone, but on p. 15 I expressed the opinion that the Greenland form may have come from the lower *perarmatum* zone, next above. Since I[2]) recorded a *Cardioceras* aff. *zenaïdae* from the Elsworth Rock (correlated with Ilovaïsky's bed D_1, but containing many fossils of his beds C and B[3]) it is probable that *zenaïdae*-like forms have an extended range, but there is little doubt that the species just discussed is later than the isolated Jameson Land *Cardioceras caelatum*, Pavlow, figured in Plate 15, fig. 3, a form of the *cordatum* zone proper.

Unfortunately the small examples of *Cardioceras* associated with numerous pelecypods (chiefly *Parallelodon keyserlingi*) from Rosenkrantz's locality IV and stated (on p. 17) to be of perhaps the same age as *C.* aff. *zenaïdae* cannot be more accurately dated. They may, however, be higher in the Neoxfordian, for their yellowish sandstone matrix agrees with that of the main mass of the *Pecten* Sandstone. This, Dr. Aldinger found to be on the whole poorly exposed, but containing many internal casts of pelecypods, while the 2—3 m (?) of the *Pecten* band, within this *Pecten* Sandstone, although also including many pelecypods, are characterised by numerous large and tightly packed examples

[1]) Spath, *loc. cit.* (Pal. Indica, N. S., vol. IX, no. 2) pt. VI, 1933, p. 872.

[2]) *Ibid.*, p. 866.

[3]) In the Correlation Table just quoted (p. 872) the C. 3 in column 6 is a misprint for C, B.

of *Pecten* and (above) many *Ditrupa*. This rock is not represented in the material before me, except by the single *Amoeboceras* fragment figured in Plate 1, fig. 2.

The uppermost 40 m of the *Cardioceras* Shales are described by Dr. Aldinger as consisting of grey and black marls, rich in mica, with more solid, sandy bands and hard, black concretions. These marls contain fossil wood and very many crushed *Cardioceras*; the concretions on the other hand, in addition to fossil wood, include large examples of *Pecten*, *Goniomya* and *Cardioceras*, all the mollusca having white shells. At the base of this uppermost 40 m of the *Cardioceras* Shales there is a more or less continuous layer of large, hard, bluish-black concretions with *Cardioceras*; and the next lower 20 m are described merely as grey and black, solid, micaceous marls. Now there is only a single *Cardioceras* with a white test (figured in Plate 2, fig. 4); the *C.* aff. *zenaïdae* which is marked as coming from between the Charcot Bay- and the *Pecten* Sandstones is presumably from a lower level in the *Cardioceras* Shales, but from an isolated locality, away from the typical section in the *Cardioceras* Ravine. There is no evidence as to the age of the lower portion of the 200 m of *Cardioceras* Shales, but since in Jameson Land an earlier species of *Cardioceras* has been found, it will be seen that there is still room in the *cordatum* zone for all the *Cardioceras* shales.

The fossils discovered by Dr. Aldinger and Mr. Säve-Söderbergh in Jameson Land include a single belemnite, similar to *Cylindroteuthis subrediviva* (Lemoine) from the Vardekløft Formation, and preserved in the same black calcite, with white calcite in the alveolar cavity[1]). It is, however, from a locality (327), on Upper Muskox River, which is close to 328 (Storgaard River), where *Cardioceras caelatum* was found. They have not collected *Amoeboceras*, like those from the Basalt Table Mtn. (p. 78); but on Spath Fjeld, near Vardekløft itself, Dr. Aldinger has now also discovered shales with crushed *Amoeboceras*, interbedded in the sandstone overlying the Vardekløft Formation (bed C between 590 and 620 in my text-fig. 10, 1932). The only fragment before me (no. 107), like some bad impressions from Dr. Bütler's horizon 24a on Jagged Mtn. (Zackenberg), seems to be closer to the forms here described from the Lower Kimmeridgian part of the succession than the Neoxfordian; and the gap between the Callovian Vardekløft Formation, and the Kløft I Formation is thus probably greater in Neill's Cliff than in the more western part of Jameson Land. From geological considerations alone, it is unlikely that the *Cardioceras* Shales, even with the unfossiliferous Charcot Bay Sandstone below, completely bridge the gap between the Neoxfordian and the Callovian, although their combined thickness is 400 m or 1330 feet.

[1]) See Spath, *loc. cit.* (Medd. om Grønl., vol. 87, no. 7), 1932, pl. XII, fig. 3.

It should be added that no Mesoxfordian (Divesian) or even Upper Eoxfordian, i. e. Upper Callovian, ammonites are known from northern Jameson Land, where Rosenkrantz's "Fossil Mountain Formation" of a thickness of about 300 m was described[1]) as presumably Oxfordian and including possibly both Upper and Lower Oxfordian. Those of his Cardioceratids from the upper fossil horizon that can be determined, are crushed *Cadoceras*, still belonging to the Callovian Vardekløft Formation; and I have already mentioned that the *"Simbirskites?"* recognised by Pompeckj and quoted by Madsen are altogether doubtful. Here again, however, the series was said to continue upward in the form of sandstones of great thickness from which no fossils have as yet been collected. Clearly there is need for far more exploration in the interior of Jameson Land before the gaps in the Jurassic sequence can be more definitely fixed; and the absence of the Vardekløft Formation in Milne Land on the one hand, and of the *Cardioceras* Beds of Storgaard River[2]) in the neighbouring Neill's Cliff on the other, suggest caution in putting forward the idea of a general Neoxfordian transgression in this part of East Greenland, or in extending it to the northern area, especially Koldewey Island, where the evidence is almost entirely negative.

The assemblages listed above from the *Pecten* Sandstone and the *Amoebites* Shales indicate that up to the Oil Shale horizon, at least, there are no major gaps in the Rauracian—Lower Kimmeridgian sequence. The faunas are not rich, but they include a few characteristic species, allowing of correlation with the ammonite zones established in north-western Europe and Russia, up to the *mutabilis* zone. I am not yet in a position to suggest definite names for the successive Neoxfordian horizons with *Amoeboceras alternans*, *A. truculentum* and *A. serratum* which I correlated with the southern *transversarium* and *bimammatum* zones, nor could zones be established on the strength of the few corresponding *Amoeboceras* (*Prionodoceras*) here described; but the new Greenland material enables us for the first time to recognise three, if not four, horizons within the *Rasenia* beds of the Lower Kimmeridgian.

It is, of course, improbable that the upper limit of the *Pecten* Sandstone coincides with the boundary line between the Oxfordian and Kimmeridgian formations. There may be a small stratigraphical gap, but while the occurrence of a *Pictonia* and of a *Prionodoceras*? in the assemblage from the concretionary band δ suggests that the fauna is still early Kimmeridgian, the *Ringsteadia* from below the *Pecten* Sand-

[1]) Rosenkrantz, in Lauge Koch: Geology of East Greenland. Medd. om Grønl., vol. 73, B, 1929, pp. 146—7. See also Lauge Koch: Stratigraphy of Greenland. *Ibid.*, p. 254.

[2]) The example of *Cardioceras caelatum* (Pavlow) here figured (Plate 15, fig. 3) was found loose, in the river bed, and could have been transported for some distance.

stone (associated with *Amoeboceras* [*Prionodoceras*] of Rauracian aspect) indicates that the 230 feet thickness of *Pecten* Sandstone really covers only a comparatively small range near the border-line between the Rauracian (or uppermost Neoxfordian) and the Sequanian (or Eo-Kimmeridgian).

When deciding whether to refer the assemblage from the nodule bed δ to the *baylei* or the "*cymadoce*" zone of Salfeld[1]), it must be remembered that the commonest ammonites are those large forms of *Rasenia* with smooth outer whorls which form the true *cymadoce* group but which are of pre-*uralensis* age. They are, however, associated already with two species of *Amoebites*, indicative of the higher zone; and it might thus be held that the equivalent of the *baylei* zone, if not missing altogether, would have to be looked for in the upper part of the *Pecten* Sandstone, apparently unfossiliferous. On the other hand, the gigantic *Rasenia borealis* comes from the nodule bed γ which is 30 m or 100 feet higher than horizon δ; and the fragmentary and doubtful *Rasenia*(?) figured in Plate 15, fig. 6, is from much higher still, suggesting that these highest Eo-Kimmeridgian shales are still in the *Rasenia* zones, especially since there are numerous large Cardiocerates but not a trace of *Aulacostephanus*.

The *baylei* zone, of course, like the earlier zone of *Ringsteadia anglica*, may be called a passage horizon. *Ringsteadia* does range (in Dorset) through perhaps 12 m or 40 feet of deposits at the top of the Oxfordian, but *Pictonia*, even at the most typical locality (Ringstead Bay) is confined to a few feet at the base of the Kimmeridge Clay[2]). At Westbury, Wiltshire, I have myself found *Pictonia* (of the type of *P. latecostata*, Tornquist) together with *Ringsteadia*; and in the clays immediately above the iron ore, small *Prorasenia*, such as are here figured from Wootton Bassett, occur, together with large, smooth, body-chambers that may be *Pictonia* or *Rasenia* of the *cymadoce* group. In Pomerania, Dohm united the zones of *Pictonia baylei* and *Ringsteadia*, but his badly figured, gigantic ammonites are difficult to compare with the smaller types of these forms. For general correlation, the forms of *Amoeboceras* (*Prionodoceras*) of the Neoxfordian, and of *Amoebites* etc. in the Eo-Kimmeridgian, are thus of far greater significance, having also been found in Scotland[3]) and Russia, Spitsbergen and Greenland, in addition to the less well

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[1]) Die Gliederung des oberen Jura in Nordwesteuropa &c. N. Jahrb. f. Min. &c., Beil. Bd., XXXVII, 1913, p. 129.

[2]) Salfeld, *loc. cit.* (1913), p. 205. See also Arkell: Jurassic System in Britain, 1933, pp. 451 & 454.

[3]) Bailey and Weir: "Submarine Faulting in Kimmeridgian Times: East Sutherland". Trans. Roy. Soc. Edinb., vol. LVII, pt. II, 1932, p. 463, also stated that "the *baylei* zone had not been identified".

established occurrences in Novaya Zemlya and California. Since the nodule bed δ is 19 m or over 63 feet above the *Pecten* Sandstone, its reference to the "*cymadoce*" zone is thus justifiable. But in view of the occurrence of a doubtful *Rasenia*? some 180 feet higher it seems that even the horizon γ (with *R. borealis*) may fall within the "*cymadoce*" zone of Salfeld. The two groups of forms recognised by Salfeld in the genus *Rasenia* are thus probably successive in time, *R. cymadoce*, still close to *Pictonia*, being the older and perhaps confined to the *baylei* zone; *R. uralensis* and the typical Market Rasen species, never associated with *Prorasenia*, the younger[1]). In a slowly accumulated deposit like the Abbotsbury Iron Ore the separation of these two elements may be very difficult; conversely in East Greenland, the "*cymadoce*" (or better *uralensis*)[2]) zone may include as much as a hundred feet of shallow-water deposits.

Unfortunately the evidence for dating the two highest assemblages (with *Amoeboceras* (*Euprionoceras*) *kochi* and *A.* (*Hoplocardioceras*) *decipiens*) is as yet inconclusive. The doubtful *Rasenia*? sp. ind. figured in Plate 15, fig. 6 might conceivably be a crushed form of *Aulacostephanus* of the group of *A. phorcus* (Fontannes)[3]), placed by Beurlen[4]) in the *pseudomutabilis* (or *eudoxus*) zone. In Dorset, only small forms of *Amoeboceras* of the *anglicum* group (= *Nannocardioceras*) go up into the *Aspidoceras* beds ("*yo*" or upper *mutabilis* zone), 20—25 feet below "Broad Bench". According to Salfeld, they occur even in the next higher *pseudomutabilis* zone, although I have not myself found either *Aspidoceras* and its aptychi, or *Nannocardioceras* in the *Aulacostephanus* shales which range (for 140 feet) up to 30 feet above the Maple Ledge stone band, to be followed by the first *Gravesia* 45 feet below Yellow Ledge[5]). In Scotland, however, large forms of *Amoeboceras* (*Euprionoceras* and *Amoebites*) occur in the *mutabilis* and *eudoxus* beds of Culgower and West Garty, so that the Cardiocerates alone cannot be accepted as evidence of an age earlier than the *pseudomutabilis* zone. Again

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[1]) Not *vice versa*, as stated by Buckman, who separated the *baylei* and *cymadoce* hemerae by four imaginary horizons, among them the *uralensis* hemera (Type Ammonites, vol. VII, 1930, p. 25).

[2]) This species has been misinterpreted by R. Douvillé (Pal. Universalis, 1911, pl. 210). At Market Rasen, Lincolnshire, forms exactly like d'Orbigny's figs. 6—7 occur quite commonly and I have seen it also from Kintradwell, Scotland (B. M., no. C. 36505).

[3]) In Dumortier and Fontannes: Description des Ammonites de la zone à *Amm. tenuilobatus* de Crussol (Ardèche). 1876, p. 108, pl. XV, figs. 3, 3a.

[4]) Die Gattung *Rasenia* im Schwäbischen Jura. Centralbl. f. Min. etc., 1924, p. 251.

[5]) On the eastern side of Kimmeridge Bay (Hen Cliff) I have found *Gravesia* of the *gigas* type between 30 and 52 feet below Yellow Ledge.

Buchia (*'Aucella'*) *bronni* is not helpful, since it ranges from the Neoxfordian up to the *eudoxus* zone. It has, however, been found on Koldewey Island (Kløft II) together with *Aulacostephanus*? *groenlandicus*, Ravn, and since *Aulacostephanus* is so common in Britain as well as in Russia, its absence in Milne Land is at least as suggestive as the morphological resemblance between *Hoplocardioceras* and *Aspidoceras*. Unfortunately, as the next higher 160—170 feet of shales have not yielded fossils of any kind, it is impossible to appraise the extent of the gap which separates the assemblage of the Oil Shales from the first Neo-Kimmeridgian ammonites above. In Dorset, the 140 feet of *Aulacostephanus* beds are succeeded by 50 feet of *Gravesia* beds (up to Yellow Ledge), then 80 feet of shales with *Subplanites* and *Lithacoceras* spp. and *Subdichotomoceras*(?) spp. (up to Top Ledge), further 80 feet of shales with *Subplanites grandis* and *S. kimmeridgensis* (Neaverson), *Lithacoceras*(?) *pyriticum* (Neaverson) and *L.*(?) *bivium* (Buckman), and 125 feet more with *Subplanites* and *Virgatosphinctoides* spp. (up to the lowest of the three white stone bands (= Blake's[1]) bed 20). I am including the 60 feet of shales in between the three white stone bands in the *pectinatus* zone, although, as mentioned in the discussion of this succession in the next part, I have not found *Pectinatites* myself until about six feet below the middle band. But it will be seen that there are at Kimmeridge about 500 feet of shales in between the upper *mutabilis* (or "*yo*") and the *pectinatus* zones, as against 300 feet at Cape Leslie. This, however, does not prove that there is a stratigraphical gap in the Greenland sequence; the intervening Middle Kimmeridgian shales will simply have to be left out of the discussion until more ammonite evidence is collected. It may, however, be remembered that even in the Boulonnais the Kimmeridgian (so-called Lower and Middle Portlandian) succession in between the Argiles feuilletées noires (below the La Rochette nodule bed) and the Grès de la Crèche inférieur below (with *Gravesia portlandica* and *Perisphinctes bleicheri*) is far less well developed than on the Dorset coast, only just across the Channel, comprising only about 40 feet of deposits[2]).

The approximate positions in the Upper Jurassic of the Milne Land faunas dealt with in the present part are shown in the following scheme (p. 74).

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[1]) On the Kimmeridge Clay of England. Quart. Journ. Geol. Soc., vol. XXXI, 1875, p. 199.

[2]) See Pruvost: Les subdivisions du Portlandien boulonnais d'après les ammonites. Ann. Soc. géol. Nord, vol. XLIX, 1925, pp. 194—195.

Ammonite Zones of the Neoxfordian and Eo-Kimmeridgian and their Representatives in East-Greenland.

	Zones:	Milne Land	Jameson Land	Northern Area
	Gravesia portlandica and *Perisphinctes bleicheri*	?	—	—
	Aulacostephanus pseudomutabilis and *A. undorae*	?	—	—
Eo-Kimmeridgian	*Aulacostephanus yo* and *Aspidoceras longispinum*	Oil Shales with *Hoplocardioceras decipiens*	—	*Hoplocardioceras decipiens* (Kuhn Island)
	Pararasenia mutabilis	[Ditto w. *Euprionoceras kochi*?]	—	?
	Rasenia uralensis and *Amoebites kitchini*	Horizon γ (w. *Rasenia borealis*)	—	*Aulacostephanus* (?) *groenlandicus* (Koldewey Island)
	Pictonia baylei and *Rasenia cymadoce*	Horizons δ (w. *Rasenia orbignyi*)	*Amoebites*? spp. (Vardekløft and Jagged Mountain)	[Hochstetter Foreland?]
Neoxfordian	*Ringsteadia anglica* and *Amoeboceras serratum*	*Pecten* Sandstone (upper part)?	*Amoeboceras rosenkrantzi* (Basalt Table Mountain)	[*Parallelodon keyserlingi* bed (Fligely Fjord)?] *Amoeboc. rosenkrantzi* (Wollaston Foreland)
	Amoeboceras truculentum	*Amoeboceras* aff. *superstes*	?	*Amoeboceras ravni* (Koldewey Island)
	Amoeboceras alternans	*Amoeboceras transitorium*		
	Cardioceras maltonense	*Cardioceras* aff. *zenaïdae*		—
	Cardioceras cordatum	(Charcot Bay Sandstone?)	*Cardioceras caelatum* (Storgaard River)	—
	Cardioceras cardia	—	—	—
	Creniceras renggeri	—	—	—

(b). Comparison with other Faunas.

On perusing the faunal lists given in section III of this paper it will be seen that those species that are not new are compared or identified chiefly with Russian forms, and only occasionally with species of north-western Europe, if we except pelecypods like the Pectens etc. that were attached to British species merely because these are better known than the corresponding forms of, for example, Spitsbergen. These are still largely undated and to me at least, the date of existence is perhaps the most important factor to know about any fossil. Spitsbergen, of course, is the region to which we look in the first place when correlating the Greenland faunas here described, especially since I have myself[1]) recorded from there such ammonites as *Amoeboceras*, *Pictonia* and *Rasenia*.

In the case of the first of these three genera, there can be no doubt that both the Greenland and the Spitsbergen forms are extremely close to the British and Russian species of *Amoeboceras*. This genus is the direct successor of *Cardioceras* which was equally prolific in earlier Oxfordian times in northern Europe and spread as far as Siberia and into the Sundance Sea from Alaska down to Wyoming and Utah. Both are so widely distributed in the Arctic region and in northern Europe that specific comparisons are unnecessary. The Greenland forms identified with the Siberian *Cardioceras caelatum*, Pavlow, or the Central Russian *C. zenaïdae*, Ilovaïsky, could well be matched by examples from the English *cordatum* beds or those of Lithuania, Poland, the Ardennes and Switzerland, but all the Alaskan and Wyoming species of *Cardioceras* known to me are different simply because they are of earlier (upper *lamberti-* lower *cordatus*) date. *Cardioceras* itself has been recorded by Sokolov[2]) from Spitsbergen and by Frebold from Novaya Zemlya, but I am here suggesting (p. 22) that the latter author's *C. excavatum* var. *arctica*, Pavlow, is in reality an *Amoeboceras* of the upper Neoxfordian.

The genus *Amoeboceras*, including the younger Cardiocerates, in fact, seems to have a far wider distribution around the Arctic than *Cardioceras* itself. In some areas, no doubt, such as Novaya Zemlya, whence Salfeld and Frebold[3]) recorded a small *Amoeboceras*, referred to *A.* (*Nannocardioceras*) *subtilicostatum* (Pavlow), there has as yet been insufficient exploration. Conversely, in others, such as the Petchora region, the record of *Cardioceras cordatum* (by Keyserling) is probably

[1]) *Loc. cit.* (Geol. Mag., 1921), p. 351.

[2]) See in Sokolov and Bodylevsky, *loc. cit.* (Skrifter om Svalbard, no. 35), 1931, p. 20, but also p. 136.

[3]) Jura- und Kreidefossilien von Nowaya Semlja. Rep. Sci. Res. Norweg. Exped. Novaya Zemlya, 1921, No. 23, 1924, p. 5, pl. 1, fig. 6.

due to misidentification of one of those forms of *Amoeboceras* that were later (1912) described by Sokolov, although there is perhaps no reason why *Cardioceras sensu stricto* should not also occur. But even on the opposite side of the Arctic Basin, the Sundance Sea of the Divesian and early Cardioceratan had disappeared to leave a small coastal strip submerged, from California to Alaska, in which incompletely known Kimmeridgian forms of *Amoeboceras* (so-called *A. dubium*) persisted. Like earlier Neo-Jurassic faunas, they immigrated from the Arctic Province and, however hypothetical may be the Mackenzie Strait, across the Yukon, *Amoeboceras* from Alaska and California cannot anywhere be matched more perfectly than by the impressions figured in Plate 3, fig. 1. This is not to say that *Amoeboceras* must necessarily have originated in the Arctic; but while this genus, like its ancestor *Cardioceras*, is far more varied in the Russian and British deposits of Oxfordian age, the Lower Kimmeridgian of East Greenland has yielded two groups of Cardiocerates (*Euprionoceras* and *Hoplocardioceras*) which are entirely unknown in England, and in the case of the second, even in Spitsbergen. This group (*Hoplocardioceras*) has been mistaken for *Aspidoceras*, a genus unknown from the Arctic and entirely replaced by *Amoeboceras* already in Scotland; and it is interesting to note that in Alaska, such southern elements as *Lytoceras* and *Phylloceras* are associated with *Amoeboceras* and "*Aucella*"[1]). We know from the distribution of the cephalopods and other mollusca, which could not have lived in an ice-covered sea, as much as from the northward extension of the range of corals, that in the Upper Jurassic the climate must have been warmer than at the present day. But this does not exclude the existence of climatic zones. No doubt, the dependence of ammonite dispersal on ocean currents and the existence of actual land barriers influenced the composition of the ammonite faunas in northern and southern areas, for there is no question of the reality of the so-called Boreal Province. But the poverty of the northern faunas in ammonite genera, and the abundance of individuals of the few types known, is again strikingly displayed by the *Amoeboceras* faunas of Milne Land, Jameson Land, and Wollaston Foreland.

The higher faunas of the Rasenian age and especially of the succeeding Aulacostephanitan[2]) are difficult to correlate since there are so few comparable assemblages described from the Arctic Province. *Rasenia*

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[1]) Stanton and Martin: "Mesozoic Section on Cook Inlet and Alaska Peninsula". Bull. Geol. Soc. America, XVI, 1905, p. 407.

[2]) The term "Physodoceratan", used by Buckman (Type Ammonites, IV, 1922, p. 7) is not acceptable since the genus *Physodoceras*, if not confined to the Rasenian, is essentially an early Eo-Kimmeridgian element and since the forms envisaged by Buckman are true *Aspidoceras*.

has been recorded from Spitsbergen, but although some of Frebold's[1]) examples distantly resemble Ravn's *Aulacostephanus*? *groenlandicus*, others are more doubtful; and this author himself stated[2]) that some resembled *Rasenia trimera* (Oppel). The association of at least one example with an *Amoebites* of the *kitchini* group on the same slab (Frebold's pl. IX, figs. 1 and 3) makes the generic identification probable, even if the inner whorls appear to be different from those of true *Rasenia*. The badly preserved specimens recorded by myself[3]) are even more doubtful, as is shown by the determination of one as *R.*? cf. *swindonensis* (Pavlow), a Portlandian species. I assumed them to come out of nodules in the micaceous *Amoeboceras* Shales, considering their different preservation, but they may well be much later forms. Likewise the species of *Pictonia*, including the ammonites figured by Lindström as *Ammonites triplicatus*, were thus determined partly on the strength of the supposed association, partly on account of the smooth outer whorls. But Frebold[4]) figured a number of these and allies as *Perisphinctes* cf. *panderi* and referred them to the Lower Volgian, as Sokolov had done in 1922; and since Frebold's specimens are more favourably preserved, though also crushed, they may be held to show insufficient resemblance to a *Pictonia* like *P. costigera* Buckman[5]) to justify my (1921) determination. But Pompeckj also had recorded a *Perisphinctes* cf. *triplicatus* (Lindström), together with *Aulacostephanus* and corresponding "*Aucella*". Moreover, it is only the discovery of very well-preserved and very abundant material of forms of this *panderi* group in Milne Land by Rosenkrantz and Aldinger that enables me now to appreciate the extended range (from the Kimmeridgian into the Portlandian) of these ammonites; but since they will be dealt with fully in the next part of this memoir, it must suffice to state that neither *Pictonia* nor *Rasenia* is as yet known from Spitsbergen in undoubted representatives though *Aulacostephanus* may perhaps occur. Pompeckj already recorded *Aulacostephanus* sp. and *A.* cf. *subeudoxus* (Pavlow) from Spitsbergen and, however badly preserved the original specimen of the latter may be, I am not convinced that it is identical with Ravn's *Aulacostephanus*(?) *groenlandicus*, any more than are the two Spitsbergen examples of *Rasenia* figured by Frebold[6]), or, particularly, his Kuhn Island form[7]). Yet it is possible that the form here described as *Rasenia*

[1]) *Loc. cit.* (Skrifter om Svalbard, No. 31), 1930, pl. IX, fig. 4, pl. XXII, fig. 2.

[2]) *Ibid.*, pp. 21—22.

[3]) *Loc. cit.* (Geol. Mag., 1921), p. 351.

[4]) *Loc. cit.* (Skrifter om Svalbard, No. 31), 1930, e. g., pl. XII, fig. 2.

[5]) Type Ammonites, vol. VI, 1927, pl. 716 (Compare Frebold's fig. 1 of pl. XI or some of the figures on pl. X).

[6]) *Loc. cit.* (Skrifter om Svalbard, No. 31), 1930, pl. IX, fig. 4, pl. XXII, fig. 2.

[7]) *Loc. cit.* (Medd. om Grønl., vol. 94, no. 1), 1933, pl. II, fig. 13.

borealis is closer to the Koldewey Island form than is admitted on p. 49. In that case the resemblance between the Upper Jurassic of the northern area, recently discussed by Frebold[1]), and that of Scoresby Sound would be enhanced. Among a large number of *Amoeboceras* impressions from southern Jameson Land (Basalt Table Mountain, horizon No. 24) collected by Dr. Bütler, three of which are here figured (Plate 13, figs. 5—7), there are some very good matches of Ravn's examples of *A. alternans*; and Mr. Rosenkrantz's material from the *Cardioceras* Valley on Wollaston Foreland includes a very similar assemblage of forms of the *serratum-alternoides* group, *A. rosenkrantzi*, nov. (Plate 12, fig. 4; Plate 13, fig. 5) being common to both areas. On Kuhn Island the ammonites are badly preserved and some Aptian *Sanmartinoceras* have been mistaken for forms of *Amoeboceras*; if I am right in identifying *Aspidoceras* sp. ind. from that island with *Amoeboceras* (*Hoplocardioceras*) *decipiens*, here described, the resemblance between the northern and southern Jurassic areas of East Greenland is still further strengthened but there is no section available from anywhere, comparable to that measured by Dr. Aldinger on Milne Land.

As regards the palaeogeography of the Arctic in Oxfordian and Eo-Kimmeridgian times, there is little to add to what I[2]) have previously said, although my correlation of the boreal Jurassic was concerned chiefly with earlier formations. The occurrence of identical or almost identical forms of *Amoeboceras* in Milne Land and Scotland on the one hand, Novaya Zemlya and Siberia on the other, like the occurrence of the West European *Rasenia orbignyi* (Tornquist) is convincing proof that there was still direct marine communication between these areas, as in the Callovian. The more interesting problem as to the affinity of the East Greenland highest Jurassic with the Volgian of Russia will be discussed in the next part.

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[1]) *Loc. cit.* (Medd. om Grønl., vol. 94, no. 1), 1933, p. 66.
[2]) *Loc. cit.* (Medd. om Grønl., vol. 87, no. 7), 1932, pp. 146 &c.

V. SUMMARY OF RESULTS

1) The present account deals with the invertebrates of the lower part only of the Upper Jurassic succession at Cape Leslie, corresponding to Kløft I Formation on Koldewey Island and shown to be of Neoxfordian and Eo-Kimmeridgian age.

2) The Charcot Bay Sandstone which separates this succession from the fundamental Caledonian granite is unfossiliferous and of unknown age, but there is some evidence for the existence of a stratigraphical gap between the Callovian Vardekløft Formation and the Upper Oxfordian even in Jameson Land.

3) There is no natural boundary line between the lower set of beds in Milne Land and the upper series (Cape Leslie Formation) with rich ammonite faunas of Neo-Kimmeridgian and later age, to be described in the next part, but there is an interval of unfossiliferous shales. All the rocks are comparatively shallow-water deposits.

4) The Cardiocerates of the Neoxfordian are not numerous enough for definite zoning, but in the Eo-Kimmeridgian three or four successive horizons, characterised by *Rasenia orbignyi*, *R. borealis* (*Amoeboceras* [*Euprionoceras*] *kochi*) and *A.* (*Hoplocardioceras*) *decipiens*, respectively, can be distinguished.

5) The last ammonite horizon mentioned is probably developed also on Kuhn Island; the Neoxfordian Cardiocerates are identical with or similar to those known from Jameson Land, Wollaston Foreland, and Koldewey Island, but no detailed section is known elsewhere, comparable to that measured by Dr. Aldinger on Milne Land.

6) The ammonites are all boreal elements. A number are identical, or almost identical, with north-west European (especially Scottish), Spitsbergen, Russian and Siberian species, but the Californian and Alaskan *Amoeboceras dubium* may also be represented, while the examples of the southern genus *Aspidoceras*, recorded from East Greenland, are believed to be misidentified Cardioceratids.

7) There are again few genera, but with a large number of individuals,

representing a feeble selection of the types known to have existed in the contemporaneous seas of lower latitudes.

8) The other invertebrates described are mainly belemnites and pelecypods from one sandstone horizon of Neoxfordian age, possibly identical with the *Parallelodon keyserlingi* bed of Fligely Fjord, Kuhn Island. There are also a few worms and a single ophiuroid. *Buchia* ('*Aucella*') occurs at only one Lower Kimmeridgian shale horizon, but there are many examples in sandstones at various horizons in the Cape Leslie Formation.

9) There must still have been direct marine communication between East Greenland, Scotland and north-western Europe, generally, Novaya Zemlya and Siberia on the one hand, and Alaska and California, on the other, as in Callovian times, but there is an apparent absence in the Arctic of ammonite faunas of Divesian age.

VI. SUMMARY OF NEW NAMES

		Page
Cardioceras (*Cawtoniceras*) ***blakei***, sp.nov. (Plate 13, fig. 4).		16
Amoeboceras (*Prionodoceras*) ***transitorium***, sp. nov. (Plate 1, fig. 8).		17
—	(*Prionodoceras*) ***franconicum***, nom. nov. (*Cardioceras excavatum*, Dorn, *non* Sowerby sp.).	15
—	(*Prionodoceras*) ***pseudocaelatum***, nom. nov. (*Cardioceras* cfr. *alternans* [*non* v. Buch] Ilovaïsky).	19
—	(*Prionodoceras*) ***marstonense***, sp. nov. (Plate 4, fig. 5).	20
—	(*Prionodoceras*) ***marchense***, nom. nov. (*Cardioceras* aff. *excavato*, Crick *non* Sowerby sp.).	17
—	(*Prionodoceras*) ***leucum***, sp. nov. (Plate 5, fig. 3).	22
—	(*Prionodoceras*) ***simplex***, nom. nov. (*Cardioceras bauhini*, Nikitin *non* Oppel sp.).	22
—	(*Prionodoceras?*) ***prorsum***, sp. nov. (Plate 5, fig. 5).	24
—	(*Prionodoceras*) ***nigrum***, nom. nov. (*Cardioceras* cf. *nathorsti* var. *robusta*, Frebold, partim).	25
—	(*Prionodoceras*) ***regulare***, nom. nov. (*Cardioceras* cf. *nathorsti*, Frebold, partim).	25
—	(*Prionodoceras*) ***freboldi***, nom. nov. (*Cardioceras* cf. *nathorsti*, Frebold, partim).	25
—	(*Prionodoceras*) ***rosenkrantzi***, sp. nov. (Plate 12, fig. 4; Plate 13, fig. 5).	25
—	(*Prionodoceras*) ***ravni***, sp. nov. (Plate 4, fig. 4).	17
—	(*Amoebites*) ***rasenense***, sp. nov.. (Plate 1, fig. 6).	29
—	(*Amoebites*) ***salfeldi***, sp. nov. (Plate 2, fig. 7).	31
—	(*Amoebites*) ***irregulare***, sp. nov. (Plate 1, fig. 1).	32

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Amoeboceras (*Amoebites*) ***subkitchini***, sp. nov. 30
(Plate 1, fig. 3).

— (*Amoebites*) ***elegans***, sp. nov. 33
(Plate 4, fig. 2).

— (*Amoebites*) ***pseudacanthophorum***, sp. nov..... 35
(Plate 5, figs. 7—8).

Euprionoceras, sub-gen. nov. (of *Amoeboceras*, Hyatt) 12
Sub-genotype: *Amoeboceras* (*E.*) ***kochi***, sp. nov. 26
(Plate 5, fig. 2).

Amoeboceras (*Euprionoceras?*) ***aldingeri***, sp. nov..... 28
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Hoplocardioceras, sub-gen. nov. (of *Amoeboceras*, Hyatt) 13
Sub-genotype: *Amoeboceras* (*H.*) ***decipiens***, sp. nov. 36
(Plate 3, fig. 2, etc.).

Nannocardioceras, sub-gen. nov. (of *Amoeboceras*, Hyatt).... 13
Sub-genotype: *Amoeboceras* (*N.*) *anglicum* (Salfeld)

Rasenia ***borealis***, sp. nov. 48
(Plate 6, fig. 1; Plate 7).

— *orbignyi* (Tornquist) var. ***ornata***, nov. 44
(Plate 10, fig. 1; Plate 11, fig. 1).

— *orbignyi* (Tornquist) var. ***aperta***, nov. 44
(Plate 9, fig. 1).

— *orbignyi* (Tornquist) var. ***suburalensis***, nov..... 44
(Plate 8, fig. 2).

— ***similis***, sp. nov. 46
(Plate 14, fig. 2).

— ***inconstans***, sp. nov..... 45
(Plate 10, fig. 6 etc.).

— ***involuta*** (Salfeld MS), sp. nov. 48
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— ***evoluta*** (Salfeld MS) sp. nov. 48
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Færdig fra Trykkeriet den 8. April 1935.

PLATES

Plate 1.

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- 2a, b. *Amoeboceras* (*Prionodoceras*) aff. *superstes* (Phillips). Neoxfordian, *Pecten* Sandstone. (Loc. 233) 23

- 3a, b. *Amoeboceras* (*Amoebites*) *subkitchini* sp. nov. Two sides of (crushed) holotype. Lower Kimmeridgian, nodule bed *δ*. (Loc. 249) 30

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- 7. *Amoeboceras* (*Euprionoceras*?) sp. juv. ind., perhaps young of *A.* (*E.*?) *aldingeri* sp. nov. (Plate 2, fig. 6). Lower Kimmeridgian, nodule bed *δ*. (Loc. 186) 29

- 8a, b. *Amoeboceras* (*Prionodoceras*) *transitorium* sp. nov. Holotype, with restored sectional outline. Neoxfordian, just below *Pecten* Sandstone. (Loc. 231) 17

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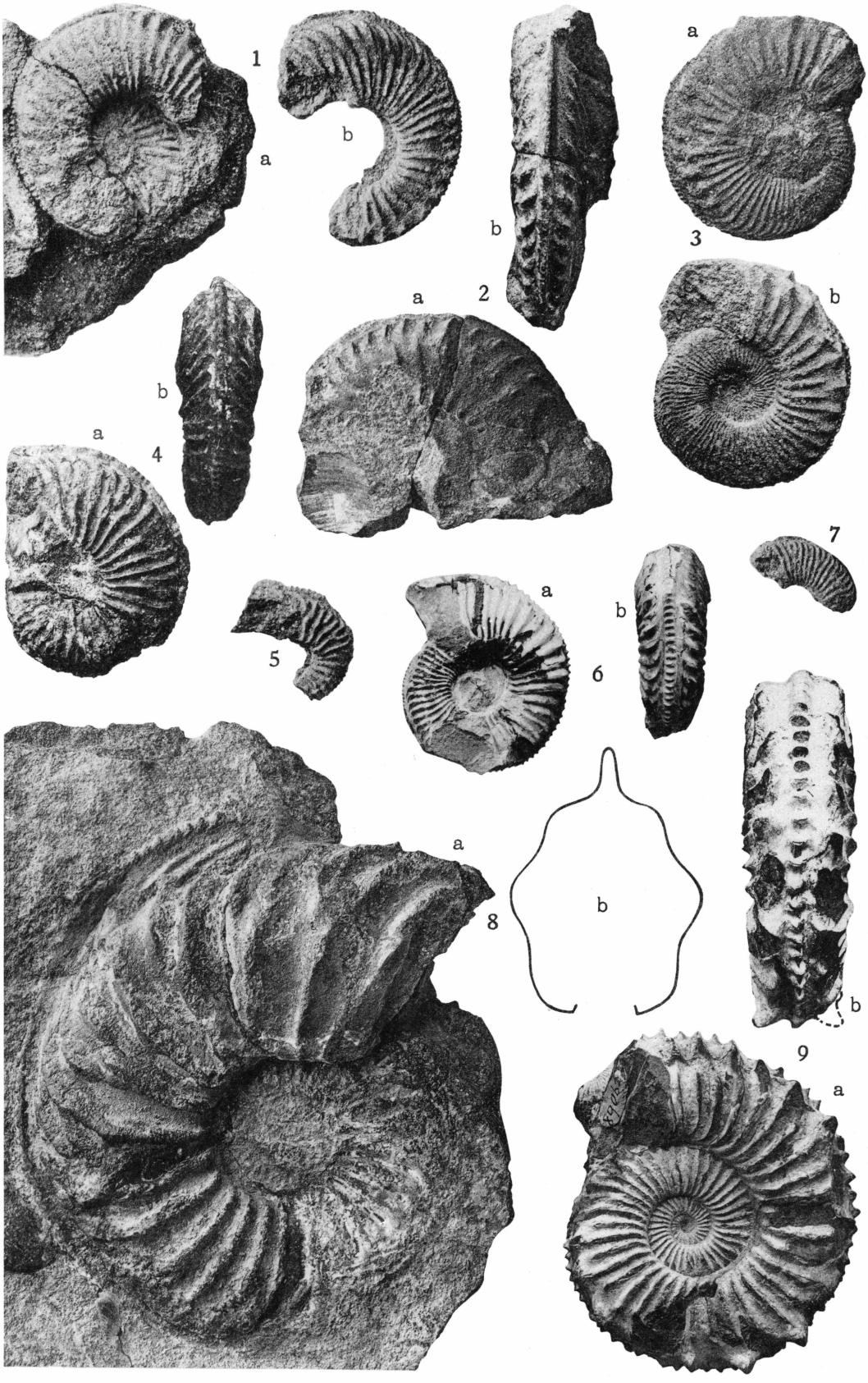

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Plate 2.

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- 2. *Amoeboceras* (*Hoplocardioceras*) *decipiens* sp. nov. Two smaller examples on slab with numerous crushed *Lucina* (?) sp. ind. Lower Kimmeridgian, upper *Amoebites* (= Oil) Shales. (Loc. 243) 36

- 3. *Cardioceras* aff. *zenaïdae*, Ilovaïsky. Side- and peripheral views and sectional outline. Neoxfordian, between Charcot Bay and *Pecten* Sandstones. (Loc. 255) 14

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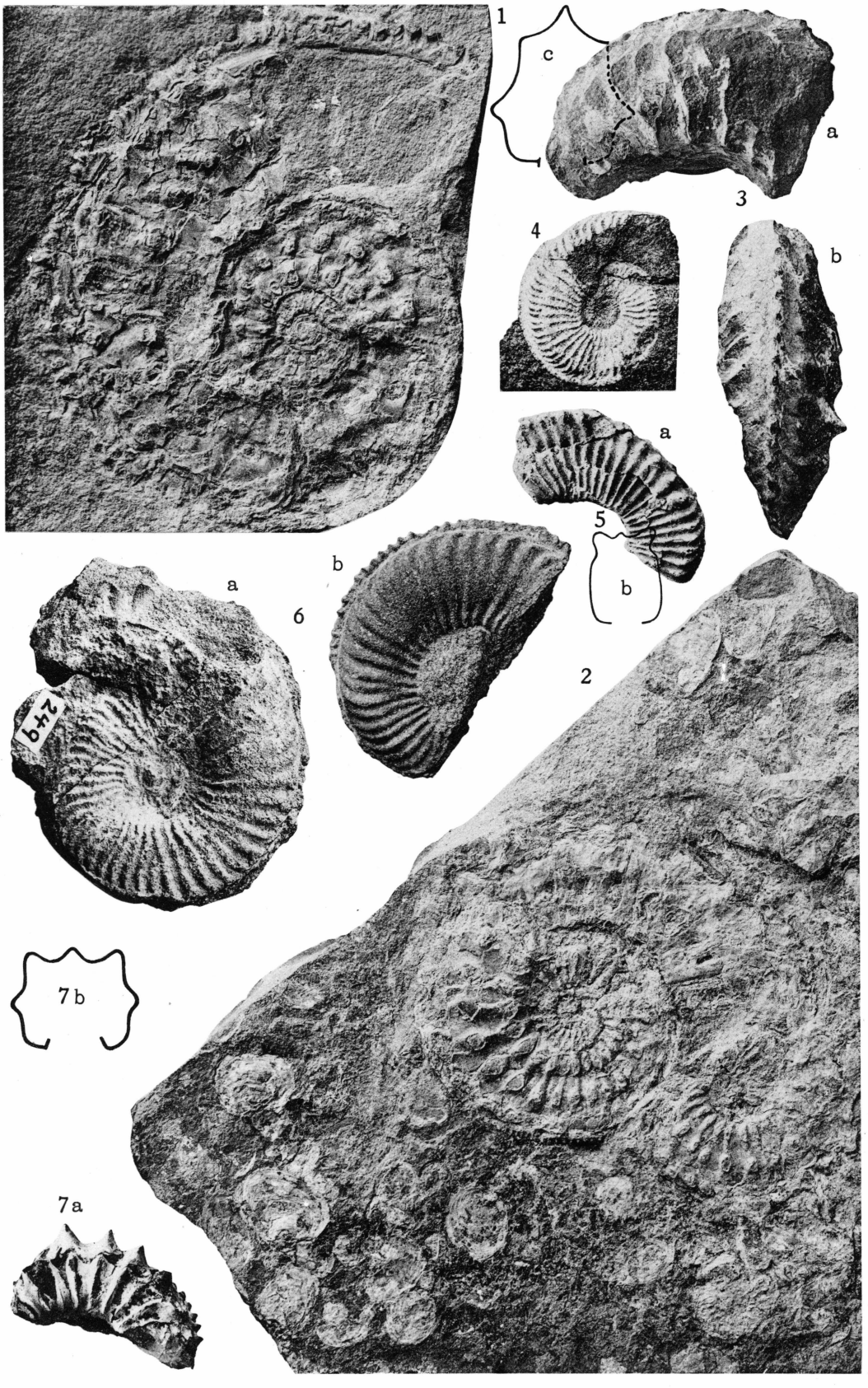

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Plate 3.

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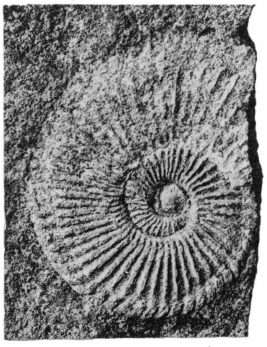
- 4a, b. *Amoeboceras* (*Prionodoceras*) *ravni* sp. nov. Holotype, with sectional outline. Neoxfordian, East Coast of Scotland (Shandwick?). B. M., no. C. 27667 17

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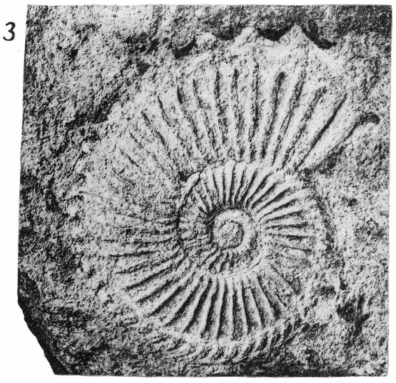
- 6. *Amoeboceras* (*Prionodoceras*) *marchense* sp. nov. External suture-line, enlarged × 3, of holotype (B. M., no. 50098) figured by Crick (*loc. cit.*, 1898, pl. XVIII, figs. 9—10). Neoxfordian, Ampthill Clay, Cambridgeshire 17

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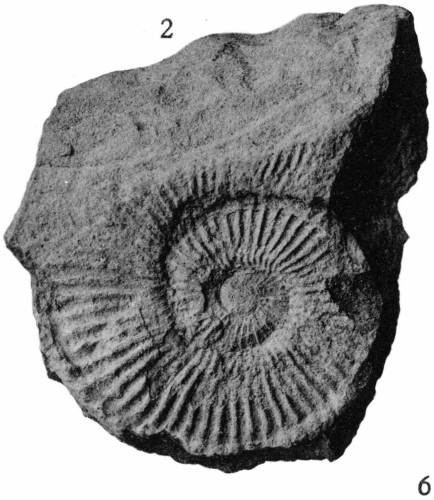
- 8. *Amoeboceras* (*Euprionoceras?*) *nathorsti* (Lundgren), a, b, on a slab of bituminous shale with *A.* (*Amoebites*) *beaugrandi* Sauvage sp. (? left centre) and two intermediate examples (on right). Lower Kimmeridgian, *mutabilis* zone, Culgower, Scotland. (B. M., no. C. 13181) 27

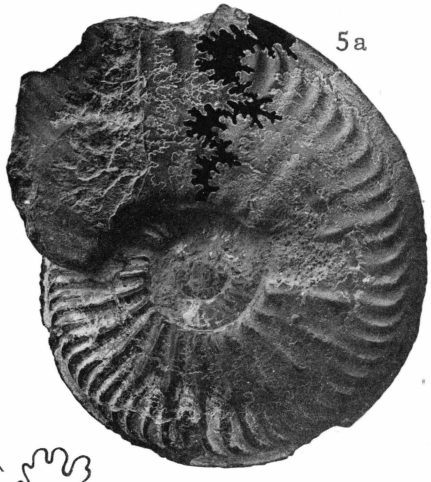

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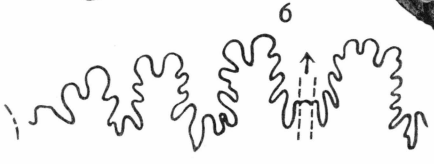

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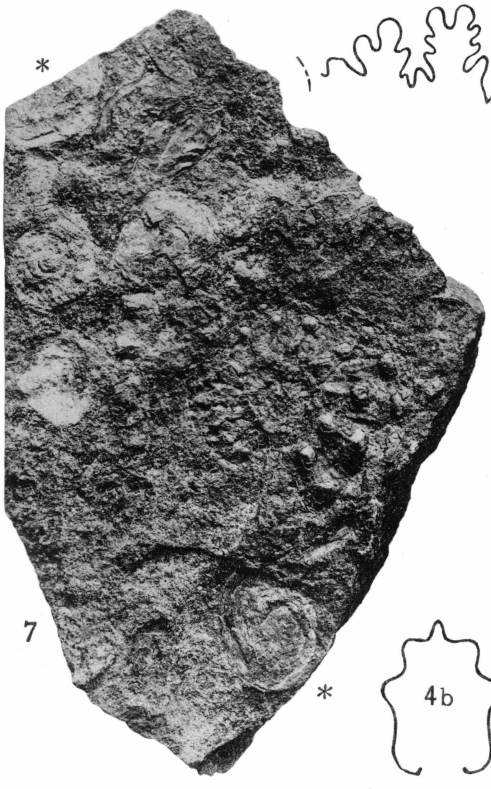

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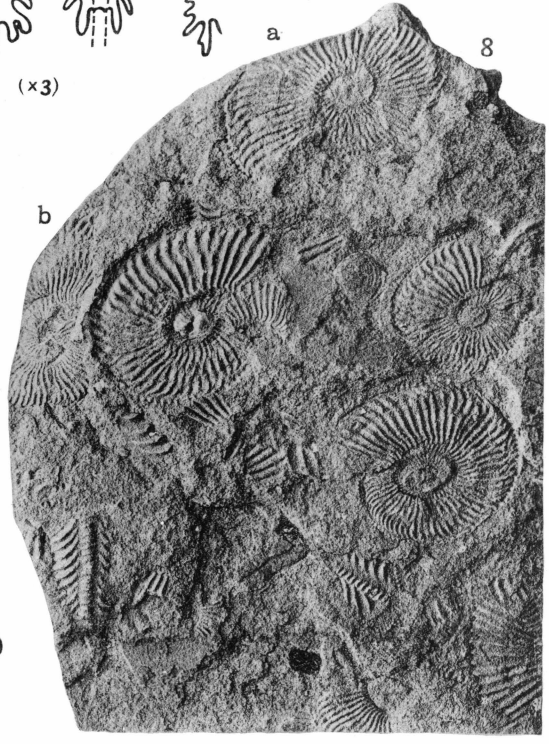
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Plate 5.

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Figs. 1, 6. *Amoeboceras* (*Amoebites*) cf. *elegans* sp. nov. and cf. *dubium* (Hyatt). Squeezes of two impressions (compare Plate 3, fig. 1). Lower Kimmeridgian, upper *Amoebites* (= Oil) Shales. (Loc. 237)..... 34

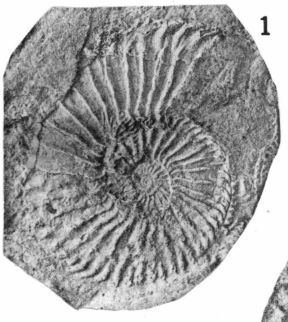
- 2a, b. *Amoeboceras* (*Euprionoceras*) *kochi* sp. nov. Holotype impression and gypsiferous fragment, showing keel. Lower Kimmeridgian, upper *Amoebites* (= Oil) Shales. (Locs. 237 and 208)..... 26

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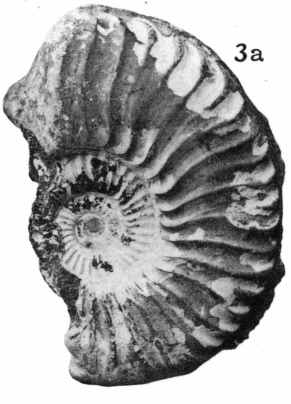

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Plate 6.

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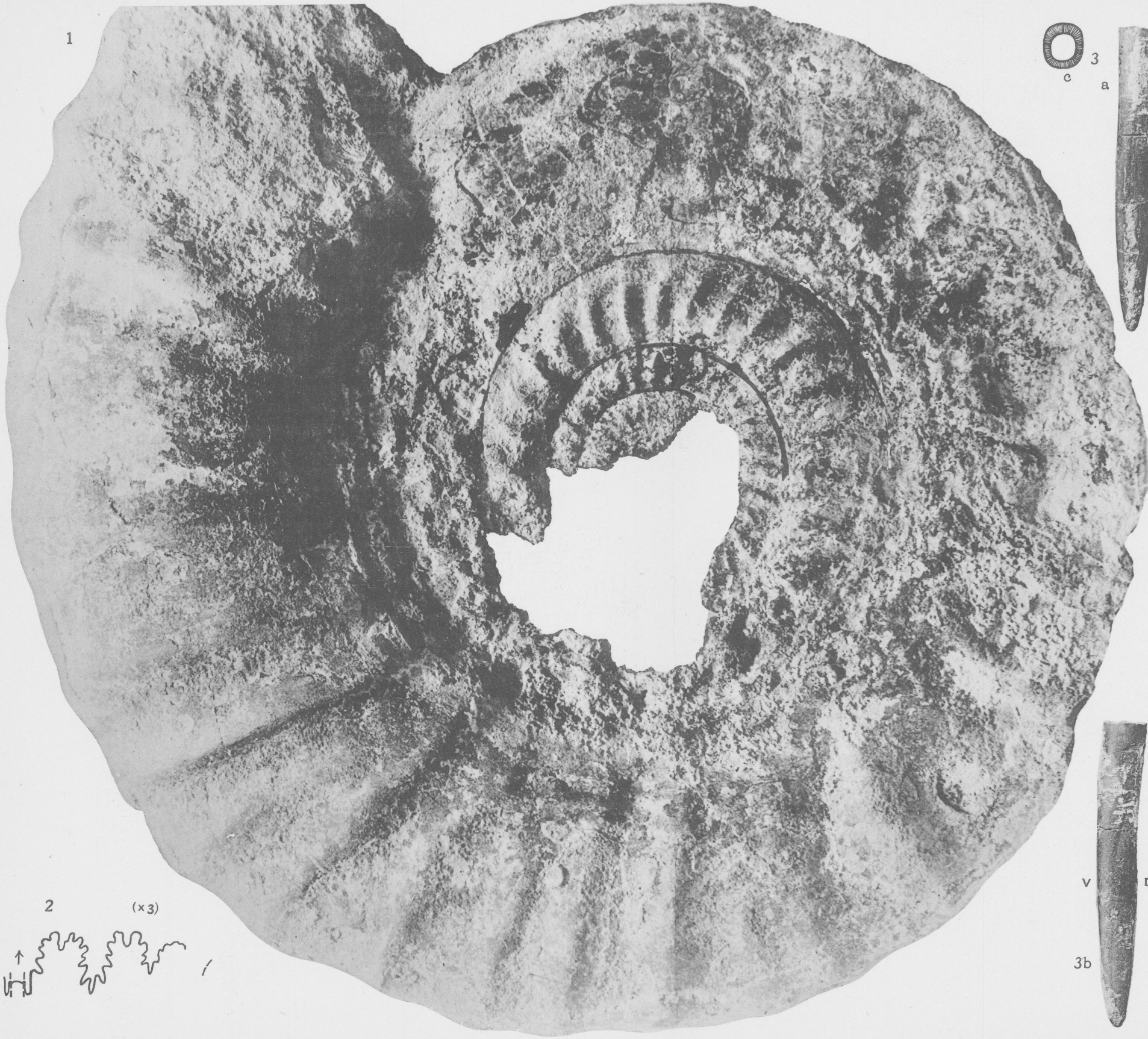
Fig. 1. *Rasenia borealis* sp. nov. Crushed paratype. Lower Kimmeridgian, nodule bed γ. (Loc. 194) 48

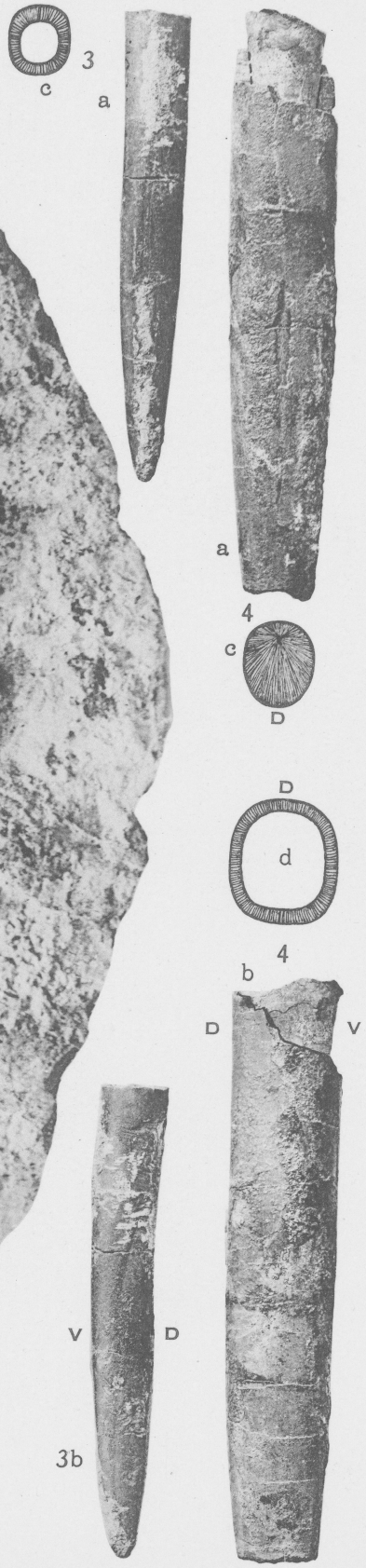
- 2. *Amoeboceras* (*Amoebites*) sp. juv. (labelled "cf. *kitchini*" by Salfeld). External suture-line (enlarged $\times$ 3) of a fragment from the Lower Kimmeridgian of Cromarty, Scotland. (B. M., no. C. 13314) 30

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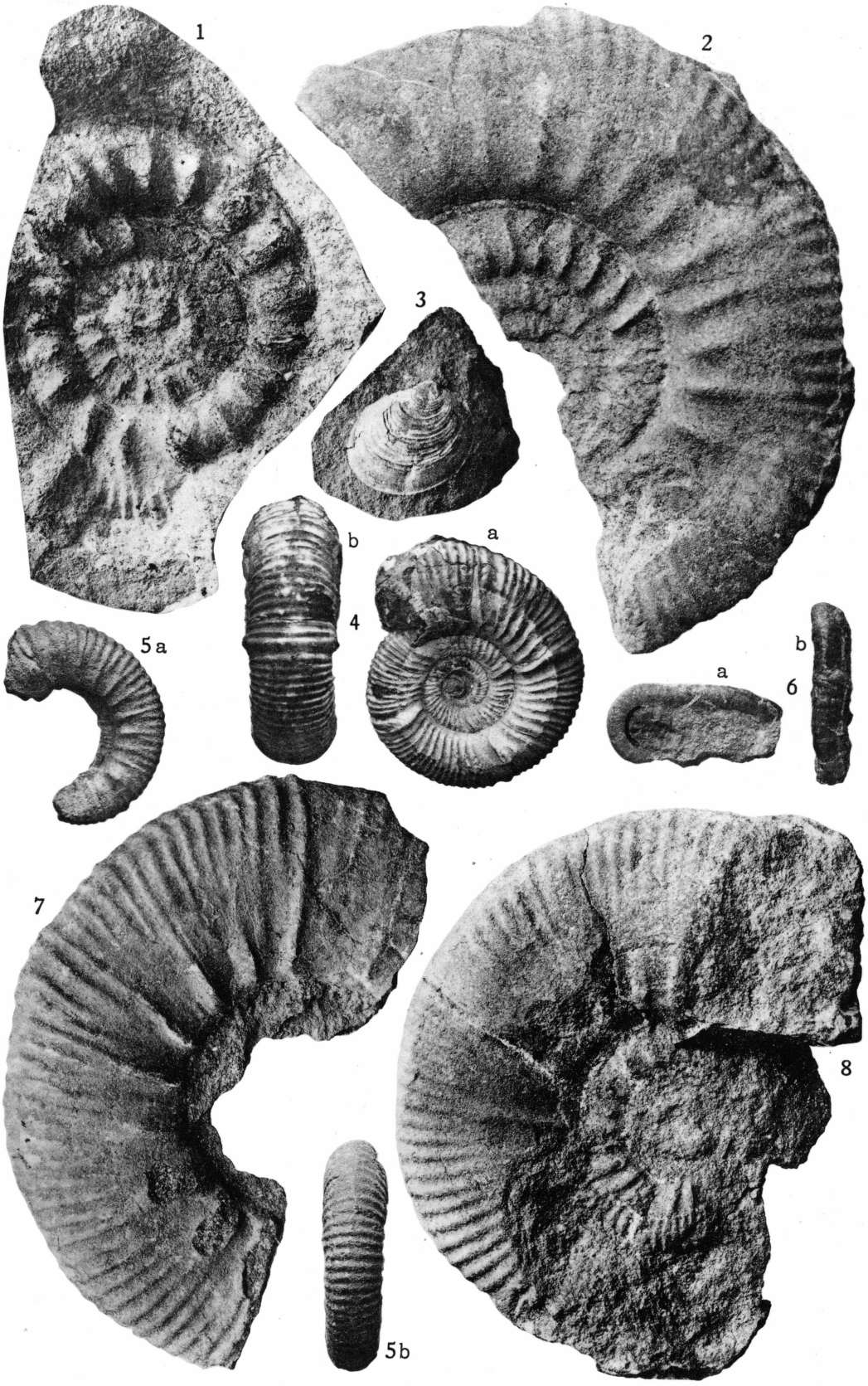

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Plate 9.

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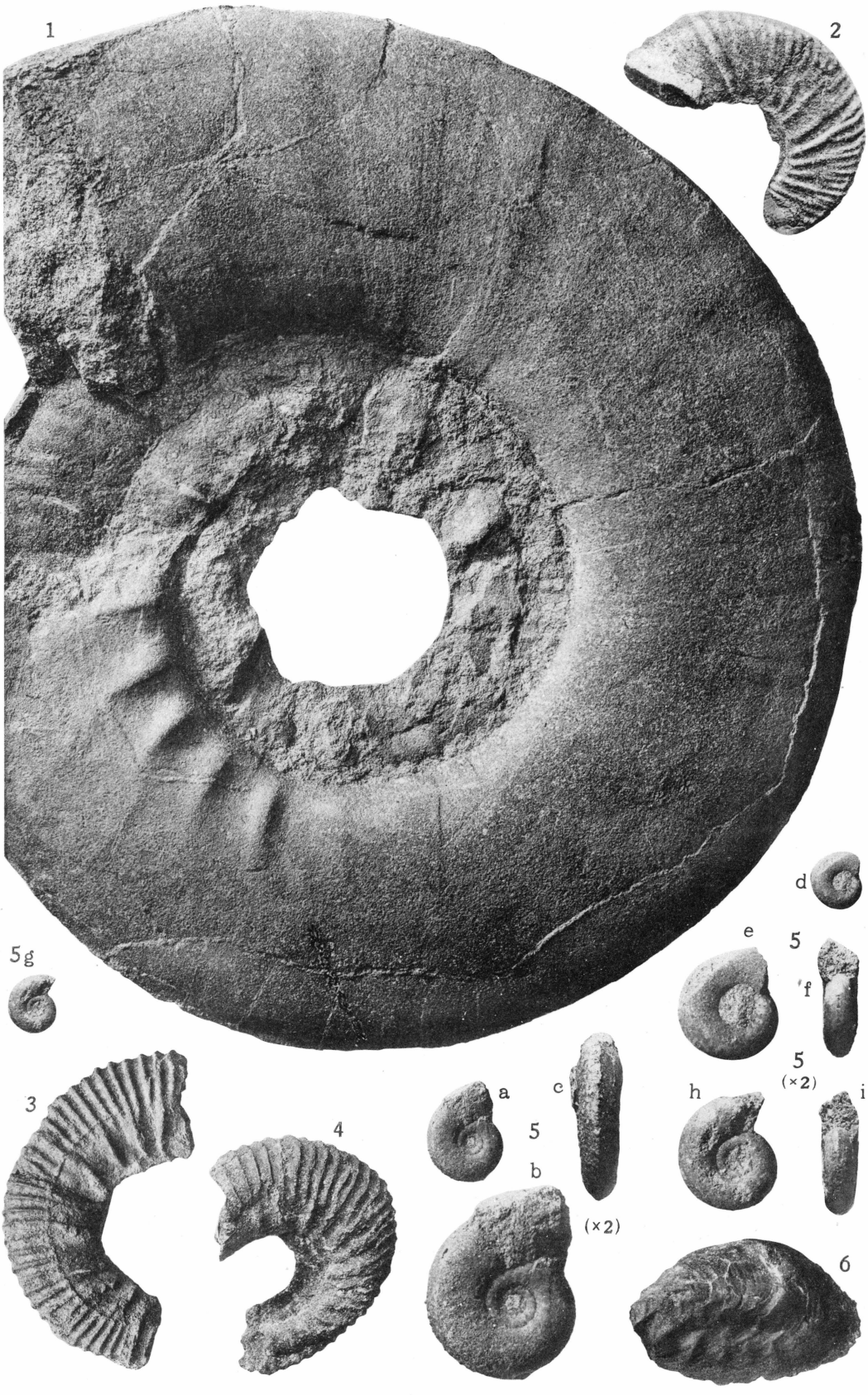
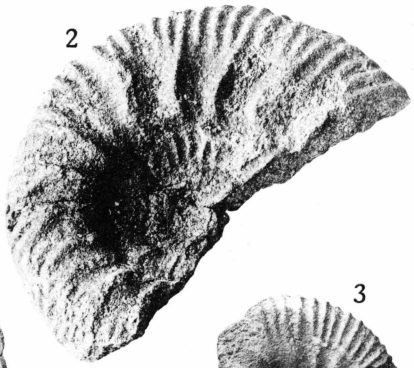

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(×2)
3
4
a
c
5
b
(×2)
h
i
6

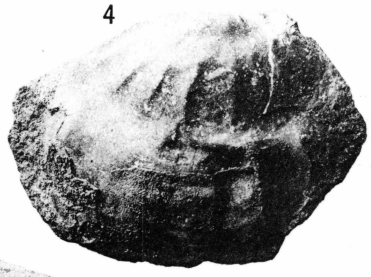
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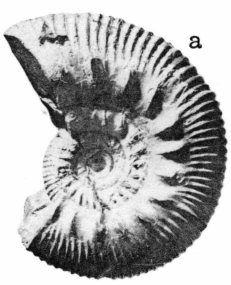
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1


2


3


4


a


b
5


6


V
D
7a


b


7
c

Plate 11.

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1

3a

3b


2

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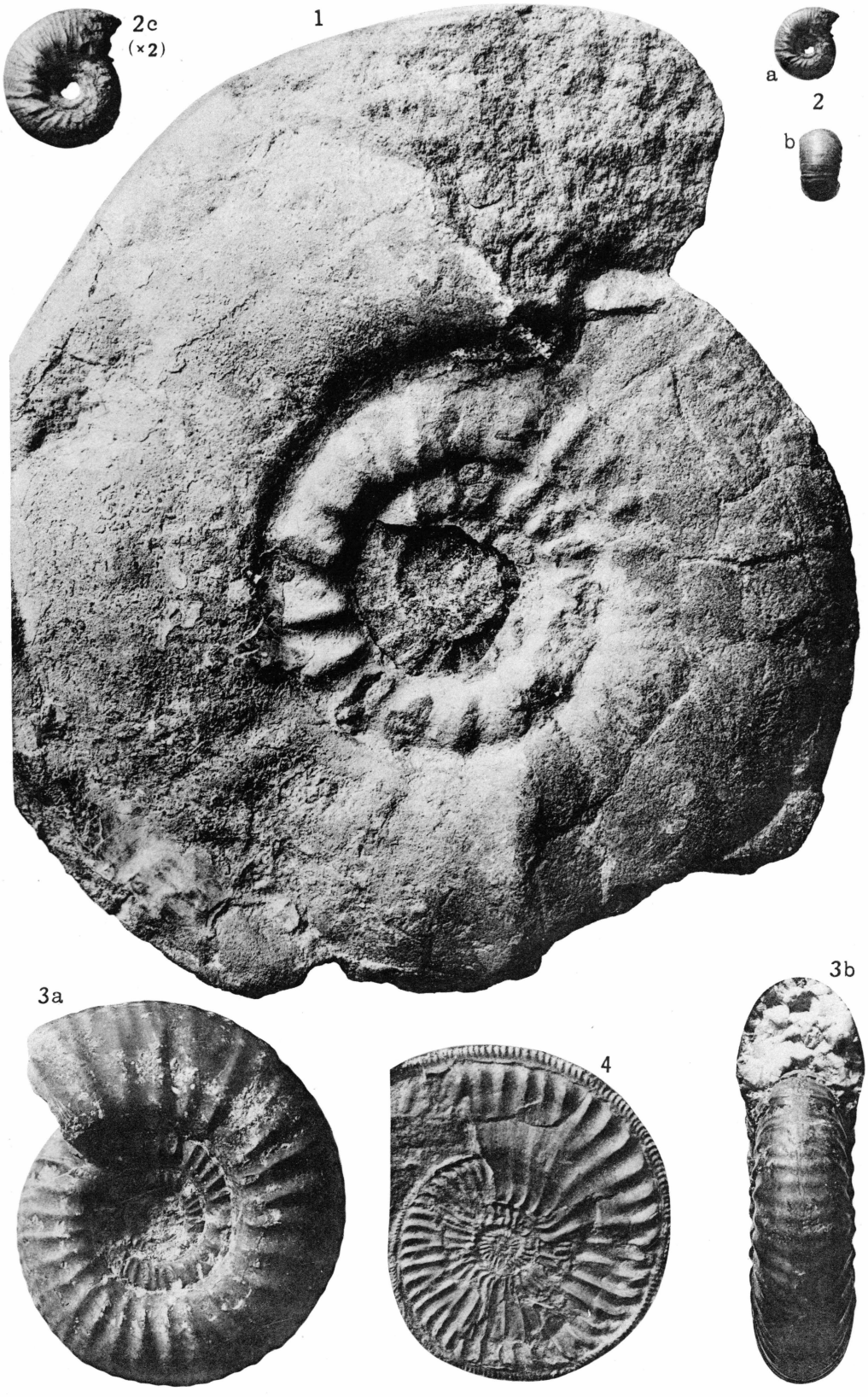

2c
(×2)
1
a
2
b
3a
4
3b

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3a
1a
2
3b
1b
5
7
a
4
b
8a
6
*
8b

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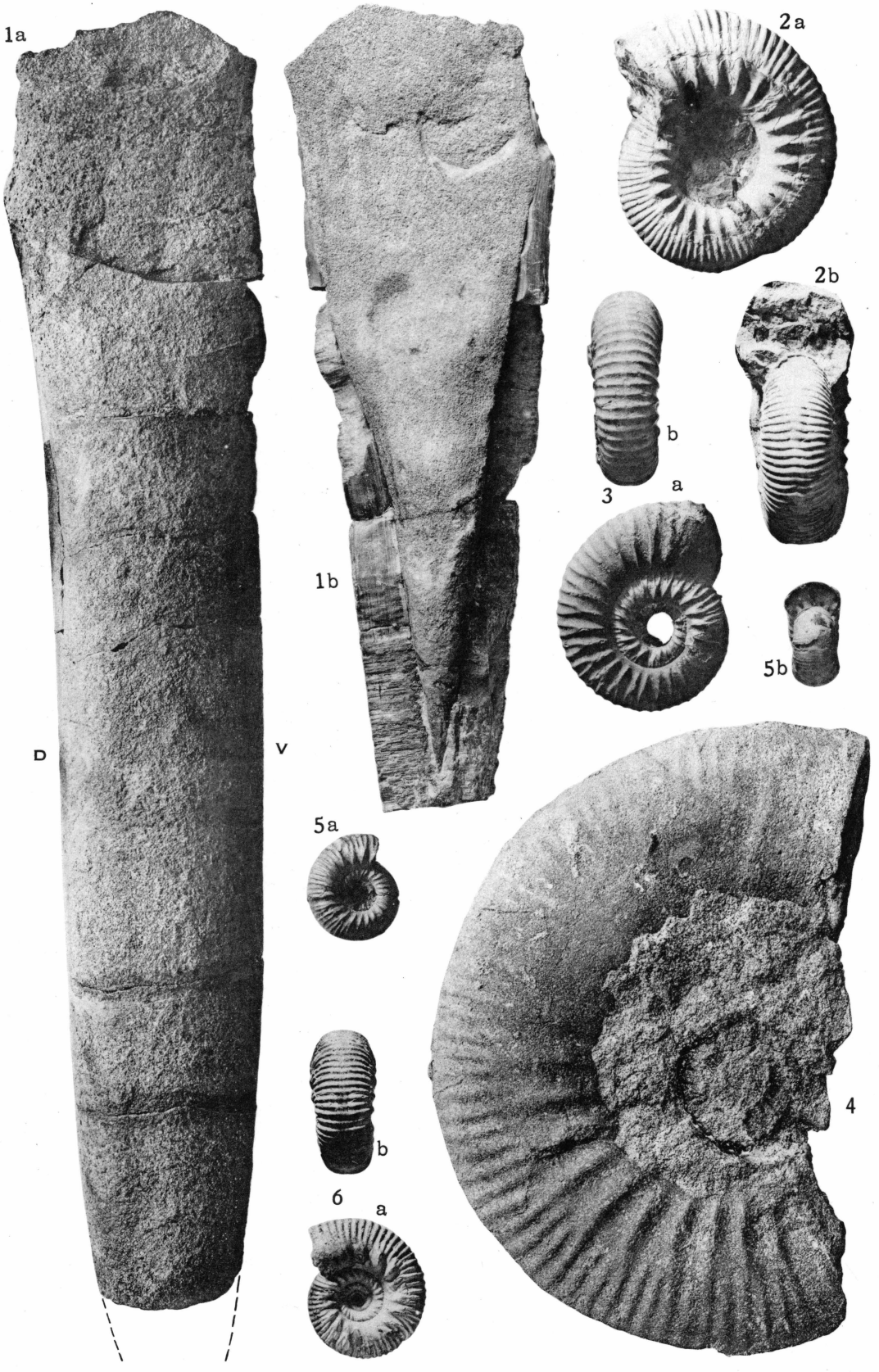

1a
1b
D
V
2a
2b
3
a
b
4
5a
5b
6
a
b

Plate 15.

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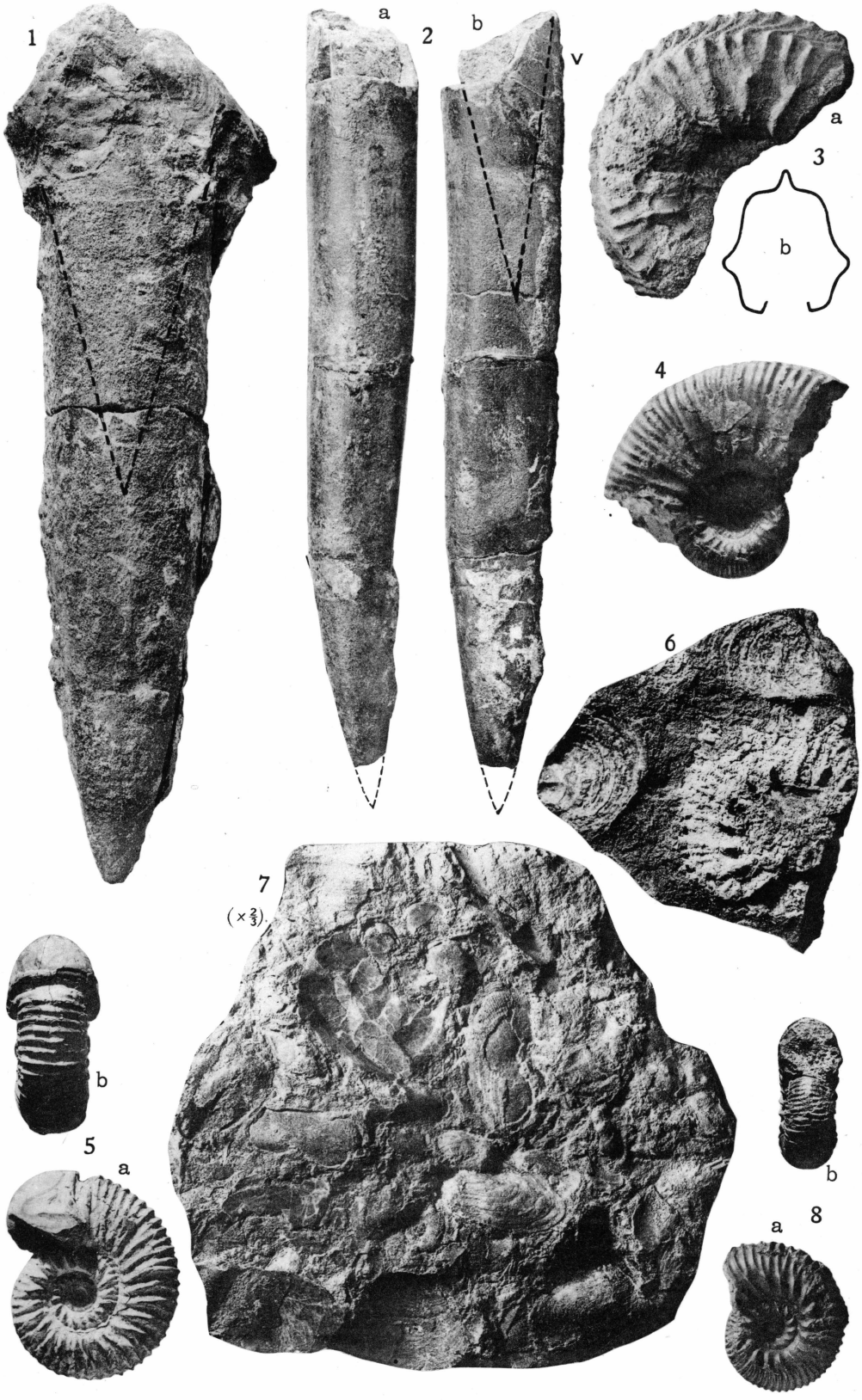
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1
2
a
b
V
a
3
b
4
6
7
(×⅔)
b
5
a
b
8
a