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THE JURASSIC AND CRETACEOUS
STRATIGRAPHY AND PALAEONTOLOGY
OF TRAILL Ø, EAST GREENLAND

BY

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WITH 14 FIGURES IN THE TEXT AND 25 PLATES

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PREFACE

The material for the following account was obtained during two summer seasons in East Greenland, in 1949 and 1950 as a member of the Lauge Koch Expedition. In the first season the south coast of Traill Ø was visited from July 27th until August 17th; in the second, from July 15th until August 30th, the Rold Bjerger and adjacent areas in Traill Ø were studied, and the neighbourhood of Mountnorris Fjord examined. The results provide a fairly complete outline of the geology of the Mesozoic part of Traill Ø. Many details are still lacking, but while further work in certain directions may prove profitable, other problems are likely to remain unsolved on account of the scarcity of exposures in some formations and of fossils in others.

I am indebted to Dr. LAUGE KOCH for the opportunity to work in East Greenland, for discussion of various problems and for much advice and information during the working out of the results. My assistants in the field were Messrs. J. W. COWIE and S. L. PAGE in 1949, and D. MACKNEY, E. W. ROBERTS and F. W. SHERRELL in 1950, all students of Bristol University. To all of them I offer my best thanks.

Prof. W. F. WHITTARD has provided facilities for the palaeontological work in the geological laboratories of the University of Bristol, and has read and improved the draft of this paper. I am indebted to Dr. L. F. SPATH for advice on a number of palaeontological matters, and for allowing me to examine some of the material described by him from East Greenland. Mr. C. W. WRIGHT and Mr. R. CASEY have kindly discussed a number of the Cretaceous ammonites, and suggested several of the identifications which I have adopted, which are acknowledged where they occur in the paper. Dr. L. R. COX has answered several enquiries on lamellibranchs, and Mr. L. BAIRSTOW has discussed '*Onychites*' and provided references. I have benefited from a number of discussions with Mr. M. Y. HASSAN while he was a research student at Bristol University.

Dr. H. M. MUIR-WOOD kindly undertook to examine the brachiopods and her report is published in *M.o.G.*, vol. 111, no. 6.

The final copies of the maps which form plates 1—4 have been drawn by the Geodetic Institute, Copenhagen. The aerial photographs which illustrate the paper were all taken by the expedition's photographers, the ground photographs by the writer. The photographs of fossils were taken by Mr. E. W. SEAVILL in conjunction with the writer.

Bristol, May 1952.

Note on new topographical names and geological localities.

In order to facilitate the geological descriptions a number of new topographical names have been introduced. The following is the complete list, together with the maps accompanying this paper in which they may be found:

Name	Map	Translation
Morris Bjerg	Pl. 1	Mount Morris
Lycett Bjerg	„	Mount Lycett
Sortefjelde	„	Black Mountains
Prospektfjeld	Pl. 2	Prospect Mountain
Bath Elv	Pl. 4, fig. 1	Bath River
Bristol Elv	„ „	Bristol River
Polyptychiteselv	„ „	Polyptychites River
Grønnebjerg	Pl. 1	Green Mountains
Lilleelv	Pl. 3	Little River
Bordbjerget	„	Table Mountain

Localities where fossils were found, or where sections were measured, have been allotted serial numbers which are shown on the geological maps which accompany this paper. The appendix (p. 149) will show the part of the island in which any particular locality is situated, and the map on which its exact position may be found. Numbers missing from the consecutive series were used for localities outside the area, or for specimens which are not referred to individually.

I. HISTORY OF RESEARCH

The history of research on the Mesozoic rocks of Traill Ø does not date back very far, for although SCORESBY in 1822 landed at Vandyke Klipper and reported the presence of "slateclay" as well as of many varieties of igneous rocks, the Mesozoic age of the sediments was not established until over a century later. On KOCH's map of 1929 (pl. 2) the area which we now know to consist of Mesozoic formations is shown as occupied by Devonian and Carboniferous rocks. In 1932 NOE-NYGAARD visited the island and recognised the presence of younger systems, but his observations from that and succeeding years were not published until 1938 (in FREBOLD and NOE-NYGAARD). NOE-NYGAARD's work established the presence of Eotriassic, Jurassic and basal Cretaceous rocks, but he did not obtain much information about their distribution. Only a few Mesozoic fossils were recovered, some from loose blocks, and from them FREBOLD deduced the presence of Eotriassic, Bathonian, Portlandian and Valanginian beds. Two of the fossils found were figured, *Cranocephalites cf. furcatus* Spath and *Aucella piriformis* Lahusen.

In the year that FREBOLD and NOE-NYGAARD's results were published, there appeared the first report, written in Greenland, of STAUBER's work in the season 1936—37 on Geographical Society and Traill Øer (STAUBER, 1938). The work contains, understandably, hardly any definite fossil records, but STAUBER had recognised in the field marine Eotrias, sandstones with plant remains which he attributed to the Rhaetic, Upper Jurassic black shales, and shales of both lower and upper Cretaceous age. The Valanginian, already found by NOE-NYGAARD, was not apparently seen by STAUBER, but his important contribution was the recognition of the Jurassic and Cretaceous black shales which form a considerable part of the island, but which had not previously been known. The main structural outlines were also given for the first time (STAUBER, *op. cit.*, pl. 1) in the accompanying map; this showed the major fault which delimits the Mesozoic outcrops to the west, the wide expanse of Cretaceous shales which forms almost all the eastern part of Geograph-

ical Society Ø and the central part of Traill Ø, and the upfaulted Trias and Jurassic areas to the east of Bjørnedal and in the Mols Bjerger, as well as delimiting the areas occupied by the plutonic igneous masses which had been mapped by SCHAUB. In 1939 STAUBER published, as part of a series of papers by Swiss geologists summarising their work in Greenland, a brief general account of the area between Scoresby Sund and Sofia Sund which does not give any details regarding Traill Ø, although it contains some misleading information, for instance, that the Aptian is widely spread (p. 171), and shows in the stratigraphical table (p. 174) the presence of Rhaetic-Lower Lias and Middle/Upper Lias which is not even now proved.

In 1940, STAUBER published an account of investigations in northern Jameson Land which includes a short section on Traill and Geographical Society Øer and a small-scale map which covers those islands. Here he records the finding of macrocephalitids in the sandstones of Forchammers Bjerg, and claims the underlying sandstones with plants and coal as Rhaetic in age. He also mentions the Valanginian for the first time in his reports and says that it has the "grösste Verbreitung" in both islands, a statement difficult to interpret in the light of subsequent knowledge. He surmises the presence of Senonian, although it is not clear on which island he found it.

In 1942, STAUBER published a massive and comprehensive volume on the Trias of East Greenland, in which the sections of that age studied by him in Traill Ø are given in great detail, although the palaeontology and stratigraphy are not adequately discussed.

STAUBER has published no detailed information regarding the post-Triassic rocks but he has drawn a complete map (published by KOCH, 1950, pl. 3) of the portion of Traill Ø occupied by Mesozoic formations. This map shows the general features of the geology, but is unfortunately inaccurate in many details. The presence of lower Cretaceous only is shown, whereas there are, in fact, considerable areas of Cenomanian, Turonian and Senonian rocks, and the marine Jurassic is undifferentiated. The errors in the position and extent of some of the outcrops will not be elaborated here as they can easily be found, if necessary, by comparing the map with those which accompany the present work. The structural features shown by STAUBER have certain peculiarities, including several overthrusts, which do not appear to be justified. They are more fully discussed below (section IX).

Summaries of the then available information on the Jurassic and Cretaceous rocks of Geographical Society and Traill Øer were given by MAYNE in 1947 and 1949. The igneous rocks were described by SCHAUB (1942) but no detailed petrographic investigations have been published.

SPATH (1946) reported briefly on the Cretaceous ammonites collected by STAUBER and others in East Greenland. The only forms identified from Traill Ø were examples of *Schloenbachia* from the mountain west of Bjørnedal. No other work has been published on the palaeontology, and so the basis for the other formations which had been stated to be present, with the exception of FREBOLD's brief notes in 1938, remained unknown until the investigations of the present writer.

II. THE REGIONAL BACKGROUND

The Mesozoic rocks of Traill Ø form part of a belt which extends without interruption, except by fjords and quaternary deposits, from Scoresby Sund at latitude $71^{\circ}30'$ N. to Kuhn Ø at 75° N. From Kong Oscars Fjord northwards the belt is bounded on the west by a fault zone which throws the Mesozoic down against Palaeozoic rocks. In Jameson Land, the Mesozoic rocks lie conformably on those of Palaeozoic age at the western margin of the belt, and unconformably on crystalline rocks at the eastern; this area has been little disturbed by faulting. Elsewhere, however, there are important north-south faults within the belt as well as at its western margin, and also transverse faults which are partly concealed at the present day by the fjords. Along the belt sediments were laid down discontinuously during the Triassic, Jurassic and Cretaceous Periods. Until about the end of the Callovian stage, sandstones are prominent members of the sedimentary series; thereafter, the rocks are predominantly shales. The total thickness of the beds laid down in Traill Ø was of the order of 3,000 metres. The succession is incomplete; almost the whole of the Lower and Middle Jurassic and much of the Lower Cretaceous are unrepresented, and the remainder of the succession shows many stratigraphical gaps. The Middle and Upper Jurassic are less complete, so far as the faunal evidence goes, than in Jameson Land and Milne Land, and their study has not yielded any new facts about the East Greenland succession. The lowest Cretaceous beds, also, provide evidence of only two horizons out of a larger number known from further north; the Upper Cretaceous, on the other hand, while far from complete, includes a greater number of zones than have been yet found anywhere else in East Greenland, and includes the highest known Mesozoic fauna. No sediments of Tertiary age have been found anywhere on the island.

Traill Ø presents a contrast to the country south of Kong Oscars Fjord, where Cretaceous rocks are unknown, but is essentially similar to Geographical Society Ø, from which it is separated by Vega Sund, and similar conditions appear to have obtained in both islands during

Mesozoic times. Considerably fewer geological horizons are known from Geographical Society Ø than from Traill Ø, but this is probably due to the fact that the northern island has been less extensively investigated. When we next see the belt, on Hold with Hope, Jurassic rocks are absent and the Trias is succeeded by Cretaceous sediments. Neither group is very thoroughly known. In the northern area (Clavering Ø, Wollaston Forland and Kuhn Ø) the Jurassic sequence is broadly similar to that of Traill Ø, but Cretaceous beds higher than the Albian are unknown.

III. TOPOGRAPHY

The Jurassic and Cretaceous rocks of Traill Ø occur in the eastern part of the island, bounded on the west by a major fault-line beyond which they have been completely removed by denudation. The only other sediments found in the Mesozoic area are Triassic and their outcrops are small. There are considerable occurrences of igneous rocks; on the one hand a series of basic intrusions which are ubiquitous, and on the other plutonic masses of syenite which form the two extensions at the eastern end of the island, north and south of Mountnorris Fjord.

The physiography of the area presents two contrasted types. The centre of the island is a low-lying, gently undulating country, seldom rising above a height of 200 or 300 metres. This area of low relief is continuous to the east with Mountnorris Fjord, and extends to the north coast of the island between the mouth of Maanedal and the western slopes of the Mols Bjerge, but is elsewhere surrounded by mountains. To the south, a range extends from the Svinhufvuds Bjerge to Kap Simpson; to the east lie the Mols Bjerge, to the north the Rold Bjerge and the Grønnebjerge. Westward lie unnamed mountains of Devonian and Carboniferous rocks.

The plan of field work adopted was determined by the physiographic features. In the central lowland region exposures are few, and the topography shows little positive reflection of the geology, the masses which are upstanding from the undulating country being principally dolerite intrusions. The central area is probably mainly underlain by Cretaceous shales. The mountains, on the other hand, offer numerous exposures, and here also the greatest stratigraphic variety occurs and the major structures are to be traced. The field work for the present investigation has been almost entirely confined to the mountainous areas, although the central area has been penetrated on a few excursions and a great part of it has been seen from the surrounding mountains or from the air. The Rold Bjerge have been examined fairly thoroughly, likewise the

Sortefjelde, the mountains on either side of Bjørnedal, and the southern side of the Mols Bjerger. The coastal face of the Svinhufvuds Bjerger has been cursorily examined. The northern part of the Mols Bjerger awaits investigation, and the areas which are principally occupied by the plutonic masses have not been visited, although it may be hoped that they will yield interesting data on the igneous history of the area, as well as stratigraphical information.

IV. PALAEOZOIC ROCKS

The only rocks encountered during the investigation which are proved to be of Palaeozoic age were baked sediments at an altitude of 1,090 m on the western side of Bordbjerget (locality 86), where brachiopods were found. The fauna has not been studied in detail but appears to be of Permian age, and its presence necessitates the fault which is assumed to traverse this mountain (p. 54, pl. 3).

The Grønnebjerge to the south of Maanedal are made up of green-grey micaceous sandstones and shales, with ripplemarks and other sedimentary structures. These beds, which are faulted against the Cretaceous shales which lie to the east, have a considerable lateral extent and are believed to be at least 300 or 400 m thick. No fossils were found on the few occasions when they were traversed so that their age is unproved, but they are most probably of Carboniferous date. If this interpretation is correct the Carboniferous outcrop in the centre of Traill Ø extends from 15 to 20 km further east than is shown in STAUBER's map (in KOCH, 1950, pl. 3) which clearly requires considerable revision in this area.

V. TRIASSIC ROCKS

The Triassic rocks were not examined in detail, but faunas were collected from them in the Rold Bjerge where it became necessary to revise previous ideas of the structure. STAUBER's map (in KOCH, 1950, pl. 3) shows a succession of Eotrias, non-marine Triassic formations and Rhaetic-Lias continental beds capped by marine Jurassic at the top of Bordbjerget. This mountain was climbed in order to investigate the supposed Jurassic sediments, but its structure was found to be quite different from the version given by STAUBER. The age of the sandstones which form the lower slopes is unproved, but at two localities just below the 800 m contour marine Eotriassic fossils were found. Coarse, irregularly-bedded yellow and greenish sandstones at locality 83 yielded *Claraia* at 795 m, and at locality 84 *Ophiceras*, *Claraia* and other lamellibranchs at an altitude of 770 m. The fossiliferous beds are succeeded by massive sandstones and these by banded sandstones and shales, with gypsum in thin veins and larger masses, at about 880 m, marking the beginning of the Klitdal Formation or Continental Series of STAUBER. The beds with gypsum are followed by green shales, and at the summit massive sandstones are again found, associated with conglomerates of small quartz pebbles and with pellets of grey-green shale.

The Kap Biot Formation¹⁾ is exposed along the coast to the south of Morris Bjerg, in the eastern part of the Mols Bjerge, and in a faulted wedge in Maanedal. In all these places the formation is characterised by the presence of dark red and purple marls, associated with reddish and white sandstones which show current-bedding and ripplemarks. The formation is exposed to a thickness of at least 300 m. A section which was presumably measured on the coastal side of Morris Bjerg is given by STAUBER (1942, p. 98), but whether the greater part of his

¹⁾ The Kap Biot Formation is approximately, if not exactly, equivalent to STAUBER's "Bunte Serie" (1942: see table, pp. 20—21). The writer strongly urges that the name Kap Biot Formation be retained, and Bunte Serie abandoned on account of the similarity of the term to the familiar European Bunter, identical in literal meaning and almost so in spelling, but probably not of the same age.

section on the coastal side of the Rold Bjerge (*op. cit.*, pp. 59—61) can be attributed to the Kap Biot Formation or "Bunte Serie", as STAUBER alleges, seems doubtful to the present writer. The red and purple marls are absent, and the rocks forming the coastal mountains where STAUBER's section was measured appeared to the writer's party to be continuous with those of Bordbjerget, where Eotriassic fossils were found at an altitude of almost 800 m. STAUBER does not record finding any Eotriassic fossils in the Rold Bjerge, and the few data obtained by the writer do not support his interpretation (1942, p. 58).

VI. JURASSIC ROCKS

A. Rhaetic and Lias.

There is no evidence for the presence on Traill Ø of the continental Kap Stewart Formation, of Rhaetic and Lower Liassic age. Although STAUBER has indicated outcrops of this date on his maps (1940, pl. 1, and pl. 3 in KOCH, 1950) he gives no detailed sections, nor any palaeontological evidence. A single plant, "*Equisetites* sp. A. indet.", has been identified by HARRIS (1946, p. 6) from Kap Palander, but although this is possibly of Liassic age (a similar form was found at a Liassic locality in western Jameson Land) Harris (*op. cit.*, p. 8) points out that in itself the specimen resembles almost equally well both Keuper and Middle Jurassic species, and remarks that it would not be surprising if the occurrence proved to be older or younger than the Lias. The Rhaetic and Lower Liassic floras which are so well-developed in southern Jameson Land are almost certainly absent from Traill Ø, since the examination of the island by FREBOLD and NOE-NYGAARD, by STAUBER and by the writer has failed to yield a single indisputable plant of that age. It is true that the sandstones and shales which occur below the lowest Bathonian fossil horizon, described below as the Plant Beds and provisionally attached to the base of the Yellow Series, are undated palaeontologically and could be regarded as of Rhaetic or Liassic age. The lithological evidence is unhelpful; the beds lack certain features, notably ripplemarks and mud-cake conglomerates, which appear to characterise the typical development of the Kap Stewart Formation; on the other hand, if the formation is represented, the difference in geographical conditions between Traill Ø and Jameson Land which must have existed to account for the absence of the typical flora in the more northern area may be presumed to have resulted also in a difference in lithology. The presence of horizons with indeterminable plant remains¹⁾ in the Plant Beds is no evidence for assigning the beds to the Lias and it is

¹⁾ Prof. T. M. HARRIS, the authority on the Rhaetic-Lias floras of Greenland, has kindly examined the plant remains found but reports that none are of any use in dating the beds.

on account of their lithological similarity to beds occurring within the undoubted Bathonian-Callovian deposits that the series is regarded as of the later age. The question remains open, however, and only the recovery of diagnostic fossils could settle it beyond doubt.

A Lower Liassic flora certainly occurs in the Pictet Bjerge, on the opposite side of Kong Oscars Fjord to Traill Ø, and has been described by HARRIS (1946). Unfortunately no detailed account has been published of the beds in which it was found, or of their disposition. Further east, NOE-NYGAARD (1934, pl. 2) has coloured almost the whole of the mountain on the eastern side of Antarctica Havn, 855 m high, as Rhaetic-Liassic, but even if beds of this age are present they do not form more than the lower half of the mountain, since the Bathonian ammonite *Cranocephalites* was found by PARKINSON and WHITTARD (1931) at an altitude of about 450 m. A little more is known of the Kap Stewart Formation around Fleming Inlet, further south, but no useful information has been published concerning its occurrence in the neighbourhood of Antarctica Havn.

The marine Lias, developed in Jameson Land as the Neills Cliff Formation and other beds, is unknown in Traill Ø. STAUBER (1939, p. 174) in a stratigraphical table indicated the presence of Middle or Upper Lias in the south-east of the Island, but no evidence has been published in support of this statement, nor have any marine Liassic fossils ever been found to the writer's knowledge.

B. Bathonian and Callovian.

The lower of the two Jurassic formations present on Traill Ø consists predominantly of sandstones and is identified with the Yellow Series¹⁾ (Gelbe Serie) of MAYNC (1947, p. 120). MAYNC suggested (*op. cit.*, p. 156) that the Yellow Series might be represented on Traill and Geographical Society Øer, but the evidence available at the time he wrote was inconclusive. Subsequent investigations have shown that there is both a strong similarity in facies and a parallel sequence of faunas between the Yellow Series in the area 74°—75° N. latitude and the beds in Traill Ø which are now attributed to the formation. The age of the series in both areas is Upper Bathonian to about the middle of the Callovian (p. 130). MAYNC's belief (1947, pp. 126, 184—85) that the

¹⁾ The term "Yellow Series" has also been applied to an exceptional facies of the Aptian on the north coast of Hold-with-Hope (KOCH, 1931, p. 46; MAYNC, 1949, p. 126). The name is mentioned by MAYNC in inverted commas and is not adopted by him, and it seems advisable to restrict the name to the Jurassic formation.

Yellow Series extends up into the Neo-Oxfordian is misleading and is discussed below (p. 48).

Although the presence of the Yellow Series is now well established the detailed knowledge of it leaves a good deal to be desired, since considerable parts of the succession are masked by scree and faunas are rare.

The principal occurrences are in the eastern part of the island, in the Mols Bjerge and in the neighbourhood of Bjørnedal. A wedge of sandstone along the fault-line in Maanedal is lithologically similar but of unproved age. The occurrences will be described under the several areas.

Mols Bjerge (Pl. 4, fig. 1).

The southern part only of this mountain mass has been examined during the present investigation, and was visited by D. MACKNEY and E. ROBERTS. The Yellow Series dips westwards at about 10° and forms a continuous outcrop. Fossils have been found only at locality 104, where *Cranocephalites* occurs in loose debris, apparently near the top of the series.

The lower part of the Yellow Series forms the spur between Bath Elv and Bristol Elv, but has not been studied in detail. The upper part is best displayed in Bristol Elv, where at an altitude of about 225 m massive beds including both sandstones and conglomerates with pebbles up to about 1 cm in diameter, are exposed in the stream, dipping approximately to the west at a small angle. The beds continue to be exposed in the stream up to a height of 265 m. On the spur west of this valley a thickness of 10 m of beds is exposed at an altitude of 400 m, coarse sandstones and conglomerates being again present. The head of the valley has two branches, between which is a precipice made up of the Yellow Series, in which nearly 100 m of sandstones are estimated to be exposed (pl. 9, fig. 1).

The Yellow Series in the southern part of the Mols Bjerge has an apparent thickness of at least 600 m, but the possibility that the apparent thickness is increased by strike faulting cannot at present be excluded. The base has not been accurately located, nor is it known whether the series is complete because higher Jurassic strata have not been proved in the area.

Maps and a photograph of the coast to the north of the Mols Bjerge published by STAUBER (1942, figs. 5, 6, and in KOCH, 1950, pl. 3) show a succession from Trias to Cretaceous with a westerly dip. There appear to be several hundred metres of Jurassic beds in this succession, and the presence of Rhaetic-Lias is also claimed (see p. 17). Only the Triassic portion of the succession has been published in detail by

STAUBER, and the Jurassic and Cretaceous part await thorough examination; the base of the Jurassic is seen in the second valley east of Kap Palander (STAUBER's Profile 6) and there seems to be a good chance of establishing a succession.

Northern part of Bjørnedal and Lycett Bjerg (Pl. 2).

The structure of the northern part of Bjørnedal appears to be simple, the Jurassic beds having a dip of about 5° to the south-east. A section across the valley has been constructed (text-fig. 5, C—C) and thicknesses can be estimated with a fair degree of accuracy.

The lowest Jurassic beds seen are exposed in the bottom of the valley about 4 km from its northern mouth. The base of the exposure lies at 90 m above sea-level and the lowest beds are soft, black, micaceous shales of which at least 10 m are exposed at localities 126 and 138. The shales contain badly preserved ammonites which may be *Arctocephalitids*. The series of beds to which the shales belong continues to be exposed for about one kilometre upstream, and includes black, sandy or silty, rusty-weathering shales, with flattened pyritic concretions at several horizons and indeterminate impressions of plants on some of the bedding planes. A total thickness of between 25 m and 30 m is seen. On the slopes to the north-west sandstones appear, interbedded with black shales. After an unexposed interval a prominent band of massive, coarse sandstone occurs at a horizon 90 m above the lowest exposures in the valley bottom, and is followed by black shales with a good deal of thin-bedded sandstone for the next 10 m, and thereafter by shales with occasional sandstone bands. The uppermost part of the series is again ill-exposed but probably contains an increasing proportion of sandstone. The total thickness proved of the black shale and sandstone series is 130 m; the base has not been seen. A group of sandstones about 220 m thick follows and is well exposed in a gully on the north-western side of Bjørnedal, about three and a half kilometres inland. Massive sandstones predominate but at several horizons more thinly-bedded rocks occur, usually associated with thin, irregular beds of dark micaceous shale containing traces of plants. No fossils have been found in the sandstones, but they are succeeded by shales with *Cardioceras* belonging to the Black Series and are therefore the highest beds of the Yellow Series.

Cranocephalites has been found on the coast immediately north-west of the northern end of Bjørnedal, at shore level (locality 136) and, further north-west, at an altitude of 90 m (locality 120), two occurrences which probably represent the same stratigraphical horizon. The fossils occur in brown to purple and grey ferruginous-weathering sandstones, sometimes thinly-bedded, and characterised, particularly at locality 136, by

horizons crowded with indeterminate plant remains. The slope above these fossil localities is composed of sandstone scree although the rock is seldom exposed, and *Cranocephalites* was again found loose in the scree (locality 139), at a level about 180 m above the horizon of localities 120 and 136. We have here, therefore, about 200 m of sandstones with *Cranocephalites*. Their relation to the succession in Bjørnedal is not established beyond doubt, but they appear to belong stratigraphically below the black shales of localities 126 and 138. This position accords best with the structure of the area, since with the south-easterly dip the *Cranocephalites* sandstones would naturally disappear beneath the surface towards Bjørnedal.

There are thus at least 550 m of beds belonging to the Yellow Series in this area, and the base of the series is not seen. The succession may be summarised as consisting chiefly of sandstones except for the intercalation of a predominantly shaly series, over 100 m thick, at about the middle of the succession.

Southern part of Bjørnedal and Morris Bjerg (Pl. 2).

The upper part of Morris Bjerg is formed of Jurassic sandstones which have a south-easterly dip of approximately 10° . The lowest beds attributed to the series are well exposed along a tributary to the Bjørnedal stream between 4 and 5 km from its south-western mouth, and are light and dark sandstones interbedded with black shales which contain poorly preserved and indeterminate plants. The following section was measured at localities 17 and 18:

	m
Yellow sandstone, nodular weathering	2.0
Black shales	2—3
Light-coloured, micaceous, false-bedded sandstone	11.0
(not exposed: mainly sandstones)	9.0
Black shales and sandstones, with plants	7.0
Grey sandstone	2.0 approx.
Black, thin-bedded shales and sandstones	8.0
Light grey sandstones, weathering white, with bands of black shale and of pebbles	6.0
Dolerite sill.	
Conglomerate	0.5
Coarse grained sandstone	4.0 approx.
Black paper shale	0.3
Sandstone with pebbles	1.5
Black, often micaceous, fissile shale, with plants, and thin beds of greyish-black sandstone	21.0
Coarse white sandstone, with small quartz pebbles at some horizons	7.0 approx.

The total thickness of beds in this section is about 80 m. At locality 30, about 500 m to the north, there is a small section in the same series in the main Bjørnedal stream:

	m
Current-bedded massive sandstone	1.0 seen
Black shale with plants, and dark, fissile micaceous sandstones	3.0
Flaggy, light-coloured sandstones	2.0
	6.0

The beds were also examined near a dolerite sill immediately above locality 30, on the north side of the valley, where the succession exposed is:

	m
Baked grey sandstone	—
Greyish-black micaceous shale	2.5
Black sandstone	9.0 approx.
(Unexposed: principally black shales)	—
Grey sandstone and shale	4.0
Black shale	0.5
Grey, flaggy, fine grained sandstone	6.0
Grey sandstone, weathering brown	4.0
Grey shale	1.2
Very micaceous, coarse, grey sandstone	4.0
Shales	0.5
Grey sandstone, weathering brown	1.0
Conglomerate	0.5
Grey sandstone	3.5
Dolerite sill.	Total approx.... 35.0

The full thickness of these rocks, which will be referred to as the Plant Beds, has nowhere been determined, but cannot be less than 100 m. The Plant Beds have yielded no identifiable fossils but are attached to the Yellow Series on account of the strong lithological resemblance of some of the beds to rocks found higher in the Series.

The remainder of the Yellow Series is most clearly exhibited in the summit region of Morris Bjerg (pl. 6), where a thickness of at least 500 m is present. The screes are largely formed of sandstone but exposures are few, and the succession cannot be determined in detail. At locality 23 *Cranocephalites* was found, and at locality 26, on the next spur to the south, the closely allied *Arctocephalites* characterises a horizon which is probably not more than 80 m higher in the succession. Below the *Cranocephalites* bed are about 250 m of mainly coarse-grained, irregularly bedded sandstones. Above it, however, shaly and carbonaceous material appears. A little above locality 23, on the same ridge,

coarse, white sandstone debris is associated in the screes with black sandstone and with muddy patches indicating the presence of dark shales, although the latter are never actually exposed. There follow brown-weathering sandstones with plant material and with occasional bands of subangular quartz pebbles up to 3 mm in size, which continue up to a point at 800 m altitude and stratigraphically about 200 m above the *Cranocephalites* horizon. At this point there is an exposure of dark grey and pinkish-white sandstones, capped by an acid igneous intrusion. Between this level and the summit a large part at least, of the succession is made up of grey, micaceous sandstone, with shaly horizons and much carbonaceous matter, well exposed, although largely inaccessible, on the north face of the mountain.

The summit of Morris Bjerg is composed of grey sandstones and thinly-bedded, soft, black shales. The shales recall the Black Series (see below) but no fossils were found despite an extensive search, so that the horizon of the highest beds on Morris Bjerg is not proved.

The succession on the mountain may be summarised as follows:

	m
Dark grey sandstones and soft black shales (?Oxfordian or Kimmeridgian)	—
Sandstones, largely grey and micaceous with shaly and carbonaceous horizons.....	200
Irregularly bedded, greyish, brown-weathering sandstones with scattered subangular quartz pebbles	?80
Brown-weathering sandstones with <i>Arctocephalites</i> . Associated are some sandstone beds with borings.....	?
White sandstone, dark sandstone and shale	?80
Grey sandstone, weathering brown, and with hard, brown-weathering nodules: <i>Cranocephalites</i>	?
Sandstones	?250
Plant Beds	100+

A minimum thickness of about 700 m must therefore be allowed to the Yellow Series of Morris Bjerg, including the Plant Beds. This thickness is of the same order as the figures for the Mols Bjerge and the northern part of Bjørnedal, but the available data do not permit close comparison between the three areas.

To the north of Morris Bjerg ammonites have been found in the sandstones which succeed the Plant Beds. *Cranocephalites*, probably representing the same fauna as at locality 23 on Morris Bjerg, was recovered from loose debris near locality 19, in blocks of light grey sandstone. A little further east, at locality 31, is the only known occurrence of *Keplerites* on Traill Ø. The succession here is

	m
Brown to yellow sandstone, mainly thin-bedded	44
Dark grey, irregularly bedded, micaceous sandstone, with carbonised wood and <i>Keplerites</i>	?1
(Unexposed: shale or friable sandstone)	17
White to pinkish sandstone, massive	17
Total...	79

The dip is variable and the thickness of beds separating the *Keplerites* bed from the *Cranocephalites* horizon cannot be found exactly. It appears to be not less than 100 m, and may be considerably greater.

The uppermost part of the Yellow Series, above the *Keplerites* horizon, presumably forms part of the steep slope up to locality 32, on the neighbouring spur, where *Amoeboceras* was found near the base of the Black Series. The slopes in between are almost entirely composed of debris from acid igneous sills and on account of the variability of the dip and the unknown thickness of the intrusions the thickness of the Yellow Series above the *Keplerites* horizon cannot be reliably estimated.

Lastly, at locality 37 (pl. 7, fig. 2), on the opposite side of Bjørnedal from the exposures just described, is a good section through a series of barren sandstones which are presumed to belong to the Yellow Series. The succession is

	m
Light grey sandstone, weathering white, grains up to 3 mm	5.6
Conglomerate with quartz pebbles up to 1 cm	0.5
Grey sandstone, a few grains 2 mm in size with carbonaceous and ferruginous specks and some white felspar grains ..	1.0
Dark grey sandstone, weathering white, average grain size 1 mm but with occasional quartz pebbles up to 1 cm. The lower part has white felspar	1.3
Coarse sandstone with felspars	2.0
Grey sandstone with scattered white felspar; cavities along bedding-planes with patches of black, bituminous material	1.4
Dark grey sandstone	1.5
(Unexposed)	6.0
Grey sandstone mottled with darker patches; occasional white felspar	1.6
Light grey sandstone	1.8
Grey sandstone, with bands of quartz pebbles up to 5 mm in diameter. Some layers with felspar	3.0
Coarse light grey sandstone, with many quartz pebbles up to 1 cm	2.3
Coarse sandstone, streaked with grey and speckled with yellow and red; some quartz pebbles up to 1 cm	1.0
Coarse grey sandstone, mottled with black; yellow patches. Some bands of quartz pebbles	1.9
Dark grey sandstone, with white felspars	2.6
Coarse sandstone with orange patches, and quartz pebbles ..	1.4

Fairly fine grained grey sandstone, with coarser bands, white felspar	2.2	
Fine grained grey sandstone	0.6	
Soft, coarse grained grey sandstone, with felspar grains and occasional quartz pebbles up to 5 mm	0.5	
Grey sandstone with bands of varying grain size, speckled with orange-brown	1.8	
Coarse sandstone, strongly ferruginous, with seams of quartz pebbles up to 1 cm	2.2	
Coarse sandstone, some bands with grains up to 3 mm, with felspar grains; mottled and streaked with black	3.0	
Coarse sandstone with felspar, mottled with orange-brown..	3.0	approx.
Light-coloured, fine grained sandstone, some beds fissile and micaceous, false-bedded	12.0	
	60.0	

Svinhufvuds Bjerger.

Cranocephalites pompeckji was found associated with fossil wood in a boulder of strongly micaceous, yellow-brown sandstone, at about 150 m altitude on the coastal face of the Svinhufvuds Bjerger (locality 147). Here a strip of yellow sandstones is exposed running parallel to the major fault (pl. 14, fig. 2). The rocks are light yellow to yellowish-green in colour, usually thickbedded and rather friable, so that they weather into rounded rather than angular masses. Carbonised wood is common but no other fossils were recovered. The rocks differ in several respects, notably in colour and hardness, from the sandstones of the Yellow Series in Bjørnedal, and no date can be suggested for them even on the basis of the lithology.

At locality 143 on the same coastal slopes of the Svinhufvuds Bjerger boulders of hard, coarse sandstone, in places micaceous and felspathic, and unfortunately unrelated to any outcrop, yielded a lamellibranch fauna which cannot be dated closely. Some of the species are near to Bathonian forms described from England but others can be matched from stages as far apart as the Toarcian and the Oxfordian, and it is impossible to decide whether this fauna occurs within the Bathonian—Callovian Yellow Series or whether it represents an earlier or later horizon undetected elsewhere in Traill Ø.

The faunas recovered from the Yellow Series are as follows:

Tychonis zone.	Locality
<i>Keplerites (Seymourites) traillensis</i> sp. nov.	31
<i>Cadoceras</i> sp. indet.	42
Kochi zone.	
<i>Arcticoceras</i> sp. indet.	141
Nudus zone.	
<i>Arctocephalites</i> cf. <i>nudus</i> Spath	26
<i>Arctocephalites</i> spp. indet.	26

Pompeckji zone.

<i>Arctocephalites</i> (<i>Cranocephalites</i>) <i>gracilis</i> Spath.....	136
<i>A. (C.) kochi</i> sp. nov.....	104, 120
<i>A. (C.) kochi</i> var. <i>latus</i> nov.....	120, 137
<i>A. (C.) kochi</i> var. <i>pygmaeus</i> nov.....	?104, 137
<i>A. (C.) maculatus</i> Spath	23
<i>A. (C.) maculatus</i> var. <i>transitoria</i> Spath.....	23
<i>A. (C.) maculatus</i> var. <i>rusticus</i> nov.	23, 120, 136, 141
<i>A. (C.) parvus</i> sp. nov.	120
<i>A. (C.) pompeckji</i> Madsen var. <i>intermedia</i> Spath	147
<i>A. (C.) pompeckji</i> aff. var. <i>costata</i> Spath	147
<i>A. (C.) vulgaris</i> Spath	139
<i>Cylindroteuthis subextensa</i> (Nikitin).....	120
<i>Camptonectes giganteus</i> Arkell	120
<i>Camptonectes</i> sp.	120
<i>Goniomya literata</i> (J. Sowerby)	137
<i>Gresslya peregrina</i> (Phillips)	120, 137
<i>Inoceramus ?retrorsus</i> Keyserling	147
<i>Mactromya</i> aff. <i>aceste</i> (Cottreau ex d'Orbigny).....	120
<i>Oxytoma</i> cf. <i>expansum</i> (Phillips)	23, 136
<i>Protocardia</i> cf. <i>stricklandi</i> (Morris and Lycett).....	147
<i>Rhynchonella</i> cf. <i>atla</i> Oppel	137
<i>R.</i> cf. <i>triplicosa</i> Quenstedt	120, 137
<i>Terebratula</i> spp. indet.	137

?Pompeckji zone.

Indeterminate Arctocephalitids	126, 138
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Age unknown: ?Yellow series.

<i>Cylindroteuthis</i> sp. indet.	143
<i>Camptonectes giganteus</i> Arkell	143
<i>Lucina</i> sp. indet.	143
<i>Meleagrinella</i> sp. indet.	143
<i>Nucula</i> sp. indet.....	143
<i>Osteomya dilata</i> (Phillips)	143
<i>Ostrea</i> (<i>Liostrea</i>) ? <i>erina</i> (Thevenin ex d'Orb.)	143
<i>Oxytoma</i> cf. <i>expansum</i> (Phillips)	143
<i>Parallelodon</i> ? <i>keyserlingi</i> (d'Orb.)	143
<i>Protocardia</i> cf. <i>stricklandi</i> (Morris and Lycett).....	143
<i>Pseudolimea duplicata</i> (J. de C. Sow.)	143
<i>Tancredia</i> sp. indet.	143

Maanedal (Pl. 3).

In Maanedal a faulted wedge of sandstones occurs which may be of Jurassic age, although no fossils have been found. The sandstones form a prominent, light-coloured ridge, about 400 m long, on the northern side of the valley (pl. 11, fig. 2, text-fig. 1). At the eastern end of the ridge are exposed six or seven metres of conglomerates with quartz pebbles up to 10 cm in diameter, and with one or two seams of sandstone, about half a metre thick, interbedded. To the west of this exposure

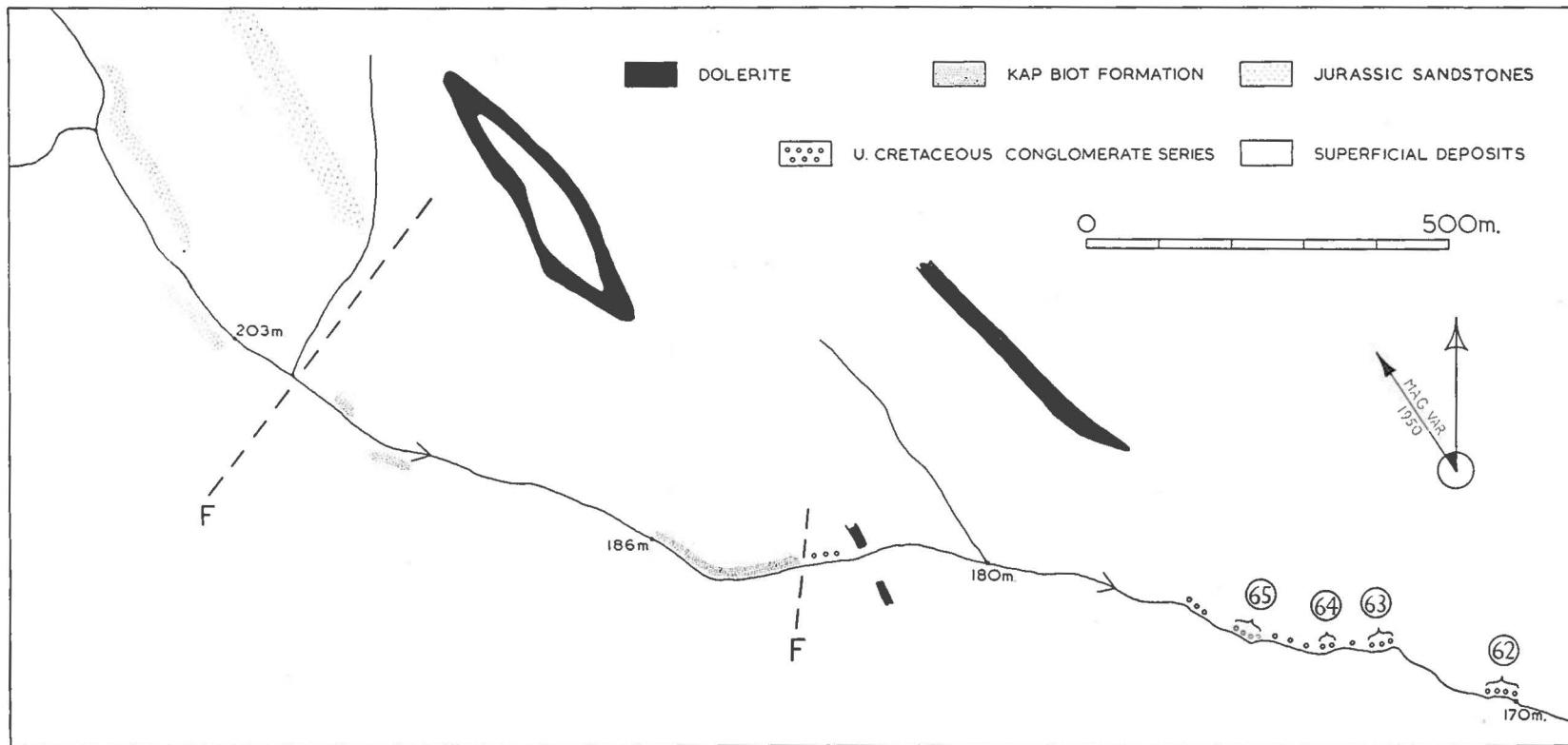


Fig. 1. Sketch-map of part of Maanedal showing the positions of some of the exposures of Mesozoic rocks. Scale 1:10,000.

occur white and brownish-yellow, soft, sandstones, with rusty-weathering pyritic nodules up to 2 cm in diameter. Bands of conglomerate are presumed to be interbedded as quartz pebbles are fairly common in the debris. Near the western end of the ridge a bed of grey limestone was seen. The obvious comparison of these beds is with the Yellow Series, and they resemble, in the presence of quartz conglomerates, the rocks attributed to the series in Geographical Society Ø, about 25 km further north (DONOVAN, 1949, p. 5). In view of the proximity of major fault-lines and the tendency for a sandstone-conglomerate facies to develop along them at any period of tectonic activity, it would be unwise to be dogmatic as to the age of the present occurrence. NOE-NYGAARD, however, records (in FREBOLD & NOE-NYGAARD, 1938, p. 17) finding on the north side of the Rold Bjerger very badly preserved impressions which were recognised by SPATH as indicating the presence of Bathonian-Callovian beds.

C. Oxfordian and Kimmeridgian.

Beds of Kimmeridgian and possibly of Upper Oxfordian age, referred to the Black Series of MAYNC (1947, p. 128) have been studied only in the Bjørnedal area. A wedge of friable black shales along the Maanedal fault, barren except for indeterminate *Buchia* of Upper Jurassic aspect (locality 73), may belong to the Black Series but no extensive outcrops have been found in that part of the island. Jurassic beds higher than the Yellow Series have not so far been reported from the Mols Bjerger.

In the northern part of Bjørnedal, the Black Series is well shown on the spurs on the south-eastern side of the valley, where it overlies the Yellow Series (pl. 6, fig. 2). Near the base (locality 127) *Cardioceratid* ammonites were collected which indicate the presence of the Lower Kimmeridgian. The relationship of the Black Series with higher beds is faulted in all the places which have been examined, but a thickness of at least 500 m is present. A fossil horizon (locality 128) was found at the top of one of the spurs but the ammonites are unfortunately too poor to fix the horizon; they may still be Lower Kimmeridgian. On the opposite side of the valley, almost at the base of the Black Series (locality B92), a single *Cardioceras* was found which may be of Upper Oxfordian age. The presence of the Upper Oxfordian is suggested at one other place in Traill Ø (locality 28); the example from locality B92 is not good enough for the identification to be beyond question, but even if the base of the Black Series is of Upper Oxfordian date it is clear that the greater part was deposited in Lower Kimmeridgian times.

The Black Series is exposed at a number of places near Morris Bjerg, principally along a faulted belt which runs northwards from the coast. No information could be obtained there as to the thickness or the palaeontological succession. The presence of the Upper Oxfordian is suggested at locality 28, as at B92, but all the other localities (see below) yielded Lower Kimmeridgian faunas. Between localities 15 and 14 the Black Series may be succeeded by the Infravalangian, but the junction may, on the other hand, be faulted.

The Black Series appears to succeed the Yellow Series conformably below locality 32, but the screes of igneous rock already mentioned mask the junction. Below the black shales, which are clearly attributable to the Black Series and contain Kimmeridgian fossils, there are near locality 32 40—50 m of black sandstones which weather to light pink and grey shades, and a similar rock is seen just below the summit of Morris Bjerg. No fossils have been found in these sandstones and their age is not known, although their colour, which is due to carbonaceous matter, suggests that they form the base of the Black Series.

The fauna of the Black Series is as follows:

?Upper Oxfordian.		Locality
<i>Amoeboceras</i> (<i>Prionodoceras</i>) sp. indet.....		28
<i>Cardioceras</i> sp. indet.		B92
Upper Oxfordian or Lower Kimmeridgian.		
Indeterminate <i>Cardioceratids</i>		13, 40, 43
<i>Buchia concentrica</i> (J. de C. Sow.).....		15
<i>Buchia</i> sp. indet.		73
Lower Kimmeridgian.		
<i>Amoeboceras</i> (<i>Amoebites</i>) sp. indet.		16, 22
<i>A.</i> (<i>Euprionoceras</i>) sp. indet.		32, 127
<i>Rasenia</i> sp. indet.		22
<i>Buchia concentrica</i> (J. de C. Sow.).....		16, 22, 127
Kimmeridgian (horizon unknown)		
Indeterminate <i>Cardioceratids</i>	} 128	
Indeterminate ammonite of <i>Pictonia</i> — <i>Decipia</i> group.....		
Large " <i>Onychites</i> "		
<i>Ostrea</i> (<i>Liostrea</i>) <i>bononiae</i> Sauvage		

STAUBER reports (1938, p. 26) "50—80 m of apparently transgressive black, Upper Jurassic shales" near the coast to the north of the Mols Bjerg. The occurrence has not been visited by the writer and no further information has been published by STAUBER.

D. ? Upper Portlandian.

Clay-ironstone nodules in the Mols Bjerger (locality 104) and at the foot of the northern slope of Lycett Bjerg (locality 121) carry *Buchia crassicollis* in some abundance. The only other fossil from the nodules is *Antinomia* cf. *sima* (Zeuschner) represented by a single incomplete example from locality 104. The identification is subject to reservations but Dr. Muir-Wood concludes that, on the present evidence, an Upper Portlandian age is most probable for this fossil. Locality 104 has not been seen by the writer; the beds are stated to be "shales with red ironstone nodules", and occur above the sandstone of the Yellow Series. The lowest beds seen in the vicinity of locality 121 (see map, pl. 2) are thin and unevenly bedded grey, micaceous sandstones, which are first seen at an altitude of 46 m and are intermittently exposed, becoming massive, up to just below 90 m altitude, where coarse, black, micaceous shales, crowded with clay-ironstone nodules up to at least 30 cm in diameter, occur. The age of the sandstones is not known. The ironstone nodules are so abundant—they are in some places touching one another with only wisps of shales in between—that it is hard to believe they are autochthonous, and the bed containing them may, in fact, be the base of the succeeding Albian series, the result of the destruction of the beds which originally contained the nodules at the time of the Albian transgression.

Only a few metres of the shale with ironstone nodules is exposed, and a little higher in the valley, at 107 m altitude, light-coloured sandstones are seen. At 120 m black shales with thin sandstones, probably of Albian age (see p. 36), begin to be exposed.

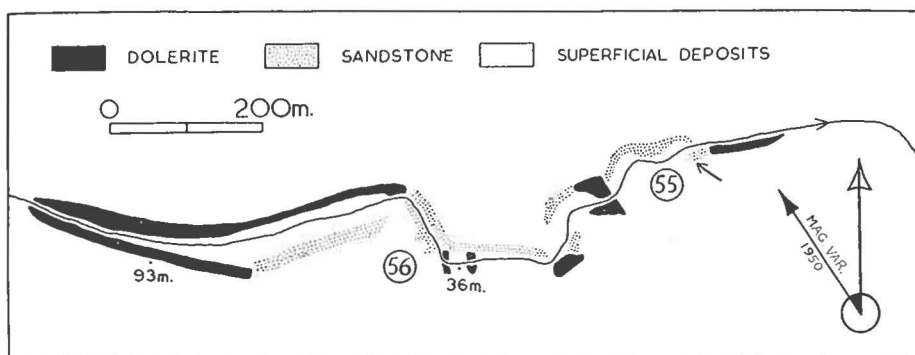


Fig. 2. Sketch-map of the neighbourhood of localities 55 and 56, west of the Rold Bjerger, showing the extent of the sandstone exposures. Scale 1:10,000.

VII. CRETACEOUS ROCKS

A. Age uncertain.

Sandstones of uncertain age are exposed near the mouth of the river which flows down from Maanedal, between localities 55 and 56 (pl. 3 and text-fig. 2). The lowest beds are seen at the northern end of the section (locality 55) where grey and white banded, flaggy sandstones, with a few darker, more shaly horizons, are exposed. They are completely barren of organic remains. Upstream the beds continue to be well-exposed, intruded here and there by dolerite, for a distance of about 600 m, until they are masked by scree from a major dolerite sill. Towards the top the sandstones become more irregularly bedded, and alternate with appreciable thicknesses of dark shale. There are also beds of grey sandstone with furoid markings, and pyritic nodules. The total thickness exposed was estimated at not less than 50 m. The only fossil found (locality 56) was a damaged lamellibranch which may be either a *Buchia* or an *Inoceramus*, but is not more accurately determinable.

What is believed to be the same series is exposed at locality 88, on one of the Scott Keltie Øer (pl. 3). Here are seen about 10 m of banded, greyish sandstones with subsidiary shale, and occasional concretionary layers, lying nearly horizontally. No fossils were found at this exposure. About 150 m to the north Turonian beds outcrop at locality 89, but their relation to the sandstone series is not exposed.

It is greatly to be hoped that further work will date these rocks more closely, since they may represent yet another chapter in the sedimentary history of the area, of which we are not yet aware.

B. Infravalanginian.

No ammonites of this stage have been found in Traill Ø, and the age assignment of the beds rests on belemnites. The *Pachyteuthis* Beds which represent the stage occur for certain only at locality 14 near Morris Bjerg, and localities 78—80 near the coast north of the Rold Bjerger. At locality 14 about 50 m of shales is exposed, interspersed with occasional bands of harder, grey micaceous mudstone. At locality 78 shales are also exposed, but at locality 79 hard, black micaceous sandstones are dominant. Nearby again, at locality 80, finegrained sediments occur, but they are badly cleaved and shattered, probably by a fault which brings in black shales (text-fig. 3). Beds which may belong to the same series occur along the fault zone on the coastal side of the Svinhufvuds Bjerger, but only *Buchia* has been found in them so they cannot be dated with certainty. The lithology here (localities 148, 149) includes coarser grained sediments than are known from the proved Infravalanginian exposures, coarse, orange-brown feldspathic sandstones being associated with finer grained beds of the same colour.

The greatest thickness measured is that of 50 m at locality 14, but the top or bottom of the series has nowhere been seen.

The Infravalanginian fauna includes three recognisable species only:

	Locality
<i>Pachyteuthis</i> aff. <i>partneyi</i> (Swinnerton).....	14, 79, 80
<i>Buchia crassicollis</i> (Keyserling)	14, 78—80, 148, 149
Indeterminate lytoceratid	80
' <i>Rhynchonella</i> ' cf. <i>decipiens</i> d'Orbigny	80

The age of the beds is discussed on p. 134.

The beds here regarded as Infravalanginian may be the ones described by NOE-NYGAARD (in FREBOLD & NOE-NYGAARD, 1938, p. 17) as a series of light, sandy shales, with poorly preserved plants, and harder bands which yielded indifferent belemnites and lamellibranchs which were interpreted by SPATH as of Portlandian age. The exact site of NOE-NYGAARD's discovery is not clear; it appears to have been on the largest of the Scott Keltie Øer near the Eskimo ruins; but the sense of the German is not clear and does not exclude a position on the coast of Traill Ø itself, where there are also ruins marked on the Geodetic Institute map opposite the middle of the largest island in Vega Sund. The exposures at localities 78 to 80 do not fit the description given by NOE-NYGAARD of his locality, which, whether on Traill Ø itself or off the coast, has apparently not been rediscovered during the present investigation.

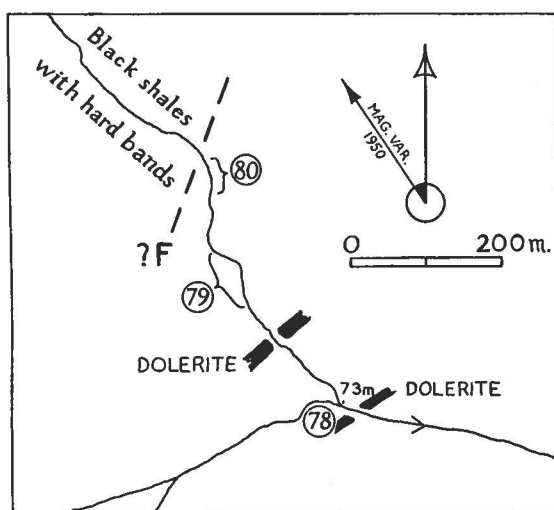


Fig. 3. Sketch-map showing the positions of localities 78 to 80 in the *Pachyteuthis* Beds north of the Rold Bjerger. Scale 1:10,000.

C. Valanginian.

Beds of certain Valanginian age have only been discovered at one place on Traill Ø, locality 92 on the south-western flank of the Mols Bjerger (pl. 4, fig. 1), where a rich and well-preserved ammonite fauna, described elsewhere in this volume, was collected. The fossils are preserved in hard, red, calcareous mudstone, but green-grey beds also occur and the red colour may be the result of alteration by intrusions. The beds were only seen in scree. In the stream bed below the fossiliferous red beds were grey, banded shales and sandstones, which may be Infravalanginian but which yielded no fossils. Higher up the slope are black shales, with subsidiary sandstone, of Albian or Cenomanian age. There is no information as to the thickness of the Valanginian beds.

The age of the beds is deduced from the ammonites to be Middle Valanginian (Polyptychitan Age). For a discussion of the evidence see page 134.

The fauna from locality 92 is as follows:

Phylloceras sp.

Lytoceras sp. cf. *exoticum* Uhlig

Polyptychites (*Polyptychites*) *michalski* aff. var. *tuberculata* (Bogoslovsky)

P. (P.) cf. *middendorffi* Pavlov

P. (P.) aff. *triptychiformis* (Nikitin)

P. (P.) undulatocostatus sp. nov.

P. (P.) mokschensis (Bogoslovsky)

- P. (P.)* sp. cf. *diptychoides* Pavlov and *variisculptus* Pavlov
P. (P.) sp. I
Polyptychites sp. II
Polyptychites sp. III
Polyptychites (Euryptychites) traillensis sp. nov.
P. (E.) sp. cf. *traillensis* sp. nov.
P. (E.) laevis sp. nov.
Dichotomites gregersemi Anderson var. *paucicostatus* var. nov.
D. sp. ? nov.
Neocraspedites evolutus sp. nov.
Neocraspedites greenlandicus sp. nov.
Neocraspedites sp.
Pachyteuthis subquadratus (Roemer)
Buchia crassicollis (Keyserling)

On the southern side of the Svinhufvuds Bjerge, at locality 150, grey limestone blocks with *Buchia crassicollis* may correspond to the "Aucella-bearing limestones" of MAYNC (1949, p. 186, etc.) and thus be of Valanginian age. No other fossils have been found, however, and the age of the blocks is not strictly determinable.

D. Aptian.

Aptian beds have only been detected in the neighbourhood of Morris Bjerg, where they consist of black shales. They are much disturbed so that the thickness, and relationship to other members of the Cretaceous succession, is unknown. The fossils found are:

	Locality
<i>Sanmartinoceras ?haugi</i> (Sarasin)	9
<i>Lytoceras polare</i> Ravn	27
<i>Lytoceras</i> sp. indet.	9
<i>Inoceramus</i> sp. indet.	27

The first fossil listed indicates the Upper Aptian (Gargasian). *Lytoceras polare* may occur already in the Lower Aptian (SPATH, 1946, p. 7) but, as SPATH remarks, may be a long ranging species, so that there is not necessarily any great difference in age between the beds at localities 9 and 27.

Although the evidence is negative and therefore inconclusive, the fact that the Aptian has only been proved in one part of Traill Ø, and doubtfully from a locality in Geographical Society Ø¹), lends support

¹ STAUBER (1938, p. 27) cited "*Lytoceras sammartino*" (? an error for *Lytoceras polare*, or for *Sanmartinoceras*) from south-east Geographical Society Ø, as indicating the presence of Aptian beds, but no Aptian fossils were recognised by SPATH (1946) among the ammonites collected by STAUBER. Either the specimen was mislaid or STAUBER's field identification was wrong.

to the belief that it is of no great thickness and, in addition, may not be present throughout the whole area of the two islands. It is suggested below that in one place the Albian may rest unconformably on pre-Aptian sediments.

E. Albian.

The Lower Albian has been found only at locality 74, in the Rold Bjerger, where shales baked by intrusions yielded the following fauna:

Arcthoplites sp. cf. *jachromensis* (Nikitin)
Leymeriella sp. cf. *tardefurcata* (d'Orb.)
 "Puzosia" *sigmoidalis* sp. nov.
Entolium cf. *orbicularis* (J. Sow.)
Spondylus cf. *gibbosus* d'Orb.
Pleurotomaria sp. indet.
 ?*Caryophyllia* sp. indet.
 Indeterminate echinoids.

The *Leymeriella* is only a fragment but indicates the middle or upper Tardefurcata Zone of the Leymeriellian Age. Two other exposures of shales near the Rold Bjerger (localities 69, 75) belong to the Albian but have only yielded *Inoceramus anglicus* and so are not dateable more closely, though they may represent higher horizons than locality 74. At locality 66 hard, shelly bands in soft, black micaceous shales yielded *Aucellina caucasica*, indicating a probable Albian age. These exposures do not permit the outcrop of the Albian beds to be traced accurately, or the thickness estimated.

In the Mols Bjerger occur the only other outcrops of Albian beds which have yielded ammonites. The fossils are poor but indicate higher horizons than at locality 74. At locality 110, indeterminable Hoplitids probably represent Middle Albian forms, and at locality 112, where sandstones are associated with the shales, a fragment of what appears to be a Mortoniceratid suggests the presence of the lower part of the Upper Albian. In addition to the rather unsatisfactory ammonites, both these exposures yielded *Inoceramus anglicus* and *Aucellina gryphaeoides* and the first form quoted was also found in banded shales at locality 102, on the western flank of the Mols Bjerger. No estimate of the thickness of the Albian could be made in the area.

The north-western part of Lycett Bjerg is composed of Cretaceous rocks of Albian and Cenomanian age, but no ammonites were found and the stages cannot be subdivided. The lowest exposure is along a stream at locality 122, commencing at an altitude of 49 m. The section is:

(f) Black shales, with a few ferruginous nodules up to 30 cm in diameter; poorly exposed.....	m c. 20
(e) Massive, ferruginous sandstone, with scattered small fragments and fossil wood	0.6
(d) Shales	c. 1.0
(c) Brown, micaceous sandstone, with bed of conglomerate at the top	0.6
(b) Conglomerate with quartz pebbles.....	0.3
(a) Coarse, black, micaceous shale	c. 6.0

Inoceramus anglicus was found in bed (a). The conglomerate at the top of bed (c) included pebbles of quartz, ironstone, a brightly-coloured orange-brown sandstone, and brown sandstone with fossil wood fragments. The section is unique among beds of proved Albian age in Traill and Geographical Society Øer and may represent the basal beds of the Albian, since a few hundred metres to the south, at locality 121, is the occurrence of Valanginian(?) nodules which has already been described (p. 30) as having been probably reworked in the course of a later transgression.

A higher part of the Albian is represented at Lycett Bjerg by alternating sandstones and shales. The sandstone bands are flaggy and micaceous; many are only one or two centimetres thick, but bands up to 15 cm are not uncommon. The sandstone, subsidiary to the shale in abundance, is commonest near the middle part of the succession. The shale and sandstone series has so far proved to be barren of fossils.

Near the top of the Albian at Lycett Bjerg, shales exposed along a stream bed (localities 129, 130) between 325 m and 340 m altitude yielded *Inoceramus anglicus*, *Aucellina caucasica* and *A. gryphaeoides*. A little higher, at locality 131 (altitude 366 m) examples of *Inoceramus* occur which are poorly preserved but show affinity with *I. crippei* and may herald the Cenomanian, although the stages cannot be accurately delimited on the basis of species of *Inoceramus*. In the absence of ammonites the boundaries of the Albian remain uncertain, but about 300 m of sediments are probably attributable to the stage at Lycett Bjerg.

On the south coast of the island, sandstones associated with black shales at locality 151 may be of topmost Albian or of Cenomanian age; Albian is not proved along the south coast and probably lies for the most part below sea level.

The present knowledge of the Albian of Traill Ø, as of the rest of East Greenland, is inadequate, since no good successions or well-preserved faunas have been found. On the northern side of Lycett Bjerg the unusually coarse clastic deposits described above occur apparently near the base of the Albian which may there be transgressive on to late Jurassic or early Cretaceous rocks. The lithology elsewhere suggests that deposition was fairly continuous, but in the absence of faunas to

prove the various zones we do not know whether part or all of the stage is represented. *Aucellina* probably characterises the upper part, being found in ?Upper Albian in the Mols Bjerge, and near the top of the local development at Lycett Bjerg; usually abundant where it occurs, it is absent from the Lower Albian faunas, both in Traill Ø and, with one doubtful exception, in Geographical Society Ø (DONOVAN, 1949, locality 8, p. 7).

On the side of Bjørnedal opposite to Lycett Bjerg *Inoceramus anglicus* at locality 133 indicates that rocks of Albian date are present in the Cretaceous shales which are faulted against the Jurassic sandstones at Prospektfjeld. Cenomanian is also present here (p. 38).

F. Cenomanian.

The Cenomanian is the most impressive part of the Cretaceous sequence along the south coast of Traill Ø, and forms the Sortefjelde. The sediments in these mountains are approximately horizontal and yield fossils characteristic of the Varians Zone, which is represented by at least 350 m of beds. The zone consists largely of black shales, strongly micaceous at some horizons, with pyritic nodules and hard bands exhibiting cone-in-cone structure of the type figured by MAYNE (1949, pl. 4). Different lithology is found at localities 145 and 146, at the western end of the Sortefjelde, which lie between 530 and 590 m altitude and are probably near the top of the zone. At 530 m blocks of sandstone, some irregular in shape, some rounded, occur in the shales, together with continuous sandstone beds. Some of the sandstones are coarse, and carry small quartz pebbles. The blocks presumably represent beds of sandstone which were subjected to penecontemporaneous erosion, and in fact the members of my party who examined the locality had the impression that some of the blocks could be traced westwards, along an inaccessible face, into thick continuous beds.

Penecontemporaneous erosion may again be represented in the sequence on the eastern side of a valley near the western end of the Sortefjelde. At 305 m altitude there begin to be exposed shales with regular bands of grey, micaceous sandstone, which continue upwards for 35 m. Then follow about 23 m of black shales with layers of sandstone blocks, about 10 cm thick and up to 30 cm long (pl. 14, fig. 1). There are blocks of both fine- and coarse-grained sandstone. The occurrence is similar to that at localities 145 and 146 (which have not been seen by the writer), but whether the two are on the same stratigraphical horizon is not known.

At Lycett Bjerg Cenomanian beds are present, but no ammonites have been found, and the zone cannot therefore be determined. The

deposits consist almost exclusively of black shales and seem to succeed the Albian conformably at an altitude between 350 and 400 m. At least 300 m of Cenomanian shales are present in the upper part of the mountain.

The Cenomanian is present as well as the Albian in Prospektfjeld, as was shown by the occurrence of *Inoceramus crippsi* in scree derived from altered sediments near the syenite contact (locality 135).

In the Mols Bjerge, the stage is again represented by black shales with *Inoceramus crippsi*, and again no ammonites have been found. No reliable estimate can be given of the thickness of the beds.

In the eastern part of the Rold Bjerge the presence of the Cenomanian is proved by *Schloenbachia* at one locality (91) and, rather more doubtfully, by other fossils at a few other places. The beds do not seem to have any great superficial extent, the bulk of the Cretaceous rocks exposed here belonging to higher stages.

The Cenomanian in Traill Ø is probably represented by at least 400 m of beds, wholly or largely of the Varians Zone, and may be considerably thicker in the Sortefjelde. The sediments are often barren, but *Inoceramus crippsi* is fairly frequently found, and *Aucellina* appears to range up into the stage from the Albian, as it does in England. The full faunal list is as follows:

	Locality
<i>Schloenbachia</i> cf. <i>subplana</i> (Mantell)	2
<i>S. subtuberculata</i> (Sharpe)	5, 145
<i>S. ?subtuberculata</i>	2
<i>S. subvarians</i> Spath	2
<i>S. ?subvarians</i>	5, 146
<i>S. sp. indet.</i>	47, 52, 91
<i>Mesogaudryceras</i> cf. <i>leptonema</i> (Sharpe)	2
<i>Inoceramus crippsi</i> Mantell	Common throughout Traill Ø in the Ce- nomanian.
<i>Variamussium ignoratus</i> (Ravn)	2, also 8 and 39 (age uncertain)
<i>Nucula pectinata</i> J. Sow. var. <i>cretae</i> Gardner	2
<i>Lucina</i> sp. indet.	2
Lamellibranch sp. I	91
Lamellibranch sp. II	91
' <i>Natica</i> ' sp. indet.	91
Indeterminate Rhynchonellid	3

G. Turonian.

Cretaceous beds younger than the Cenomanian have been found only in the Rold Bjerge, where three stratigraphical subdivisions, namely the Upper Turonian, the Upper Santonian, and the Upper Campanian, are recognised.

Along the coastal side of the Rold Bjerge Turonian rocks succeed the Cenomanian at an altitude of about 300 m. There is presumed to be a non-sequence since only the Varians Zone of the Cenomanian has been proved, and the earliest Turonian deposits are likely already to belong to the upper part of the stage. The probable local base of the Turonian is seen at two exposures near the coast, localities 51 and 59, and is characterised by the presence of sandstone and conglomerate and beds with conspicuous felspar content. At locality 51 the following section was measured:

	m
Shales	—
Massive, coarse sandstone, with felspar grains and a few pebbles....	0.5
Fissile, micaceous sandstones and shales	6.0
Conglomerates interbedded with grey shales and siltstones.....	2.0
Fissile, micaceous sandstones, with lenticles of shale	2.0
Shales with thin-bedded, micaceous and feldspathic dark grey sandstone	10.0
Micaceous shales (baked by intrusion)	10.0
Dolerite sill	—

All the thicknesses are approximate. *Scaphites* aff. *morrowi*, *Inoceramus* ?*lamarcki*, and *Nucula whitfieldi* were found at this exposure. The *Scaphites* indicates an Upper Turonian age.

A little over a kilometre to the north-west of the last exposure beds of similar facies, although without conglomerates, are found at locality 59. Here about 12 m of interbedded shales and micaceous sandstones, with some feldspathic beds, are exposed in a stream bed, and are succeeded by dark grey shales of which no great thickness is seen. The lower part of the succession yielded *Scaphites*? cf. *morrowi*, *S.* sp. cf. *geinitzi*, *Inoceramus lamarcki*, *Lucina* sp. indet., and ?*Actinocamax* sp. In view of the absence of conglomerates the beds may represent a slightly higher horizon than locality 51, but lateral variation is to be expected in sediments of this type and it is not necessary to assume any significant difference in age between the rocks at the two localities.

On account of the profusion of dolerite sills the sediments are hardly seen *in situ* at all on the mountain side above localities 51 and 59, although screes of baked argillaceous rock indicate that the sills are intruded into shales. A number of the screes were searched for fossils, without success, but in a small gully, at an altitude of 600 m and almost directly above locality 51, shales accompanied by some harder beds were exposed and yielded *Inoceramus lamarcki* (locality 60).

It is unfortunately not possible to make a reliable estimate of the thickness of the Turonian. Several major sills are intruded into it, and although dips have been measured where possible they are not consistent, as will be seen from the map (pl. 3); there is a general tendency

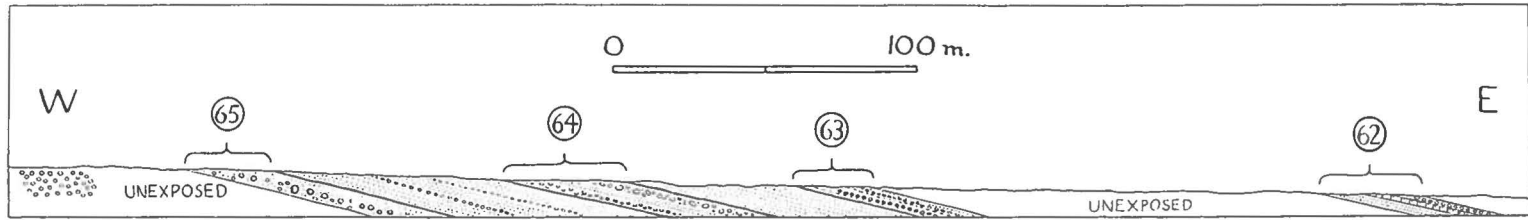


Fig. 4. Diagrammatic section showing the relative positions of the sections measured at localities 62 to 65 in Maanedal, in sandstones and conglomerates of probable Turonian age. The line at the base of the diagram represents an altitude of 170 m. Vertical and horizontal scales 1:2,500.

for the dip to be into the mountain, but the data are not sufficient to show whether this is a significant trend or merely a chance effect. The minimum thickness must be of the order of 300 m to account for the observed distribution of the beds.

In the coastal region of the Rold Bjerge, then, the Upper Turonian has a probable thickness of at least 300 m, a series of basal sandstones and conglomerates, bearing ammonites and at least 30 m thick, being succeeded by shales which are largely barren but occasionally yield *Inoceramus*. The beds follow the Cenomanian at least non-sequentially if not unconformably, but their relationship to higher formations has not been seen.

In Maanedal an isolated find of *Inoceramus lamarchi* suggests that an important series of conglomerates and associated beds represent the episode of tectonic activity that was responsible for the coarse basal facies of the Turonian on the other side of the Rold Bjerge. A series of coarse clastic rocks, sandstones with beds of conglomerate, dipping at 12° or 13° to the east, are exposed along the stream at the eastern end of Maanedal (text-fig. 1). The conglomerates and the beds intimately associated with them are the best exposed and four sections were measured in detail within the series, at localities 62 to 65. The relative positions of these sections in the sequence is shown in text-figure 4. The lithology is illustrated in plates 12 and 13.

To the west of locality 65 some ferruginous conglomerates are poorly exposed; locality 65 itself displays about 4.5 m of grey, micaceous sandstones with conglomerates, which carry very large boulders; one boulder, of fossiliferous, crystalline, oolitic limestone, is 2 m high (pl. 12, fig. 2). The dip is irregular, as might be expected. Grey sandstones with bands of conglomerate are then intermittently and poorly exposed, followed at locality 64 by the following succession:

	m
Conglomerate with quartz pebbles usually less than 15 cm in diameter, limestone boulders up to 60 cm long, and hard grit boulders one of which is 90 cm long (Pl. 12, fig. 1).....	3.0
Coarse sandstone with some pebbles.....	2.0
Conglomerate with pebbles of quartz, limestone and dark micaceous sandstone. Most of the pebbles are smaller than 10 cm in diameter but there are a few up to 30 cm.....	2.4

The interval between this and the next section is again poorly exposed, but appears to consist of fine and coarse sandstones with scattered pebbles. At locality 63 the following section was observed:

	m
Black sandstone, with mica flakes and scattered quartz pebbles up to 3 mm in diameter; patches of calcite	0.9
Breccia with irregularly-shaped pieces of argillaceous and calcareous rocks; the matrix is black sandstone	0.3
Rotten black shale	0.15
Dark conglomeratic sandstone, with blocks of limestone	0.4
Rotten black beds consisting of an argillaceous matrix with quartz grains and mica flakes. Towards the bottom, beds of hard, dark grey sandstone, weathering orange-brown, predominate	2.3
Conglomerate to breccia, most of the fragments less than 2.5 cm across	0.4
Rotten black beds, as above	seen 1.2

A specimen of *Inoceramus lamarcki* was found in a loose block of the rotten black beds. This exposure is followed by an unexposed interval, after which the highest beds seen are displayed at locality 62. The succession is:

(Dolerite intrusion)	m
Conglomerate with quartz pebbles up to 20 cm in diameter in a matrix of hard, grey micaceous fine-grained sandstone (Pl. 13, fig. 1)	1.5
(Not exposed)	0.5
Grey limestone, with white patches of calcite and dark veins. Irregularly bedded and nodular (Pl. 13, fig. 2)	1.8
Dark grey micaceous sandstone, with pebbles of quartz; the rock is similar to the top bed but the pebbles are not so large or so numerous; masses of limestone in the top part	1.4
Brown-weathering, grey micaceous sandstone and shale; some beds irregular, some banded	2.1

The total thickness of the series is about 80 m, made up as follows:

	m	
Section at locality 62	7.3	
Unexposed; presumably shales or sandstones	30	approx.
Section at locality 63	5.7	
Sandstones, poorly exposed	10	approx.
Section at locality 64	7.4	
Sandstones, poorly exposed	16	approx.
Section at locality 65	4.5	
	80	approx.

Inoceramus lamarcki indicates either a Turonian or a Lower Senonian age. It is a pity that the beds are not more closely dated, but perhaps fortunate that even this single fossil was found as the facies is not favourable for the preservation of shells. These conglomerates are provisionally regarded as of the same age as the Upper Turonian beds on the northern side of the Rold Bjerger, already described. The strong variability in the character of the sediments which is bound to occur

over quite short distances may be sufficient to account for the probably thicker and certainly more strongly rudaceous development of the basal beds in Maanedal.

Lastly, a find of Turonian rocks on an island in Vega Sund (locality 89) again shows the coarse clastic lithology which on the mainland of Traill Ø characterises the basal part of the development of the stage. The exposure yielded *Inoceramus lamarcki* from blue-grey shales which were interbedded with sandstones, some beds of which were coarse and felspathic. Baked argillaceous sediments, with a few sandy beds, were found at another coastal exposure about 1 kilometre to the north, but yielded no fossils. The sediments of the Vega Sund area are too little known for the relationships of this occurrence to be clear.

The Turonian fauna is:

	Locality
<i>Scaphites</i> aff. <i>morrowi</i> Jeletzky	51, ?59
<i>S.</i> sp. cf. <i>geinitzi</i> d'Orbigny	59
? <i>Actinocamax</i> sp.	59
<i>Inoceramus lamarcki</i> Parkinson	51, 59, 60, 63, 89
<i>Lucina</i> sp. indet.	59
<i>Nucula whitfieldi</i> Weller	51

H. Senonian.

Species of *Sphenoceramus* which indicate an Upper Santonian or Lower Campanian age (see p. 95) have been found at four localities, 50, 67 and 68 in the neighbourhood of the Rold Bjerger and Maanedal, and 81 on the large island in Vega Sund (pl. 3). The occurrences are too scattered to provide any indication of the thickness, relationships or lateral extent of the beds. The lithology in every case was argillaceous, but no sections could be measured in detail. The fauna from these *Sphenoceramus* Beds, as they may be termed, comprises:

	Locality
<i>Inoceramus</i> (<i>Sphenoceramus</i>) <i>steenstrupi</i> de Lorient	50, 67, ?68, ?81
<i>I.</i> (<i>S.</i>) ? <i>patootensis</i> de Lorient	50
<i>I.</i> (<i>Inoceramus</i>) ? <i>lamarcki</i> Parkinson	81
<i>Oxytoma tenuicostata</i> (Römer)	50
<i>Linuparus dülmensis</i> (Geinitz)	50

There is a considerable stratigraphical gap, if the evidence of *Inoceramus* may be relied on for dating even in a general way, of at least the whole of the Lower Senonian (Coniacian) between the Turonian sandstones and shales and the *Sphenoceramus* Beds. The beds at locality 81, with *I.* ?*lamarcki*, as well as *I.* (*S.*) ?*patootensis*, might at first sight be regarded as intermediate, but in fact their fauna is not well pre-

served, nor their stratigraphical relations clear, and the gap cannot be regarded as filled.

Dark grey shales are exposed intermittently along Lilleelv, and near the 72 m level bear pyrite nodules and blocks of cone-in-cone structure. Further downstream at locality 57 were found echinoids which are attributed, with some reservations (p. 129), to *Micraster* sp. indet., and which if correctly interpreted indicate a Senonian age. Stratigraphically below the horizon with *Micraster*, thin-bedded shales, with some hard siliceous beds and ferruginous (?pyritic) nodules, are exposed for several hundred metres downstream. It is possible that the rocks at Lilleelv represent a horizon in the Upper Cretaceous which has not been found elsewhere, since they differ in lithology and fauna from the other post-Cenomanian formations which have been recognised.

The highest stratigraphical horizon on Traill Ø, the Upper Campanian, has been found at one place only, locality 58 near the mouth of Maanedal. The rock is a baked shale but was not seen *in situ*, as all the fossils were collected from a scree on the northern side of the stream. The fauna is as follows:

Scaphites greenlandicus sp. nov.

S. nodosus Owen var. *quadrangularis* Meek and Hayden

Lucina laminosa (Reuss)

Nucula cancellata Meek and Hayden

?*Tellina steenstrupi* de Loriol

There is probably little hope of establishing a detailed succession in the post-Cenomanian rocks in the Rold Bjerger region, and they are absent, possibly removed by denudation, over much of the remainder of the island. Further research, in Geographical Society Ø and in the less well-known parts of Traill Ø, is needed if our knowledge of the Upper Cretaceous of East Greenland is to be increased.

VIII. STRATIGRAPHICAL COMPARISON WITH OTHER PARTS OF EAST GREENLAND

A. Bathonian and Callovian.

The Yellow Series is developed on Geographical Society Ø and has been reported from Laplace Bjerg by STAUBER (1940, p. 32) and from the transverse valley about 18 km to the west by the writer (1949, p. 5) who estimated a minimum thickness of 300 m. In the more westerly area quartz conglomerates occur in the succession and are reminiscent of those in the wedge of sandstones in Maanedal on Traill Ø (p. 26). No Bathonian or Callovian fossils have been found in Geographical Society Ø and the Yellow Series is recognised there only on lithological grounds.

On the opposite side of Kong Oscars Fjord to Morris Bjerg the Yellow Series is developed in the neighbourhood of Antarcetics Havn where PARKINSON and WHITTARD (1931, p. 653) found a *Cranocephalites* fauna (SPATH, 1932, p. 136) at the base of 400 m of sandstones in the mountain immediately east of the inlet. Liassic beds are also shown in this mountain by NOE-NYGAARD (1934, pl. 2) and by STAUBER (in KOCH, 1950, pl. 4) but our knowledge of their supposed occurrence is unsatisfactory and no fossils are reported (see also p. 18). Investigations were conducted to the west of Antarcetics Havn (the eastern part of the Pictet Bjerger) by the writer in the summer of 1949, but with disappointing results, as far as stratigraphy is concerned, since no diagnostic fossils were found. The succession begins with more than 200 m of dark sandstones and grey and black micaceous shales, which have indeterminate plant fragments and are similar to the Plant Beds of Bjørnedal. They are succeeded by at least 700 m of sandstones of various types; occasional very poor ammonites, probably of Callovian age, were found loose, and in a general way the beds are assumed to correspond to the Yellow Series, although their age limits are unknown. No trace of the Black Series has been found in this area. A Liassic flora has been recorded from the Pictet Bjerger by HARRIS (1946, p. 34) but nothing is known of the field occurrence and since it was not located by the writer it may

occur in the western part of the Pictet Bjerger where, according to BIERTHER (1941, pl. 1), lower beds are brought in by a fault. The only salient fact which emerges is that to the west of Antarctica Havn about 1000 m of beds, principally sandstones, seem to be referable to the Yellow Series, although the possibility of continental Liassic beds forming the lower part of the succession cannot be excluded.

To the west of the head of Carlsberg Fjord the Fossil Mountain Formation has been studied by ROSENKRANTZ (1929, p. 146), who attributed it to the Oxfordian. SPATH has shown (1932) that the beds belonging to this formation on Mikael's Bjerg and Hjørnefjeldet are in reality of Upper Bathonian and Callovian date; they correspond both in lithology and in age to the Yellow Series. The upper part of the succession was studied on Mikael's Bjerg, and a sketch section showing the positions of the ammonite horizons was published by SPATH. The thicknesses of the beds are not given, but the succession may be summarised as follows (SPATH, 1932, p. 129):

Sandstones

Keplerites (*Seymourites*) horizon

Micaceous sandstones and shales with *Arcticoceras*, *Cadoceras*

Coarse, micaceous sandstone; *Arcticoceras*

Micaceous sandstone with phosphatic nodules containing *Arcticoceras*.

The total thickness appears to be about 100 m. Lower beds are present but were not examined on account of snow. They are also present on Hjørnefjeldet where the following section was recorded (SPATH, 1932, p. 133):

	m
Sandstone with phosphatic concretions and abundant fossils;	
<i>Arctocephalites</i>	25 seen
Sandstones with <i>Arctocephalites</i> (<i>Cranocephalites</i>)	90
Micaceous shales	130
Coarse, yellow sandstone	95
Oyster Bed (Toarcian)	

The yellow sandstone above the Oyster Bed is not dated, nor are the sandstones above the *Keplerites* horizon on Mikael's Bjerg. The former, at least, and the micaceous shales above them, should probably be included in the Fossil Mountain Formation, but even if they are left out of account there are several hundred metres of sandstones (there appears to be a gap between the two successions given above) which are dated as Bathonian and Callovian. Thus the arenaceous facies so strongly developed at Antarctica Havn persists, apparently diminished in thickness, as far south as Mikael's Bjerg. At Katedralen, about 40 km further south, only one fossil horizon is known, yielding *Cranocephalites*. Below are sandstones and clays; above are

black shales with fossil wood (about 40 m) followed by yellow sandstones with fossil wood and bands of shale (about 130 m). The beds above the *Cranocephalites* level are reminiscent of the beds with black shales which occur in the lower part of the Yellow Series in northern Bjørnedal. Katedralen is the most southerly occurrence of *Cranocephalites*; at Harris Fjeld and at Vardekløft a *Kepplerites* (*Seymourites*)-*Cadoceras* fauna is found about 150 m above the base of a series of micaceous shales with ammonites occurring in clay-ironstone nodules and in calcareous concretions. *Arcticoceras* has been found loose but there is no evidence for lower horizons and SPATH believes that the beds with lower faunas which are found at Hjørnefjeldet are absent. This series, which outcrops on the western shore of Hurry Inlet, is the Vardekløft Formation of ROSENKRANTZ and, as SPATH has already pointed out (1932, p. 124), appears to be the time-equivalent, in a different facies, of part of the Fossil Mountain Formation.

North of Traill and Geographical Society Øer, the Jurassic is missing in Hold with Hope, and the Yellow Series is next met with in north-east Clavering Ø where it has a thickness of over 472 m. From here northwards it has been described in detail by MAYNC (1947). In north-west Wollaston Forland the whole of the Yellow Series is intermittently exposed and is 528 m thick (MAYNC, 1947, p. 59). The other sections recorded by MAYNC are less complete, but it is clear that the thickness of the Series in the region of Clavering Ø and Wollaston Forland is of the same order as in Traill Ø. A detailed comparison of the lithology is difficult since there is variation within fairly wide limits, but there seems to be no significant difference in facies between the two areas. The shales which occur in some of the Yellow Series sections further south do not appear to be conspicuous in the area described by MAYNC, although it must be remembered that shale horizons are commonly masked by scree from adjacent, more resistant, beds and may thus escape notice.

Further north still our knowledge of the Jurassic rocks has been recently summarised by MAYNC (1947, pp. 146—153). On Hochstetter Forland Jurassic rocks earlier than the Oxfordian are unknown, but on Koldewey Ø sandstones of Callovian age are again found; about 50 m of beds are present, and may be a purely local accumulation. This is the northernmost occurrence of Bathonian-Callovian beds in East Greenland.

Thus the arenaceous facies known as the Yellow Series can be traced southwards about as far as the head of Hurry Inlet and northwards to Wollaston Forland. In Jameson Land and Traill Ø the range of the faunas in the Series is the same: the earliest are characterised

by *Cranocephalites* and the latest by *Seymourites*. In the northern region the earliest ammonite is *Arctocephalites*, which occurs alongside *Seymourites* in what must be a condensed deposit on Wollaston Forland (MAYNC, 1947, p. 84). Thus throughout their considerable, if discontinuous, lateral extent of about 450 km the time range of the arenaceous deposits is similar. The statement by MAYNC (1947, p. 126) that the Yellow Series in his area (73° — 75° N. lat.) includes the Argovian (i. e. Lower Oxfordian) is not supported by any evidence in his paper, the highest faunal elements mentioned by him being *Cadoceras* and *Seymourites*. The occasional records of *Quenstedticeras* from the area (FREBOLD, 1932a, p. 23) were probably based on misidentified *Arcticoceras*, as in Jameson Land (see SPATH, 1932, p. 124), and so far there has been no confirmation of their existence.

B. Oxfordian and Kimmeridgian.

The Black Series is probably developed on Geographical Society Ø but the very brief references in the literature do not permit comparisons to be made. STAUBER (1938, p. 27) mentions black Upper Jurassic shales on the south-east coast of the island, his profile VII showing a few metres of these beds succeeded by Cretaceous rocks. His 1940 map (pl. 1) shows Upper Jurassic in this place and also on the eastern side of the Laplace Bjerg massif. Neither of these records is accompanied by any fossil evidence or any information as to the lithology or thickness of the beds, and further investigation will be necessary before the presence of the Black Series can be confirmed or further details given.

In Scoresby Land and the northern part of Jameson Land there is no evidence of any sediments later than the Yellow Series, and it is not known whether the absence of the Black Series is due to complete removal by denudation or to nondeposition. In south-eastern Jameson Land occasional Cardioceratids have been found, in sandstones with associated shales, but virtually nothing is known about the formation which yields them (ALDINGER, 1935, p. 36; SPATH, 1935, p. 69). One of STAUBER's maps (pl. 4 in KOCH, 1950) shows "Malm" in the central part of Jameson Land, with outliers as far north as Olympen, but there is no other indication in the literature of the existence of these beds or of their character.

The only well-known occurrence of Oxfordian and Kimmeridgian rocks south of Kong Oscars Fjord is in Milne Land, and has been exhaustively described stratigraphically by ALDINGER (1935) and palaeontologically by SPATH (1935). The lithological succession may be summarised as follows:

		m
Lower Kimmeridgian	Shales, with oil shales and bands of concretions	125
	Pecten Sandstone	70
Upper Oxfordian	Shales, with bands of concretions	200
Age unknown	Charcot Bay Sandstone	

The total thickness dated as Upper Oxfordian and Lower Kimmeridgian is thus 395 m.

To the north of Hold with Hope, where Jurassic rocks are unknown, the Black Series is found in Clavering Ø, Wollaston Forland and Kuhn Ø which constitute the type area for the formation. The most complete succession is at Ugpiik Ravine, on Kuhn Ø (MAYNC, 1947, p. 21) where shales with occasional limestone bands are proved to a thickness of 635 m, the top not being seen. In Wollaston Forland the series appears to be thinner, but no complete section is known. At Cardiocerasbjerg 155 m are present, the upper part much more sandy than on Kuhn Ø; but the succession is continued by unconformable Valanginian and the Black Series may have suffered an unknown amount of erosion. It is in general more sandy in Wollaston Forland than in Kuhn Ø. The Black Series in Traill Ø is closely similar to the thick, argillaceous facies in Kuhn Ø, except that even the limestone bands which punctuate the otherwise uniform lithology in Kuhn Ø have not been found in Traill Ø. The fauna in both areas is virtually restricted to ammonites (*Amoeboceras*) and *Buchia*.

At Hochstetter Forland black shales are found which are correlated by MAYNC (1947, p. 148) with the Black Series. On Koldewey Ø, whence extensive Oxfordian-Kimmeridgian faunas are known, the rocks of this age are predominantly sandy, doubtless as a result of the local erosion of crystalline rocks.

C. Infravalanginian.

Several horizons attributed to the topmost Jurassic and the Infravalanginian have been recognised from different parts of East Greenland on the basis of ammonites (SPATH, 1946, 1947, 1952), but since the Traill Ø sediments cannot be dated accurately extensive comparison is not profitable. The beds do not appear to bear close lithological resemblance to Infravalanginian rocks described from southern Jameson Land (ALDINGER, 1935) or from the mountain Niesen, the principal Infravalanginian section on Wollaston Forland (MAYNC, 1949, p. 95).

D. Valanginian.

The Polyptychitan fauna from locality 92 in the Mols Bjerge is the same as that found in bed 1 at Rodryggen, near Albrechts Bugt, Wol-

laston Forland (MAYNC, 1949, p. 70), which the writer has been able to inspect by the courtesy of Dr. L. F. SPATH who has briefly reported on it (1946, p. 6). The similarity in the mode of preservation of the ammonites from the two localities suggests that the "Albrechts Bugt Facies" of Wollaston Forland was also deposited in Traill Ø, but no section through the Traill Ø Valanginian has yet been obtained, nor is any intermediate occurrence known.

E. Aptian.

The Aptian of Traill Ø is the southernmost known occurrence of the stage in East Greenland. The stage may be present in Geographical Society Ø ('*Lytoceras sammartino*' cited by STAUBER, 1938, p. 27) but nothing is known of the occurrence or the lithology. At the next occurrence to the north, Stensiös Plateau on the northern side of Hold with Hope, a facies very different from the Traill Ø shales is found, namely coarse sandstones and conglomerates (MAYNC, 1949, p. 128) which represent a more marginal facies than that of Traill Ø. Since there is probably also a difference in age (the only diagnostic ammonite found at Stensiös Plateau was the Lower Aptian *Deshayesites*) our knowledge of the palaeogeography is not much advanced, except that we now have proof that the sea in the Upper Aptian, at least, extended over the coastal region of East Greenland as far south as Traill Ø, and that either the tectonic activity and associated rapid erosion evidenced by the section at Stensiös Plateau had died down, or the coast-line lay some distance to the west.

F. Albian.

The Albian beds of Traill Ø are clearly a continuation of those on Geographical Society Ø where Lower Albian (Leymeriellan) occurs near the south coast (SPATH, 1946, p. 9; DONOVAN, 1949, p. 7), characterised, as on Traill Ø, by *Leymeriella* and *Arcthoplites*; similarly, higher beds in both islands yield *Inoceramus anglicus* and *Aucellina gryphaeoides*. A queried *Hysteroeras* from Geographical Society Ø (SPATH, *op. cit.* p. 10) may indicate the presence of beds of the same horizon as those with *Mortoniceratids* on Traill Ø (locality 112), but the part of the stage which bears these faunas is at present obscure. Middle Albian ammonites, known from Geographical Society Ø (SPATH, *loc. cit.*), have not been found in Traill Ø but their absence may well be due to collection-failure.

North of Kejser Franz Josefs Fjord the available palaeontological evidence is not precise enough for useful comparison. In the Giesecke Bjerger MAYNC (1949, p. 160) reports beds in his Aptian-Albian series

with *Inoceramus*, some of which may be Albian species. *I. anglicus* is noted by MAYNC (*op. cit.* p. 145) at Kap Broer Ruys in Hold with Hope, in shales associated with sandstones and limestones, and shales with *I. anglicus* are also found on Clavering Ø (FREBOLD, 1932, p. 14). MAYNC mentions Hoplitid ammonites from Wollaston Forland (*op. cit.* pp. 48, 76) but they do not appear to have been examined by a specialist.

On Sabine Ø there are about 400 m of shales and marls with *Gastropilites*, referred to the Middle Albian (SPATH, 1946, p. 8), but there is nothing comparable to this fauna from Geographical Society Ø or Traill Ø. The Albian has not been reported from Kuhn Ø.

A belt of Albian sediments, which was probably continuous when deposited, can therefore be traced from Traill Ø as far as Wollaston Forland, with some variation in facies. In many places the Albian has not been separated from the underlying Aptian and the two stages are therefore treated by MAYNC as a single unit (1949, p. 37). In Hold with Hope and Wollaston Forland, at least, sedimentation appears to have been continuous throughout the two stages and it may not be possible to separate them rigidly even when all the faunas have been determined. MAYNC (*op. cit.* p. 211) estimates that the Aptian and Albian together account for more than 2,000 m of sediments in Wollaston Forland, a much greater thickness than can be attributed to the two stages in Traill Ø.

G. Cenomanian.

The only other known occurrence of Cenomanian in East Greenland is on Geographical Society Ø, where shales yielding Varians Zone ammonites and *Inoceramus crippi* belong to the same facies and basin of deposition as the Traill Ø sediments (SPATH, 1946, p. 10; DONOVAN, 1949, p. 8). From Hold with Hope to Wollaston Forland, where the Aptian and Albian are strongly developed, no evidence of the presence of the Cenomanian has been found, although higher beds have a limited distribution in eastern Hold with Hope (FREBOLD, 1934). Whether the Cenomanian was not deposited, or whether it has been removed by denudation in that area, remains an unanswered question. Certainly the Aptian-Albian series was subjected to later Mesozoic or early Tertiary erosion, for according to MAYNC (1949, *e. g.* pp. 35, 53, 147) it is unconformably overlain by Tertiary strata at several places in Hold with Hope, Wollaston Forland and Sabine Ø.

H. Turonian and Senonian.

The only evidence hitherto published for the presence of Turonian beds in East Greenland was the identification by SPATH (1946, p. 10)

of two Upper Turonian ammonite species said to be preserved in a "fissile sandy shale". The provenance of the specimens was not stated, although it was presumably Geographical Society or Traill Ø, and nothing is known of the beds in which they were found, so that comparisons with the Turonian rocks described in the present work cannot be made. SPATH's two species have not been found in the Turonian of the Rold Bjerger, but this does not necessarily indicate any substantial difference in age between the two occurrences, and may be due merely to collection-failure.

Senonian rocks were previously known from only one place, Knudshoved on the eastern coast of Hold with Hope, described by FREBOLD (1934) and by MAYNC (1949, pp. 141—144). The clearest section is given by MAYNC who records about 45 m of light-coloured, micaceous sandstones, associated with subsidiary shales, followed by about 80 m of beds which are largely obscured but which appear to consist principally of black shales. Fossils occur in clay-ironstone concretions in both parts of the succession, and include *Sphenoceras*. A thickness of about 125 m of sandstones and shales at Knudshoved is thus proved to belong to the Senonian. FREBOLD thought their age to be most probably Upper Emscherian (i. e. Lower Santonian), for the reason that he regarded the *Sphenoceras*, which he attributed to two new species *Inoceras* (*Sphenoceras*) *teichert* and *I. (S.) geltingi*, to be closely related to *I. cardisoides* Goldfuss, but he was careful to point out that the beds could not be dated accurately and might be older or younger. Since the age of even the Traill Ø *Sphenoceras*, which is more closely comparable with described species, cannot be exactly determined it seems unsafe at present to regard the Knudshoved Senonian beds as dated closely within the limits of the upper part of the Lower Santonian and the Lower Campanian. The Traill Ø *Sphenoceras* are very similar, so far as can be determined, to the species found in the fauna at Patoot in West Greenland, usually dated as Upper Santonian. Since the Knudshoved species differ from the Traill Ø and Patoot forms in the wider spacing of the concentric ornament they may provisionally be supposed to be at least slightly different in date, but whether older or younger is unknown.

As no sections were measured in the Senonian of Traill Ø lithological comparisons cannot be made, except to state that no sandstones of Senonian date have so far been proved outside Hold with Hope, all the faunas in Traill Ø having been found in shales.

In the north-eastern part of Hold with Hope the Home Forland Beds, which comprise at least 300 m of sandstones with subsidiary shales, yield *Oxytoma tenuicostata* and bear some lithological resemblance

to the Senonian of Knudshoved; they were attributed to the Upper Cretaceous by FREBOLD and implied by him to be the same age as the Knudshoved series. MAYNC (1949, p. 212) throws doubt on this correlation and believes that the record of *Oxytoma* may have been an error. He states (*op. cit.* p. 144) that near Knudshoved the Senonian was seen to rest with a basal conglomerate on beds which were attributed to the Home Forland Beds, and concludes that the latter are much earlier in date, possibly Aptian-Albian. There were no fossils to date the rocks beneath the Senonian and there seems to be little reason for preferring MAYNC'S view to FREBOLD'S. His principal evidence for placing the Home Forland Beds in the Lower Cretaceous is their lithological similarity with Aptian-Albian series elsewhere, but in the present writer's view it is dangerous, in the absence of fossils, to attempt to date the Cretaceous formations of East Greenland on the basis of their lithology.

No progress in the understanding of the Santonian—Lower Campanian deposits in East Greenland is likely to be made unless additional fossils, particularly ammonites, are found, and it is possible that further work in Geographical Society and Traill Øer will produce the desired information. The circumstances at Knudshoved do not appear to be favourable towards further discoveries, although even a chance find of an ammonite would be welcome, and there is a possibility that the beds also extend into the areas north and south of Knudshoved (Tobiasdal, Taagefjeldene and Östersletten) which MAYNC was not able to examine (1949, p. 141).

IX. STRUCTURE

The area is one of nearly horizontal or low-dipping beds. Dips up to about 30° were observed at a number of places but they are seldom consistent and are attributed to local disturbance by faults and igneous intrusions. The major structural elements are faults, mostly trending nearly north and south, which occur in two groups with their downthrow sides opposed, forming a graben in which Cretaceous rocks are preserved.

The western side of the graben has a simple structure (pls. 1, 3, 5). Near the north coast of Traill Ø there are two major faults. The western one, which will be referred to as the Bordbjerg Fault, throws down Trias against ?Carboniferous and Permian; the other, the Maanedal Fault, throws down Cretaceous against Trias in the Rold Bjerger. Where it crosses Maanedal this fault is interrupted by several transverse faults which shift it to the east on the south side of the valley (pl. 3); southwards from here it throws down Cretaceous against the green series of unknown age (p. 14). The Maanedal Fault has been traced nearly halfway across the island until it runs into the low-lying country between Karupelv and Gudenev, which has not been examined by me but where the solid geology appears to be obscured by superficial deposits. In the Svinhufvuds Bjerger a continuation of the Maanedal Fault reappears but has not been mapped except on the coastal slopes, and its simple character on plate 1 may be due to lack of evidence. STAUBER (1942, text-fig. 8. and pl. 2, *and* pl. 3 in KOCH, 1950) has marked the fault in the Svinhufvuds Bjerger as an overthrust, but no evidence has been collected to support his view. Further west in the Svinhufvuds Bjerger other faults are indicated by STAUBER, but the writer has not been able to examine them.

The eastern margin of the graben is more complex (pls. 1, 2, pl. 4, fig. 1, pl. 6, text-fig. 5). Near the south coast it is of conventional form: three faults, two mapped and one inferred (pl. 2, pl. 5, fig. 2, text-fig. 5) each downthrow to the west. East of the fault zone lie Triassic and Jurassic rocks with an easterly dip of 10° at Morris Bjerger which probably decreases further east. About the western end of Lycett

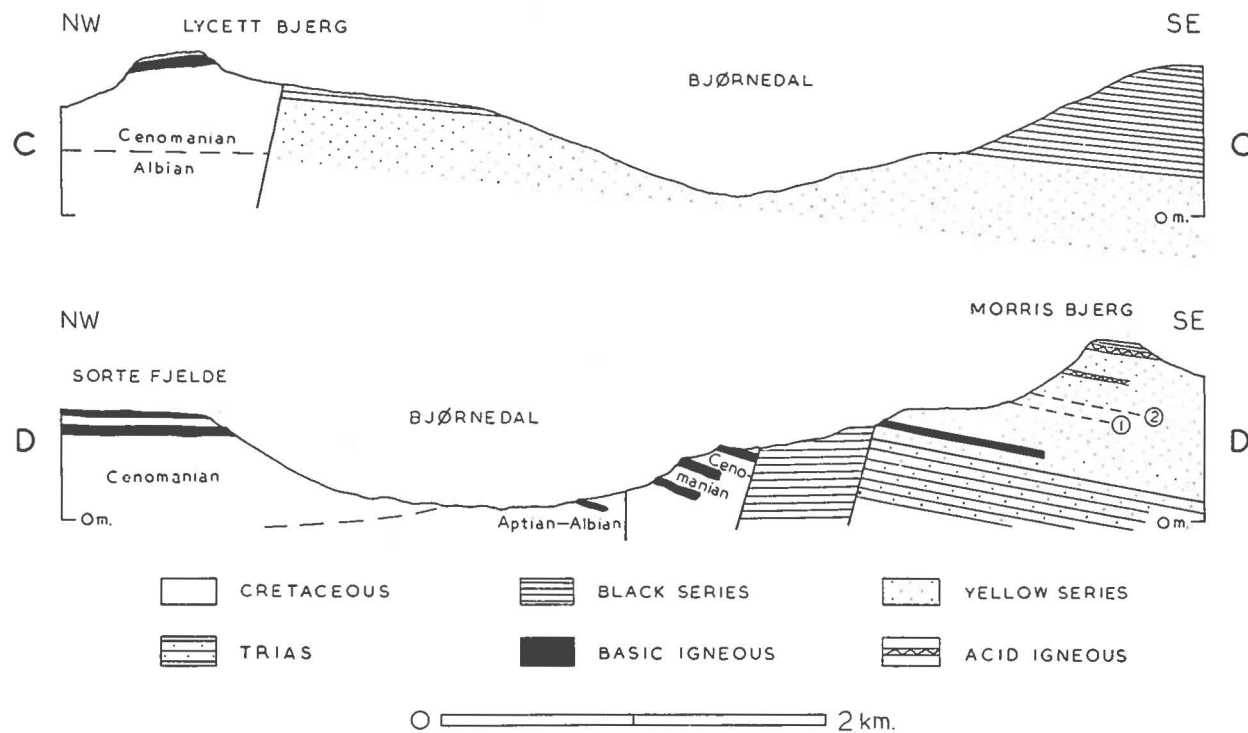


Fig. 5. Generalised geological sections across Bjørnedal along the lines C—C and D—D marked on plate 2. The broken lines numbered 1 and 2 in section D—D indicate the positions of the *Cranocephalites* and *Arctocephalites* horizons respectively. The vertical and horizontal scales are 1:40,000.

Bjerg the faults probably unite, and along the northern section of Bjørnedal there is only one major fault, throwing Jurassic against Cretaceous, and meeting the Morris Bjerg faults at an angle of about 125° . This fault was traced nearly to the northern mouth of Bjørnedal, where it appears to turn abruptly northwards again and where there may be subsidiary, associated structures, difficult to trace since they occur within the sandstones of the Jurassic Yellow Series. About 5 km to the east of the fault zone just described, at the northern end of Bjørnedal, a fault with a north-easterly trend and south-easterly downthrow can be traced for a short distance immediately east of Bredgletscher, where it limits the Jurassic outcrop to a narrow belt and again brings in Cretaceous rocks. This fault does not appear to traverse the syenite area, for on the south coast of the island the Jurassic outcrop is unaffected by faults.

North of Mountnorris Fjord the eastern margin of the graben is marked, not by faults, but by a zone of westerly dip, which reaches a maximum of about 8° or 9° and may be regarded as a gentle and indefinite monocline (pl. 5, fig. 1). The structure is terminated to the east by a fault which throws down Cretaceous against the Triassic rocks of the eastern part of the Mols Bjerge (pl. 4, fig. 1); this fault corresponds to the one just described to the east of Bredgletscher, and may be a continuation of it across Mountnorris Fjord.

A critical examination must now be made of the theory that overthrusts are present within the area, first propounded by SCHAUB (1942, p. 40) and adopted by STAUBER in his later maps (1942, pl. 2, and in KOCH, 1950, pl. 3). SCHAUB regards the displacement which separates the Jurassic from the Cretaceous at Morris Bjerg as an overthrust; STAUBER (*loc. cit.*) in addition adopts a similar interpretation for the displacement in the Svinhufvuds Bjerger, although on an earlier map (1938, pl. 1) he had shown both these lines as faults. It may be stated immediately that the writer's investigation has not produced any evidence for overthrusting at either of these places; on the contrary, comparatively detailed mapping of Morris Bjerg has demonstrated the presence of several normal faults. In the Svinhufvuds Bjerger it was not possible to trace the course of the fault except near the coast, but while its outcrop in plan might suggest an overthrust, no phenomena were observed to support such a theory, and the soft Cretaceous shales on the eastern side of the displacement are quite undisturbed. The thrust-like course of the outcrop, which may have been exaggerated by STAUBER, is due to the fact that the fault turns through a fairly sharp angle near the coast, a phenomenon which is known elsewhere in the area, for instance in the Rold Bjerger.

SCHAUB's reasons for his thrust-plane should, nevertheless, be examined. They are of two kinds: theoretical and factual. From the theoretical viewpoint, SCHAUB appears to believe that, as the syenite was intruded along a circular zone around the outside of the central "Three Bay Zone" (Dreibuchtenzone), the sedimentary rocks which had to be displaced to make way for the magma were pushed upwards and outwards and thus thrust over rocks further away from the intrusion. He also assumes (*op. cit.* p. 39) that the strata into which the syenite was intruded were approximately horizontal and unfaulted prior to the intrusion, but his only grounds for the supposition are that previous intrusions were too slight to have had any appreciable effect on the structure (the possibility of tectonic disturbance is not considered), and he remarks that one cannot determine from the field evidence how the rocks were disposed prior to the intrusion. In fact the evidence as to the relative ages of the faulting and of the different types of igneous intrusion is far from adequate, as is pointed out elsewhere (p. 63), and at present there would be no serious objection to believing that the igneous activity was later than the faulting. SCHAUB's theorising as to what might or should take place during an intrusion is, however, of no validity as proof that such events did occur, or that the resulting structures are present. The only concrete evidence cited by SCHAUB (*op. cit.*, p. 40) is that "the peak west of Steenstrupsbjaerg (i. e. Morris Bjerg) is made of Dogger (Middle Jurassic), whereas Cretaceous is found at its base". This statement does not agree with his map (*op. cit.*, pl. 1), where the sandstones which form the summit are shown, correctly, as continuing down to sea-level. Cretaceous rocks form the western slopes of the mountain only, as shown in plate 2. The disagreement between SCHAUB's interpretation and that of the present writer can thus be explained by the misinterpretation of the sedimentary rocks by SCHAUB, and by the fact that his version rests mainly on theoretical considerations. STAUBER has published no remarks on his Svinhufvuds Bjerger overthrust, and the writer can only state his disagreement with STAUBER's interpretation without being able to comment on that author's reasons.

Within the Cretaceous area the structure can only be traced where the various subdivisions can be identified palaeontologically, and since the occurrence of fossils is very sporadic, information as to the structures is correspondingly incomplete. In the Sortefjelde the strata are approximately horizontal, perhaps dipping slightly towards the centre of the Cretaceous graben. In the Rold Bjerger-Maanedal area the evidence is inadequate to work out the structure in detail, but is provisionally interpreted (pl. 5, fig. 1) as a faulted syncline or basin in which Turonian and Senonian rocks have been preserved; there is little doubt that the true state of affairs is considerably more complicated. Difficulty is

introduced here, as elsewhere, by the impossibility of distinguishing dips of tectonic origin from local disturbance of the shales by basic igneous intrusions.

Structural relations with neighbouring parts of East Greenland.

1. Northward continuations & structure of Vega Sund.

The Bordbjerg Fault, which limits the Carboniferous outcrops in the westernmost part of the Rold Bjerger, is continued in Geographical Society Ø. On the northern shore of Vega Sund, however, it throws down Cretaceous against Trias and Jurassic, and a transverse fault in Vega Sund is postulated to account for the difference in level of the rocks on the two shores. The transverse fault is presumed to be continuous with the Maanedal Fault and to account for the westward shift of the margin of the Cretaceous outcrop across Vega Sund (pl. 1). The continuation of the Bordbjerg Fault traverses Geographical Society Ø, as shown by STAUBER (1938, pl. 1, and later maps) and is then interrupted for 30 km by Kejser Franz Josefs Fjord, but it is perhaps not unreasonable to recognise it again in the fault which forms the eastern margin of the Giesecke Bjerger in Gauss Halvø. The slight easterly deviation in its course which is implied by this correlation is paralleled by a similar deviation in the 'post-Devonian main fault' as it crosses the eastern tip of Ymers Ø (see pl. 5 in KOCII, 1950). There is a general parallelism between the post-Devonian main fault and the one under consideration, both in Geographical Society and Traill Øer and in Gauss Halvø.

The structures in the Mols Bjerger cannot be traced northwards across Vega Sund, since no evidence is available as to the stratigraphy of the islands in the Sund or of the south-eastern part of Geographical Society Ø. Further north, at Laplace Bjerger, westerly-dipping Jurassic rocks are cut off to the east by a fault which throws down Cretaceous against them, producing a structure similar to that in the Mols Bjerger; but whether the Laplace Bjerger structure is a continuation of the Mols Bjerger structure, shifted eastwards in the Vega Sund region, will only be discovered by further work in this area.

2. Southward continuations.

With the exception of the 'post-Devonian Main Fault' none of the faults known on the south coast of Traill Ø can be linked with structures on the other side of Kong Oscars Fjord. The western margin of the Cretaceous graben of Traill Ø appears to have its beginnings in several

faults, all throwing down to the east, which intersect the coast of Scoresby Land between Mesters Vig and Antartics Havn (BIERTHER, 1941, pl. 1; STAUBER, 1942, pl. 4); a short distance southwards from the coast, according to STAUBER and BIEROTHER, these faults die out and the relations of the sediments from the Carboniferous to the Jurassic are normal and sequential. The fault zone of Bjørnedal is not represented on the southern side of Kong Oscars Fjord, where the Mesozoic basin is bounded on its eastern side, as in the Mols Bjerger, by a zone of westerly dip, not appreciably faulted as far as we know. Although the sediments to the south of Kong Oscars Fjord are downfolded gently to form a shallow basin in which Jurassic rocks are preserved, the most striking feature of this side of the fjord is the absence of the graben which contains Cretaceous sediments on Traill Ø. To account for the differences in the geology of the north and south shores of the fjord BÜTLER has postulated a fault (1948, p. 79, pl. 3) along Kong Oscars Fjord, and suggests that it is a hinge fault on the basis of STAUBER's map of the altitude of the base of the Trias (1942, pl. 6). This supposition does not seem to be justified by the evidence, since an examination of the published maps shows that everywhere between Kap Biot and Mesters Vig the rocks on the northern side of the fjord are at a lower level than the corresponding beds on the south. STAUBER's map, referred to by BÜTLER, is unlikely to be very close to the truth on account of the scantiness of the evidence on which it is based, and moreover contains some features which are difficult to understand, for instance, the fall in level of the base of the Trias from —400 to —1,000 m(!) between the Svinhufvuds Bjerger and Bjørnedal, for which there is no evidence. The present writer believes that the Kong Oscars Fjord fault or fault zone has a downthrow which is everywhere to the north, although doubtless variable in amount.

X. IGNEOUS ROCKS

The igneous rocks were not especially studied, because the investigation was primarily concerned with the stratigraphy of the sediments; they are intimately associated with the sediments, however, and cannot be omitted from the present account. They belong to two groups: basic rocks occurring as hypabyssal intrusions, and plutonic masses of syenite with associated minor intrusions. The syenites, whose occurrence has been described in detail by SCHAUB (1942), were not seen at close quarters by the writer. Where sediments near the contact were observed during the present investigation they were not disturbed or affected in any way except by thermal metamorphism. The intermediate or acid minor intrusives seen by the writer are on a minor scale, being restricted to the immediate neighbourhood of the syenite masses; a few thin sills, not shown on SCHAUB's map, occur on the western side of Bjørnedal, but do not extend further west. The structures believed by SCHAUB to be associated with the syenite contact are discussed elsewhere (p. 56).

The basic intrusions are ubiquitous throughout the central part of Traill Ø which is occupied by the predominantly argillaceous Cretaceous rocks, and are much more numerous than SCHAUB's small map of their distribution indicates (1942, text-fig. 3); their abundance is well indicated by STAUBER (pl. 3 in KOCH, 1950) though his map is incorrect as to details. While some of the intrusions are sills of conventional form, others almost defy mapping on account of their complex shape. The major sills are traceable laterally for several kilometres and may be over 100 metres thick. The thickest sill noted forms a capping to the Cretaceous rocks just east of the fault-line in the Svinhufvuds Bjerge, (seen at the right-hand end of STAUBER's text-fig. 8, 1942) and is at least 130 m thick in places. The sills commonly dip at angles of up to about 30°, and show well-developed columnar structure. Whether or not they are concordant with the bedding of the sediments cannot often be determined when the sills are intruded into shales, but along the coastal side of the Sortefjelde and the western side of Bjørnedal they are at least approximately so. The rarer sills intruded into sandstones follow the bedding, as on the coastal side of Morris Bjerget (pl. 6, fig. 1).

In the Sortefjelde there are two major sills, which are well seen on the western side of Bjørnedal, and can be traced most of the way along the coast to the Svinhufvuds Bjerger. At Bjørnedal the minimum thickness of the lower was estimated to be 40 m, and of the upper, 75 m. The upper may be continuous with the 140 m thick sill already mentioned. In the faulted blocks of Jurassic and Cretaceous shales on the eastern side of Bjørnedal a number of sills occur, but none of them can be clearly connected with the two across the valley. Another sill, dipping north-eastwards and at least 50 m thick, forms the summit of Lycett Bjerger. The Jurassic sandstones which form the south-eastern part of Lycett Bjerger are intruded by a few thin acidic sills, none of them more than about 5 m thick. The northwestern side of the same mountain, composed of Cretaceous shales, has a number of basic intrusions but no definite pattern could be discerned.

One or more sills outcrop near the summit level of the southern part of the Mols Bjerger, and appear to dip westwards with the sediments. On the north face of the Mols Bjerger, immediately east of Kap Palander, one of STAUBER's photographs (1942, fig. 6) shows a thick basic sill near the top, dipping westwards conformably with the sediments.

In the Rold Bjerger several nearly horizontal sills are intruded into the shales of the eastern part of the range (pl. 11, fig. 2), and a prominent one in the sandstones of Bordbjerget (pl. 10) extends northwards to the coastal mountains.

In addition to the sills are other intrusions, irregular in form, which cannot be described under any conventional heading. Where their margins are visible they are seen to be undulating and to bear no clear relation to the disposition of the sediments, which themselves are often highly disturbed. This is the case, for example, with some of the basic intrusions on the eastern side of Bjørnedal, some in the Rold Bjerger, on the western slopes of Lycett Bjerger and in a number of places in the low-lying central part of the island.

In these occurrences the soft shales have exercised almost no directing effect on the course of the intrusive magma, which has assumed forms nearly at random. The same phenomenon is manifested, to a lesser degree, on the surfaces of the intrusions which are recognisable as sills, which are often undulating, with pockets of sediment preserved in the hollows.

No dykes of any importance have been met with in the shale areas. They occasionally intrude the sandstones, in Morris Bjerger and in the western part of the Rold Bjerger, but are seldom more than a few metres wide.

The concentration of basic hypabyssal intrusions in that part of the island which is formed of shales has already been mentioned. One

or two sills intrude the Jurassic and earlier sandstones of Morris Bjerg and the coast to the east, and sills are likewise found in the Jurassic and Triassic beds to the west of the Cretaceous area, but in neither case is there anything approaching the profusion of intrusions which has invaded the central area of Cretaceous shales. Along the coastal side of the Rold Bjerger, for example, above the lower moraine-covered slopes a whole family of sills and sill-like bodies can be seen (pl. 9, fig. 2), and in examining this and other shale areas, for instance the north-western side of Lycett Bjerg and the eastern slopes bordering Bjørnedal, small intrusions, mostly of irregular form, were constantly met with. It is clear that the shales were readily intruded while the Jurassic and older sandstones did not offer easy paths for the magma, so that intrusions in them are restricted to a few dykes and sills of conventional kind.

The Age Relations of the Intrusions.

There is little evidence at present for the date of the igneous rocks of Traill Ø. SCHAUB (1942, pp. 23—24) pointed out that the limits for their age were between Upper Cretaceous and younger Tertiary, a remark which applies to most or all of the rocks belonging to the 'Tertiary igneous province'. A lower limit can be suggested; the Upper Campanian shales of locality 58, in Maanedal, are baked by the neighbouring dolerite so that some, at least, of the basic intrusions cannot be earlier than the Maestrichtian. Whether any intrusions took place into earlier Cretaceous rocks before the termination of deposition cannot definitely be stated, but so far no evidence has been found in favour of this hypothesis. There is no upper limit to the igneous activity, for no sediments younger than Upper Campanian have been found.

A further matter of importance, although the events in question cannot be placed in the geological time-scale, is the relative ages of the several phases of igneous activity, and of the faulting. SCHAUB has published diagrams (1938, p. 35; 1942, figs. 6, 20) showing syenite cutting across basic sills already intruded into the sediments. He rejects (1942, p. 18) BACKLUND's theory that the syenite arose by the fusion of the Carboniferous and Triassic sandstones during the emplacement of the basic intrusions, and one of SCHAUB's diagrams (1942, fig. 6), showing xenoliths of 'basalt' incorporated in the syenite, indicates that some at least of the intrusions were emplaced before the formation of the syenite. According to SCHAUB the intrusion of the syenite was the final phase of igneous activity in the area. As a considerable length of geological time is available for the igneous activity there is no need to assume that the basic and the syenitic phases were closely connected.

The activity which was manifested here as intrusions and probably in other parts of East Greenland as outpourings of basalt was much more widespread geographically than are the plutonic masses of syenite.

The relative ages of the igneous activity and of the faulting has not yet been established. Major sills cannot usually be traced across fault lines but this may be due to the different behaviour of the magma in the shales and sandstones, since it is where shales have been brought against sandstones that the faults are usually traceable. This phenomenon, therefore, is not significant in the enquiry. Only one case was found where a basic sill and a fault definitely intersected, and here, on the coast south of the Svinhufvuds Bjerger, movement along the fault had occurred since the intrusion. The amount of displacement of the sill could not be traced, however, and only a small proportion of the total displacement may, in fact, have taken place since the intrusion.

There is no further direct evidence on the question. STAUBER (pl. 3. in KOCH, 1950) shows a basic dyke occupying a major fault line immediately west of Æbeltoft Vig, on the northern side of Mountnorris Fjord. SCHAUB (1942) does not show a dyke in this position. Whether or not STAUBER is correct in this case, the striking fact is that generally the intrusion of dolerite has not taken place along the major faults, suggesting that the faulting was subsequent to the intrusion of the basic rocks. This hypothesis is only advanced tentatively, since it is based on negative evidence. There appears to be no indication that the syenite has been faulted to any appreciable extent.

XI. GEOLOGICAL HISTORY OF THE AREA

Although the base of the Yellow Series has not been seen in Traill Ø, the sections along Kong Oscars Fjord, on the coastal sides of Morris Bjerg and Forchhammers Bjerg, show no significant angular discordance between the Yellow Series and the underlying Kap Biot Formation. There is, however, a stratigraphical gap, for the whole of the Rhaetic and Lias, the Bajocian and part of the Bathonian are not represented by faunas and probably not by sediments. Reasons have been given elsewhere for provisionally including the Plant Beds in the Yellow Series, and if this assignment is correct there is little room for any other strata between the Kap Biot Formation and the Yellow Series. Even if the Plant Beds should belong to an intermediate horizon, it is improbable that such rapidly deposited strata would represent more than a fraction of the period between the close of the Trias and the Upper Bathonian. Deposition was renewed in Bathonian times, therefore, after an interval during which the area, if not a scene of deposition, was not subjected to denudation of any intensity. The surface of the earlier beds possibly lay near sea-level, insufficiently elevated for active erosion to occur.

The black shales, interbedded with sandstones and occasional conglomerates of the Plant Beds, appear to have been deposited in an embayment of the sea, perhaps even on the subaerial surface of a debris fan on which plants flourished from time to time. During the formation of the rest of the Yellow Series marine conditions certainly obtained at times, as evidenced by the occasional ammonite horizons, but did not necessarily persist throughout. The close association, at several localities (*e.g.* 23, 31, 136), of plant impressions or fossil wood with marine invertebrates indicates that the vegetable matter must have been drifted, and its presence does not necessarily indicate marshy conditions. At the horizons where ammonites occur they are usually common and cannot be interpreted as casually drifted individuals. Sometimes, if not habitually, ammonites must have lived in the area of deposition of the Yellow Series.

Deposition of sandstones continued after the highest Callovian ammonite horizon (Tychonis zone) was laid down, but the beds between

this horizon and the earliest undoubted rocks of the Black Series are not sufficiently well exposed to indicate either the nature or the precise position of the junction between the Yellow and the Black Series. No discordance of dip between the two series has been observed, although the evidence is unsatisfactory, but the supply of sandy sediment which characterised the Yellow Series was diminishing, and in view of the gap between the faunas of the two formations there are presumably non-sequences in the succession.

The Black Series consists of soft, black, thin-bedded shales, with crushed impressions of ammonites and of *Buchia* almost their only fossils. Fossils are, indeed, absent altogether except at a few widely separated horizons, and the facies corresponds closely to the "black shale facies" which characterises deposition in basins with restricted circulation of the bottom waters and consequent accumulation of unoxidised sulphides and carbon. A corresponding sequence of facies occurred in the Wollaston Forland—Kuhn Ø area, where the Yellow Series and Black Series are also recognised. No definite explanation for the presence of the black shale facies can be offered, although a possible clue is supplied by the conditions in Jameson Land, where the Mesozoic trough of deposition was bounded to the east by the crystalline massif of Liverpool Land. North of Kong Oscars Fjord the depositional area may also have had an eastern shore formed of upfaulted Palaeozoic rocks. The eastern tip of Canning Land (BÜTLER, 1948), where the Pre-Cambrian Eleonora Bay Formation is succeeded westwards by Devonian and later rocks in faulted relationship, exhibit a structure which, if continued northwards, could have formed such an eastern margin.

The deposition of the Black Series was presumably terminated by uplift of the sea floor, and there is no evidence for any later formations in the Jurassic. The upper limit of the Black Series has nowhere been seen, but is presumably succeeded unconformably by Cretaceous rocks. On the southern side of the Mols Bjerger the Black Series has not been detected and the Cretaceous may rest on the Yellow Series, but the contact has not been seen.

Our knowledge of the events at about the time of the Jurassic—Cretaceous boundary is limited both by the small number of exposures known and by the lack of precise dates for some of them. Deposition recommenced at about this time, and in the Infravalangian the *Pachyteuthis* Beds indicate the flooding of the area by a shallow sea in which organisms were moderately abundant, although the fauna comprised very few species. The banded sandstones of localities 55, 56 and 88 may also have been laid down at about the same time. In the Valangian there was again deposition, of which evidence has so far been found only at locality 92, during which an ammonite fauna including a considerable

number of species flourished, as well as belemnites and lamellibranchs. Although the formations just mentioned, together with the *Buchia*-bearing nodules (p. 30), may represent as many as four separate horizons, their restricted outcrop, although no doubt partly due to overstep by later beds, suggests occasional short-lived transgressions over the area rather than the widespread and permanent establishment of marine conditions. Certainly the Infravalanginian and Valanginian deposits do not compare, as regards either their thickness or the number of faunal horizons present, with the development in Wollaston Forland where at the mountain Niesen (MAYNC, 1949, p. 95) over 200 m of sediments appear to be referable to the Infravalanginian and a similar thickness to the Middle Valanginian, and where a number of successive ammonite faunas have been recovered (SPATH, 1946, pp. 4—6; 1952).

No Hauterivian or Barremian deposits have been found in Traill Ø, or, indeed, elsewhere in East Greenland, and the remainder of the Neocomian was a period of emergence. The basal beds of the next transgression have not been seen, and so their age and nature is unknown. They are unlikely to have been much earlier than Upper Aptian. Little can be said about the geological events at this time and it is not known whether the Upper Aptian deposition continued through into the Albian, but by the Leymeriellan age of the Lower Albian a period of shale deposition had been inaugurated which continued, almost if not quite without interruption, until the middle of the Cenomanian stage. Much of the Albian—Cenomanian shale series is unfossiliferous and some portions, at least, are of the "black shale" facies, but the study of the lithology is hindered by the number of igneous intrusions which have baked the shales and destroyed their original character. The Albian includes bands of fine-grained sandstone as well as shale, although taking the stage as a whole shale is overwhelmingly dominant; the Cenomanian is wholly argillaceous except in the western part of the Sortefjelde where beds of sandstone are interpreted as the result of tectonic activity along a neighbouring fault zone. At other horizons in the Sortefjelde pyritic nodules confirm the presence of iron sulphide indicated by the black colour of the beds. During the Albian and Lower Cenomanian, therefore, just as in the Lower Kimmeridgian Black Series, the "black shale facies" obtained, probably less completely in the later period since normally developed faunas comprising a number of different species are found at a few horizons.

At the end of the Lower Cenomanian sedimentation ceased, and during the Upper Cenomanian and Lower Turonian the area was probably elevated sea-level. The Upper Turonian was marked by a new transgression, commencing with coarse sandy and conglomeratic sediments which may indicate renewed up-faulting of the area of Palaeozoic rocks to the west. This episode was short-lived and all the remaining Upper

Cretaceous rocks are argillaceous. The succeeding formations are little-known, but it is unlikely that deposition was continuous throughout the Turonian and Senonian, for the greater part of the Senonian is unrepresented by the faunas collected; these probably indicate temporary incursions of the sea. No direct evidence of further transgressions has been found in Traill Ø, although at Knudshoved in Hold with Hope the presence of coarse sandstones at the base of the series which is equivalent to the *Sphenoceras* Beds in Traill Ø suggests that there was an Upper Santonian or Lower Campanian transgression in East Greenland.

Locality 58 in Traill Ø is the only place where the Upper Campanian fauna, long known from West Greenland, has been discovered in East Greenland. There is no evidence as to whether or not deposition was continuous from the Lower into the Upper Campanian. The fauna at locality 58 is the youngest yet found in the Mesozoic of East Greenland.

XII. PALAEONTOLOGY

A. Jurassic.

Phylum MOLLUSCA.

Class *Lamellibranchia*.

Family *Nuculidae*.

Genus *Nucula* Lamarck, 1799.

Nucula sp. indet.

The shell of one example is preserved embedded in matrix so that the interior only is visible. It is 0.9 cm long, and represents a species with a more regularly oval outline than, for instance, *N. (Palaeonucula) waltoni* Morris and Lycett from the British Great Oolite. The inner margin of the shell is crenulated in characteristic *Nucula* fashion.

Occurrence: Locality 143, age unknown.

Family *Parallelodontidae*.

Genus *Parallelodon* Meek and Worthen, 1866.

Parallelodon? keyserlingi (d'Orbigny).

Two internal moulds of right valves are probably referable to the species. The ventral margin appears to be straight and almost parallel to the hinge-line, whereas in most figures of d'Orbigny's species the two diverge posteriorly. The atypical appearance of the Traill Ø examples may, however, be due to their preservation.

Shells in which the ornament is preserved have already been figured from Fligely Fjord as *M. keyserlingi* and *M. cf. keyserlingi* by Frebold (1933, pp. 21, 25, pl. 2, figs. 14—16, 21).

Occurrence: Locality 143, age unknown.

Family **Pteriidae**.

Genus **Oxytoma** Meek, 1864.

Oxytoma cf. *expansum* (Phillips).

- 1829 *Avicula expansa* Phillips, p. 129, pl. 3, fig. 35 (reversed).
 1933 *Oxytoma expansa* (Phillips). Arkell, p. 190, pl. 24, figs. 1—5.
 1948 *Oxytoma expansum* (Phillips). Cox and Arkell, p. 7.

Two left valves are both inadequate for detailed study, but clearly represent a large *Oxytoma* with ornament similar to that of *O. expansum*.

Occurrence: Localities 23, 136, Upper Bathonian; locality 143, age unknown.

Genus **Meleagrinnella** Whitfield, 1885.

Meleagrinnella sp. indet.

The genus is represented by a poorly preserved left valve. *M.* aff. *domeziana* (Borissjak) has been recorded from the Bathonian of Jameson Land by SPATH (1932, p. 105).

Occurrence: Locality 143, age unknown.

Family **Buchiidae**¹⁾.

Genus **Buchia** Rouillier, 1845.

Buchia concentrica (J. de C. Sowerby).

- 1827 *Plagiostoma concentrica* J. de C. Sow., Min. Conch. VI, p. 113, pl. 559, fig. 1.
 1848 *Buchia bronni* Rouillier.
 1907 *Aucella bronni* Lahusen. Pavlov, p. 14, pl. 2, fig. 1, text-fig. 7.
 1911 *Aucella bronni* Ravn, p. 455, pl. 32, fig. 5.
 1932 '*Plagiostoma*' *concentricum* (J. de C. Sowerby). Bailey & Weir, p. 464.
 1933 *Aucella bronni* Frebold, pp. 20, 23 (cf.).
 1935 *Buchia* aff. *bronni* Spath, p. 53, pl. 8, fig. 3.
 1951 *Buchia concentrica* (J. de C. Sowerby). Waterston, p. 40, pl. 1, fig. 2.

A number of other references will be found in the synonymies of the authors cited above, notably PAVLOV (1907) and WATERSTON (1951). The identity of the form widely known in the literature as *Aucella bronni* with the species from east Scotland named *Plagiostoma concentrica* by SOWERBY was first pointed out by WEIR, in BAILEY and WEIR, 1932. The type specimens were refigured by WATERSTON (1951, pl. 2, fig. 2b). There is little doubt that several other 'species' named by Russian authors should be united under this name, but the material in the present collection does not warrant a critical study of the species.

¹⁾ The family name Buchiidae replaces Aucellidae Lahusen, 1897, whose type genus is a junior synonym of *Buchia*.

The species has been recorded from other parts of East Greenland (as *Aucella bronni*) by RAVN, FREBOLD and SPATH (*loc. cit.*).

Occurrence: Localities 15, 16, 127; probably locality 22. Upper Oxfordian—Lower Kimmeridgian.

Family **Isognomonidae.**

Genus **Inoceramus** Wm. Smith, 1816.

Inoceramus ?retrorsus Keyserling.

1932 *Inoceramus retrorsus*, Keyserling. Spath, p. 110, text-fig. 8.

An internal mould has stout concentric ribs which are already widely spaced at a short distance from the umbo, and resembles the Jameson Land examples figured by SPATH in proportions and ornament. Little of the shell is preserved, however, and it might even belong to an extreme form of the other species recognised by SPATH (*op. cit.* p. 109), *I. ambiguus* Eichwald. The present identification is queried since it is impossible to be more definite and since SPATH himself was in some doubt as to the interpretation of the species which he recognised.

Occurrence: Localities 19(?), 147, Upper Bathonian.

Family **Pectinidae.**

Genus **Camptonectes** Meek, 1864.

Camptonectes giganteus Arkell.

Pl. 15, fig. 1.

1926 *Camptonectes giganteus* Arkell, p. 544, pl. 33, fig. 1.

1930 *Camptonectes giganteus* Arkell, p. 100, pl. 7, figs. 2, 3.

A right valve from locality 143 corresponds closely with one figured by ARKELL in 1930 (fig. 3) and with another syntype in the Oxford University Museum (J 2358). The shell is missing from the greater part of the Greenland specimen but the original surface is preserved undamaged on either side of the umbo and here displays the irregular radial striae characteristic of ARKELL's species. The posterior ear is abraded but complete; the anterior ear is damaged but enough remains to indicate its correspondence with that of *C. giganteus*. The apical angle is 105°.

The internal mould of the umbonal part of a right valve from locality 120 appears also to belong to the species, and a left valve from locality 143 probably does, but the ears are missing and the margin damaged.

A question which awaits elucidation is the relationship between *C. giganteus* and *C. broenlundi* (Ravn), described (1911, p. 465, pl. 34, figs. 5, 6) from the Oxfordian—Kimmeridgian of Store Koldewey. The left

valve figured by RAVN (fig. 5) shows the outline and convexity of this valve well, although most of the shell itself is missing. Compared with left valves of syntypes of ARKELL's species (Oxford University Museum J2356, J2359) RAVN's left valve agrees closely in outline, but the ears are less sharply demarcated from the rest of the shell and the anterior ear (the posterior is not preserved) is proportionately smaller than in *C. giganteus*, resembling in this respect *C. sandsfootensis* Arkell (1930, p. 101, pl. 8, fig. 3). The right valve of *C. broenlundi* agrees with that of *C. giganteus* except that the posterior ear bears curved growth-lines with the concavity facing posteriorly, while in *C. giganteus* (and *C. sandsfootensis*) the growth-lines on this ear are straight. The anterior ear of the right valve is not known. The radial ornament on the valves, according to RAVN's description, is of similar style to that of *C. giganteus*, but in *C. broenlundi* it covers the valves while in the English species the central region of the shell in both valves is smooth.

The slight but definite differences mentioned above, and the fact that *C. broenlundi* is incompletely described, make it desirable to keep the two species distinct in the present state of our knowledge. Further, the exact horizon of *C. broenlundi* is in doubt and that of the Traill Ø examples of *C. giganteus* is unknown. The English representatives of *C. giganteus* occur in the Corallian rocks at the base of the Upper Oxfordian.

Occurrence: Right and probable left valve from locality 143, age unknown. Right valve from locality 120, Upper Bathonian.

Camptonectes sp.

A small external mould of a right valve, 2.5 cm high and 2.3 cm long, with an apical angle of about 107° , is not identifiable specifically. The shell is smooth except for very faint traces of radial ornament. The nearest well-known species is *C. laminatus* (J. Sow.) which, however, seems usually to have stronger ornament.

Occurrence: Locality 120, Upper Bathonian.

Family **Limidae**.

Genus **Pseudolimea** Arkell, 1932.

Pseudolimea duplicata (J. de C. Sowerby).

1827 *Plagiostoma duplicata* J. de C. Sowerby, p. 114, pl. 559, fig. 3.

1853 *Lima duplicata* (Sowerby). Morris and Lycett, p. 26, pl. 3, figs. 6, 6a.

1948 *Pseudolimea duplicata* (J. de C. Sowerby). Cox and Arkell, p. 17.

A left valve agrees with the species as figured by SOWERBY, and by MORRIS and LYCETT.

Occurrence: Locality 143, age unknown.

Family **Ostreidae**.Genus **Ostrea** Linné, 1758.Subgenus *Liostrea* Douvillé, 1904.*Ostrea (Liostrea) ?erina* (Thevenin ex d'Orbigny).

- 1849 *Ostrea Erina* d'Orbigny, p. 257.
?1874 *Ostrea Erina* d'Orbigny. Dumortier, p. 201, pl. 45, figs. 1, 2.
1908 *Ostrea Erina* d'Orbigny. Thevenin, p. 200, pl. 20, figs. 8—10.
?1934 *Liostrea* cf. *erina* (d'Orbigny). Rosenkrantz, p. 118.

Locality 143 on Traill Ø has yielded a large oyster in which the outline of the shell is regular and roughly oval, the length being between 70 % and 80 % of the height. The height was at least 11 cm in the largest individuals. None of the specimens is complete, and the muscle impression and ligament pit are unknown.

The form compares closely with the example figured by DUMORTIER (1874) with the remark that he could not be certain that it represented d'ORBIGNY's inadequately described species, and the identification is queried here chiefly because the publication by THEVENIN of the interior view, reduced, of a seemingly damaged left valve from the d'Orbigny collection, and the external view of a second left valve, still does not permit DUMORTIER's identification to be definitely confirmed or rejected.

ROSENKRANTZ (1934) recorded *Liostrea* cf. *erina* from the Toarcian of Jameson Land, but did not state what figure he used for the identification. ROSENKRANTZ implies (1934, pp. 81 *et seq.*) that the Toarcian Oyster Bed on Nathorst Bjaerg is composed of *L. cf. erina*, but MADSEN (1906, p. 117, pl. 7, figs. 1—3) describes and figures, as *O. eduliformis* Schlotheim, a quite distinct oyster from the 'Oyster Bed at Mount Nathorst', and without seeing any of the specimens recorded by ROSENKRANTZ it would not be safe to assume that they are at all similar to those here recorded.

D'Orbigny lists *O. erina* as a Toarcian species and Dumortier records it from the lower part of the Toarcian, his zone of *Ammonites bifrons*.

Occurrence: Locality 143, forming oyster-bed. Age undetermined.

Ostrea (Liostrea) bononiae Sauvage.

- 1935 *Ostrea* sp. ind. Spath, p. 54, pl. 9, fig. 6; pl. 10, fig. 4.
1936 *Ostrea bononiae* Sauvage. Spath, p. 102, pl. 39, figs. 10—12, pl. 49, figs. 6a, b.

Two specimens, both of which possess strong radial ribbing, are referred to the species, which is already known from Milne Land.

Occurrence: Locality 128, ?Lower Kimmeridgian.

Family **Lucinidae**.Genus **Lucina** Bruguière, 1797.*Lucina* sp. indet.

An external mould represents a shell about 2.0 cm long and 1.8 cm high. It is of the same type as the specimens of *L. anglica* (Rollier) and *L. oolithica* (Rollier) figured by MORRIS and LYCETT (1853, pl. 6, figs. 13, 14) but is not complete enough to be certainly distinguished from some of the other, similar, Bathonian species listed by COX and ARKELL (1948, p. 33).

Occurrence: Locality 143, age unknown.

Family **Mactromyidae**.Genus **Mactromya** Agassiz, 1843.*Mactromya* aff. *aceste* (Cottreau ex d'Orbigny).1850 *Unicardium Aceste* d'Orbigny, p. 366 (*nom. nud.*)]1927 *Unicardium Aceste* d'Orbigny. Cottreau, p. 54, pl. 46, figs. 26, 27.1934 *Mactromya aceste* (d'Orbigny). Arkell, p. 306, pl. 42, figs. 1—5.

COX and ARKELL declared in 1948 (p. iv) that, in accordance with Opinion 126 of the International Commission on Zoological Nomenclature, they regarded all d'Orbigny's 'Prodrome' species which were unaccompanied by references to previous figures as *nomida nuda*, and the name therefore dates from its publication by COTTREAU in 1927. There does not seem to be any earlier valid name in the synonymy published by ARKELL (1934).

A single *Mactromya* from Traill Ø agrees well with the Corallian material figured by ARKELL, except that the Greenland shell is more compressed, the thickness being only 55 % of the length (3.3 cm) whereas the inflation of English and French examples of *M. aceste* is about 70 %. The difference may be due, at least in part, to crushing of the Greenland specimen.

The nearest *Mactromya* cited from the English Bathonian is *M. impressa* (Morris and Lycett), which differs in the form of its posterior margin from *M. aceste*.

Occurrence: Locality 120, Upper Bathonian.

Family **Tancrediidae**.Genus **Tancredia** Lycett, 1850.*Tancredia* sp. indet.

This genus is represented by the incomplete external mould of a right valve, which can be matched among British Great Oolite forms by

T. marmorea Cox and Arkell (1948, p. 37) but is too fragmentary to be definitely named.

Several species of *Tancredia* have been recorded from the Upper Jurassic of Kuhn Ø and Hochstetter Forland by RAVN (1911) and by FREBOLD (1933), but their identifications appear to have been based on MORRIS and LYCETT's figures and need to be emended since Cox and ARKELL's revision of that monograph. RAVN's plate 33, fig. 6 is not *T. curtansata* (Phillips), which is a Corallian species with a much higher shell, but is close to *T. subcurtansata*, set up by LYCETT (1863, p. 120) for the Great Oolite form. RAVN's *T. planata* Morris and Lycett (pl. 33, fig. 10) may perhaps stand, but his plate 35, fig. 1 is *T. cf. angulata* Lycett and not *T. axiniiformis* (Phillips), which is a Bajocian shell.

The form recorded as *T. sp. cf. angulata* Lycett by MADSEN (1904, p. 184, pl. 6, fig. 18) is probably a Toarcian shell.

Occurrence: Locality 143, age unknown.

Family Cardiidae.

Genus *Protocardia* Beyrich, 1845.

Protocardia cf. stricklandi (Morris and Lycett).

1853 *Cardium Stricklandi* Morris and Lycett, p. 64, pl. 7, figs. 5, 5a.

1948 *Protocardia stricklandi* (Morris and Lycett). Cox and Arkell, p. 39.

A small internal mould, whose length is 1.75 cm, height 1.65 cm, and thickness 1.15 cm agrees most nearly in form with this species. It differs from the *Protocardia* recorded by SPATH from Jameson Land (1932, p. 116, pl. 2, fig. 5), and attributed by him to *P. aff. subtrigona* (Morris and Lycett) (*recte P. lycetti* Rollier), in having a more regularly oval outline and more pointed umbones.

Occurrence: Locality 147, Upper Bathonian.

Family Ceratomyidae.

Genus *Gresslya* Agassiz, 1843.

Gresslya peregrina (Phillips).

1829 *Unio peregrinus* Phillips, p. 144, pl. 7, fig. 12.

1855 *Gresslya peregrina* (Phillips). Morris and Lycett, p. 139, pl. 15, figs. 8a, b.

1934 *Gresslya peregrina* (Phillips). Arkell, p. 319, pl. 43, figs. 7, 7a.

1948 *Gresslya peregrina* (Phillips). Cox & Arkell, p. 42.

The examples from Traill Ø agree fairly closely with the Upper Cornbrash specimen figured by MORRIS and LYCETT. The species is

variable in form and there seems no reason to qualify the inclusion therein of the East Greenland material.

Occurrence: Localities 120, 137, Upper Bathonian.

Family **Pholadomyidae**.

Genus **Goniomya** Agassiz, 1842.

Goniomya literata (J. Sowerby).

- 1819 *Mya? literata* J. Sowerby, Min. Conch. III, p. 45, pl. 224, fig. 1.
 1819 *Mya V-scripta* J. Sowerby, op. cit. p. 46, pl. 224, figs. 2—5.
 1932 *Goniomya v-scripta* (J. Sowerby). Spath, p. 120, pl. 7, figs. 4a—c.
 1948 *Goniomya literata* (J. Sowerby). Cox & Arkell, p. 45.

The well-known *G. v-scripta* is now regarded as a synonym of *G. literata*. The Traill Ø occurrence comprises one poor specimen only. The species has already been recorded from Jameson Land by SPATH (*loc. cit.*).

Occurrence: Locality 137, Upper Bathonian.

Genus **Osteomya** Moesch, 1874.

Osteomya dilata (Phillips).

- 1829 *Mya dilata* Phillips, p. 155, pl. 11, fig. 4.
 1855 *Myacites dilatus*, Phillips. Morris and Lycett, p. 114, pl. 10, figs. 5a, b.
 1948 *Osteomya dilata* (Phillips). Cox & Arkell, p. 45.

One internal mould agrees with MORRIS and LYCETT's figure of the species.

Occurrence: Locality 143, age unknown.

Class **Cephalopoda**.

Family **Belemnitidae**.

Genus **Cylindroteuthis** Bayle, 1878.

Cylindroteuthis sp. indet.

- 1932 *Cylindroteuthis?* sp. ind. Spath, p. 100, pl. 13, fig. 2, pl. 16, fig. 7, text-fig. 6.

Three fragmentary phragmocones agree with those recorded by SPATH from Jameson Land. The largest corresponds well with the example shown in SPATH's plate 13, fig. 2. The phragmocones have an elliptical cross-section which appears to be not entirely due to crushing; in the least damaged of the three the lesser diameter is 80 % of the greater.

Occurrence: Locality 120, Upper Bathonian; locality 143, age unknown.

Cylindroteuthis subextensa (Nikitin).

1932 *Cylindroteuthis subextensa* (Nikitin). Spath, p. 98, pl. 16, fig. 2.

A phragmocone, 4.7 cm long and complete with the apex except for the extreme tip, agrees with SPATH's figure of the species.

Occurrence: Locality 120, Upper Bathonian.

'Onychites'.

Pl. 15, figs. 3—7, text-fig. 6.

This name has been used for the hooks which were borne on the arms of certain dibranchiate cephalopods, and also for somewhat similar, usually much larger, objects of unknown origin.

Small '*Onychites*' are well known and are sometimes found associated with fossil belemnoids in their original positions, arranged in two rows along each arm. The hooks are usually less than 5 mm long and are often of almost microscopic size. They have been figured from the Upper Permian of East Greenland (FISCHER, 1947, p. 18, pl. 1, fig. 8, text-fig. 6) and an example 7 mm long was found during the present investigation near the base of the Black Series, of ? Upper Oxfordian age, near locality B91. The majority of these small hooks are the same basic shape, which is illustrated by the figures of NAEF (1922, fig. 68a, b, d, e). A straight, tapering shaft is curved round at one end, usually through more than a right angle, to form a sharp-pointed hook. The other end of the shaft usually has a projection on the same side as the hook, and is truncated diagonally to produce a blunt point. This was the proximal end and was embedded in the tissues of the animal, so that the shaft was directed forwards and the point backwards.

The second group of structures which have been referred to as '*Onychites*' are approximately semicircular in form, often several centimetres in length, with a point at one end and an expanded base at the other. They are much rarer than the small '*Onychites*' and therefore the five specimens which were found in Traill Ø will be described and discussed in some detail.

Two kinds can be distinguished in the Greenland material, here designated types I and II.

The hooks are flat and do not appear to have been crushed. The margins are slightly thickened, and the base is thicker than the remainder of the hook. In type I the curvature is strongest near the base and decreases towards the point, the distal part being nearly straight. The point projects appreciably beyond an imaginary line drawn through the base as shown in text-figure 6a. Type II is more nearly semicircular, with a slight flattening of the curvature about midway between the base and

the point. The tips of both specimens of this type are broken but they probably only touched, and certainly did not project appreciably beyond, a line drawn through the base (text-figure 6b). Type I is represented by two complete examples, one of which is 3.2 cm and the other 3.4 cm in length (pl. 15, figs. 3, 5), while a third (pl. 15, fig. 4) which has the point broken off appears to have been at least 3.8 cm long. Type II is slightly larger and the more complete specimen (pl. 15, fig. 7) is estimated to have been about 4.4 cm long when complete, the other (pl. 15, fig. 6) slightly

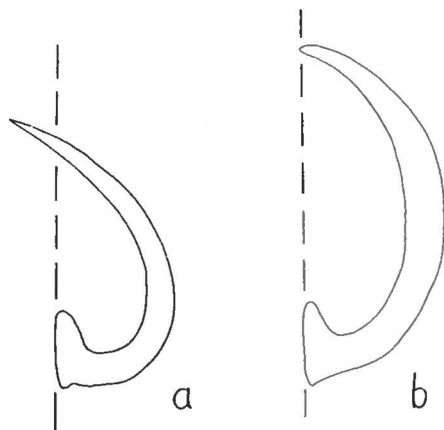


Fig. 6. Diagrams to illustrate the difference between type I (diagram a) and type II (diagram b) of '*Onychites*' from locality 128. Natural size.

smaller. The proximal end or base is similar in both types; it has two projections, a larger on the side facing the point, and a smaller on the opposite side.

Comparisons: Large '*Onychites*' were figured by QUENSTEDT (1858, pl. 24, figs. 59—62). His figures 59 and 61 represent examples of the same general pattern as those from Traill Ø. The form shown in figure 61 in particular resembles our type II, except that it is less strongly curved, so that the point does not touch a line drawn through the base. QUENSTEDT's figure 60 represents a distinct type in which there is not a gradual taper but an increase in width about half-way along, so that the broadest part is just behind the point, which is blunter than in the other types. All QUENSTEDT's specimens were from the German Lias, and TATE and BLAKE (1876, p. 448) found examples in the Lower Lias of Yorkshire corresponding to QUENSTEDT's figure 59. NAEF (1922, 68) figured an example from Nusplingen (München), whose horizon is not stated, which corresponds closely to the type represented by QUENSTEDT's figure 61.

Origin: NAEF (1922, p. 187) does not discuss the large '*Onychites*' in detail, but merely remarks that their cephalopod origin is not beyond doubt. He figures (*op. cit.* fig. 68g, h) known belemnite hooks which differ from the large '*Onychites*' only in the degree of curvature and in size. In the absence of structures in other animal groups which the large '*Onychites*' might represent they are retained here in the Cephalopoda.

The large '*Onychites*' must have belonged to an animal of much greater size than was normal among belemnoids, even allowing for the possibility that they were relatively larger in comparison with the absolute size of the animal than are the small belemnite hooks. Since no other hard parts have been described which could have belonged to such an animal it presumably had no skeletal elements apart from the hooks.

I am indebted to Mr. L. BAIRSTOW for suggestions in connections with '*Onychites*'.

Occurrence: Small '*Onychites*', locality B91, ?Upper Oxfordian. Large '*Onychites*', locality 128, ?Lower Kimmeridgian.

Family Macrocephalitidae.

Genus *Arctocephalites* Spath, 1928.

Subgenus *Arctocephalites* s. s.

Arctocephalites spp. indet.

The subgenus is represented by indifferent material from one locality only. The fossils are preserved in a hard siliceous matrix and cannot be satisfactorily extracted. Specific determinations have not therefore been attempted, but nothing suggests that the assemblage is different from that described by SPATH (1932) from Jameson Land.

Occurrence: Locality 26, Upper Bathonian, Nudus Zone.

Subgenus *Cranocephalites* Spath, 1932.

Cranocephalites is the only Macrocephalitid subgenus which is represented by comparatively abundant material from Traill Ø, but most of the material comprises crushed bodychambers, and has been named principally with reference to SPATH's (1932) extensively illustrated description of the Jameson Land *Cranocephalites* fauna. A few uncrushed specimens from three localities (104, 120, 137) are distinct from anything hitherto described and are treated below in more detail, but the distinctness of much of the remaining material, which at first sight seems different from the Jameson Land species, may be more apparent than real, due to different preservation, and consequently a cautious attitude has been adopted in looking for differences between the two faunas.

Arctocephalites (Cranoecephalites) parvus sp. nov.

Pl. 15, figs. 2 a, b, text-fig. 7.

This species is represented by one specimen only, whose dimensions are¹⁾ 4.3, 42, 60, 23. The measurements were taken just behind the final apertural constriction. Before the commencement of excentrumbilication the umbilicus is only about 10 % of the diameter. The body-chamber is three-quarters of a whorl long, and is markedly scaphitoid. The aperture is simple, with an overhanging ventral lip, and is preceded by a constricted smooth band which is 1.0 cm wide on the venter.

The last whorl bears about 18 primary ribs which are short and lean forwards. The secondaries, which arise by bifurcation and intercalation,

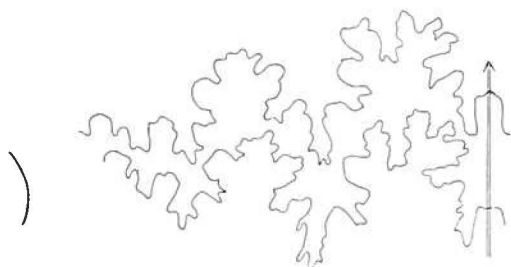


Fig. 7. Two successive external suture-lines, just before the body-chamber, of the holotype of *Cranoecephalites parvus* sp. nov. $\times 3$.

have at first the same direction as the primaries, but curve backwards as they cross the whorl-side and become almost radial in attitude on the venter, so that the ornament has a distinctive appearance. There are normally three, more rarely four, secondaries to each primary rib. The second half of the last whorl is damaged but the ribs do not appear to undergo any change until a point about 2 cm behind the aperture, when they become obsolescent. The suture-line, which is shown in text fig. 7, is similar to those of immature *Cranoecephalites* but does not show the degeneration characteristic of the genus in adults of the normal size, though the last two or three suture lines are closer together than the preceding ones.

The species is distinguished from those described by SPATH (1932) from Jameson Land by its ornament and smaller size, the adult scaphitoid and contracted body chamber being normally acquired in the genus at a diameter of between 7 and 9 cm.

Occurrence: Locality 120, ?Upper Bathonian, Pompeckji Zone.

¹⁾ Ammonite measurements given in this form follow the usual convention: Diameter (in cm), followed by whorl-height, whorl-thickness and diameter of umbilicus expressed as percentages of the diameter.

Arctocephalites (Cranocephalites) kochi sp. nov.

Pl. 15, figs. 8a, b.

This species is represented by a number of fragmentary specimens only, but is so distinct that the bestowal of a new specific name is desirable. It is possible, indeed, that were more comprehensive material available the forms described below would be found to fall into more than one species, since they show considerable variation between themselves.

The holotype (pl. 15 figs. 8a, b) is represented only by the internal cast of the last half-whorl of body-chamber, but the accompanying external mould, together with the impressed area of the body-chamber fragment, reveals the features of the ornament on the earlier part of the last whorl and the second half of the penultimate whorl. The dimensions of the holotype are 4.4, 41, 52, 21. Before the commencement of excentrumbilication the umbilicus is only 10 % or 12 % of the diameter. The body-chamber is at least half a whorl long and is scaphitoid. The aperture is similar to that of *A. (C.) parvus*.

The last whorl has 13 primary ribs, which bifurcate about one-third of the way across the whorl-side. Secondary ribs are also intercalated between those arising from the primaries, bringing the total number of secondaries on the last whorl to 36, or nearly 3 to each primary. The ribs are sigmoidal, curving forward on the whorl-side and then backwards again towards the venter. They are rounded in section, with angular intervals between them. This character is already present at a diameter of 2 cm on the holotype, and a small nucleus which seems to belong to the species shows that the sharply ribbed and compressed stage which characterises the earlier whorls of most *Cranocephalites* is not present in *A. (C.) kochi*. At the beginning of the last whorl the secondaries pass uninterrupted over the venter; about half a whorl before the aperture the venter is almost smooth, but the ribs never quite disappear as they cross it and there is a slight strengthening of ventral ornament immediately behind the aperture. On the side of the whorl the ribbing becomes coarse and blunt on the last half whorl. The ornament on the body-chamber is variable; a distorted fragment from locality 104 appears to be the end of the body-chamber of this, or a related species, and is smooth except for faint traces of primary ribs. The suture line of the species is not known.

The species is closely similar to *A. (C.) parvus* except in the ornament. The delicate ribbing of *A. (C.) parvus*, which persists unaltered to the end of the last whorl, is in strong contrast to the coarse, rounded ribs, becoming coarser and more widely spaced towards the aperture, of *A. (C.) kochi*. The primaries, inconspicuous on *A. (C.) parvus*, are prominent in the present species. Some fragmentary specimens are related

to the species by their ornament but show considerable variation in size and proportions. As a provisional measure, two extreme forms are described below as varieties of *A. (C.) kochi*.

Arctocephalites (Cranocephalites) kochi is distinguished from previously described species of *Cranocephalites*, exemplified by the type species, *A. (C.) pompeckji*, by the coarse, blunt ribbing on the inner whorls, which links the species with the genus *Xenocephalites*, of which a single specimen was described from Jameson Land by SPATH (1932, p. 44, pl. 14, fig. 4). The thickening of the ribs on the venter which characterises *Xenocephalites* is conspicuous on the earlier whorls of *A. (C.) kochi*, but the scaly appearance and forward curve on the venter are not developed. The depressed whorls and wide venter of *Xenocephalites* are also found in the young stages of the present species. *X. borealis*, the Jameson Land species, is unfortunately represented by the septate whorls only, so that the body-chamber cannot be compared with that of *A. (C.) kochi*. These comparisons suggest that *Xenocephalites* and *Cranocephalites* may be linked more closely than a perusal of the material described from Jameson Land would suggest, since some *Xenocephalites* characters occur in the inner whorls of a species which is yet retained in *Cranocephalites*. There is at present no suggestion that the transition from one genus to the other was a function of time. In Traill Ø *A. (C.) kochi* occurs in association with typical *Cranocephalites*. The *Xenocephalites* from Jameson Land was found loose, well below the *Cranocephalites* horizon on Hjørnefjeldet but associated with an ammonite which appeared to be derived from that horizon, and although SPATH (1932, p. 134) thought that *Xenocephalites* might eventually prove to characterise a horizon lower than *Cranocephalites*, there is so far no evidence for this.

Occurrence: Localities 104, 120, Upper Bathonian, Pompeckji Zone. The holotype is from locality 120.

Arctocephalites (Cranocephalites) kochi var. *pygmaeus* nov.

Pl. 16, figs. 5a, b.

The variety is represented by a body-chamber, which is complete with its adult aperture, preceded by the broad, smooth band characteristic of the species, at a diameter of 3.0 cm. The body-chamber is scaphitoid and is about two-thirds of a whorl long; it is distorted and the following dimensions are only approximate: 3.0, 43, 52, 18. The last whorl is estimated to have borne about 15 primary and 35 secondary ribs. The ribs are blunt but the grooves between them are not quite so angular as in the typical form of the species.

Occurrence: Locality 137, holotype. A fragment from locality 104 may belong to the variety. ?Upper Bathonian, Pompeckji Zone.

A. (C.) kochi var. *latus* nov.

Pl. 16, figs. 6a, b.

This variety is also represented by a body-chamber, not quite complete at the aperture. It is slightly distorted but the measurements, at the last point where the venter is complete, are approximately 4.2, 48, 67, 15. There are estimated to have been twelve or thirteen primary ribs on the last whorl, and two or three secondaries to each primary; the primaries bifurcate and in some cases an extra rib is intercalated. The secondaries can be traced across the venter up to a diameter of 3.7 cm, when the venter becomes smooth. The variety differs from the typical form in the greater whorl-thickness.

Occurrence: Locality 137 (holotype); ?Locality 120. ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) gracilis Spath.1932 *Cranocephalites gracilis* Spath, p. 22, pl. 3, fig. 1.

A number of specimens agree in size and ornament with this species. They are all crushed so that the proportions cannot be measured, but they seem to have possessed the flattened whorl-sides characteristic of *A. (C.) gracilis*.

Occurrence: Locality 136, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) maculatus Spath.1932 *Cranocephalites maculatus* Spath, p. 24, pl. 1, fig. 1, pl. 2, fig. 3.

A fragment was found which may represent the typical form of this species.

Occurrence: Locality 23, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) maculatus var. *tenuis* Spath.1932 *Cranocephalites maculatus* var. *tenuis* Spath, p. 24, pl. 4, fig. 2.

The variety is represented by abundant but crushed specimens from one locality, where it is associated with var. *rusticus* nov., described below.

Occurrence: Locality 136, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) maculatus var. *transitoria* Spath.1932 *Cranocephalites maculatus* var. *transitoria* Spath, p. 24, pl. 3, fig. 6.

The variety is represented by one uncrushed example from locality 23, identical in mode of preservation with the fragment of the typical

form found at the same locality, but different from the specimens of var. *rusticus* nov. which were partially crushed.

Occurrence: Locality 23, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) maculatus var. *rusticus* nov.

Pl. 16, figs. 1—3.

In the style of the ribbing the variety closely resembles var. *tenuis*, but it is even more coarsely costate and differs also in having a smooth venter on the body-chamber, and possibly in being more compressed than any of the Jameson Land forms. None of the specimens is undamaged but the whorl-thickness was probably a little less than the whorl-height. Some individuals of the variety reached a diameter of over 10 cm. when complete, larger than is usual for *Cranocephalites* in East Greenland. The body-chamber was about two-thirds of a whorl long, and shows the normal contraction as the overhanging aperture is approached. The ribs become restricted to the sides of the whorl by the beginning of the body-chamber, and there is no rejuvenation of ribbing on the venter as occurs in some species of the genus. The inner whorls of the variety are unknown.

Occurrence: Localities 23, 120, 136 (holotype), 141, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) pompeckji (Madsen) aff. var. *costata* Spath.

Pl. 17, figs. 2a, b.

1932 *Cranocephalites pompeckji* (Madsen) var. *costata* Spath, p. 19, pl. 5, fig. 6.

The ammonite attributed to the variety is uncrushed, and has the dimensions 6.1, —, 53, c. 17. The specimen comprises a little over half a whorl of body-chamber. About half-way round the fragment the secondary ribs cease to be continuous across the venter. The primary ribs are prominent as in SPATH's whorl-section (*op. cit.* pl. 5, fig. 6b).

Occurrence: Locality 147, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Cranocephalites) pompeckji var. *intermedia* Spath.

Pl. 17, figs. 3a, b.

1932 *Cranocephalites pompeckji* (Madsen) var. *intermedia* Spath, p. 19, pl. 5, fig. 7.

The variety is represented by a wholly septate specimen with the dimensions 4.9, —, 53, 17.

Occurrence: Locality 147, ?Upper Bathonian, Pompeckji Zone.

Arctocephalites (Craniocephalites) vulgaris Spath.

Pl. 16, figs. 4 a, b.

1932 *Craniocephalites vulgaris* Spath, p. 20, pl. 1, figs. 2—4, 6, pl. 3, fig. 5, pl. 4, fig. 3, pl. 10, fig. 3.

The species is represented by a single uncrushed body-chamber, which is almost complete at a diameter of 7.1 cm. The ribbing is slightly more widely-spaced than in the holotype of the species, so that in this character the Traill Ø specimen is transitional to var. *robusta* Spath (*op. cit.* p. 22, pl. 2, fig. 1). Throughout the fragment, which is a little more than half a whorl in length, the secondary ribbing is interrupted along the mid-ventral line by a narrow smooth band. The venter is not quite so flat as in the holotype of the species.

Occurrence: Locality 139, ?Upper Bathonian, Pompeckji Zone.

Family **Kosmoceratidae**.Genus **Kepplerites** Neumayr, 1892.Subgenus *Seymourites* Kilian and Reboul, 1909.*Kepplerites (Seymourites) traillensis* sp. nov.

Pl. 17, figs. 1 a, b.

1930 *Kepplerites tychonis* Ravn. Frebold, p. 32, pl. 7, fig. 1.

The genus has only been found at one locality on Traill Ø, and none of the specimens is perfect. Nevertheless the bulk of the material represents a form which does not correspond to any of the half-dozen species recorded from Jameson Land by SPATH (1932).

The maximum diameter of the holotype, whose body-chamber is almost complete, was about 14 cm but cannot be measured accurately. One-quarter of a whorl earlier the measurements are 11.8, 40, 41, 25.

The body-chamber is contracting and scaphitoid in form. The whorl section is parabolic with convergent sides; the whorl-height is equal to the thickness. Just before the end of the last whorl the umbilicus opens out, the whorl-height decreases and the whorl-section becomes parallel-sided with a semicircular venter. The suture-line is not shown and the inner whorls are obscured.

There are 34 primary ribs on the last whorl. They are strongly curved, and each gives rise to three or four secondaries. The secondaries lean slightly forwards and are almost perfectly straight.

FREBOLD's Spitzbergen ammonite cited at the beginning of this description has already been excluded from *K. (S.) tychonis* by SPATH (1932, p. 87) and probably belongs to the present species. The ornament agrees

well with that of *K. (S.) traillensis*, but the size of the original is not given; the figure is merely stated to be "etwas verkleinert".

The species is distinguished from *K. (S.) tychonis* Ravn, the commonest species in Jameson Land, and from the doubtfully distinct *K. (S.) svalbardensis* Sokolov and Bodylevsky (1931, p. 79, pl. 5, fig. 1), by coarser primary ribbing and larger size. The ribbing of *K. (S.) traillensis* is not unlike that of *K. (S.) antiquus* Spath and *K. (S.) peramplus* Spath, but both these species are much larger. *K. (S.) nobilis* Spath also bears some resemblance to the present species, but has coarser secondaries and the ornament becomes obsolescent by the beginning of the body-chamber.

Occurrence: Locality 31, Lower Callovian, Tychonis Zone.

Keplerites (Seymourites) traillensis var. *convergens* nov.

Pl. 18, figs. 1 a, b.

The variety is distinguished from the typical form by a more compressed whorl with flat, converging sides. The measurements of the most complete example are:

var. <i>convergens</i> nov., holotype . . .	13.5 (max.)	33	33	30
	11.8	38	36	21

The difference between the two forms is more pronounced than the measurements alone indicate, owing to the much narrower venter in the variety consequent upon the more strongly convergent whorl-sides. The characteristic whorl-section, which is developed already at a diameter of 7.0 cm has, except for the rounded venter, a *Sigaloceras*-like aspect, and the species is closely paralleled both in shape and ornament by the earlier whorls of examples of *Sigaloceras* from the Kellaways Rock of Wiltshire, England, in which the flattened venter is only developed at the end of the body-chamber.

Occurrence: Locality 31, Lower Callovian, Tychonis Zone.

Family **Cardioceratidae**.

Subfamily *Cardioceratinae* s. s.

Although material belonging to the subfamily has been found at a number of places, it is uniformly disappointing, since the preservation seldom allows more than subgeneric determination. The material bears a general resemblance to that described by SPATH (1935) from Milne Land although not all the fragments can be matched with SPATH's illustrations, which is not surprising in view of the distance between the two areas and the fact that SPATH's material also was far from perfect.

Genus *Cardioceras* Neumayr & Uhlig, 1881.*Cardioceras* sp. indet.

Pl. 25, fig. 5.

A fragment with secondary ribs which are concave forwards and at least twice as numerous as the primaries which have tubercles where the secondaries arise, may belong to this genus rather than to *Amoeboceras*.

Occurrence: Locality B92, Upper Oxfordian.

Genus *Amoeboceras* Hyatt, 1900.Subgenus *Amoebites* Buckman, 1925.*Amoeboceras* (*Amoebites*) spp. indet.

Pl. 18, figs. 2—5.

Typical but poor material is abundant at localities 16 and 22. Many of the examples belong to a form like *A. elegans* Spath (1935, p. 33, pl. 4, figs. 1, 2). A distinct type is represented by impressions in which the whorl is smooth up to a diameter of about 1 cm, a feature which distinguishes it from the species figured from Milne Land by SPATH (1935). Examples are illustrated in plate 18, figures 2, 4, 5, but the material is not adequate to support the description of a new species.

Subgenus *Euprionoceras* Spath, 1935.*Amoeboceras* (*Euprionoceras*) sp. indet.

One impression seems to be beyond doubt a *Euprionoceras*, since the ribbing persists, undiminished in strength, to a diameter of at least 10 cm. The example is not susceptible of specific identification, but the rib-spacing compares with that of *E. kochi* Spath from Milne Land, rather than with the less closely ribbed species from Spitzbergen figured by FREBOLD (1930, pl. 8) and by SOKOLOV and BODYLEVSKY (1931, pl. 6, fig. 1).

Occurrence: Locality 127, Lower Kimmeridgian.

Subgenus *Prionodoceras* S. Buckman, 1920.*Amoeboceras* (*Prionodoceras*) sp. indet.

A few fragments are attributed to an indeterminate species of this subgenus. They show an early degeneration of the ornament similar to that in *A. ravni* Spath (1935, p. 17, pl. 4, fig. 4) from Scotland, the ribbing having disappeared by a diameter of about 4.0 cm.

Occurrence: Locality 28. If the identification is correct the age is Upper Oxfordian.

Subfamily *Cadoceratinae*.

Genus *Arcticoceras* Spath, 1924.

Arcticoceras sp. indet.

The genus is represented by a single fragment which possesses the characteristic sharp, bifurcating ribbing with the forward chevron over the venter, but is not determinable specifically. The fragment is important, however, as indicating the presence of the genus and hence of the Kochi Zone in Traill Ø.

Occurrence: Locality 141 (loose in debris), Lower Callovian, Kochi Zone.

B. Cretaceous.

Phylum MOLLUSCA.

Class *Lamellibranchia*.

Family *Nuculidae*.

Genus *Nucula* Lamarck, 1799.

Nucula cancellata Meek & Hayden.

1857 *Nucula cancellata* Meek and Hayden, p. 85.

1876 *Nucula cancellata* Meek and Hayden. Meek, p. 102, pl. 28, figs. 13a—e.

1918 *Nucula cancellata* Meek and Hayden? Ravn, p. 344.

The internal mould of a right valve only was found. The species is known from North America, as already remarked by MAYNC (1949, p. 277), in the Fort Pierre (Fox Hills) Group. *Nucula* is not found in the English Senonian, according to Woods, although it occurs in continental Europe. The species was reported from West Greenland by RAVN (*loc. cit.*).

Occurrence: Locality 58, Upper Campanian.

Nucula pectinata J. Sowerby var. *cretae* Gardner.

1884 *Nucula pectinata*, var. *cretae* Gardner, p. 132.

1899 *Nucula pectinata*, Sowerby, var. *cretae*, Gardner. Woods, p. 18, pl. 3, figs. 14a, b, 15.

Woods remarked that he could not be certain, on the basis of the material available to him, whether GARDNER's variety was really distinct from the typical form of the species. The present example agrees well with WOOD's figures of the types of var. *cretae*.

Occurrence: Locality 2, Cenomanian, Varis Zone.

Nucula whitfieldi Weller.

Text-fig. 8.

1907 *Nucula whitfieldi* Weller, p. 371, pl. 29, figs. 6—12.

The specimens attributed to the species exhibit some variation in shell outline, as do those figured by WELLER. On the basis of the small number of examples found they cannot be separated from WELLER's

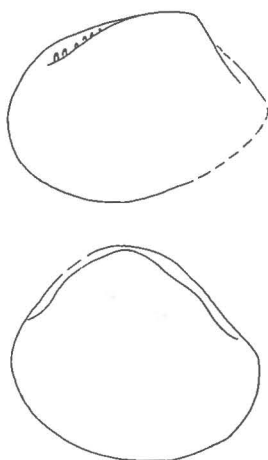


Fig. 8. Outlines of two examples of *Nucula whitfieldi* Weller from locality 51. $\times 3$.

species. The fine concentric ornament is well shown by the Traill Ø specimens. The outline of two of them is given in text-figure 8.

The type of the species is from New Jersey, from beds of Upper Senonian age. The East Greenland occurrence is earlier in date.

Occurrence: Locality 51, Upper Turonian.

Family **Pteriidae**.Genus **Oxytoma** Meek, 1864.*Oxytoma tenuicostata* (Römer).1841 *Avicula tenuicostata* Römer, pl. 8, fig. 15.1841 *Avicula lineata* Römer, p. 64.1918 *Avicula (Oxytoma) nebrascana* Evans and Shumard. Ravn, p. 335, pl. 7, figs. 3—5.1934 *Pteria tenuicostata* Römer. Frebold, p. 15, text-figs. 6—8.

The Traill Ø specimens are numerous but indifferently preserved; they agree well with the examples from Knudshoved on Hold with Hope figured by FREBOLD (*loc. cit.*), which are identified with *O. tenuicostata* (Römer).

DE LORIO (1883, p. 209) recorded *O. nebrascana* from West Greenland, and figures were given of this form by RAVN (*loc. cit.*). EVANS and

SHUMARD did not figure *O. nebrascana*, but MEEK's description and figures (1876, p. 34, pl. 16, fig. 3) show that their species has a much more closely ribbed shell than the West Greenland fossils which, in the opinion of the present writer, are closely allied to *O. tenuicostata*.

Avicula danica Ravn (1902, p. 79, pl. 1, figs. 1,2) seems doubtfully distinct from *O. tenuicostata*. RAVN only figured one left valve, 12 mm long, which is distinguished by a smooth umbo, the ribs starting about 3 or 4 mm from the point of the umbo.

Occurrence: Locality 50, Upper Santonian or Lower Campanian.

Family **Buchiidae**.

Genus **Buchia** Rouillier, 1845.

Buchia was apparently a sedentary bivalve, living attached to the substratum by means of a byssus, and its species show considerable variation between individuals. This variability has long been recognised by palaeontologists, but nevertheless a large number of species has been named, many of which are undoubted synonyms. The splitting process reached a peak with the work of PAVLOV (1907) who recognised about 65 species from the Upper Jurassic and Neocomian. The present writer does not accept many of the minor differences in shell outline, convexity, curvature of umbo, and other features, on which a number of PAVLOV's distinctions were based, as being characters of specific importance. PAVLOV's principal predecessor in the systematic treatment of the genus was LAHUSEN (1888) who was more conservative in his outlook, although he also differentiated species which some later workers have regarded as identical.

In North America STANTON (1895), describing Upper Jurassic and Neocomian *Buchia* from the Knoxville Beds, recognised only two species, while ANDERSON (1938) accepted twelve, admittedly representing a wider range than STANTON's material but following, in the main, the scale of subdivision employed by PAVLOV.

Much of the North American material appears to be specifically identical with European and Russian species, so it is not surprising to find that the examples from East Greenland represent well-known species.

A revision and synthesis of the species of *Buchia* is much needed, and it may be that only extensive statistical work would provide a really sound basis for the classification of these variable shells. In the account which follows an attempt has been made to give some of the synonyms of the species recognised, but the treatment has not been exhaustive and the conclusions should not be regarded as final.

Buchia crassicollis (Keyserling).

- 1846 *Aucella crassicollis* Keyserling, p. 300, pl. 16, figs. 9—12.
 1888 *Aucella piriformis* Lahusen, pp. 22, 42, pl. 5, figs. 1—7.
 1888 *Aucella keyserlingi* Lahusen, pp. 21, 40, pl. 4, figs. 18—23.
 1905 *Aucella Keyserlingiana* Trautschold. Woods, p. 70, pl. 10, figs. 3—5.
 1905 *Aucella volgensis* Lahusen. Woods, p. 69, pl. 10, figs. 1, 2.
 1907 *Aucella concentrica* Fischer. Pavlov, p. 66, pl. 5, figs. 27, 28.
 1907 *Aucella contorta* Pavlov, p. 67, pl. 5, figs. 29, 30.
 1907 *Aucella crassicollis* Keyserling. Pavlov, p. 62, pl. 5, fig. 16.
 1907 *Aucella Keyserlingi* Lahusen. Pavlov, p. 62, pl. 5, figs. 17—19.
 1907 *Aucella lamplughii* Pavlov, 1907, p. 65.
 1907 *Aucella piriformis* Lahusen. Pavlov, p. 63, pl. 5, figs. 20—22.
 1907 *Aucella terebratuloides* Lahusen. Pavlov, p. 60, pl. 5, figs. 4—13.
 1907 *Aucella uncitoides* Pavlov, p. 61, pl. 5, figs. 14, 15.
 1911 *Aucella crassicollis* Keyserling. Ravn, p. 459, pl. 32, fig. 8.
 1911 *Aucella concentrica* Fischer. Ravn, p. 461, pl. 32, figs. 9, 10.
 1911 *Aucella piriformis* Lahusen. Ravn, p. 460, pl. 32, figs. 11, 12.
 1938 *Aucella piriformis* Lahusen. Frebold & Noe-Nygaard, p. 25, pl. 1, figs. 3—5.

Only one locality, no. 92, yielded well-preserved material, but here an extensive series was collected which shows well the structure and variation of the species. The assemblage includes narrow, constricted forms corresponding to KEYSERLING's original figure, but a more expanded shell is the rule, and is exemplified by the majority of the figures cited above. The ornament typically consists of the sharp concentric ridges, separated by shallow, rounded hollows, which are characteristic of *Buchia*, but in some examples the ridges are overhanging on their ventral sides and the appearance is more lamellate. The spacing of the ridges varies widely and is about three times as close in specimens at one extreme as in those at the other. The umbonal portion of the shell is sometimes smooth; exceptionally, the whole shell is smooth except for fine growth-lines. The largest specimens from locality 92 have a maximum dorso-ventral dimension (measured obliquely) of about 6 cm, and some from other localities may reach a slightly larger size.

The fact that KEYSERLING's figured specimen chanced to be a narrow, rather irregular form at one extreme of the range of variation in the species has unfortunately frequently led to typical examples being separated under a number of other trivial names.

The species appears to range from the top of the Jurassic well up into the Neocomian, and it is accordingly not surprising that no significant differences can be detected between the examples from several faunas, belonging to at least two different horizons, from Traill Ø. The occurrence of this species alone, in fact, is hardly a sufficient proof of the presence of the Valanginian which both RAVN and FREBOLD and NOE-NYGAARD deduced, and the evidence of the belemnites suggests that some of Traill Ø occurrences are of an earlier date. The same species, judging

from SPATH's (1947) illustrations, occurs in the *Hectoroceras* beds of Jameson Land, of presumed Infravalanginian age.

Occurrence: Localities 14, 78—80, Infravalanginian; locality 92, Valanginian. Localities 104, 121, 148—150, horizon not exactly determined but presumably basal Cretaceous.

Buchia sp. indet.

Pl. 18, fig. 6.

Shales at locality 8 are crowded with examples of a small *Buchia*. The material includes both right and left valves, all crushed. They exhibit concentric ornament consisting of sharp ridges separated by rounded hollows, a feature typical of the genus *Buchia* but seen in the present instance on a very small scale. There is no radial ornament.

The species compares most closely with Portlandian species, of which a number have been figured by PAVLOV (1907).

Occurrence: Locality 8, age unknown.

Genus *Aucellina* Pompeckj, 1901.

Species of the present genus, like many other Pteriacea, show considerable variation among the individuals of an assemblage, and it is doubtful whether all of the dozen or so species would survive a critical revision of the genus. *Aucellina* ranges from the Aptian (*A. aptiensis* d'Orb.) to the Cenomanian. Known from the Aptian of the Caucasus, Spitzbergen, and intermediate areas, the genus was most widely distributed in the late Albian or early Cenomanian, when its geographical range included Australia (*A. hughendenensis* Etheridge), India (*A. parva* Stoliczka), Europe and Russia, and has recently been extended westwards to East Greenland (DONOVAN, 1949, p. 7). The genus does not appear to have reached North America.

Aucellina caucasica (Abich).

Pl. 19, figs. 5, 7, 8.

1851 *Aucella caucasica* Abich, p. 31, pl. 2, fig. 1.

1901 *Aucella caucasica* Pompeckj, p. 358.

1907 *Aucellina caucasica* L. von Buch. Pavlov, p. 87, pl. 6, figs. 22, 23.

? 1907 *Aucellina stuckenbergi* Pavlov, p. 86, pl. 6, fig. 21.

? 1908 *Aucellina maxima* Wolleemann, p. 158, pl. 9, figs. 2, 3.

A number of species of *Aucellina* have been described from the Albian, all of which are distinguished from *A. gryphaeoides* by the presence of stronger and more constant radial ribs, and which differ among

themselves principally in the size and shape of the shell. Distinctions between some of these species are difficult to maintain, and it seems probable to the present writer that a detailed study would show a number of them to be synonyms, although the figured material is hardly an adequate basis for a definite opinion.

A. stuckenbergi Pavlov is broader than the typical *A. caucasica* and reaches an exceptional size for the genus. *A. maxima* Wolleermann is probably also synonymous with ABICH's species, bearing in mind that ABICH's illustration is probably idealised.

A. anthulai Pavlov (1907, p. 88, pl. 6, fig. 24) and *A. pompeckji* Pavlov (*op. cit.* p. 88, pl. 6, figs. 25—27), the original figures of which leave much to be desired, may also belong to the present species, or may be transitional to *A. gryphaeoides*. *A. hughendenensis* (Etheridge, 1872, p. 346, pl. 25, fig. 3) is a similar shell from Australia, and *A. coquandiana* var. *radio-striata* Bonarelli and Nagera, from the Argentine, seems to be identical with the Traill Ø forms.

The material from Traill Ø includes some large specimens (pl. 19, figs. 7, 8) which are fairly well preserved, though they do not reveal all the characters of the shell. They are referred to *A. caucasica* because it is the earliest valid name for the radially ribbed forms. The Greenland examples should perhaps rather be attributed to *A. stuckenbergi*, if that species should be demonstrated to be distinct.

Fossils attributed to the *caucasica* group have been recorded and figured from the Aptian of Spitzbergen by FREBOLD (1930, p. 46, pl. 18, figs. 1—4) and WEIR (1933, p. 696, plate, figs. 4, 6, 10), and it is possible, therefore, that *A. caucasica* is a long-ranging species. The specimens figured by FREBOLD and by WEIR are rather poor and it is difficult to ascertain whether they differ significantly from the later forms.

Occurrence: Localities 4, 66 and 130, late Albian or early Cenomanian.

Aucellina gryphaeoides (J. de C. Sowerby).

Pl. 19, figs. 1 a, b, 6.

1836 *Avicula gryphaeoides* J. de C. Sowerby, pp. 156, 335, pl. 11, fig. 3.

1905 *Aucellina gryphaeoides* (Sowerby). Woods, p. 72, pl. 10, figs. 6—13.

1907 *Aucellina gryphaeoides* (Sowerby). Pavlov, p. 88, pl. 6, figs. 33—37.

A synonymy up to 1905 is given by Woods. *Aucellina parva* (Stoliczka), from Southern India, is similar to the present species, but the other Albian and Cenomanian species of *Aucellina* which have been described are distinguished by the greater prominence of their radial ornament. Radial ribbing in typical English examples of *A. gryphaeoides* is always faint, and appears to be absent altogether in some specimens.

One locality in Traill Ø (112) has yielded well-preserved fossils which

agree with the species in all respects. The other localities have yielded crushed material only.

Occurrence: Localities 94, 110, 112, 129, Middle or Upper Albian.

Family Isognomonidae.

Genus *Inoceramus* W. Smith, 1816.

Subgenus *Inoceramus* s. s.

Inoceramus (Inoceramus) lamarcki Parkinson.

1819 *Inoceramus Lamarckii* Parkinson, p. 55, pl. 1, fig. 3.

1912 *Inoceramus Lamarcki* Parkinson. Woods, p. 307, pl. 52, figs. 4—6, pl. 53, figs. 1—7, text-figs. 63—85 (including comprehensive synonymy).

WOODS (*op. cit.* p. 311) has remarked on the great variability of this species, and has reduced several other 'species' of *Inoceramus* to the status of varieties of *I. lamarcki*. All the material from Traill Ø is fragmentary and does not permit of reference to the different varieties of the species, except to remark that a form resembling the strongly ribbed var. *cuvieri* (J. Sowerby) is the most common.

Since *I. lamarcki* is at several exposures the only fossil which is of any use in dating them, its range in time is important for the present purpose. WOODS (*op. cit.*) gives the range in the British Isles as from the base of the Turonian stage up to and including the *Micraster coranguinum* Zone in the Lower Senonian; the allied *I. inconstans* Woods, which may not always be separable on the basis of fragmentary material, continues into the Upper Senonian. Two of the occurrences of the present species in Traill Ø (at localities 51, 59) are associated with species of *Scaphites* which, although imperfectly known, are likely to be Upper Turonian. The other occurrences are not independently dated and can only be regarded as of Turonian or Lower Senonian age.

Occurrence: Localities 51, 59, Upper Turonian. Localities 60, 63, 89, ?81, ?144, Turonian or Lower Senonian.

Inoceramus (Inoceramus) anglicus Woods.

1911 *Inoceramus anglicus* Woods, p. 264, pl. 45, figs. 8—10, text-fig. 29 (with synonymy).

1932 *Inoceramus cf. anglicus* Woods. Frebold, p. 33, text-figs. 14, 15.

1934 *Inoceramus anglicus* Woods. Rosenkrantz in Boegvad and Rosenkrantz, p. 18, pl. 1, figs. 1, 2, pl. 2, fig. 1.

1949 *Inoceramus anglicus* Woods. Donovan, p. 9.

Indifferently preserved fragments only were found which do not merit detailed remarks. The species is more common on Geographical

Society Ø where Albian beds have an extensive outcrop (see DONOVAN, 1949, pp. 6—7).

FREBOLD in 1932 recorded *I. cf. anglicus* from Clavering Ø, but ROSENKRANTZ in 1934 pointed out the apparent identity of the East Greenland material with the English species. All the Greenland material is admittedly defective and better specimens might show differences. MAYNE (1949) recorded *I. cf. anglicus* from Sabine Ø (p. 34) and Wollaston Forland (p. 46), and *I. aff. anglicus* from the southern part of Hold with Hope peninsula (p. 145).

Occurrence: Albian, probably mainly the Middle Albian, of the following localities: 69, 75, 102, 110, 112, 122, 125, 129, 130, 133. Poor material probably belonging to the species comes from localities 106, 135, 140, 151.

Inoceramus (Inoceramus) crippsi Mantell.

1822 *Inoceramus Cripsii* Mantell, p. 133, pl. 27, fig. 11.

1911 *Inoceramus Crippsi* Mantell. Woods, p. 273, pl. 48, figs. 2, 3, text-figs. 33—35.

1949 *Inoceramus crippsi* Mantell. Donovan, p. 9.

The species is abundant in the Cenomanian of Traill Ø and is often the only evidence of its age. None of the specimens is perfect, but comparatively undamaged material was obtained from some localities and agrees well with British examples of the species in both the ornament and the form of the shell.

The species was recorded from Geographical Society Ø in 1949 (DONOVAN, *loc. cit.*) but is otherwise unknown from Greenland.

Occurrence: Localities 2, 5, 47, 91, 145, Cenomanian, Varians Zone. Localities 1, 3, 4, 6, 11, 41, 44, 82, 93, B93, 94, 101, 105, 124, 135, 142, 144, 153, Cenomanian, zone not determined.

Subgenus *Sphenoceramus* Böhm, 1915.

Material attributed to *Sphenoceramus*, which is characterised by the combination of radial with concentric ornament, was found at several localities, but is unfortunately all fragmentary, so that while the ornament is in some cases well displayed the form of the shell is not. Under such circumstances the specimens could probably be referred to any of several described species, and they are here assigned to those from West Greenland merely on the grounds of geographical proximity. The subgenus had a wide distribution and it is not possible to decide from a casual examination of the literature whether all the forms named from different areas do, in fact, represent distinct species, though it seems clear that *I. (S.) patootensis* extended with little or no change from Sweden to West Greenland and possibly to Alberta, Canada (see below).

The age of the Traill Ø beds with *Sphenoceras* can only be determined approximately, as no ammonites have been found in them. The range of *I. (S.) patootensis* and *I. (S.) steenstrupi* is given in Germany (HEINZ, 1928, pl. 3) as Upper Santonian, but closely similar if not identical species range higher, for example *I. tuberculatus* Woods from the *Gonioteuthis quadrata* Zone of the English Chalk (WOODS, 1912, p. 302). The Traill Ø specimens may, therefore, be of either Upper Santonian or Lower Campanian age.

Inoceramus (Sphenoceras) steenstrupi de Loriol.

1883 *Inoceramus Steenstrupi* de Loriol, p. 211.

1918 *Inoceramus Steenstrupi* de Loriol. Ravn, p. 336, pl. 5, fig. 2.

1930 *Inoceramus Steenstrupi* de Loriol. Hägg, p. 30, pl. 2, fig. 13, pl. 3, fig. 4.

Most of the examples of *Sphenoceras* correspond with this species in their ornament, but they are all fragments of large individuals and the identification is subject to the reservation expressed above. The shells attained a dorso-ventral dimension of at least 30 cm.

Occurrence: Localities 50, 67, Upper Santonian or Lower Campanian. Poor specimens which correspond, as far as they go, with the material from localities 50 and 67 were found at localities 68 and 81.

Inoceramus (Sphenoceras) patootensis de Loriol.

1883 *Inoceramus patootensis* de Loriol, p. 211.

?1883 *Inoceramus groenlandicus* de Loriol, p. 210.

1918 *Inoceramus patootensis* de Loriol. Ravn, p. 337, pl. 5, fig. 1, pl. 6, figs. 1, 2.

1935 *Inoceramus patootensis* de Loriol. Hägg, p. 28, pl. 5, fig. 1.

Two specimens agree fairly well with RAVN's figures of the species. They are smaller, however, than the majority of specimens recorded above as *I. steenstrupi* and may only represent the umbonal part of the same species as the larger fragments. There is undoubtedly considerable variation in these two species, as in others of the genus, and the type material figured from West Greenland (one example of *I. steenstrupi* and three of *I. patootensis*) is not sufficient to show the variation or to exhibit the full characters of the species.

I. lundbreckensis McLearn (1929, p. 77, pl. 15, fig. 4), from Alberta, shows little difference from *I. patootensis* so far as the available illustrations go, but a comparison of material from Canada and West Greenland would be necessary to decide whether McLEARN's species should in fact be regarded as a synonym of *I. patootensis*.

Occurrence: Locality 50, Upper Santonian or Lower Campanian.

Family **Amusiidae**.Genus **Entolium** Meek, 1865.*Entolium* cf. *orbicularis* (J. Sowerby).

Pl. 24, fig. 2.

1817 *Pecten orbicularis* J. Sowerby, Min. Conch. II, p. 193, pl. 186.1902 *Pecten (Syncyclonema) orbicularis* Sowerby. Woods, p. 145, pl. 27, text-fig. 1 (with full synonymy).1949 *Entolium* cf. *orbicularis* (J. Sowerby). Donovan, p. 7.

The specimens from East Greenland fall within the range of variation of *E. orbicularis* except as regards the ears, which are smaller than in European specimens. The umbonal region of the specimen cited in 1949 from Geographical Society Ø is illustrated here. An example found in 1950 in Traill Ø has a height of 2.9 cm and a length of 2.85 cm.

The species is a long-ranging one and is common in Europe, but does not seem to have been reported from North America.

Occurrence: Locality 74, Lower Albian.

Genus **Variamussium** Sacco, 1897.*Variamussium ignoratus* (Ravn).1918 *Pecten (Amussium) ignoratus* Ravn, p. 342, pl. 7, figs. 13, 14.

This is a very distinctive shell, characterised by from eight to eleven strong, widely-spaced internal ribs on each valve, which originate some distance from the umbo and do not reach the ventral margin. The outside of the right valve is ornamented with fine, concentric growth-lines, that of the left apparently by fine radial ribs as well. The specimens from Traill Ø correspond closely with RAVN's description and figures of the species, but there is a puzzling difference in age, since the West Greenland fauna is generally regarded as being entirely Senonian in date, and the principal Traill Ø occurrence is securely dated as Lower Cenomanian. ROSENKRANTZ (1942, p. 39) has recently shown, however, that beds at least as early as the Coniacian occur in West Greenland, and the difference in age may thus not be unduly great. The species may perhaps be a long-ranging one, and it is also possible that still older beds occur in West Greenland.

The shell from Geographical Society Ø referred to by the writer (1949, p. 10) as *Variamussium* sp. may belong to the species.

Occurrence: Locality 2, Cenomanian, Varians Zone. Localities 8 (age uncertain), 39, Albian or Cenomanian.

Family **Spondylidae.**Genus **Spondylus** Linné, 1758.*Spondylus* cf. *gibbosus* d'Orbigny.1847 *Spondylus gibbosus* d'Orbigny, p. 658, pl. 452, figs. 1—6.1901 *Spondylus gibbosus* d'Orbigny. Woods, p. 117, pl. 20, figs. 5—11.

A small example is similar to this Albian species, though it is inadequate for proper identification. It agrees almost equally well with Wood's figures of *S. lata* (J. Sow.), an Upper Cretaceous species.

Occurrence: Locality 74, Lower Albian.

Incertae sedis.

Lamellibranch sp. I.

Two specimens represent a form which has not been identified. The shell is ovate, with a regular outline, and the height is about 55 % of the length. The example from loc. 91 bears fine, concentric ribs at intervals, separated by areas which are occupied by delicate concentric striations. The form is comparable to the specimen figured by HÄGG (1935, pl. 8, fig. 12) as 'Lamellibranch spec. 12', but not otherwise identified by him.

Occurrence: Locality 122, ?Albian,; locality 91, Cenomanian, Varians Zone.

Lamellibranch sp. II.

An incomplete internal mould belongs to a form which appears to have been trigonal and equilateral in outline. The shell is smooth and of slight convexity. The hinge is taxodont and reminiscent of *Nucula*, but a sharp carina which extends obliquely from the umbo differentiates the form from that genus.

Occurrence: Locality 91, Cenomanian, Varians Zone.

Family **Lucinidae.**Genus **Lucina** Bruguière, 1797.*Lucina laminosa* (Reuss).1844 *Venus laminosa* Reuss, p. 198.1846 *Venus laminosa* Reuss, p. 21, pl. 41, figs. 6, 15.1856 *Lucina subundata* Hall and Meek, p. 382, pl. 1, fig. 6.1876 *Lucina subundata* Hall and Meek. Meek, p. 133, pl. 17, figs. 2a—f.1902 *Lucina subnummismalis* d'Orbigny. Ravn, p. 61, pl. 4, fig. 21.cf. 1930 *Lucina subnummismalis* d'Orbigny. Hägg, p. 51, pl. 4, fig. 3.cf. 1935 *Lucina subnummismalis* d'Orbigny. Hägg, p. 48, pl. 6, figs. 12—15.1947 *Lucina laminosa* (Reuss). Hägg, p. 86.

Lucina subnummismalis (Ravn, non d'Orbigny) from the Danish Upper Cretaceous appears to be identical with the North American *L. subundata*, and both these species with the Bohemian *L. laminosa* (REUSS).

The Traill Ø specimens are small; the largest are 1.3 cm long and many are not more than half this size. They show well the regular fine concentric ornament characteristic of the species, and correspond closely in form and ornament to the examples figured by REUSS, MEEK and RAVN. The Swedish specimens illustrated by HÄGG seem to have rather prominent concentric undulations of the shell, but his pictures are enlarged and retouched and probably represent a form closely allied to, if not identical with, that under consideration.

RAVN's *L. paffi* (1918, p. 350, pl. 7, fig. 23) from West Greenland bears a fairly close resemblance to some of the East Greenland specimens, but is imperfectly known.

Occurrence: Locality 58, Upper Campanian.

Lucina sp. indet.

The anterior end of this species is rounded, the posterior truncate. The umbo is situated slightly nearer to the posterior than to the anterior end. The height of the shell is from 80 % to 85 % of the length. The ornament consists of fine, raised, concentric lines, separated by smooth, flat interspaces. At a point 5 mm ventrally from the umbo these lines are from 0.3 to 0.4 mm apart. The species is represented by several complete but small examples, and some fragments of larger individuals, the largest of which must have been about 1.7 cm long when complete.

The shape of the species closely resembles that of *L. tenera* (J. de C. Sow.) as figured by WOODS (1907, pl. 24, figs. 10—14); the ornament compares more nearly with that of *L. downesi* Woods (*op. cit.* p. 155, pl. 24, figs. 15a—c). Both these species range to the top of the Albian in the British Isles.

Occurrence: Locality 2, Cenomanian, Varians Zone.

Family **Tellinidae**.

Genus **Tellina** Linné, 1758.

? *Tellina steenstrupi* (de Loriol).

1883 *Astarte Steenstrupi* de Loriol, p. 208.

1918 *Tellina?* *Steenstrupi* de Loriol. Ravn, p. 351, pl. 7, figs. 20, 22.

A poor specimen, exhibiting only the outline and traces of the shell ornament, may represent the species. The outline is similar to that of

RAVN's examples and the surface of the shell bears fine concentric ornament.

Occurrence: Locality 58, Upper Campanian.

Class *Cephalopoda*.

Family *Belemnitidae*.

Genus *Pachyteuthis* Bayle, 1878.

The Cretaceous species of *Pachyteuthis* have been referred by some authors to *Acroteuthis* Stolley, 1911, but other workers, for instance NAEF (1922, p. 244), consider the two genera synonymous, and SPATH (1947, p. 30), although he retained *Acroteuthis*, hinted that there might be little difference between the two genera except that of age.

Pachyteuthis subquadratus (Römer).

Pl. 19, fig. 2.

1836 *Belemnites subquadratus* Römer, p. 166, pl. 16, fig. 6.

1936 *Acroteuthis subquadratus* (Römer). Swinnerton, p. 3, pl. 1, figs. 13, 14, pl. 2, figs. 1—14, pl. 3, fig. 1.

A comprehensive description and synonymy of the species is given by SWINNERTON. A series of specimens from locality 92 agrees well with PAVLOV's large Speeton example (1892, pl. 6, fig. 5) and with the series from British localities figured by SWINNERTON.

The species ranges throughout the Valanginian at Speeton, with a maximum in bed D4 (Ascendens — Ramulicosta Zones).

Occurrence: Locality 92, Middle Valanginian.

Pachyteuthis aff. *partneyi* (Swinnerton).

Pl. 19, figs. 3a, b, 4a, b.

1936 *Acroteuthis partneyi* Swinnerton, p. 12, pl. 5, figs. 1—8.

The species is represented by a number of examples which show variation, particularly in the stoutness of the guard and in the obtuseness of the apical angle, but which should probably be regarded as conspecific. The ventral furrow in the apical region corresponds well with that of *P. partneyi*, which is distinguished by this character from otherwise similar species.

In England, the species is only found in the Basement Beds of the Spilsby Sandstone, in Lincolnshire. These are Infravalanginian in age, and belong to the upper part of that stage, i. e. the beginning of the Subcraspeditan.

SPATH has figured (1947, p. 29, pl. 5, figs. 13, 14) a belemnite from the *Hectoroceras* beds of S. W. Jameson Land which he compared with *P. partneyi*, but the material was inadequate for definite identification. The apex in the specimen tapers more gradually than in most examples of the species. FREBOLD (1932, fig. 8, p. 29) illustrated a form from the "Belemnite Beds" of Wollaston Forland which is comparable with young individuals of *P. partneyi*, but the same author's *Pachyteuthis panderi* (*op. cit.* p. 24, figs. 6, 7), from the same formation and locality, is of doubtful identity, being represented only by short fragments.

Occurrence: Localities 14, 79, 80, Infravalanginian.

Family *Phylloceratidae*.

Genus *Phylloceras* Suess, 1865, *s. l.*

Phylloceras sp.

Pl. 20, figs. 6a, b.

A single example of *Phylloceras* from the Valanginian comprises a wholly septate internal mould with the following dimensions:

Diameter	Whorl height	Whorl thickness	Umbilicus
9.2	63 %	44 %	—
5.5	62 %	40 % approx.	—
3.85	61 %	43 %	—

The whorl-section is oval, with the greatest thickness a little nearer the umbilicus than the venter. The umbilicus is closed. The suture-line has the first lateral saddle the same length as the external saddle, followed by about four saddles of diminishing size.

Few species of *Phylloceras* have been figured from Valanginian horizons and none, so far as the writer is aware, from beds of the boreal Polyptychitan facies, so that the opportunities for comparison with the present form are limited. SPATH concluded (1927, p. 35) that even the apparently conservative and persistent genus *Phylloceras* was capable of considerable subdivision, and no exhaustive attempt has been made to place the present form in his scheme. It bears some resemblance to *Ptychophylloceras* in the suture-line and whorl-section, but does not show any definite trace of the periodic peripheral ridges which SPATH says (*op. cit.* p. 41) are 'generally present even on casts'. There is also a general resemblance to *Amm. picturatus* d'Orbigny, stated to be from the 'lower Neocomian' (1841, p. 178, pl. 54, figs. 4—6). Comparison with ANDERSON's (1938) Californian species, some of which may be as early as the Valanginian, is difficult on account of the inadequacy of his illustrations, but none seems to show any great similarity to the Greenland form.

Occurrence: Locality 92, Middle Valanginian.

Family **Lytoceratidae**.Genus **Lytoceras** Suess, 1865, *s. l.**Lytoceras* sp. cf. *exoticum* Uhlig.

Pl. 20, figs. 1 a, b, 2, 3 a, b.

cf. 1903 *Lytoceras exoticum* Uhlig, p. 14, pl. 1, figs. 3 a—d, 4 a—c.

The dimensions of the Greenland specimens are:—

(1)	7.6	35 %	40 %	43 %
	5.2	33 %	37 %	—
	4.15	32 %	34 % approx.	—
(2)	8.4	31 %	36 %	46 %
	2.65	—	—	49 %
(3)	4.55	33 %	36 %	49 %
	3.4	—	—	50 %
(4)	3.45	32 %	38 %	46 %
	2.5	—	—	50 %

The figures show that the whorl is slightly depressed, the thickness being consistently a little greater than the height. The whorl section is shown in figure 1 b of plate 20. The umbilicus is from 43 % to 46 % of the diameter at a size of 7—8 cm. At smaller sizes it is a little larger.

No traces of the shell remain, and the internal mould is smooth and bears no constrictions. Specimen (1) includes about one-third of a whorl of body-chamber but the other examples are wholly septate, including one 8.4 cm in diameter.

The dimensions do not differ significantly from those of UHLIG's species, which are 6.45, 33, 36, 46. *L. exoticum* is differentiated by its ornament as a member of the genus or subgenus *Pterolytoceras* Spath, but the present form is represented by internal moulds only and cannot be placed in the scheme of subdivision of *Lytoceras s. l.* adopted by SPATH, which is based on the shell ornament. For the same reason it cannot be definitely included in, or rejected from, *L. exoticum*. There are, in any case, few species of *Lytoceras* described from Valanginian deposits, with which the Greenland material can be compared.

Occurrence: Locality 92, Middle Valanginian.

Lytoceras ?polare Ravn.1911 *Lytoceras polare* Ravn, p. 485, pl. 35, fig. 9.1935 *Lytoceras polare* Ravn. Frebold, p. 96, pl. 1, figs. 1—3.

The specimens are crushed and fragmentary and are not adequate for detailed study. A small specimen bears radial constrictions about 1 cm apart at a diameter of 3 cm. Larger fragments show the closely-spaced constrictions and flares typical of RAVN's species.

Occurrence: Locality 27, Upper Aptian. Fragments from locality 9 probably belong to the species.

Family **Polyptychitidae**.

Genus **Polyptychites** Pavlov, 1892.

Subgenus *Polyptychites* s. s.

Polyptychites (Polyptychites) michalskii (Bogoslovsky) aff. var. *tuberculata* (Bogoslovsky).

Pl. 20, fig. 5.

1902 *Olcostephanus Michalskii* var. *tuberculata* Bogoslovsky, p. 135, pl. 15, figs. 4 a, b.

A septate segment of about one-quarter of a whorl, whose diameter is estimated to have been about 4.5 cm when complete, is attributed to the variety.

The right-hand side of the fragment bears two primary tubercles, and a third has been destroyed by weathering of the specimen. Each gives rise to a bundle of five secondaries. On the left-hand side two tubercles are preserved, each with a corresponding bundle of five secondaries, but the front rib of the first, and the rear rib of the second bundle do not reach right to their respective tubercles. The bundling of the secondaries does not correspond on opposite sides, the front rib of each bundle on the right-hand side forming the rear rib of the next bundle on the left-hand side. The secondaries have a gentle forward curve as they cross the venter. A part of the previous whorl is incorporated in the fragment and shows about four primary ribs corresponding to three tubercles on the outer whorl.

BOGOSLOVSKY'S var. *tuberculata* has bundles of both four and five ribs at the same diameter, and a slightly greater whorl-height, but in other respects the present fragment corresponds closely to it.

A distorted nucleus of 2.9 cm maximum diameter may have belonged to a related form. The whorls are depressed, the last strongly so, and the primary ribs are already tuberculate at a diameter of 2.3 cm; in BOGOSLOVSKY'S example of *P. michalskii* var. *tuberculata* the primary ribs only become tuberculate at a diameter of about 3.5 cm.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (Polyptychites) cf. middendorffi Pavlov.

Pl. 21, figs. 2 a, b.

cf. *Polyptychites Middendorffi* Pavlov, 1913, p. 31, pl. 7, figs. 1a—c.

The dimensions of the Traill Ø specimen are c. 7.6, 40, 53, 34, and of the inner whorl of PAVLOV'S example 8.4, 40, 57, 27. The percentages

for the Traill Ø specimen are only approximate. In the style of ribbing and the semicircular whorl-section the Greenland specimen corresponds well with PAVLOV's figure, but the proportions differ slightly, as shown by the figures. The whorl has 30 primaries at a diameter of 7.6 cm, while PAVLOV's form has 3 or 4 fewer to the whorl at the same size.

At a diameter of about 2 cm, bifurcation of the primaries is the rule, with occasional trifurcation. When the ornament is next visible, at a diameter of 4 cm, trifurcation appears to be the rule with less frequent bifurcation, although not enough of the whorl is exposed to be certain on this point. On the outer whorl each primary gives rise to three secondaries, bifurcation being followed by bifurcation of the hinder rib in the manner usual among the Traill Ø Polyptychitids. The level on the whorl-side at which the bifurcations occur is more variable than in the majority of the associated species.

The ammonite from Spitzbergen figured by FREBOLD (1929, pl. 4, figs. 1a, b) as *P. cf. ramulicosta* Pavlov seems to be closely allied to the forms under consideration, having the semicircular whorl-section of *P. middendorffi* rather than the parabolic one of *P. ramulicosta*, and much closer ribbing than the second species. PAVLOV's Speeton example of *P. ramulicosta* (1892, pl. 15, figs. 7a, b), in addition to the convergent whorl-sides which differentiate it from *P. middendorffi*, has very short primary ribs which are almost tuberculate.

Ornament similar to that of *P. middendorffi* is found in some Californian fossils figured by ANDERSON (1938, pl. 25, and pl. 26, fig. 1), attributed by their author to *Neocraspedites* (which they certainly are not) and dated by him as Hauterivian. These species ('*N. aquila* Anderson and '*N. signalis* Anderson) have larger umbilici, and more slender whorls, than the species mentioned in the preceding paragraphs. Their whorl-sections are not illustrated. Until it can be shown whether these are in fact true Polyptychitids or later homeomorphs, further comparison is perhaps profitless.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (*Polyptychites*) aff. *triptychiformis* (Nikitin).

Pl. 21, figs. 1a, b.

1902 *Olcostephanus triptychiformis* Nikitin. Bogoslovsky, p. 121, pl. 2, figs. 2a—b, pl. 4, figs. 1a—d, 2a—b, 3a—d.

The single example from Traill Ø agrees well with this species as figured by BOGOSLOVSKY, except that it has fewer ribs. At a diameter of 4.0 cm BOGOSLOVSKY's figured specimens bear 17 primary ribs to the whorl and about 45 secondaries, whereas the numbers in the Greenland form are only 14 and 37 respectively. Its dimensions are 3.85, —, 57,

c. 30, and agree closely with those of BOGOSLOVSKY's figures, whose umbilici are about 30% and whorl thicknesses range from 55% to 61%. The only other difference is in the smooth ventral band, which in the Greenland specimen is already well-marked at the beginning of the last whorl and throughout that whorl is more definite than in BOGOSLOVSKY's forms.

BOGOSLOVSKY records the species from two localities on the Oka and Mokscha rivers, to the east¹ of Moscow, in beds of Valanginian age.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (Polyptychites) undulatocostatus sp. nov.

Pl. 21, figs. 5a, b.

The species has the semicircular whorl-section which is found in *P. middendorffi* Pavlov and *P. stubendorffi* (Schmidt), and shows degeneration in ornament similar to that of the second species named, although at a smaller size. It is distinguished from PAVLOV's species by the curvature of the ribs.

The dimensions of the unique holotype and of two examples of *P. stubendorffi* are:

<i>P. undulatocostatus</i> (holotype)	4.8	41	60	27
<i>P. stubendorffi</i> :				
Pavlov, 1913, pl. 5, fig. 6	3.9	45	45	23
Pavlov, 1913, pl. 6, fig. 1,				
(Schmidt's type)	10.1	45	57	22

The whorl-section is almost perfectly semicircular. The umbilical slope is rounded on the penultimate whorl, but on the last becomes vertical and more abruptly demarcated from the whorl-side, although the boundary does not become angular.

At the beginning of the last whorl of the holotype each of the short primaries gives rise to three secondaries, which curve forwards on the whorl-side and then backwards over the shoulder before bending forwards again towards the mid-ventral line. By a diameter of 4.2 cm the primary ribs have been reduced to small tubercles and the secondaries are no longer connected with them. The last whorl has 17 primaries and about 80 secondaries, a ratio of 1:4.7, the secondaries having become finer and closer after being freed from the primaries. A similar change in ornament occurs in *P. stubendorffi* at a diameter of about 8.0 cm.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (Polyptychites) sp. cf. diptychoides Pavlov
and *variisculptus* Pavlov.

Pl. 20, figs. 4a, b.

cf. 1913 *Polyptychites diptychoides* Pavlov, p. 18, pl. 3, figs. 1a—d.

cf. 1913 *Polyptychites variisculptus* Pavlov, p. 19, pl. 3, figs. 2a—d.

In style of ornament one specimen closely resembles PAVLOV's two species cited above, but there are differences in proportions. The dimensions of the Traill Ø example at two diameters are: 6.8, —, c. 50, 25, and 4.8, —, 49, 28.

P. diptychoides has a thicker whorl (54 %) and consequently a wider and flatter venter. *P. variisculptus* has also a whorl thickness 54 % of the diameter, and a larger umbilicus (33 %) than either *P. diptychoides* or the present form.

The primary ribs on the Traill Ø specimen bifurcate until a diameter of 4.5 cm is reached, when three secondaries to each primary become the rule. A similar change occurs in both of PAVLOV's species; in *P. diptychoides* at a diameter of between 5.5 and 6.0 cm, and in *P. variisculptus* between 4.8 and 5.8 cm.

The Traill Ø species therefore differs from PAVLOV's northern Siberian forms principally in having more slender whorls, and in the onset of trifurcation at a slightly earlier stage.

The Traill Ø specimen is wholly septate and is probably, like most of the ammonites from the same locality, the nucleus of a much larger form. PAVLOV's figured specimen of *P. variisculptus* has a fragmentary outer whorl preserved which is still septate at a diameter of about 11.5 cm.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (Polyptychites) mokschensis (Bogoslovsky).

Pl. 21, figs. 3a, b.

1902 *Olcostephanus mokschensis* Bogoslovsky, p. 124, pl. 3, figs. 2, 3.

A wholly septate specimen, 4.9 cm in diameter including a fragment not shown in plate 21, figure 3a, has regularly bifurcating ribs up to a diameter of 4.4 cm. Trifurcation can be just made out on the final fragment, whose surface is much weathered.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites sp. I.

This specimen, at a diameter of about 2 cm, has a compressed whorl-section with rounded umbilical margin and narrow venter. At a size of about 3.5 cm the umbilical slope is becoming flatter and more clearly differentiated, and at the maximum diameter of c. 5.3 cm the whorl has

become semicircular in section, with steep umbilical slopes sharply demarcated from the whorl-side, and a broad, flattened venter.

At a diameter of 3.5 cm the whorl bears 27 primary ribs, each of which bifurcates almost half-way across the whorl-side. The secondaries swing sharply forward on the shoulder of the whorl and form a pronounced chevron on the venter. The last whorl is fragmentary and much damaged, and nothing can be said about its ornament except that the ventral chevron has become much less strongly curved, consequent upon the broadening of the venter.

Accurate measurements are not possible on this specimen and the following figures are approximate only:

5.3	—	55	32
3.1	—	—	23

The whorl-section of the present form is of the same type as that of *P. stubendorffi* Schmidt (PAVLOV, 1913, pl. 6, fig. 1), but the semicircular habit may be acquired earlier. *P. stubendorffi* also has long primaries at a diameter of about 4 cm, but the ratio of secondaries to primaries is much higher, and the ventral chevron, although present, is not so strong.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites sp. II.

Pl. 21, fig. 4 a, b.

A form similar to the last in shell-form has different ribbing. The dimensions are:

4.5	38	56	27	39 ¹⁾
3.8	—	—	22	34

The whorl section at a diameter of 3 cm has the width about equal to the height, a narrow venter and rounded umbilical slope; by a size of 4.5 cm it has become depressed and more nearly semicircular in form with steep umbilical slopes and a sharp umbilical angle, the change being accompanied, as shown by the above table, by a widening of the umbilicus. There are about 26 primary ribs to the whorl at a diameter of 4.2 cm. Over half of these bifurcate high up on the whorl-side, as in the last species; the remainder have a third rib joined to the primary near the umbilical margin. The secondary ribs cross the venter with a forward curve, which at a diameter of 3.8 cm is much weaker than it is half a whorl ear-

¹⁾ Where five figures are given in the tables of measurements, the last column represents the diameter measured across the umbilical angle, expressed as a percentage of the diameter of the whorl.

lier. The ornament on the second half of the last whorl has been obliterated by weathering.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites sp. III.

The measurements of this specimen are:

4.15	42	47	25
3.1	45	45	26

At the earliest diameter at which the characters of the whorl are displayed this specimen shows normal Polyptychitid features similar to those of *P. ramulicosta* Pavlov, though with a stronger ventral curve in the ribbing. At a diameter of about 2.6 cm the primary ribs begin to become widely spaced and tuberculate, and the secondaries less rigidly connected with them. On the second half of the last whorl, which is wholly septate, the primaries are irregular and there are several constrictions of varying depth. The spacing of the secondary ribs remains unaffected by these changes; there are about 68 on the last whorl.

The irregular features displayed by the ornament on the last half-whorl suggest that the specimen may be a malformation rather than a distinct species.

Occurrence: Locality 92, Middle Valanginian.

Subgenus *Euryptychites* Pavlov, 1913.

Polyptychites (Euryptychites) traillensis sp. nov.

Pl. 21, figs. 6a, b, pl. 22, figs. 2a, b.

The holotype of the species is wholly septate and has the dimensions 5.2, 39, 72, 35, 46¹⁾. The last whorl bears 22 primary and 66 secondary ribs. From the earliest diameter at which the ribbing can be seen, namely 3.3 cm, the arrangement of the ribs is perfectly regular; each of the short primaries bifurcates, and the hinder of the two resulting secondaries almost immediately divides again. The umbilical slope is smooth. The secondary ribs lean forwards and show a marked forward curve on the venter.

Two other specimens are provisionally attached to the species, in the absence of sufficient material to indicate the range of variation. The first (pl. 22, figs. 2a, b) has fewer secondary ribs, consequent upon the fact that trifurcation is established at a later stage than in the holotype. The earliest whorl preserved displays regularly bifurcating ribs; at a diameter of 2.5 cm, the first group of three secondaries arises from a primary,

¹⁾ See footnote on page 106.

followed by two simple bifurcations and thereafter by alternate groups of three and two. The first part of the next whorl is missing. The remainder bears alternate groups of two and three up to a diameter of about 4 cm, after which the last three primaries all give rise to groups of three ribs. The other example has the dimensions 4.8, —, 71, —, 46. From the earliest point at which the ribbing is seen, at a diameter of about 3.4 cm, each primary gives rise to three secondary ribs, as in the holotype. The ornament continues regularly in this fashion until a size of 4.3 cm when two bundles of four ribs occur. Thereafter the bundles are 3.3.4.3.3. to the end of the specimen. Where four secondaries arise from a primary the extra rib occurs at the front of the bundle and arises directly from the primary.

P. traillensis is similar in proportions and in the arrangement of the ribbing to *P. gravesiformis* Pavlov, from Speeton, but differs from this and from other related species such as *P. sphaericus* von Koenen (1902, pl. 4, figs. 1—5) in the pronounced forwardly-directed arc of the secondaries across the venter. The lectotype of *P. gravesiformis* (Pavlov, 1892, pl. 13, figs. 7a—c) is more raricostate than the present species, but PAVLOV's Simbirsk fossil (*op. cit.* pl. 8, fig. 14) is similar in rib-frequency. Its whorl-section, however, is more nearly semicircular and the ribs are nearly straight on the venter.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (Euryptychites) sp. cf. traillensis sp. nov.

Pl. 22, figs. 3a, b.

Two ammonites have similar shells to *P. traillensis* but distinctive ribbing. Only additional material could satisfactorily determine the significance of the differences, so they are described below without being named as a separate species. The dimensions of the first specimen (pl. 22, figs. 3a, b), 4.6, 37, 74, 33 and 4.2, —, 70, —, do not differ significantly from those of typical examples of *P. traillensis*. The frequency of the ribbing also corresponds well with that species; there are 22 primary and 52 secondary ribs on the last whorl. At the beginning of this whorl each primary bifurcates, but an extra secondary rib occurs after the seventh primary on the whorl, and, after some alternation of groups of two and three, groups of three secondaries are established by a diameter of 4.1 cm. At an early stage in the ontogeny of typical examples of *P. traillensis* the primary ribs simply bifurcate at a short distance from the umbilical angle. When a third rib is added, it appears in front of the bundle and is joined to the primary just below the existing point of bifurcation, producing the pattern already described of a bifurcating primary followed by a further bifurcation of the rear secondary. In the specimen now being

described, where simple bifurcation occurs, the primaries are relatively shorter and start to divide almost on the umbilical angle. When a third rib is added to the bundle, it also is joined to the primary on the umbilical angle and owing to the shortness of the primary the characteristic pattern is not developed. At the end of the last whorl, where groups of three ribs are the rule, the primaries are becoming tuberculate and there is no well-defined bifurcation, the three secondaries merely diverging from the primary.

The course of the ribs across the venter is more sinuous than in *P. traillensis*. In that species the secondary ribs are nearly straight and inclined forwards from the beginning of their course. In the present specimen, they are more nearly radial near the umbilicus and bend forwards as they approach the venter, so that they are concave forwards on the whorl side and convex at the mid-ventral line. The contrast is clearest at a diameter of about 3 cm.

The second specimen which is here recorded as *P. (E) sp. cf. traillensis* cannot be completely freed from matrix. The diameter is 4.3 cm and the whorl thickness 67 %. The ribs bifurcate on the umbilical angle as in the last specimen described, and follow the same sinuous course. By the maximum diameter of 4.3 cm, however, trifurcation has not yet appeared.

Occurrence: Locality 92, Middle Valanginian.

Polyptychites (Euryptychites) laevis sp. nov.

Pl. 22, figs. 1a—f, text-fig. 9.

The holotype is wholly septate but the last few septa show the approximation and the shortening of the elements which commonly precede the adult body-chamber, so probably only the body-chamber is missing. On this assumption the ammonite would have been about 10 cm in diameter when complete. The outer whorl is of typical *Euryptychites* form, with umbilical tubercles but smooth whorl-sides, the secondary ribbing being restricted to the venter. The specimen was dissected and has the following dimensions at different sizes:

7.3	40	74	25	40 ¹⁾
6.0	42	71	23	37
4.5	42	63	21	—
3.6	43	64	c. 22	—

The cadicone form is only assumed by the last septate whorl. The penultimate whorl of the holotype (pl. 22, figs. 1a, b) has a parabolic section and is not very different in form from that of *P. beani* Pavlov,

¹⁾ See footnote on page 106.

except that the ornament is much coarser. At a diameter of 4.5 cm there are 16 primary and 37 secondary ribs to the whorl; at the beginning of this whorl the short, tuberculate primaries bifurcate regularly, but half-way round, at a size of 3.6 cm, the connection of secondaries with primaries is indistinct and the ratio of one to the other becomes greater than two to one. Thereafter the smooth band on the whorl side becomes more and more well-marked and the whorl-thickness progressively greater. The last whorl has 16 umbilical tubercles and 44 ventral ribs. On the penultimate whorl the secondary ribs have a strong forward curve over the venter, but with the broadening of the whorl this becomes weaker and is scarcely detectable at the end of the last septate whorl.

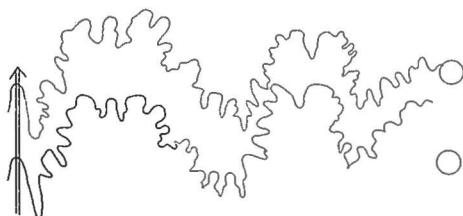


Fig. 9. Two successive external suture-lines of *Polyptychites* (*Euryptychites*) *laevis* sp. nov. at a diameter of 7.3 cm. The positions of two umbilical tubercles are indicated.
 $\times 1\frac{1}{2}$.

A second, much weathered example about 4.5 cm in diameter, also belongs to the species but does not merit further comment.

Other species of *Euryptychites* show laevigation but normally this affects the secondary ribs uniformly, in contrast to the present species where they disappear altogether on the whorl-sides but remain, albeit diminished in prominence, on the venter. A somewhat similar change is shown, at a greater diameter, by *P. tschekanovskii* Pavlov, and the phenomenon is, of course, common among species with parabolic to semi-circular whorl-section which do not attain cadicone form, where it leads to the forms known as *Neocraspedites*.

Occurrence: Locality 92, Middle Valanginian.

Genus *Dichotomites* von Koenen, 1909.

Dichotomites gregersenii Anderson var. *paucicostatus* nov.

Pl. 23, figs. 1 a, b.

ANDERSON'S species (1938, p. 158, pl. 28, figs. 3, 4) is represented by a new variety from Traill Ø. The holotype of the variety (pl. 23, figs. 1 a, b) has the following dimensions at the maximum and an earlier diameter: 5.65, —, —, 20; 4.8, —, 39, 22. There are 21 primary ribs on the last whorl and about 68 secondaries, and apart from the slightly smaller umbilicus the present variety differs from the typical form of

the species in possessing fewer ribs. The ribs on ANDERSON's holotype (*op. cit.* pl. 28, fig. 3) cannot be accurately counted, but a segment of a little less than half the last whorl (dia. 5.1 cm) bears about 40 secondaries, and the last whorl must have had about 30 primaries. The ratio of primaries to secondaries is about the same in both cases, that is approximately 1:3. In the present variety the basic pattern of the ribbing is trifurcation of the primary ribs, but some of the secondaries are not definitely joined to their primaries and in addition a few extra secondaries are intercalated. The ribbing is similar to that of the typical form of the species, and ANDERSON mentions that young examples of the latter exhibit the stage when only two secondaries arise from each primary. The holotype of var. *paucicostatus* has a constriction at the beginning of the last whorl. Constrictions cannot be certainly made out in ANDERSON's figures of *D. gregersenii* but are present in the related *D. tehamaensis* Anderson (*op. cit.* pl. 28, fig. 2).

D. gregersenii belongs to the distinctive group of species which also includes *D. tehamaensis* Anderson and *D. burgeri* Anderson from California, *D. anabarensis* (Pavlov) from northern Siberia, and possibly *D. fragilis* (Pavlov, *non* Trautschold) from Speeton, in which the primary ribs are prominent or 'pinched-up' and extend nearly half-way across the whorl-side before giving rise to the secondaries. This is in strong contrast to the condition in *D. bidichotomus*, the type species of the genus, where pairs or larger groups of ribs arise very near the umbilical margin from primaries which are short or reduced to tubercles, and higher on the whorl-side each of these ribs again bifurcates, so that there is multiplication of the ribs at two levels. In some forms of the *anabarensis* group, for example the present variety, the secondaries are not all joined to primaries, and a *Tollia*-like effect tends to be produced.

D. burgeri differs from *D. gregersenii* in possessing closer ribbing and more compressed whorls. *D. anabarensis* agrees closely with the Greenland example here described as to proportions, but differs from it and from the American species in that a number of the primaries give rise to only two secondaries; on the last whorl (diameter 6.1 cm) there are 32 primary and only 78 secondary ribs, a ratio of 1:2.45, whereas in the other species there are just over three times as many secondaries as primaries.

A nucleus 2.75 cm in diameter is probably conspecific with the form described above. Its umbilicus is 22 % and whorl thickness 40 % of the diameter. At the beginning of the last whorl, fine ribbing on the ventral area is the only ornament present, but a diameter of about 1.9 cm the primary ribs appear. Three secondaries regularly arise from each primary in the usual polyptychitid manner, by bifurcation followed by further

subdivision of the hinder rib. There are about 80 secondary ribs on the last whorl.

Occurrence: Locality 92, Middle Valanginian.

Dichotomites sp. ?nov.

Pl. 23, figs. 2a, b, text-fig. 10.

The proportions of the specimen described below are 4.0, 44, 40, 22. The greatest diameter of the specimen is 5.1 cm, and the beginning of the body-chamber appears to be included. The last whorl bears 15 primary ribs. The secondaries cannot be counted but in general each primary gives rise to three secondary ribs, although at least two near the

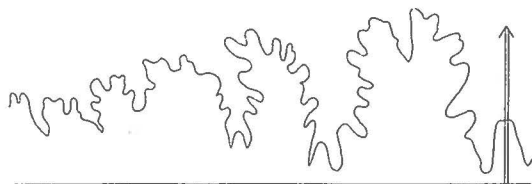


Fig. 10. External suture-line of *Dichotomites* sp. ?nov. at a diameter of about 4.0 cm. $\times 3$.

beginning of the last whorl undergo simple bifurcation only. Where three secondaries arise from a primary this occurs by bifurcation not far from the umbilical margin, followed by bifurcation of the forward rib, in contrast to the majority of Traill $\emptyset$ polyptychitids in which it is the hinder rib which divides again. The ribs curve forwards and die out on the shoulders of the whorl, leaving the venter smooth.

The species is noteworthy on account of the coarse ornament and smooth venter. Since many species of *Dichotomites* are based on much larger specimens, of which the inner whorls have not been figured, comparisons are not very satisfactory. The smooth venter, however, represents a trend which is not normally found in *Dichotomites*.

Occurrence: Locality 92, Middle Valanginian.

Genus *Neocraspedites* Spath, 1924.

The material assigned to the present genus does not belong to the same group of species as *N. semilaevis*, the type species. One species, *N. greenlandicus* sp. nov., could be regarded as doing so, but the other two forms, although represented by poorly preserved material, are connected with *Neocraspedites* by the characters of their earlier whorls but develop *Polyptychites*-like whorls before the body-chamber is reached. The

inference seems to be that the *Neocraspeditid* trend, that is, disappearance of the ornament of the whorl-sides, affected species of *Polyptychites* s.s. as well as *Dichotomites* from which the well-known *Neocraspeditids* are believed to have evolved. A similar trend certainly affected *Euryp-tychitids* as demonstrated by *P. (E.) laevis* sp. nov. The genus *Neocraspedites* is here retained for what may be parallel developments from *Polyptychites* to SPATH's '*Craspedites*-like developments of *Dichotomites*' (1924, p. 75).

Neocraspedites greenlandicus sp. nov.

Pl. 23, figs. 4 a, b.

The holotype has the dimensions 7.3, 45, 46, 21. Compared with species of the group of *N. semilaevis* (von Koenen), the type species of the genus, the present form is differentiated by thicker whorls and a consequently broader venter and more strongly convergent whorl-sides, and by the absence of primary ribs on the umbilical margin. The ventral ribs, which constitute the only ornament, number 76 on the last whorl, and this is wholly septate. They have a marked forward curve on the venter which is greater than in VON KOENEN's (1902) North German species. The whorl-section at the beginning of the last whorl, at a diameter of about 4.5 cm, is little different from that of typical *Neocraspedites*, and the squat appearance characteristic of the species is only developed towards the end of the last whorl. The umbilical wall is vertical, the umbilical margin rounded.

Occurrence: Locality 92, Middle Valanginian.

Neocraspedites sp.

Pl. 24, figs. 1 a, b.

An indifferently preserved ammonite closely resembles the last species, in both morphology and ornament, at a diameter of about 4 cm, except that the venter is slightly flattened. Weathered remains of the next whorl show that by a diameter of about 5.3 cm the umbilical slope has become sharply differentiated from the whorl-side, and the whorl thickness has increased to at least 50 % of the diameter. The whorl-section is parabolic and there is no flattening of the venter as found in *N. greenlandicus*.

In contrast to *Neocraspedites* of the *semilaevis* group, which probably evolved from *Dichotomites* by the disappearance of ribbing on the whorl-sides, the present species appears to be the result of a similar trend from some species of *Polyptychites*. *Neocraspedites* may in any case

be a polyphyletic genus including smooth-sided species descended from different species of *Dichotomites* and the present form is provisionally included in it.

Occurrence: Locality 92, Middle Valanginian.

Neocraspedites evolutus sp. nov.

Pl. 23, figs. 3a—d.

The species is based on a single specimen comprising just over one complete whorl, whose dimensions are 9.5, 36, 42, 38; 6.8, 41, 39, —. The specimen is worn and distorted in places and the proportions given are only approximate. The earliest part (pl. 23, figs. 3a, b) has a whorl section with convergent sides and flattened venter. The whorl sides are smooth but the venter bears delicate, forwardly curving ribs. At this stage the shell is closely similar in ornament and in cross-section to that of *N. greenlandicus* at about the same diameter, but has a larger umbilicus, blunt umbilical tubercles, and secondaries which reach farther down the whorl-side. By the beginning of the last half-whorl of the specimen, which is wholly septate, the whorl-section has become almost parallel-sided with a semicircular venter. The ventral ribs, though still present, are faint but the umbilical tubercles have increased in prominence. The whorl-height has almost ceased to increase although the shell is still septate.

N. greenlandicus may have developed a similar outer whorl, but in view of the differences in the proportions the two forms are here kept separate, although more extensive material might confirm the suggestion that they are closely related.

The earliest part of the shell preserved in the holotype of *N. evolutus* differs little from typical *Neocraspedites* except, like *N. greenlandicus*, in having slightly stouter whorls. Normal examples of the genus do not, however, develop the semicircular whorls of *N. evolutus*. VON KOENEN'S (1902, pl. 5) North German examples are all wholly septate, but several specimens from Speeton preserved at the Geological Survey Museum, London are complete with all or most of the body-chamber, and show no significant change in whorl-section. No. 17842 has the aperture preserved (max. dia. 12.8 cm) and shows a reappearance of *Dichotomites*-like ribbing on the body-chamber, though the penultimate whorl has smooth sides. A similar strengthening of ornament towards the end is seen on other specimens (no. 17849) but does not produce isolated tubercles as in *N. evolutus*. A similar type of whorl is shown at a diameter of about 8.0 cm and onwards by a *Polyptychites* from northern Siberia figured by PAVLOV (1913, pl. 6, figs. 1a, b), which differs only in having

a smaller umbilicus and less incurved umbilical walls. PAVLOV's specimen has typical *Polyptychites* characters at the beginning of the last whorl, which suggests that species such as *N. evolutus* and possibly *N. greenlandicus* evolved from *Polyptychites* (via forms such as *P. stubendorffi*, in which the *Polyptychites* ornament persists to a late stage) rather than from *Dichotomites* as the Speeton Neocraspeditids appear to have done.

Occurrence: Locality 92, Middle Valanginian.

Family **Desmoceratidae**.

Genus "**Puzosia**" auctt. (? New Genus).

A series of ammonites from the Lower Albian cannot be satisfactorily ascribed to any named genus. They are here referred to "*Puzosia*" merely on account of a superficial resemblance to certain species of that genus of similar age, and because what appears to be a close relative of the present forms has been described by WARREN (see below) as *Puzosia*? sp. A new generic name is probably required but the species described below is not at present sufficiently well-known to be the type species of a new genus. The features which distinguish the form from *Puzosia* will be considered after the species has been described.

I am indebted to Mr. R. CASEY, of the Geological Survey of Great Britain, for considerable help with the study of this material and for drawing my attention to WARREN's publication.

"*Puzosia*" *sigmoidalis* sp. nov.

Pl. 24, figs. 3—6, text-fig. 11.

cf. 1947 *Puzosia*? sp. Warren, p. 122, pl. 29, figs. 6, 7.

None of the specimens displays the proportions of the species in full. The umbilicus is between 29 % and 33 % of the diameter, and the whorl-section appears to have been compressed. The whorls are flat-sided, the latero-umbilical angle fairly sharp, and the umbilical wall steep. The whorl bears sigmoidal constrictions, usually eight in number, which are deeply incised on the internal mould, each constriction having slightly raised margins. Some of the specimens (e.g. pl. 26, figs. 5, 6) show further ornament consisting of from six to nine blunt ribs between each pair of constrictions, and following the same sigmoidal course. Other examples, including the holotype, are perfectly smooth between the constrictions, but the difference between the two forms is attributed to the mode of preservation and possibly also to individual variation, since specimens intermediate between the smooth forms and those with strong

ribbing are present. The individuals which are nearly or quite smooth are in most cases internal moulds; those with strongly developed ribbing may represent the outer surface of the shell, but this cannot be proved since the matrix has been altered by igneous intrusions. The suture-line is imperfectly preserved in a few individuals and is shown in text-fig. 11. It is referred to again below. Most of the specimens are small and the holotype (pl. 24, fig. 3) shows the last suture at a diameter of 3.4 cm, followed by a quarter of a whorl of incomplete body-chamber. A few fragments represent individuals at least twice this size.



Fig. 11. Parts of three successive external suture-lines of the holotype of "*Puzosia*" *sigmoidalis* sp. nov. at a diameter of about 3.0 cm. $\times 3$.

The form described by WARREN (1947, p. 122, pl. 29, figs. 6, 7), known only from an incomplete body-chamber, bears a similar type of ornament to the present species. It differs from "*P.*" *sigmoidalis* in having more closely-spaced constrictions, and only four or five ribs between each pair, but the fragment belongs to an individual of larger size than the majority of the Traill Ø specimens and the significance of the difference is difficult to assess. WARREN's example appears to be at least congeneric with the present species, and comes from a fauna which is likely to be of basal Middle Albian age in the view of Mr. CASEY.

The species belongs to a genus which is distinguished from *Puzosia* by the coarse, blunt ribbing and by the suture-line, which does not show the sharp decline of the auxiliary elements towards the umbilicus which is characteristic of *Puzosia*. The specimens without ribs between the constrictions bear a strong resemblance to the earlier *Melchiorites*, but this is probably to be interpreted as homeomorphy rather than as indicating any close connection between the two genera.

Occurrence: Locality 74, Lower Albian (Leymeriellan), Tardefurcata Zone.

Family **Aconeceratidae**.Genus **Sanmartinoceras** Bonarelli & Nagera, 1921.*Sanmartinoceras ?haugi* (Sarasin).

Pl. 24, fig. 7.

1893 *Oppelia haugi* Sarasin, p. 156, pl. 4—6, figs. 11a—c, text-fig. 4.

An impression and a fragment from one locality only are attributed to *Sanmartinoceras*. The better example is 3.7 cm in diameter and does not agree with the only well-figured species from East Greenland, namely *S. groenlandicum* Rosenkrantz (*in* Boegvad & Rosenkrantz, 1934, p. 20, pl. 4, fig. 3, pl. 5, figs. 1—5) from Kuhn Ø, which has stronger ornament and a different radial line.

RAVN's *S. pusillum* (1911, p. 492, pl. 36, figs. 7—9) is founded on a specimen only 2.3 cm in diameter, which may, as suggested by SPATH (1946, p. 7), be the same species as ROSENKRANTZ's. FREBOLD (1935, p. 100, pl. 2, figs. 1—3) found the genus on Koldewey Ø but the examples which he attributed to RAVN's species are rather small for definite identification.

The Traill Ø examples correspond with *S. haugi* in strength of ornament and in the course of the ribs, but it would be unwise to make a definite identification on the basis of the material available.

Occurrence: Locality 9, Upper Aptian.

Family **Hoplitidae**.Genus **Arcthoplites** Spath, 1924.*Arcthoplites* sp. cf. *jachromensis* (Nikitin).

Pl. 25, figs. 3, 4, text-fig. 12.

1888 *Hoplites jachromensis* Nikitin, p. 57, pl. 4, figs. 1, 2, ? figs. 3—7.1902 *Hoplites* cf. *jachromensis* Nikitin. Bogoslovsky, p. 128, pl. 6, fig. 4; pl. 7, fig. 3; pl. 8, fig. 1.1924 *Arcthoplites jachromensis* (Nikitin). Spath (Gault Amm., Pt. 2), p. 76.1930 *Hoplites* (*Sonneratia*?) cf. *jachromensis* Nikitin. Frebald, p. 49, pl. 19, figs. 2, 3, 5.1931 *Sonneratia*(?) cf. *jachromensis* Nikitin. Sokolov & Bodayevsky, p. 104, pl. 12, fig. 2.

The exact determination of the Traill Ø specimens, and, for that matter, of other Arctic material attributed to the genus, is difficult or impossible owing, on the one hand, to the crushed and fragmentary nature of the material and, on the other, to the small size of the only undamaged specimen originally figured by NIKITIN.

All the specimens from Traill Ø are crushed pieces showing the whorl side only, but nevertheless some of the characters of the species are

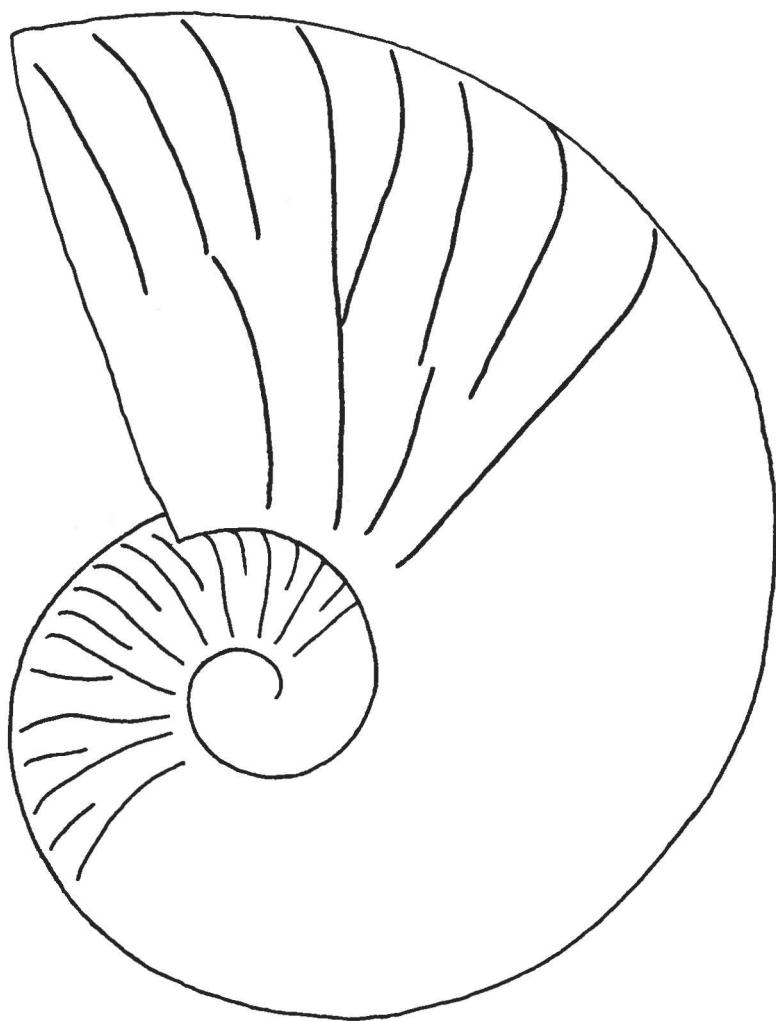


Fig. 12. Diagrammatic reconstruction of *Archoplites* sp. cf. *jachromensis* (Nikitin) from fragments found at locality 74. Natural size.

shown. The largest fragment (pl. 25, fig. 3) belonged to an example at least 14 cm in diameter, at which size the umbilicus was between 26 and 30 %. There were about 24 primary ribs, and twice as many secondaries at this size. The whorl-height must have increased rather rapidly with growth. The primary ribs on the early whorls, and occasionally in the adult, bifurcate about half-way across the whorl side, where the secondaries arise, but the normal condition on the adult whorl is for the primaries to continue and for the secondaries to arise be-

tween them, usually nearer to one of the neighbouring primaries than to the other.

Occurrence: Locality 74, Lower Albian (Leymeriellan), Tardefurcata Zone.

Genus *Leymeriella* Jacob, 1907.

Leymeriella sp. cf. *tardefurcata* (d'Orbigny).

1841 *Ammonites tardefurcatus* d'Orbigny, p. 248, pl. 71, figs. 4, 5.

1924 *Leymeriella tardefurcata* (d'Orbigny). Spath (Gault Amm., Pt. 2), p. 84.

The present genus, which was abundant at a locality in the south-east of Geographical Society Ø (see SPATH, 1943, p. 729; 1946, p. 9) is represented only by a fragment from Traill Ø. The specimen shows the ornament characteristic of the type species of the genus but does not permit of exact identification.

Occurrence: Locality 74, Lower Albian (Leymeriellan). The specimen indicates the middle or upper Tardefurcata Zone.

Family *Schloenbachidae*.

Genus *Schloenbachia* Neumayr, 1875.

Schloenbachia subvarians Spath.

1853 *Ammonites varians* var. *intermedia* Mantell. Sharpe, p. 23, pl. 8, figs. 7 a, b.

1926 *Schloenbachia subvarians* Spath, p. 81.

1951 *Schloenbachia subvarians* Spath. Wright & Wright, p. 22.

The specimens are crushed in shale but their ornament, at least, agrees well with English examples of the species.

The species has already been reported from Geographical Society Ø by SPATH (1946, p. 10) and the present writer (DONOVAN, 1949, p. 8).

Occurrence: Probably the commonest species of *Schloenbachia* in the area. Lower Cenomanian, Varians Zone, of localities 2 and 5. Fragment of a large example (dia. c. 20 cm) from locality 146.

Schloenbachia subtuberculata (Sharpe).

1853 *Ammonites varians* var. *subtuberculata* Sharpe, p. 22, pl. 8, figs. 5 a—c, 6 a, b.

1926 *Schloenbachia subtuberculata* (Sharpe). Spath, p. 81.

1951 *Schloenbachia subtuberculata* (Sharpe). Wright & Wright, p. 22.

This species is not as common as *S. subvarians*, but an impression from locality 5 shows the ornament well, and an uncrushed fragment, showing the venter, was obtained from locality 145.

Occurrence: Lower Cenomanian, Varians Zone, of localities 5, 145; ?locality 2.

Schloenbachia cf. *subplana* (Mantell).

- 1822 *Ammonites varians* var. *subplana* Mantell, p. 116, pl. 21, fig. 2.
1853 *Ammonites varians* var. *subplana* Mantell. Sharpe, p. 23, pl. 8, fig. 10.
1938 *Schloenbachia subplana* (Mantell). Spath, p. 546.
1951 *Schloenbachia subplana* (Mantell). Wright & Wright, p. 23.

Two small specimens with ornament suggesting *S. subplana* were found at locality 2.

Family **Gaudryceratidae**.Genus **Mesogaudryceras** Spath, 1927.*Mesogaudryceras* cf. *leptonema* (Sharpe).

- 1855 *Ammonites leptonema* Sharpe, p. 32, pl. 14, fig. 3.
1927 *Mesogaudryceras leptonema* (Sharpe). Spath, p. 66.
1951 *Mesogaudryceras leptonema* (Sharpe). Wright & Wright, p. 12.

A specimen from the Cenomanian (Varians Zone) of locality 2 has been recognised by Mr. C. W. WRIGHT as a member of the present genus. It is compared with Sharpe's species, but unfortunately the small size and indifferent preservation do not allow more definite determination. This is believed to be the first record of the genus outside the British Isles.

Family **Mortoniceratidae**.

Genus unknown.

A fragment of the whorl-side of an ammonite from locality 112 represents a strongly ornamented form with stout umbilical tubercles which appears to be a Mortoniceratid. If the identification is correct, the presence of the lower part, at least, of the Upper Albian is indicated, but unfortunately more definite evidence for beds of that age is not at present forthcoming from East Greenland.

Family **Scaphitidae**.Genus **Scaphites** Parkinson, 1811.*Scaphites* sp. cf. *geinitzi* d'Orbigny.

Pl. 25, fig. 1.

- 1850 *Scaphites Geinitzii* d'Orbigny, p. 214.
1896 *Scaphites Geinitzi* d'Orbigny. Woods, p. 81, pl. 3, figs. 5—7.
1951 *Scaphites geinitzi* d'Orbigny. Wright and Wright, p. 13.

The species under consideration is represented by a single internal mould of the body-chamber, complete with the aperture but showing the side of the whorl only. The ornament consists of delicate primary

ribs which end in small tubercles, and secondaries which arise both from the tubercles and between them. There are three times as many secondaries as primaries. Within about 1.5 cm of the aperture the secondaries become more widely spaced than on the earlier part of the body-chamber. The line of tubercles at the ends of the primaries appears to be placed about two-thirds of the way from the umbilicus to the periphery, but this may not be its true position since the specimen has been flattened. The suture-line is not visible.

The example described above differs from typical English specimens of *S. geinitzi* in having almost straight primary ribs which show no tendency towards a sigmoidal curvature, and in the spacing-out of the ribs immediately behind the aperture. The ornament on *Scaphites* body-chambers often shows considerable variation between individuals of the same species, but on the basis of the single specimen available it is deemed unsafe to identify the Greenland form more closely with *S. geinitzi*. *S. delicatulus* Warren (1930, p. 66, pl. 3, fig. 3, pl. 4, figs. 7, 8) has ornament of the same pattern as *S. geinitzi* and the Greenland form, according to WARREN's description; unfortunately his illustrations are not clear enough to show the ornament. WARREN's figured specimen is 2.3 cm in maximum length and differs from *S. geinitzi* in having a thicker whorl and body-chamber. The proportions of the Greenland form are unknown and it is compared with *S. geinitzi* because d'ORBIGNY's species is better known than WARREN's.

S. geinitzi is found in the upper part of the Turonian of Great Britain, France, and Germany, and reaches maximum abundance in the *Holaster planus* Zone. *S. delicatulus* occurs in the lower part of the Smoky River Shale of Alberta, of Turonian age according to WARREN.

Occurrence: Locality 59, Upper Turonian.

Scaphites greenlandicus sp. nov.

Pl. 24, figs. 9, 10.

1872 *Scaphites roemeri* d'Orbigny. Schlüter, p. 89, pl. 27, fig. 4 only.

? 1876 *Scaphites nicolletii* Morton. Meek, p. 435, pl. 34, fig. 4 only.

1885 *Scaphites roemeri* Moberg, p. 29, pl. 3, fig. 9.

1897 *Scaphites roemeri* d'Orbigny. Madsen, p. 49, plate.

1918 *Scaphites nicolletii* Morton. Ravn, p. 363, pl. 9.

The examples of Upper Senonian *Scaphites* from West Greenland, which appear all to belong to one species, have been placed in *S. roemeri* by MADSEN and *S. nicolleti* by RAVN. In the writer's view neither of these attributions can be maintained. *S. nicolleti* is a small species, MORTON's figured specimen (1842, pl. 10, fig. 3) being only 4.2 cm in greatest diameter, and moreover MORTON mentions (*op. cit.* p. 209) that the species

has 'numerous minute tubercles' on the shoulders of the whorl. The tubercles are not shown in MORTON's figure but are seen in the smaller of MEEK's examples (1876, pl. 34, fig. 2b) and are close-set, about one to each rib. The West Greenland species is appreciably larger than *S. nicolleti* and does not show the same kind of tuberculation. This identification has already been rejected by ROSENKRANTZ (1942, p. 40).

The identification with *S. roemeri* is more plausible. The examples figured by MADSEN and by RAVN correspond well with one of SCHLÜTER's illustrations of *S. roemeri* (1872, pl. 27, fig. 4), but the form depicted in that figure differs in several ways from figures 1—3, of the same plate, which agree with the specimen for which d'ORBIGNY (1850, p. 214) proposed the name *roemeri*, namely RÖMER, 1841, pl. 15, fig. 1. SCHLÜTER particularly remarks (p. 89) on the variability of *S. roemeri*, but nevertheless his figure 4 differs significantly from the typical form of the species. It has finer ribbing, and the shape of the shell and that of the aperture are quite different. RÖMER does not give a peripheral view or a whorl-section, but specimens which correspond to his figure 4 are normally much fatter than the fossil represented in figures 1—3, although the slenderness of the latter may possibly be an erroneous restoration by the draughtsman. The development of tubercles in the new species, as in *S. roemeri*, is variable, but the number ranges from none to two and the more numerous tubercles characteristic of *S. roemeri* are not found.

The greatest diameter of the adult shell is usually about 7.5 cm; MADSEN (1897, p. 50) says the largest specimen from West Greenland is 8.3 cm long. The umbilicus is closed. The whorl-thickness of the holotype at a diameter of approximately 6.5 cm is 36 %. The whorl-sides are flat, and parallel or slightly convergent. The aperture is overhanging and has a pointed rostrum, but is not perfectly preserved in any of the Greenland examples.

At a diameter of about 2 cm (MADSEN, *op. cit.*, fig. 2b) the inner part of the whorl-side bears ribs separated by flat interspaces. By intercalation of secondary ribs the total number of ribs on the venter is increased to about three times the number of primaries. On the adult whorl the ribs are closely crowded on all regions of the whorl, secondaries are continuously being intercalated all the way across the whorl-side, and there are two or three times as many ribs on the venter as at the umbilical margin. The ribs in the adult have a sinuous course, curving strongly backwards from the umbilical margin, then taking a forward sweep towards the middle of the whorl-side, and curving backwards again into a radial direction towards the venter. The density of the ribbing varies between individuals. On the venter of the holotype there are about 12 ribs to the centimetre at 5.5 cm diameter. Other specimens, including MADSEN's figure 1 and one of the Traill Ø examples, have slightly finer

and closer ribbing. Exceptionally there are one or two small, blunt tubercles on each side of the venter at the beginning of the body-chamber. Tubercles are not known from West Greenland examples (MADSEN, p. 50) but are present on SCHLÜTER's German specimen and on two from Traill Ø (pl. 24, figs. 9, 10).

The suture-line of the species is not known from any Greenland example.

Types: A specimen in the Mineralogical Museum, Copenhagen, figured by MADSEN (figs. 3a, b) and by RAVN (fig. 2) is taken as the holotype of the new species. The body-chamber is not complete but it is the only figured specimen in which the venter and whorl-section are well displayed. Another example figured by RAVN (fig. 1) is regarded as a paratype to exemplify the form of the shell and the aperture.

The species is found in both East and West Greenland, in Germany, and in Sweden (*S. roemeri* Moberg, 1885, pl. 3, fig. 9). It may be represented in North America by the larger of the two examples figured by MEEK (1876, pl. 34, fig. 4) as *S. nicolleti*, but figured North America material is not adequate to establish the occurrence of the species there beyond doubt. The series figured by NOWAK (1912, pl. 33, figs. 8—22) as *Hoploscaphites constrictus* Sow. and varieties from Poland is closely related to the present species but smaller in size, sometimes develops a number of peripheral tubercles on the body-chamber, and usually shows a greater contrast between the ornament on the septate portion of the shell and on the body-chamber. NOWAK's examples well illustrate the variation which may be expected in an assemblage of *Scaphites* of the present type.

Occurrence: The species is represented by several fragments from loc. 58. The species is found in Europe in beds of Upper Campanian age.

Scaphites aff. *morrowi* Jeletzky.

Text-fig. 13.

1935 *Scaphites pygmaeus* Morrow, p. 465, pl. 50, figs. 2a—e, 3.

1949 *Scaphites morrowi* Jeletzky, p. 330.

The single fragment from Traill Ø comprises the last few gas-chambers and the beginning of the body-chamber. Only the whorl-side is preserved. The ribs are sharp, and the primaries run straight across the whorl side and over the venter; at the beginning of the body-chamber they begin to bear rudimentary tubercles about two-thirds of the way across. The secondaries arise, one between each pair of primaries, from one-half to two-thirds of the way across the whorl-side. The suture-lines, so far as they can be made out, are shown in text fig. 13. There is one suture to every two primary ribs.

The specimen agrees well with the corresponding portion of *S. morrowi*, and the ribbing is like that described by MORROW for his species. The suture corresponds in general plan but is not quite so regular in its detailed arrangement. No significant difference can be found between *S. morrowi* and the Traill Ø specimen, but it would be unwise to assert absolute identity on the basis of such fragmentary material.



Fig. 13. Side-view of the fragment of *Scaphites* aff. *morrowi* JELETZKY from locality 51. $\times 3$.

The species described by MORROW as *S. pygmaeus* proved to be preoccupied and the name *S. morrowi* was proposed by JELETZKY in its place.

S. morrowi occurs in the Blue Hill Shale of the Carlile Formation of Kansas, U.S.A. According to Schuchert (1943, p. 825) this formation corresponds to the top of the Turonian Stage.

Occurrence: Locality 51, probably Upper Turonian. A fragment from loc. 59 may belong to the same or an allied species.

Scaphites nodosus Owen var. *quadrangularis* Meek & Hayden.

Pl. 24, fig. 8.

1876 *Scaphites nodosus* var. *quadrangularis* Meek & Hayden. Meek, p. 428, pl. 25, figs. 2—4.

One external mould of a damaged *Scaphites* from the same locality as *S. greenlandicus*, representing the body chamber and aperture, corresponds with the present variety. The original description was unillustrated, but MEEK in 1876 figured the type (fig. 3) and two other specimens,

one (fig. 2) more compressed than the type, and the other (fig. 4) larger and with coarser ornament. The fragment from Traill Ø agrees well with MEEK's figures 2 and 3 as regards ornament; it appears to belong to the more compressed, flat-sided form represented by figure 2, but owing to the incompleteness of the specimen this point cannot be checked closely.

Also comparable is *S. constrictus* J. Sowerby as figured by DE GROSSOUVRE (1894, p. 248, pl. 31, figs. 1, 2, 7, 8), the principal difference being that the East Greenland form, like some of the North American examples, does not acquire widely-spaced ribs on the body chamber.

The variety is found in the Fort Pierre Group of the western U.S.A., and is stated by REESIDE (1928, p. 32) to be of Upper Campanian age.

Occurrence: Locality 58, Upper Campanian.

Phylum ARTHROPODA.

Class Malacostraca.

Family Palinuridae.

Genus *Linuparus* White, 1847.

Synonyms: *Podocratus* Geinitz, 1850.

Thenops Bell, 1858.

Podocrates Schlüter, 1862.

Linuparis Stebbing, 1893.

About half a dozen species, ranging from Aptian to Recent, are attributable to the genus. Fossil remains, with the exception of one or two species, are rare, but show that the maximum geographic range of the genus was in late Cretaceous times. The earliest known representative is *L. carteri* (Reed) from the British Aptian, known from three specimens of which two are figured by Woods (1925, p. 29, pl. 8, fig. 2), and the genus is next met with in the Upper Turonian of France whence ROMAN and MAZERAN (1913, p. 113, pl. 4, fig. 29, text-fig. 34) described *L. euthymei*, a species which is doubtfully distinct from *L. vancouverensis* (Whiteaves, 1903, p. 325, pl. 41, fig. 1) from the Upper Cretaceous (?Senonian) of British Columbia. In the Senonian *L. dülmensis* (Geinitz) has been recorded, under different names, from Bohemia, Germany, Sweden, western Canada, Dakota and Tennessee, and its occurrences in Europe and America have now been linked by the present discovery in East Greenland. Both Lower and Upper Senonian fossils occur which, with the present incomplete knowledge of their morphology, must all be referred to GEINITZ's species.

In the Eocene the genus is again restricted to north-west Europe, whence two species are recognised, and continued to exist in this area

at least until Middle Oligocene times, for it has been found in beds of that age in Schleswig-Holstein. The single living representative, *L. trigonus* (de Haan), is the type species of the genus and is found only in the Sea of Japan.

Further discussion of the genus will be found in ORTMANN (1897, pp. 290—293) and WOODS (1925, pp. 26—28).

Linuparus dülmensis (Geinitz).

Pl. 25, fig. 2, text-fig. 14.

- 1850 *Podocratus dülmensis* Geinitz, p. 96, pl. 2, fig. 6.
- 1862 *Podocratus Dülmensis* Becks. Schlüter, p. 713, pl. 12, figs. 1—3.
- 1874 *Podocratus Schlüteri* Tribolet, p. 362.
- ? 1879 *Podocratus Dülmensis* Becks. Schlüter, p. 603, pl. 13, figs. 1, 2.
- 1885 *Hoploparia* (?) *canadensis* Whiteaves, p. 238, and 1885a, p. 87, pl. 11.
- 1897 *Linuparus atavus* Ortmann, p. 293, text-figs. 1—4.
- 1900 *Linuparus* (*Podocrates*) *canadensis* (Whiteaves). Woodward, p. 396, pl. 16, fig. 1.
- 1926 *Podocratus canadensis* (Whiteaves). Rathbun in Wade, p. 185, pl. 63, figs. 12, 16.
- 1929 *Linuparus dülmensis* (Becks MS), Geinitz. Glaessner, p. 232.

The type figure of *H. (?) canadensis* differs from GEINITZ's and SCHLÜTER's figures of *P. dülmensis* in that the median ridge of the carapace, posterior to the cervical groove, is marked off laterally by deep, angular, longitudinal grooves. There is no doubt that these resulted from the crushing of the carapace after burial, and they are to be observed, less symmetrically developed, in various other examples of the species including the one from East Greenland. When this fact is taken into consideration WHITEAVES' figure, and the other North American examples which have been published under his trivial name, agree perfectly with *L. dülmensis*. ORTMANN, when he described *L. atavus* in 1897, appears not to have known of WHITEAVES' species, and WHITEAVES himself (1903, p. 325) placed *L. atavus* in the synonymy of *L. canadensis*.

L. dülmensis is distinguished from the other species of the genus by the well-developed spines which occur both on the anterior part of the carapace, where they form a characteristic pattern, and on the median and lateral keels posterior to the cervical groove. The arrangement of the spines has been well described by WHITEAVES and by ORTMANN (*loc. cit.*).

The single specimen from Traill Ø is incomplete, only part of the carapace being preserved, but a partial reconstruction can be made (text-fig. 14). The specimen is small, examples of the species being known from both North America and Europe which attain a size twice that of the present example. Measurements of several examples of the species are:

	Length of carapace from the cervical groove forwards:	Breadth across lateral ridges, immediately behind cervical groove:
Traill Ø	2.65 (estimated)	2.4 (estimated)
Schlüter 1862, pl. 12, fig. 2	c. 5.4	4.6
<i>Ibid.</i> fig. 3	> 3.5	3.5
Whiteaves, 1885 a, pl. 11	> 4.5	> 3.4
Ortmann, 1897, text-fig. 1	3.8	3.6

As shown by the accompanying photograph (pl. 25, fig. 2) the carapace is considerably damaged. The anterior margin is not complete but the base of the supraorbital spines is assumed to be represented by the broken triangular fragment which has been displaced to the right of the mid-line, and fragments may be seen of the margin lateral to these spines, but the antero-lateral spines are not preserved. The slight ridge which bears the “curved, longitudinal series of three spines” (ORTMANN, *op. cit.*, p. 294) forms the apparent lateral margin on the left side of the

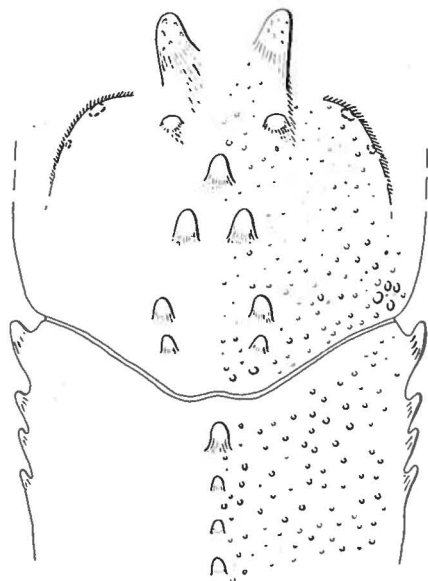


Fig. 14. Partial reconstruction of the specimen of *Linuparus dülmensis* (Geinitz) from locality 50. $\times 2$. The anterior margin and the posterior part of the carapace are omitted. The spinose lateral ridges on the post-cervical region have been turned outwards and appear to form the lateral margins, as the actual margin has been bent underneath. The granular ornament is shown on the right-hand side of the carapace only.

anterior part of the carapace, for the area between it and the true lateral margin has been folded underneath. On the right side the the row of three spines is not preserved, and the lateral margin is also destroyed

except for a short distance immediately in front of the cervical furrow. The arrangement of tubercles on the median part of the anterior section of the carapace, characteristic of the species, is well seen. Although the carapace is broken in several places, and along some of the fractures the neighbouring sections have been forced one over the other, the form of the part of the specimen in front of the cervical groove can be restored with some confidence. Along the cervical groove itself a break has occurred and the posterior portion has been pushed forward and over the anterior. Behind the cervical groove the tuberculate median ridge is well shown and also the right lateral one which, on account of the true lateral margin having been bent underneath it, appears to form the lateral margin of the carapace. The posterior part of the post-cervical region is missing. A portion of the under surface has been exposed but is much damaged and does not merit further comment.

Occurrence: Locality 50, *Sphenoceras* Beds, Upper Santonian or Lower Campanian.

Phylum ECHINODERMATA.

Class *Echinoidea*.

Family *Spatangidae*.

Genus *Echinospatangus* Meuschen, 1778.

Echinospatangus sp. indet.¹⁾

The specimens bear some resemblance to *E. argillaceus* (Phillips) originally described from the Speeton Clay of Yorkshire, and also known from the Aptian of France, but it would be unwise to assert specific identity since the original shape of the test in the crushed Greenland material is unknown. Comparison is only possible as regards the shape and disposition of the pore-pairs, which corresponds, in particular, with the figures given by d'ORBIGNY (1855, pl. 845). However, in the Greenland form the antero-lateral ambulacral areas are characteristically short.

The age of the material from Traill Ø is not known, and the echinoids cannot be identified sufficiently closely to give an exact horizon. *Echinospatangus* is principally a Lower and Middle Cretaceous genus, and the specimen is likely to come from the Aptian, Albian or Cenomanian rocks rather than from the Turonian or Senonian formations also found in the island.

Occurrence: Locality 61, age uncertain.

¹⁾ The notes on this and the following species have been very kindly contributed by Mr. M. Y. HASSAN, who has been good enough to examine the material.

Genus **Micraster** Agassiz, 1836.

? *Micraster* sp. indet.

The specimens would be certainly identifiable as *Micraster* if it were not for the distortion of the test and obliteration of the structure of the apical disc which make exact comparison of the Traill Ø material impossible.

The closest species to the present form is apparently *M. leskei* (De Moulins), well-known from the Senonian of England, France, and elsewhere, which is similar in the nature of the pore-pairs and the interporiferous areas. It is undesirable to be dogmatic as to the identification of the species since other important features, particularly the details of the peristome and periproct, and the shape of the test, are not known from the Greenland material.

Occurrence: Locality 57, ?Senonian.

Indeterminate echinoid remains.

Echinoid remains have been recovered from a number of Cretaceous exposures, but unfortunately all are crushed and in a poor state of preservation as regards the details of the test. A preliminary examination has not revealed any recognisable forms except the two mentioned above, and it is doubtful whether further progress could be made with the material.

Phylum COELENTERATA.

Class *Anthozoa*.

Genus **Caryophyllia** Lamarck, 1801.

? *Caryophyllia* sp.

An example 11 mm in diameter has about 50 septa, the longer reaching almost to the axis.

Caryophyllid corals were recorded by the writer (1949, pp. 7, 11) from Geographical Society Ø from beds probably at about the same horizon as the Traill Ø occurrence.

Occurrence: Locality 74, Lower Albian (Leymeriellan), Tardefurcata Zone.

XII. NOTES ON THE FAUNAS

A. Jurassic.

Bathonian—Callovian.

The relationships and correlation of the Bathonian and Callovian faunas of East Greenland were discussed at length by SPATH (1932) when he described the extensive faunas from Jameson Land. No important new faunal elements have been discovered since SPATH wrote, nor do discoveries elsewhere add much to SPATH's conclusions.

SPATH recognised four successive groups of strata which he named after the characteristic ammonite genera, and within the main groups he recorded (*op. cit.* p. 138) a number of horizons which are probably applicable to Jameson Land only.¹⁾ For convenience of reference the following zonal names are used for East Greenland in the present work:

Name	Index species	Spath's subdivisions
Tychonis Zone	<i>Keplerites (Seymourites) tychonis</i> (Ravn)	<i>Keplerites-Cadoceras</i> Beds, ? <i>pars</i>
Kochi Zone	<i>Arcticoceras kochi</i> Spath	<i>Arcticoceras</i> Beds
Nudus Zone	<i>Arctocephalites (Arctocephalites) nudus</i> Spath	<i>Arctocephalites</i> Beds
Pompeckji Zone	<i>Arctocephalites (Cranoccephalites) pompeckji</i> (Madsen)	<i>Cranoccephalites</i> Beds

The POMPECKJI and NUDUS zones should possibly be regarded as subzones of a single zone. SPATH's provisional placing of the *Cranoccephalites* and *Arctocephalites* Beds as equivalent to two successive zones in the European sequence tends to overstress the differences between the two faunas whereas, as SPATH pointed out (1932, pp. 14—15), *Cranoccephalites* and *Arctocephalites* are both closely related and separated only

¹⁾ MAYNC in 1949 (p. 161) listed as "Ammonitenzonen (SPATH 1932)" SPATH's horizons, in four groups numbered (1) to (4). The term zone was not used by SPATH and I do not think that MAYNC intended to suggest the elevation of the horizons to the dignity of zones. In case they should be so interpreted, however, it is important to emphasise that they are quite unsuitable for the purpose.

by 20 m of beds in their field occurrence. The horizons represented in the *Keplerites*—*Cadoceras* Beds in Jameson Land may belong to more than one zone, as mentioned below.

In attempting to date the *Keplerites*—*Cadoceras* Beds SPATH was faced with a dilemma. Consideration of the species of *Cadoceras* led him to state that "the East Greenland species do not include a single form that points to the Middle rather than to the Lower Callovian or to a still earlier horizon" (1932, p. 140). *Seymourites*, represented by abundant material from Vardekløft, but not known from the extensively-studied European successions, appeared likely to be pre-Callovienne Zone in date; the genus *Keplerites*, to which *Seymourites* is attached as a subgenus, is found in the Herveyi Zone in Europe, at the base of the Callovian (top of Bathonian in SPATH's classification). From the evidence of these two genera the beds with *Seymourites* and *Cadoceras* would seem to fall most comfortably at the horizon of the Herveyi or Koenigi Zones, and to be equivalent to Upper Cornbrash or Kellaways Clay of the English succession.

A single ammonite from Jameson Land, however, identified as a *Kosmoceras* (*Gulielmiceras*) and described as a new species, *K. (G.) pauper* Spath, was found (SPATH, *op. cit.* p. 97) to be almost indistinguishable from examples from the Kellaways Rock of Yorkshire. This is the only ammonite which can be directly compared with forms from England, and indicates a Middle Callovian age, equivalent to the Callovienne or Jason Zone in Europe.

The position of *K. (G.) pauper* in the Greenland sequence is unfortunately not certainly known. The principal occurrence of *Cadoceras* and *Seymourites* is at Vardekløft on the shores of Hurry Inlet, where many ammonites have been found in a line of calcareous or clay-ironstone concretions. Near Point Constable, about 15 km to the north, three ammonites were recovered; two species of *Cadoceras*, one of which also occurs in the concretions at Vardekløft, and the *Gulielmiceras* referred to above. They were identical in preservation with the Vardekløft specimens, but all were found loose, and there is no proof that they were all derived from the same bed. SPATH (*op. cit.* p. 146) assumed that more than one fauna is represented in the *Keplerites*—*Cadoceras* beds which he regarded as of both Lower and Middle Callovian age (equivalent to Koenigi and Callovienne Zones of Europe), recognising a lower Victor (after *Cadoceras victor* Spath) and an upper Pauper horizon. SPATH remarked that the ammonite horizon at Vardekløft might be a condensed deposit, and the results of the work in Traill Ø provide a further, if slight, reason for suspecting that this may be the case. The absence of *Seymourites* near Point Constable may be held to be accidental, since only three ammonites were found in all. In Traill Ø, however, a bed with *Keplerites* (*Sey-*

mourites) in a series of presumably rapidly deposited sandstones contained this ammonite in abundance but no other genera, whereas the only specimen of *Cadoceras* recovered, admittedly fragmentary and found in scree, was in a quite different matrix. The examples of *Kepplerites* (*Seymourites*) are attributed to a new species but are so similar to Jameson Land species that they are undoubtedly of the same age. It is possible, therefore, that the *Cadoceras* and *Kepplerites* (*Seymourites*) elements of the fauna of the concretion band at Vardekloft may yet be proved to be of different ages if suitable localities for collecting can be found, either in Traill and Geographical Society Øer, or in central Jameson Land where *Seymourites* also occurs (STAUBER, 1940, p. 22).

Although *Arctocephalites* was first described from Franz Josef Land and *Kepplerites* (*Seymourites*) is known from Spitzbergen and elsewhere, the only region which affords a detailed parallel for the East Greenland Bathonian—Callovian faunas is North America, but the comparisons do not assist much with the dating of the faunas in terms of the European succession. *Seymourites* and *Arctocephalites* (as "*Miccocephalites*" and "*Metacephalites*") have for some time been known from Canada (McLEARN 1929; BUCKMAN, 1929) and IMLAY (1948) has more recently reported from the western interior of the United States a sequence of faunas in which the presence of *Arctocephalites*, *Arcticoceras* and *Seymourites* suggests a close connection with East Greenland. Between the *Arcticoceras* and *Seymourites* zones in North America IMLAY records (*op. cit.* p. 15) a zone characterised by *Gowericeras*, which he therefore correlates with the Koenigi Zone of Europe. IMLAY only figured (1948, pl. 7, figs. 1—11) one of the seven species of *Gowericeras* which he claims to have recognised, namely the new species *G. subitum* Imlay. The figures do not enable IMLAY's generic identification to be unreservedly confirmed, for typical examples of *Gowericeras* have bituberculate primary ribs, whereas the North American forms have only one tubercle near the ventral end of each primary; moreover the ribbing on their outer whorls is nearly straight and lacks the strongly curved primaries, and the abrupt backward bend near the origin of the secondaries, which are typical of many English species of *Gowericeras*.

Above his *Gowericeras* zone IMLAY recognises two horizons within the beds with *Seymourites*, a lower characterised by *K. (S.) cf. tychonis* (Ravn) and an upper by *K. (S.) mclearnii*, a new species. The lower horizon he equates with the *Seymourites* fauna of Jameson Land. From the upper he reports *Grossouvria* and *Sigaloceras* and correlates it with the Calloviense Zone of Europe, but the ammonites are not described or figured so that the correlation cannot be discussed in detail.

The *Arcticoceras* fauna was regarded by SPATH as not earlier than the Koenigi Zone, but IMLAY (*op. cit.* p. 15) would now place it lower,

since in North America it occurs below the *Gowericeras* fauna mentioned above. There is, however, no positive evidence for its exact position, and there is no reason why the *Gowericeras* fauna of North America should represent the whole of the Koenigi Zone of Europe, nor why the *Arcticoceras* fauna, even if below *Gowericeras*, should be the equivalent of the whole of the Macrocephalus Zone of ARKELL (= Herveyi Zone of SPATH's 1932 table, p. 145) as it is shown in IMLAY's table (*op. cit.* pl. 4).

Arctocephalites and *Cranocephalites* are not readily dateable. The two genera (or subgenera, as they are here regarded) are closely and apparently directly related, and *Arctocephalites* in turn appears to be connected by transitions to *Arcticoceras*; in any case the ranges of the two latter genera overlap at Hjørnefjeldet. SPATH therefore reasonably concluded that the three faunas were not widely separated in time, and regarded the *Cranocephalites* and *Arctocephalites* faunas as approximate equivalents of the Lower and Upper Cornbrash of England respectively, although it seems equally probable, in view of the close association of the two faunas emphasised by SPATH (see, *i. a.*, *op. cit.* p. 14) that both might be assigned to the Upper Cornbrash (Herveyi Zone of SPATH, Macrocephalus Zone of ARKELL, 1946), in which case the whole of the East Greenland succession discussed above would be of Callovian age in the interpretation adopted by some workers (see ARKELL, 1946, p. 9). IMLAY (*op. cit.* pp. 14—15) rejects the last possibility and assigns *Arctocephalites* to the Discus Zone at the top of the Bathonian, so that according to his interpretation *Cranocephalites* lies even lower, but there is as yet no evidence to settle the question. IMLAY (*loc. cit.*) also reported the European genus *Procerites* associated with *Arctocephalites* but no details are available. It is much to be hoped that a full account of the North American ammonites briefly reported on by IMLAY will be published soon, since they are evidently an important addition to the faunas of the province to which East Greenland, Spitzbergen and Franz Joseph Land also belong.

The lamellibranchs of the Yellow Series are mostly longranging forms, closely allied to the European faunas of the time, and call for no special comment. An interesting addition to the Bathonian—Callovian faunas was the discovery, for the first time in beds of this age in Greenland, of brachiopods associated with *Cranocephalites* at localities 120 and 137. They are described in a separate paper (M. o. G., vol. 111, no. 6) by Dr. MUIR-WOOD who finds that their closest affinities are with species from the Carpathians. The Traill Ø material is fragmentary and of limited variety and comment on the significance of these affinities should perhaps be reserved.

Oxfordian—Kimmeridgian.

Ammonite faunas at this time were less strikingly differentiated geographically than during the Bathonian and Callovian, and the relationships and age of the Greenland Cardioceratid faunas, to which no new elements have been added by the present investigation, have been fully discussed by SPATH (1935, p. 68 *et seq.*). The single example of *Rasenia* and the indeterminate perisphinctids from locality 128 are quite inadequate for further discussion.

B. Cretaceous.

Infravalanginian.

The only fossils available for dating the *Pachyteuthis* Beds are the belemnites, *Buchia* being unsuitable for precise stratigraphic correlation. The belemnites are identified with a species described from the base of the Spilsby Sandstone of Lincolnshire, England, and the beds are therefore provisionally assigned to the upper part (Subcraspeditan) of the Infravalanginian stage. The correlation should be accepted with reserve, since although the stratigraphical range of the species in England is restricted, this may be due to the incompleteness of the succession, and only the finding of suitable ammonites would date the beds beyond question. The unique Lytoceratid found in the *Pachyteuthis* Beds is not specifically determinable.

Valanginian.

The ammonite fauna from locality 92 consisting, except for *Phylloceras* and *Lytoceras*, solely of Polyptychitidae may be placed at once in the Polyptychitan Age of the Valanginian. Closer definition of the horizon in terms of zones recognised elsewhere is difficult since most of the species are new and show certain local peculiarities, and the stratigraphy of the Russian faunas, where the closest relations of the East Greenland species are to be found, is not known in detail.

The presence of *Lytoceras* and *Phylloceras* is anomalous in a fauna which is otherwise entirely of "boreal" aspect. Both the genera are absent from the well-known Polyptychitid faunas of Russia, North Germany and England. SPATH (1939, p. 146) has pointed out that our knowledge of faunal provinces at this time is inadequate and the subject is complicated by the incompleteness of the successions in most areas. SPATH believes (*op. cit.* p. 147, note 1) that, even, in the southern Tethyan area, if a complete succession was discovered the Polyptychitids would be found in their appropriate place, although possibly dominated by other forms, and remarks that they are not unknown in localities outside the northern province. Even if the Polyptychitids may have extended into the Tethyan

area during their acme, the fact remains that the long-ranging southern genera *Lytoceras* and *Phylloceras* did not normally live in the areas where Polyptychitids were abundant. The East Greenland faunas from Traill Ø and Albrechts Bugt may belong to a horizon in the Valanginian, marked by a temporary northward spread of *Lytoceras* and *Phylloceras*, which is unrepresented by faunas elsewhere in the "boreal province".

None of the Polyptychitids are unreservedly identified with species described from other areas, and the number of forms which are provisionally compared with existing species might be reduced if more material were available. Nevertheless the presence in the faunal list of a number of Russian species serves to emphasise that the nearest allies of the present fauna are to be found among the Russian and Siberian Polyptychitidae described by NIKITIN (1888), BOGOSLOVSKY (1902) and PAVLOV (1913). If there is a greater similarity, however, to Russian forms than to species from Speeton (England) and North Germany, this is probably due primarily to the absence of the faunas in question in the last two areas, rather than to faunal differentiation within the boreal province. Nevertheless, geographical dispersion is likely to have produced some local peculiarities, and certain characteristics of the East Greenland fauna are attributable with as much plausibility to this cause as to any age difference between the assemblage and its nearest relations. One such feature is the unusually strong forward curve of the ribs on the venter in most of the species, and another is the combination in several species of a Neocraspeditid trend in ornament with Polyptychitid or Euryptychitid shell-form. These features are manifested irrespective of the usual generic or subgeneric grouping and are evidence at once of the fundamental homogeneity of the Polyptychitidae, which underlies extreme differences in shell-form, and of the intricate interrelationships between ammonite "species". The attempt to classify the East Greenland material is a warning against any over-rigid subdivision of the Polyptychitidae.

Occasional reference is made in the specific descriptions to Californian species and one Greenland specimen is described as a new variety of a Californian form. There is no general similarity between the Valanginian faunas of California and Greenland, and the apparent relationship of one or two species may not be very close.

The age of the Valanginian fauna will only be considered briefly. The best-known succession in the Polyptychitid province is at Speeton in Yorkshire, England (SPATH, 1924), but unfortunately it affords no close parallel with the present fauna. The East Greenland assemblage clearly has no affinity with the earliest Polyptychitan faunas, of the *diplotomus* and *brancoi* zones, which are found in Northern Germany (VON KOENEN 1909) but are not represented at Speeton. Neither is there much in common with the ammonites of the *ramulicosta* zone at Speeton

(bed D₃), but there are some grounds for comparison with the *dichotomus* fauna which occurs at Speeton derived in bed D₂. Both are characterised by the presence of *Euryptychites* and *Neocraspedites*, and there is a fairly close resemblance between the species of *Euryptychites* in the two faunas. On the other hand, *Dichotomites* of the *bidichotomus* group, prominent at Speeton, have not been found in East Greenland, which moreover yields a number of species which can be matched from Russia but not from Speeton. Since the upper part of the Valanginian is incompletely represented by the derived faunas at Speeton, closer dating in terms of the Speeton succession is not possible, and the precise equivalents of the East Greenland fauna and its Russian relations are not found in Yorkshire. The tentative conclusion is that the East Greenland fauna represents a horizon near the top of the Polyptychitan Age.

Aptian.

The Aptian beds are dated by an example of *Sanmartinoceras*, closely comparable with European species of the genus which had a wide distribution during the Gargasian stage of the Upper Aptian. The only other fossils, apart from *Inoceramus*, are specimens of *Lytoceras* which agree with *L. polare* Ravn already described from East Greenland.

Albian.

The Lower Albian at locality 74 is dated by a fragment of *Leymeriella*, a genus familiar in England and France. The other ammonites in the fauna belong to two genera which are unknown in the north-west European area. One, described on page 115 as "*Puzosia*" *sigmoidalis*, is a new Desmoceratid which can only be matched in a fauna from Alberta, Canada. Other, probably different, Desmoceratids are recorded from the Lower Albian of Geographical Society Ø by SPATH (1946, p. 9) as *Puzosia* (*Callizoniceras*?) sp. and *Beudanticeras* cf. *hulenense* Anderson, and by the present writer (1949, p. 7) as *Puzosia* sp., but these species, which are all represented by poorly preserved material, have not been studied in detail.

The second genus, *Archthoplites*, is known from Spitzbergen as well as from East Greenland and Central Russia whence it was originally described, but none of the material found outside Russia is good enough, to judge from figured examples, for satisfactory comparison with the type-figures. The specimens from Spitzbergen and East Greenland all appear to be close to the type-species *A. jachromensis* (Nikitin), although better material might reveal differences.

In comparison with more southerly areas, the Lower Albian fauna of Traill and Geographical Society Øer is meagre. None of its southern

companions accompanied *Leymeriella* to East Greenland. *Archhoplites* seems to have been a true boreal genus, perhaps spreading westwards from Russia, and "*Puzosia*" (gen. nov.) *sigmoidalis*, together with the *Beudanticeras* cf. *hulenense* recorded by SPATH, link the area with North America, *B. hulenense* being a Californian species.

Higher beds in the Albian have yielded fragments of Mortoniceratids, but as in the case of the Hoplitids from Geographical Society Ø (SPATH, 1946, p. 9; DONOVAN, 1949, p. 7), no material suitable for extensive study has been found. Some of the Middle Albian Hoplitids are like English forms (SPATH, *loc. cit.*) but others cannot be matched by European species (DONOVAN, *op. cit.* p. 9). *Inoceramus* and *Aucellina*, common at some horizons in the Middle and ? Upper Albian, are both well-known European lamellibranch genera.

Cenomanian.

The Cenomanian beds are securely dated as belonging to the Varians Zone by numerous examples of the ammonite *Schloenbachia*, which agree with well-known European species. *Inoceramus crippsi*, the dominant lamellibranch, is also a characteristic European species, although similar ones are found in North America and their relationships to the European forms have not been fully investigated. The other members of the fauna are rare and do not merit comment, except for the shell recorded as *Variamussium* cf. *ignoratus* (Ravn) which remains something of a puzzle. Species which are closely similar are found in the Albian (DONOVAN, 1949, pp. 7, 10) of Geographical Society Ø and the Upper Cretaceous (? Senonian) of West Greenland, but no closely comparable forms have been recognised from the Cretaceous of Europe or North America.

Turonian.

Two species of *Scaphites* have been found in the Turonian. They are identified with described species with reservations which are due to the inadequacy of the material rather than to any positive differences. One species, *Scaphites* sp. cf. *geinitzi*, shows similarity to both European and Canadian species and it is unknown to which it is more closely related. The second species is compared with *S. morrowi* which was described from Kansas. Several other North American species of *Scaphites* belong to the same species-group as *S. morrowi*, which seems to be unrepresented in Europe. Both the species of *Scaphites* indicate an Upper Turonian date. *S.* aff. *lamberti* was recorded from Geographical Society Ø by SPATH (1946, p. 11) but this species has not been found by the present writer, neither has *Prionotropis*, a common European and American Turonian ammonite also recorded by SPATH (*loc. cit.*). On account of the rarity of

identifiable Turonian ammonites from East Greenland (three specimens examined by SPATH and three by the present writer) it would be unsafe to assert that the *Prionotropis* indicates a different horizon from the Traill Ø *Scaphites*.

The Turonian *Inoceramus*, identified with the European *I. lamarcki*, cannot be discussed at length since no complete or uncrushed examples were found. *I. lamarcki* is an exceedingly variable species and most of the Traill Ø fragments can be matched with British examples. A number of species of *Inoceramus* have been set up by McLEARN (1926) and WARREN (1930) for material from Alberta which includes examples close to *I. lamarcki*.

Senonian.

The *Sphenoceras* Beds are characterised by species of the *steenstrupi-patootensis* group which are common in the Upper Santonian and Lower Campanian of Europe, West Greenland and Canada. The only other identifiable lamellibranch is *Oxytoma tenuicostata* which closely resembles European forms, as do the examples from Knudshoved in Hold with Hope. The West Greenland species of *Oxytoma* is also regarded by the present writer as more closely comparable to the European *O. tenuicostata* than to the North American *O. nebrascana* with which it was identified by RAVN (see p. 88). The geographical distribution of the crab *Linuparus dülmensis* is fully described on page 125. The *Sphenoceras* Beds have yielded no ammonites, so their age cannot be exactly determined.

The unique occurrence of Upper Campanian at locality 58 is dated by *Scaphites greenlandicus* and allied species which were distributed, at this time, in a belt which included Germany, East Greenland, West Greenland and part of North America. Two of the lamellibranch species of this date are common to East and West Greenland and one of these (*Nucula cancellata*) also occurs in North America. The third lamellibranch recorded (*Lucina laminosa*) is as widely distributed as the *Scaphites*, being recorded from Bohemia, Sweden, Denmark, and North America. It may be represented by the imperfectly known *L. pfaffi* from West Greenland.

XIII. SUMMARY OF RESULTS

1. An extensive investigation of the Mesozoic rocks of Traill Ø, East Greenland, has been made for the first time, and a detailed stratigraphical and palaeontological account is given.
2. The Jurassic rocks are referred to the predominantly sandy Yellow Series, of Bathonian—Callovian age, and the argillaceous Black Series, Oxfordian—Kimmeridgian age, and are comparable to the development in the area from 74° N. to 75° N. latitude. The Upper Portlandian may be represented.
3. The Cretaceous rocks are largely shales and are shown to include formations belonging to the ? Upper Infravalanginian, Middle Valanginian, Upper Aptian, Albian, Lower Cenomanian, Upper Turonian and Senonian stages. The Valanginian, Aptian and Albian beds are also represented between 73° N. and 75° N. latitude, but the Cenomanian and higher beds have only been found in the area of Traill and Geographical Society Øer, with the exception of the Senonian of Hold with Hope. The highest Senonian fauna, of Upper Campanian age, is the youngest Mesozoic fauna known from East Greenland, and is closely related to the fauna of the same age in West Greenland.
4. The Jurassic faunas closely resemble those already described from Jameson Land and Milne Land by SPATH (1932, 1935). Elements from the faunas occur also in Spitzbergen and Franz Josef Land, and there are close parallels in western North America.
5. The Cretaceous faunas show affinities with both North America and Europe. Much of the material is indifferently preserved, but the good Polyptychitid ammonite fauna from the Middle Valanginian is noteworthy. The Albian fossils represent a still incompletely known fauna, but the Cenomanian ones are for the most part of European affinities. The Turonian and Senonian faunas include species of *Scaphites* and *Inoceramus* with both North American and European connections, and the Senonian crab *Linuparus dülmensis* was an unusual find.

6. The main structural elements within the area are faults, which define a graben within which the Cretaceous rocks are preserved. The age of the faulting is unknown but presumably Tertiary.
 7. The igneous rocks comprise plutonic masses of syenite, with associated minor intrusions, and a series of basic intrusions. Some or all of the igneous rocks are post-Campanian but there is no more exact evidence as to their age.
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Stratigraphical Table.

System	Stage		Formations in Traill Ø
CRETACEOUS	SENONIAN	CAMPANIAN { Upper Lower	Shales of Locality 58.
		SANTONIAN { Upper Lower	<i>Sphenoceras</i> Beds
		CONIACIAN { Upper Lower	
	TURONIAN { Upper Lower		Sandstones & shales of the Rold Bjerge
	CENOMANIAN { Upper Lower		
	ALBIAN { Upper Middle Lower		Middle Cretaceous Shale Series
	APTIAN { Upper Lower		Shales of localities 9, 27.
	BARREMIAN		
	HAUTERIVIAN		
	VALANGINIAN { Upper Middle Lower		? Albrecht's Bugt Facies at locality 92
	INFRavalanginian { Upper Lower		<i>Pachyteuthis</i> Beds
JURASSIC	PORTLANDIAN { Upper Middle Lower		Nodules of localities 104, ?121
	KIMMERIDGIAN { Upper Middle Lower		Black Series
	OXFORDIAN { Upper Middle Lower		
	CALLOVIAN { Upper Middle Lower		Yellow Series
	BATHONIAN { Upper Middle Lower		

APPENDIX

List of Geological Localities in Traill Ø.

The following list includes all the localities referred to in the foregoing paper, together with the area in which they are situated and the map on which they are shown. Where a mountain flanks a valley the boundary between the two, for the purpose of the description of localities, is necessarily arbitrary.

Localities	Situation	Map
1	Sortefjelde	Pl. 4, fig. 2.
2	—	} Pl. 2.
3	Morris Bjerg	
4, 5	Sortefjelde	} Pl. 4, fig. 2.
6, 7	—	
8, 9, 11, 13, 14, 15	Bjørnedal	} Pl. 2.
16	Morris Bjerg	
17, 18, 19	Bjørnedal	
22, 23, 26, 27, 28	Morris Bjerg	
30, 31	Bjørnedal	
32	Morris Bjerg	
37, 39, 40, 41	Bjørnedal	
42, 43, 44	Lycett Bjerg	
47	Sortefjelde	} Pl. 3.
50, 51, 52, 55, 56	Rold Bjerge	
57	Lilleelv	
58	Maanedal	
59, 60, 61	Rold Bjerge	
62, 63, 64, 65, 66, 67	Maanedal	
68	South of Maanedal	
69	—	Not on map. About 8.5 km south of locality 66.
71	Maanedal	} Pl. 3.
73, 74	Rold Bjerge	
75	Maanedal	
76	Rold Bjerge	
78, 79, 80	North of Rold Bjerge	
81	Scott Kelties Øer	
82, 83	Rold Bjerge	
84, 85, 86, 87	Bordbjerget	

(continued)

Localities	Situation	Map
88, 89	Scott Kelties Øer	} Pl. 3.
91	Rold Bjerger	
92	Mols Bjerger	Pl. 4, fig. 1.
B92	Lycett Bjerger	Pl. 2.
93	Mols Bjerger	Pl. 4, fig. 1.
B93	Lycett Bjerger	Pl. 2.
94, 98, 101, 102, 103, 104, 105, 110, 112	Mols Bjerger	Pl. 4, fig. 1.
120, 121, 123, 124, 125	Lycett Bjerger	} Pl. 2.
126, 127, 128	Bjørnedal	
129, 130, 131	Lycett Bjerger	
133, 135	Prospektfjeld	
136, 137	Lycett Bjerger	
138	Bjørnedal	
139, 140, 141	Lycett Bjerger	
142, 143	Svinhufvuds Bjerger	Pl. 4, fig. 2.
144—150	—	Pl. 4, fig. 2 ¹⁾ .
151	—	Pl. 4, fig. 2.

¹⁾ These locality numbers mainly refer to finds in loose debris within a small area. It was not practicable or necessary to plot them individually on the map.

PLATES

Plate 1.

Generalised geological map of the eastern part of Traill Ø. The igneous intrusions, outside the principal syenite areas, have been omitted. Scale 1:250,000.

The four rectangles on the map indicate, from above downwards and from left to right, the areas covered by the other maps in this paper, as follows: plate 3; plate 4, fig. 1; plate 4, fig. 2; plate 2.

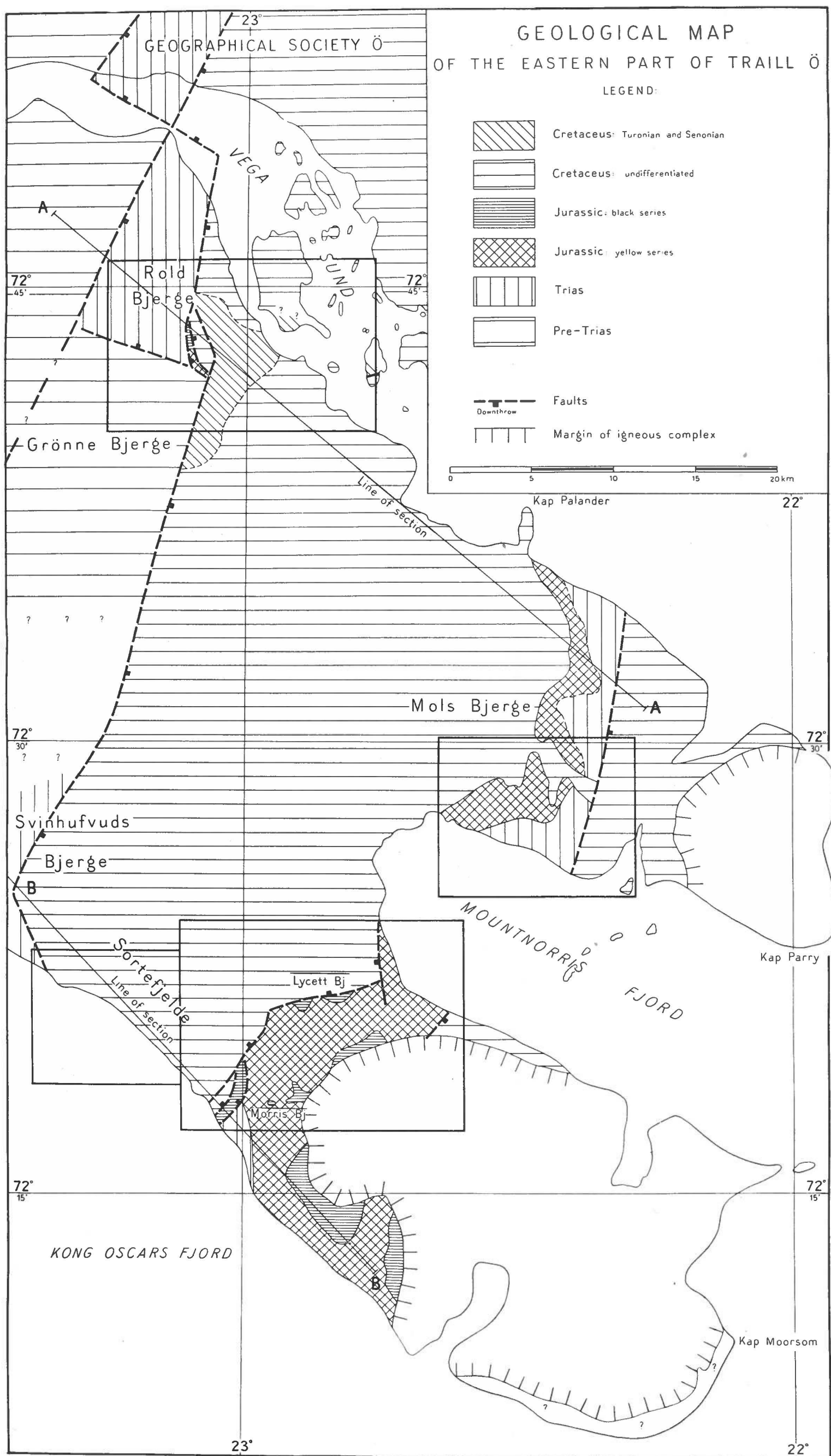


Plate 2.

Geological map of the neighbourhood of Bjørnedal, Traill Ø. Scale 1:66,666.

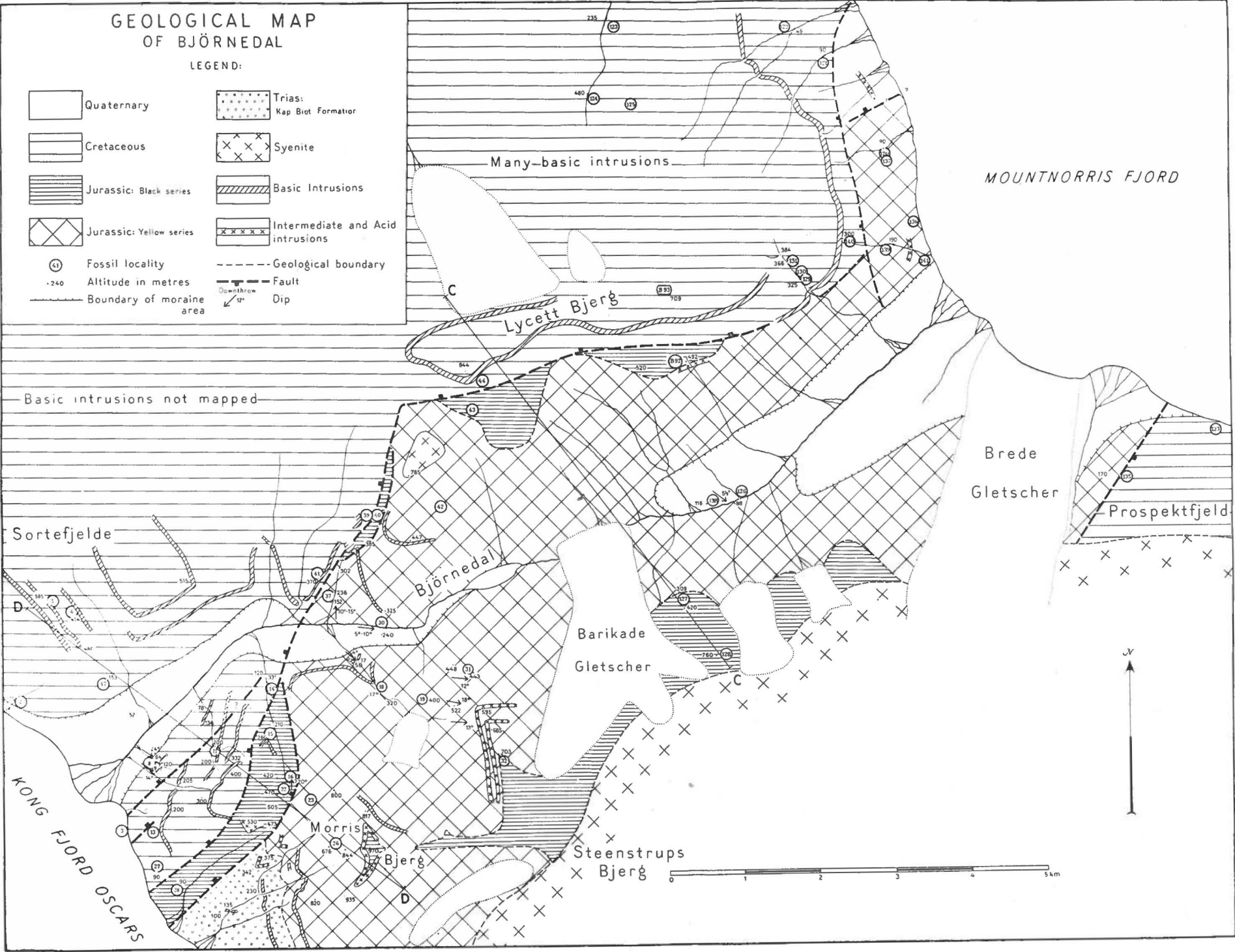


Plate 3.

Geological map of the neighbourhood of the Rold Bjerge, Traill Ø. Scale 1:50,000.

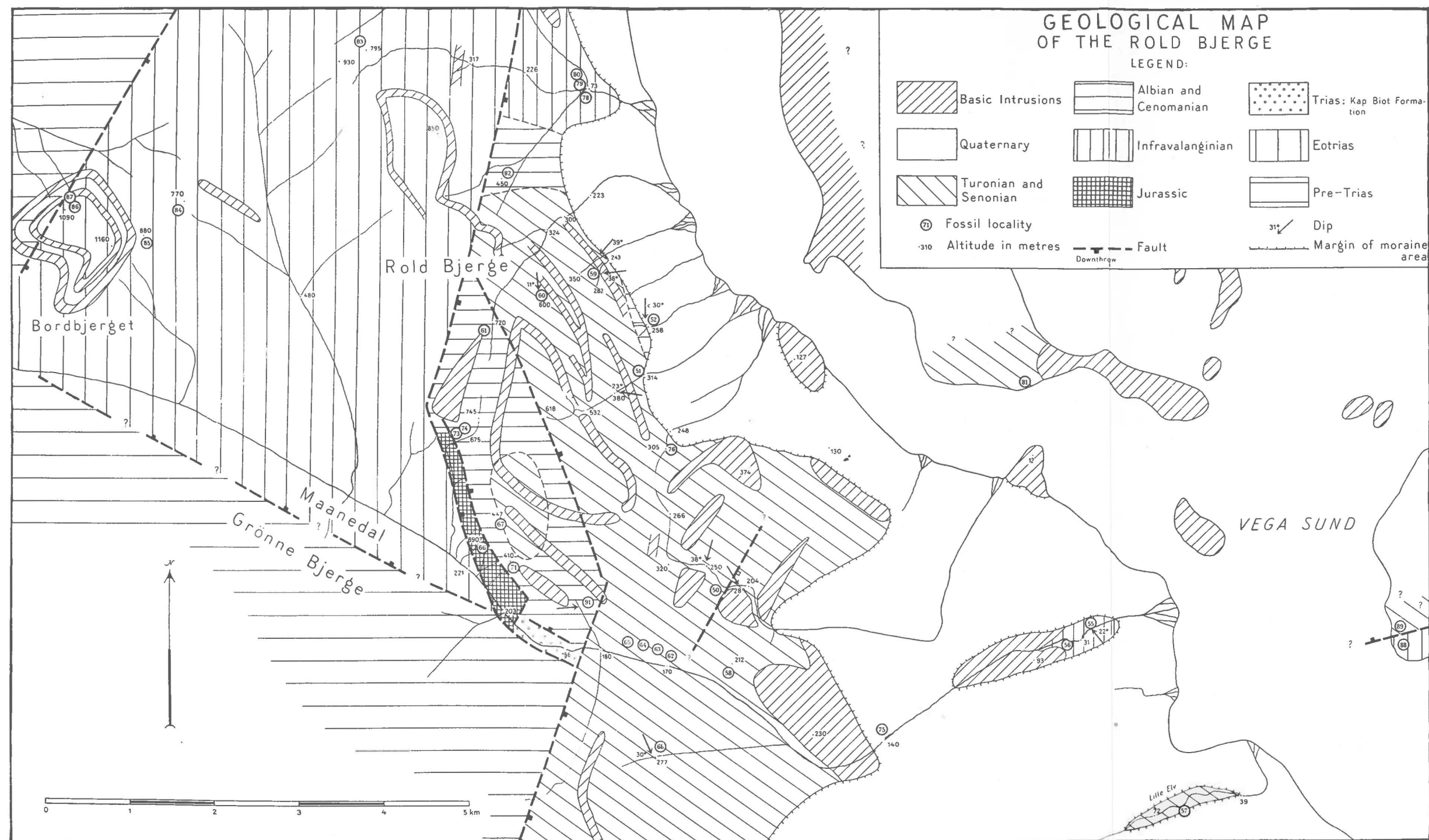


Plate 4.

- Fig. 1. Geological map of the southern part of the Mols Bjerge, Traill Ø. The igneous intrusions have been omitted. Scale 1:100,000.
- Fig. 2. Geological map of part of the Svinhufvuds Bjerge, Traill Ø. Localities 144—150 represent finds in loose debris within a small area, and it was not possible to plot them individually on the map. Scale 1:100,000.

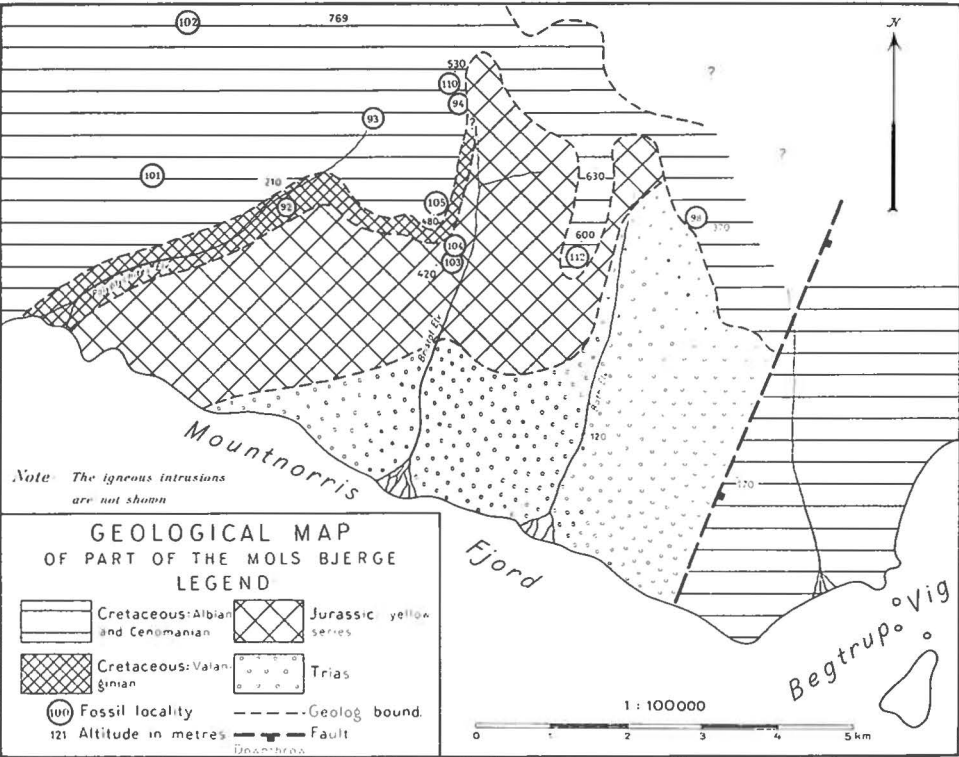


Fig. 1

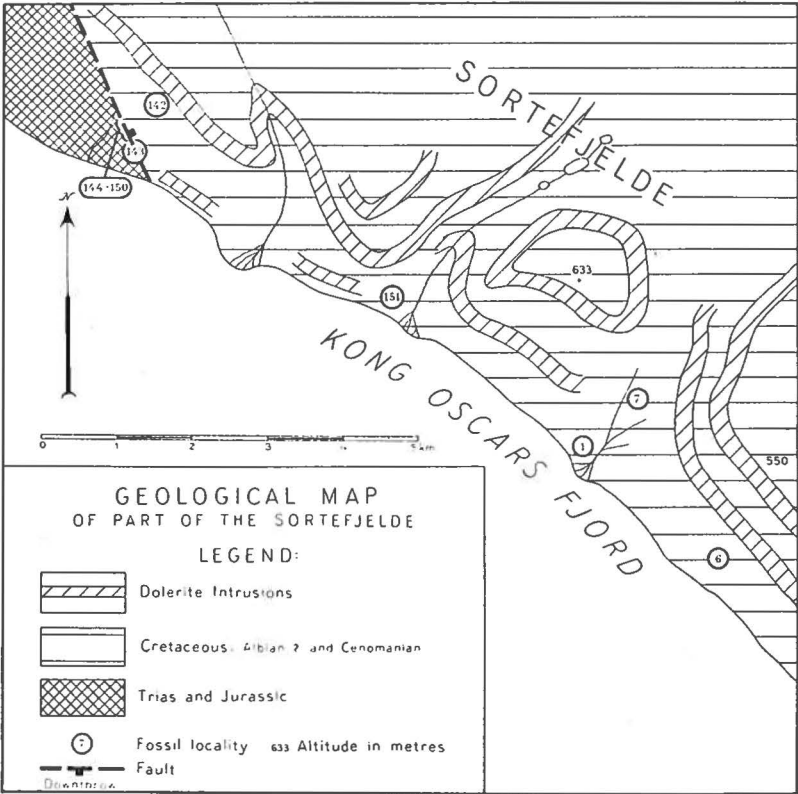


Fig. 2

Plate 5.

Generalised sections through the eastern part of Traill Ø. The upper section is along the line A-A on plate 1, the lower along the line B-B.

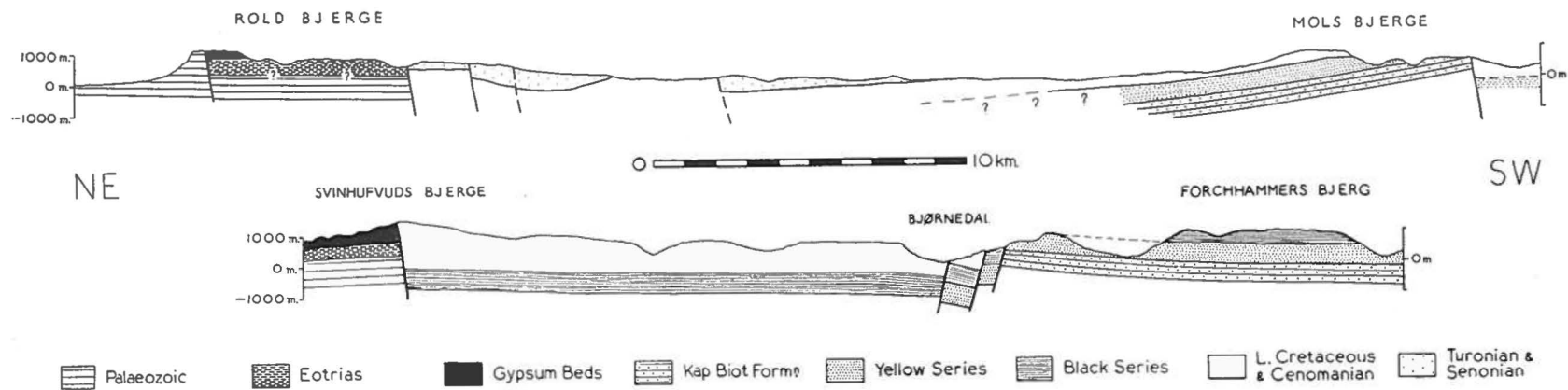


Plate 6.

- Fig. 1. Aerial view of the south-western flank of Morris Bjerg showing how the position of one of the faults (indicated by broken white line) is reflected by the topography. To the right of the fault are Triassic and Jurassic sandstones, to the left Upper Jurassic and Cretaceous shales. Another fault occurs within the shale area but its position is not indicated by the topography. Part of Bjørnedal is seen in the top left-hand corner of the picture. The position of locality 28 is shown.
- Fig. 2. Aerial view of Morris Bjerg from the north-west. The Bjørnedal stream is seen in the bottom left-hand corner, and part of Steenstrups Bjerg in the distance. The position of one of the main faults, also shown in fig. 1, is here again reflected by the topography, and is shown by a broken line. The positions of several fossil localities are shown.



Fig. 1.

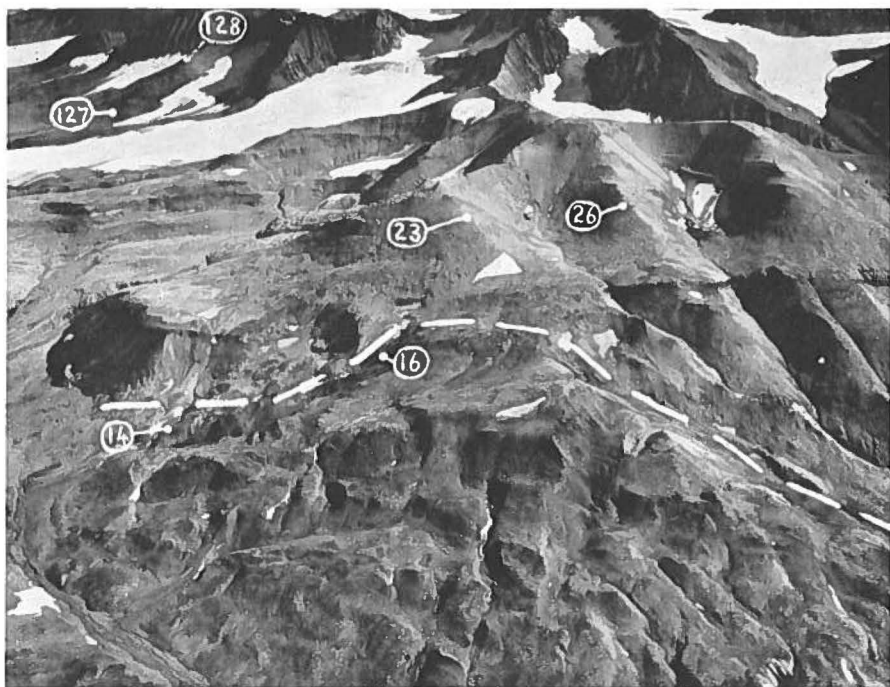


Fig. 2.

Plate 7.

- Fig. 1. Looking north across Bjørnedal. The right-hand summit is the western end of Lycett Bjerg, formed of light-coloured sandstones of the Yellow Series. A fault along the valley to the left of Lycett Bjerg brings in Cretaceous black shales, intruded by basic sills, which form the rest of the landscape.
- Fig. 2. The lower part of the exposure of sandstones, believed to belong to the Yellow Series, at locality 37.



Fig. 1.



Fig. 2.

Plate 8.

- Fig. 1. Aerial view of Prospektfjeld and Bredgletscher. Prospektfjeld is formed of black Albian and Cenomanian shales but a wedge of sandstones of the Jurassic Yellow Series occurs on the western flank, bounded by a fault (indicated by broken white line). The white patches to the left of the fault are debris from acidic minor intrusions. Jagged peaks of syenite form the hinterland.
- Fig. 2. Aerial view of Lycett Bjerg from the north, showing typical Cretaceous shale and dolerite topography. Beyond the summit are seen Steenstrups Bjerg (the highest peak), formed of syenite, Morris Bjerg, and Kong Oscars Fjord at the right-hand side of the picture.

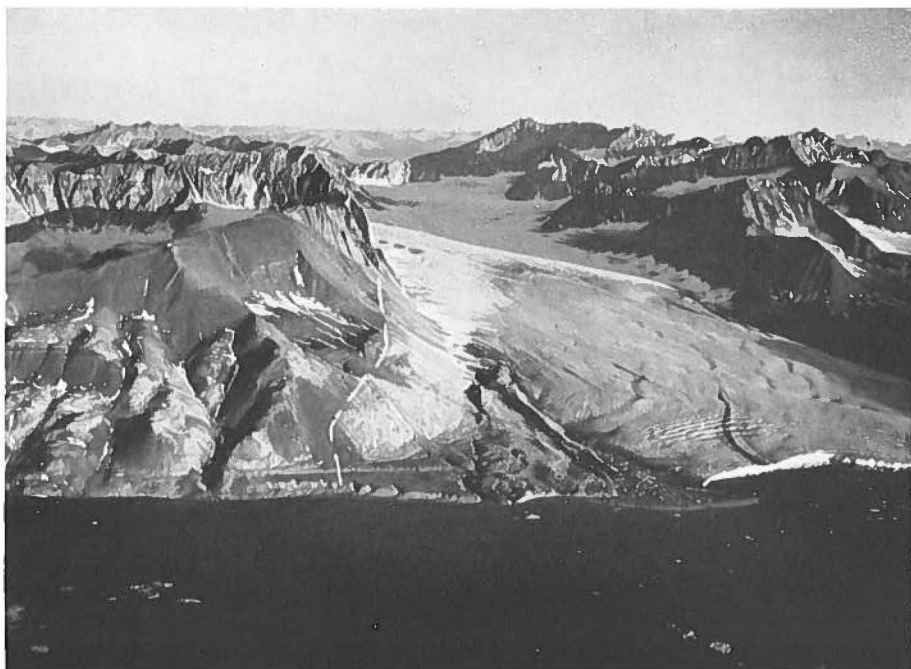


Fig. 1.



Fig. 2.

Plate 9.

- Fig. 1. Aerial view of part of the northern shore of Mountnorris Fjord, with Bristol Elv on the left and Bath Elv on the right. The spur between the two valleys is formed of sandstones of the Yellow Series dipping westwards and clearly shows the scarp (to the right) and dip-slope. The steep slope at the head of Bristol Elv is also formed of the Yellow Series. The black screes on the extreme right of the picture are derived from Cretaceous shales which overlie the sandstones.
- Fig. 2. Aerial view of the Rold Bjerge from the east. Part of the largest island of the Scott Keltie group appears in the bottom right-hand corner. The lower slopes above the shore are moraine. Above this are shales (mainly Cenomanian and Turonian) intruded by dolerite sills, with Triassic sandstones faulted against them at the right-hand side of the picture (fault indicated by broken white line). The same sandstones also form the flat-topped Bordbjerget seen just to the right of the centre of the picture. The distant mountains are formed of Devonian and Carboniferous rocks.



Fig. 1.



Fig. 2.

Plate 10.

- Fig. 1. Aerial view of the western part of Maanedal, from the south-east. The foreground is formed of the green sandstone series of ?Carboniferous age, and the country on the far side of the valley of Triassic sandstones. The flat-topped mountain almost in the centre is Bordbjerget, with a dolerite sill below the summit. Several dykes intrude the sandstones to the right of Bordbjerget. The distant mountains are on Geographical Society O.
- Fig. 2. Aerial view, from the north, of the north-western face of Bordbjerget, formed of ?Carboniferous and Permian rocks. Marine Permian fossils were found near the summit on this side. The country to the left of the summit is formed of Triassic sandstones faulted against the earlier beds.



Fig. 1.



Fig. 2.

Plate 11.

Fig. 1. Conglomerate and sandstone of ?Jurassic age in Maanedal. See page 26.

Fig. 2. Aerial view across part of Maanedal from the south. The foreground is composed of green sandstones of ?Carboniferous date. The white area almost in the centre and immediately beyond the stream is a faulted wedge of sandstones, probably the Jurassic Yellow Series, and beyond it lie Cretaceous shales intruded by dolerite. In the distance is Vega Sund with the Scott Kelties Oer, and Geographical Society O at the top of the picture. The positions of several geological localities are shown.



Fig. 1.



Fig. 2.

Plate 12.

Fig. 1. The upper conglomerate at locality 64.

Fig. 2. Large limestone boulder (immediately to left of figure) in Turonian conglomerate at locality 65.



Fig. 1.



Fig. 2.

Plate 13.

Fig. 1. Locality 62. Close-up of the top conglomerate. The scale is 15 cm long.

Fig. 2. Locality 62. Close-up of the limestone bed. The scale is 15 cm long.



Fig. 1.

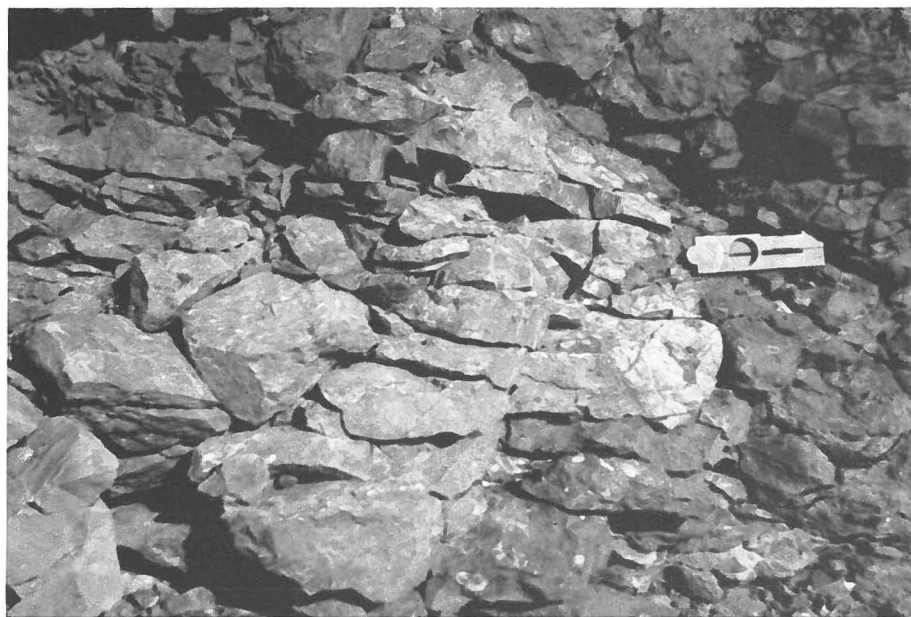


Fig. 2.

Plate 14.

- Fig. 1. Blocks of sandstone in Cenomanian black shales at the western end of the Sortefjelde. See page 37.
- Fig. 2. Looking along the fault on the south side of the Svinhufvuds Bjerger. The gully marks the position of the fault: to the left are sandstones of ?Jurassic age, to the right Cenomanian shales.



Fig. 1.



Fig. 2.

Plate 15.

- Fig. 1 *Camptonectes giganteus* Arkell. Right valve from locality 143, age unknown.
- Figs. 2 a, b *Arctocephalites (Craniocephalites) parvus* sp. nov. Side and peripheral views of holotype. Locality 120, ? Upper Bathonian, Pompeckji Zone.
- Figs. 3—5 'Onychites', type I. Locality 128, ? Lower Kimmeridgian.
- Figs. 6, 7 'Onychites', type II. Locality 128, ? Lower Kimmeridgian.
- Figs. 8 a, b *Arctocephalites (Craniocephalites) kochi* sp. nov. Side view of holotype (8 a) comprising body-chamber fragment including aperture, with the earlier part of the last whorl completed by an impression from the natural mould. 8 b, the same impression with the body-chamber removed to show the ribbing on the second half of the penultimate whorl. Locality 120. ? Upper Bathonian, Pompeckji Zone.

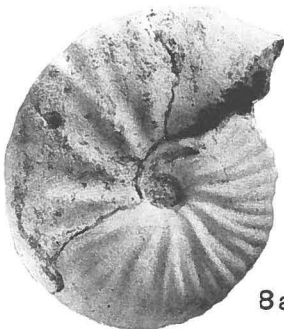
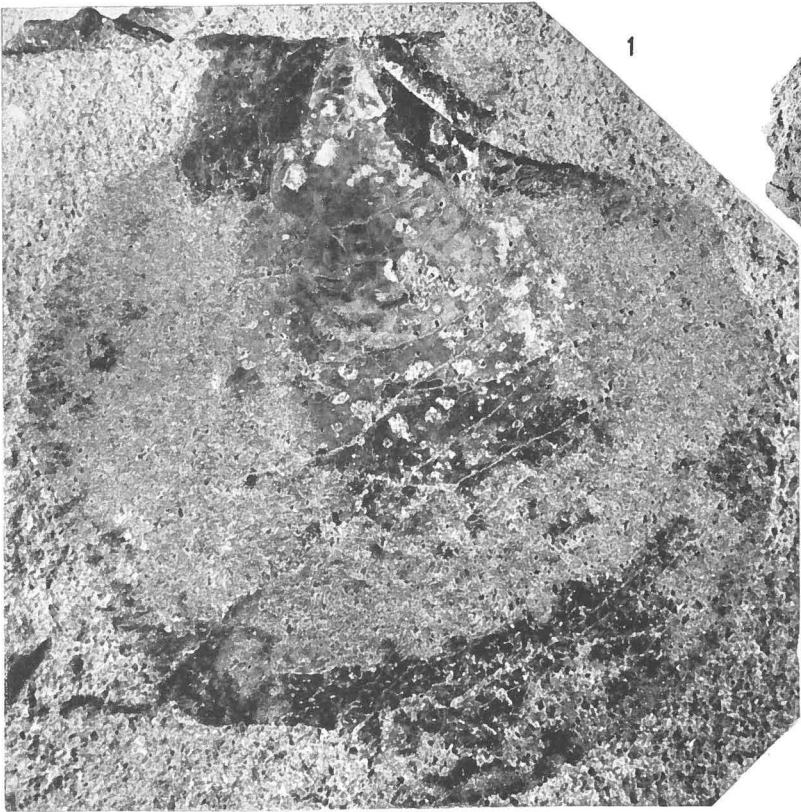


Plate 16.

- Figs. 1—3 *Arctocephalites (Cranoecephalites) maculatus* Spath var. *rusticus* nov. 1, holotype, 2, paratype, both from locality 136. 3, impression of natural mould from locality 120. All ?Upper Bathonian, Pompeckji Zone.
- Figs. 4 a, b *Arctocephalites (Cranoecephalites) vulgaris* Spath. Side and peripheral views of uncrushed body-chamber from locality 139, ?Upper Bathonian, Pompeckji Zone.
- Figs. 5 a, b *Arctocephalites (Cranoecephalites) kochi* sp. nov. var. *pygmaeus* nov. Side and peripheral views of holotype. Locality 137, ?Upper Bathonian, Pompeckji Zone.
- Figs. 6 a, b *Arctocephalites (Cranoecephalites) kochi* sp. nov. var. *latus* nov. Side and peripheral views of holotype body-chamber. Locality 137, ?Upper Bathonian, Pompeckji Zone.

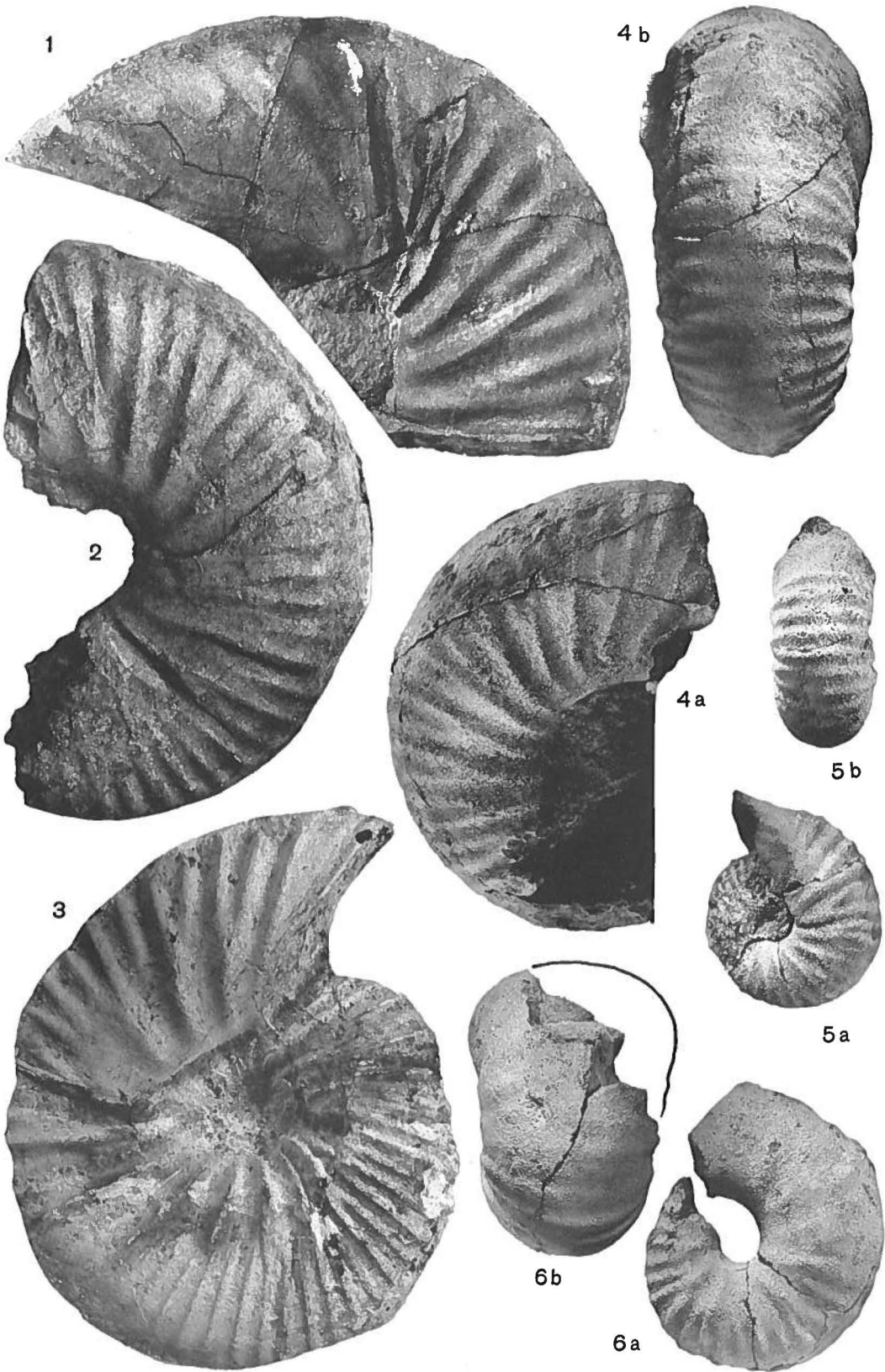


Plate 17.

Figs. 1 a, b *Kepplerites (Seymourites) traillensis* sp. nov. Side and peripheral views of holotype. Locality 31, Lower Callovian, Tychonis Zone.

Figs. 2 a, b *Arctocephalites (Cranocephalites) pompeckji* (Madsen) aff. var. *costata* Spath. Side and peripheral views of body-chamber from locality 147, ? Upper Bathonian, Pompeckji Zone.

Figs. 3 a, b *Arctocephalites (Cranocephalites) pompeckji* (Madsen) var. *intermedia* Spath. Side and peripheral views of septate example from locality 147, ? Upper Bathonian, Pompeckji Zone.

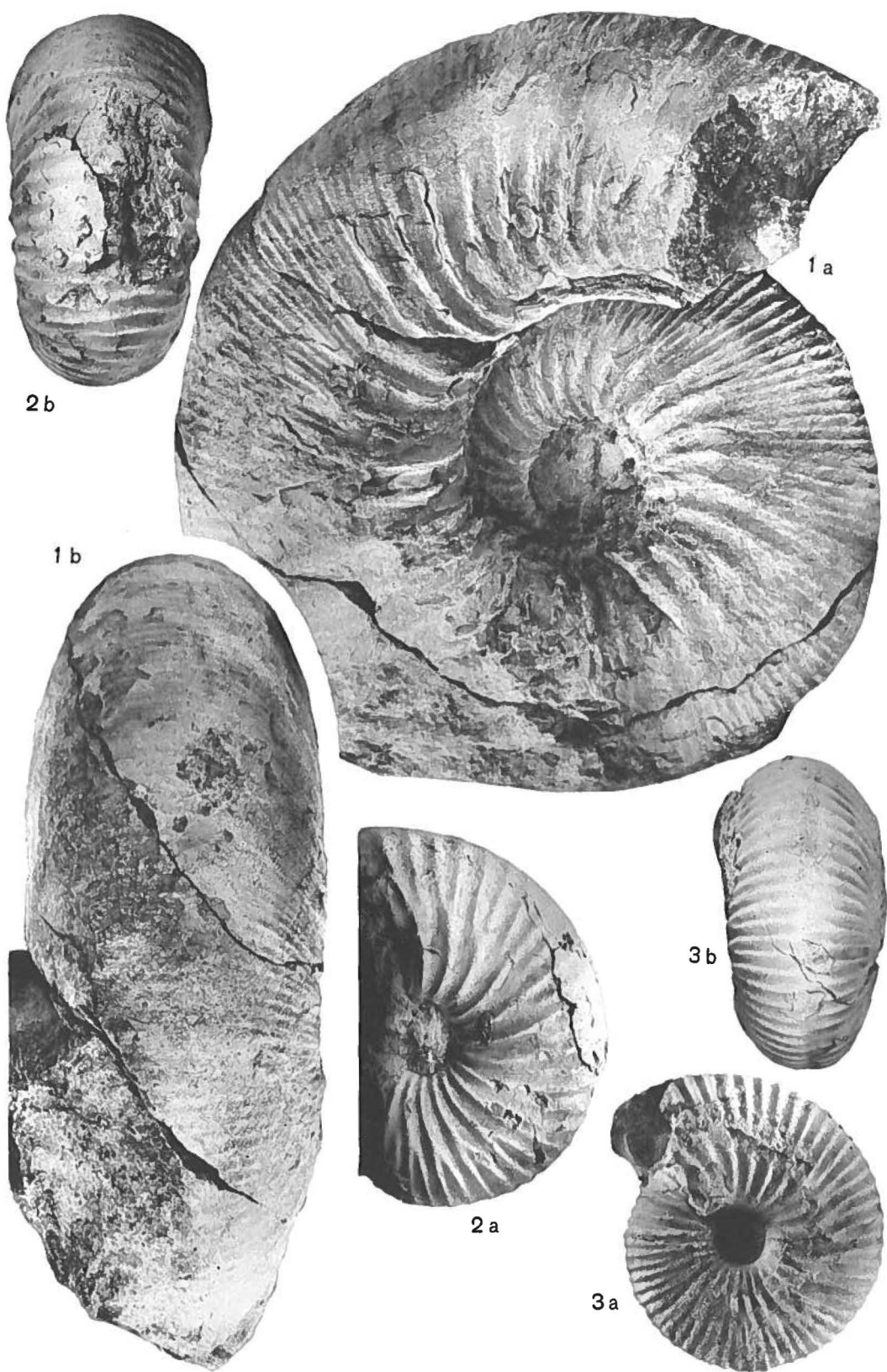


Plate 18.

- Figs. 1 a, b *Kepplerites (Seymourites) traillensis* sp. nov. var. *convergens* nov. Side and peripheral views of holotype. Locality 31, Lower Callovian, Tycho-nis Zone.
- Figs. 2—5 *Amoeboceras (Amoebites)* spp. indet. Crushed individuals from locality 16, Lower Kimmeridgian.
- Fig. 6 *Buchia* sp. indet. Locality 8, age unknown. $\times 2$.

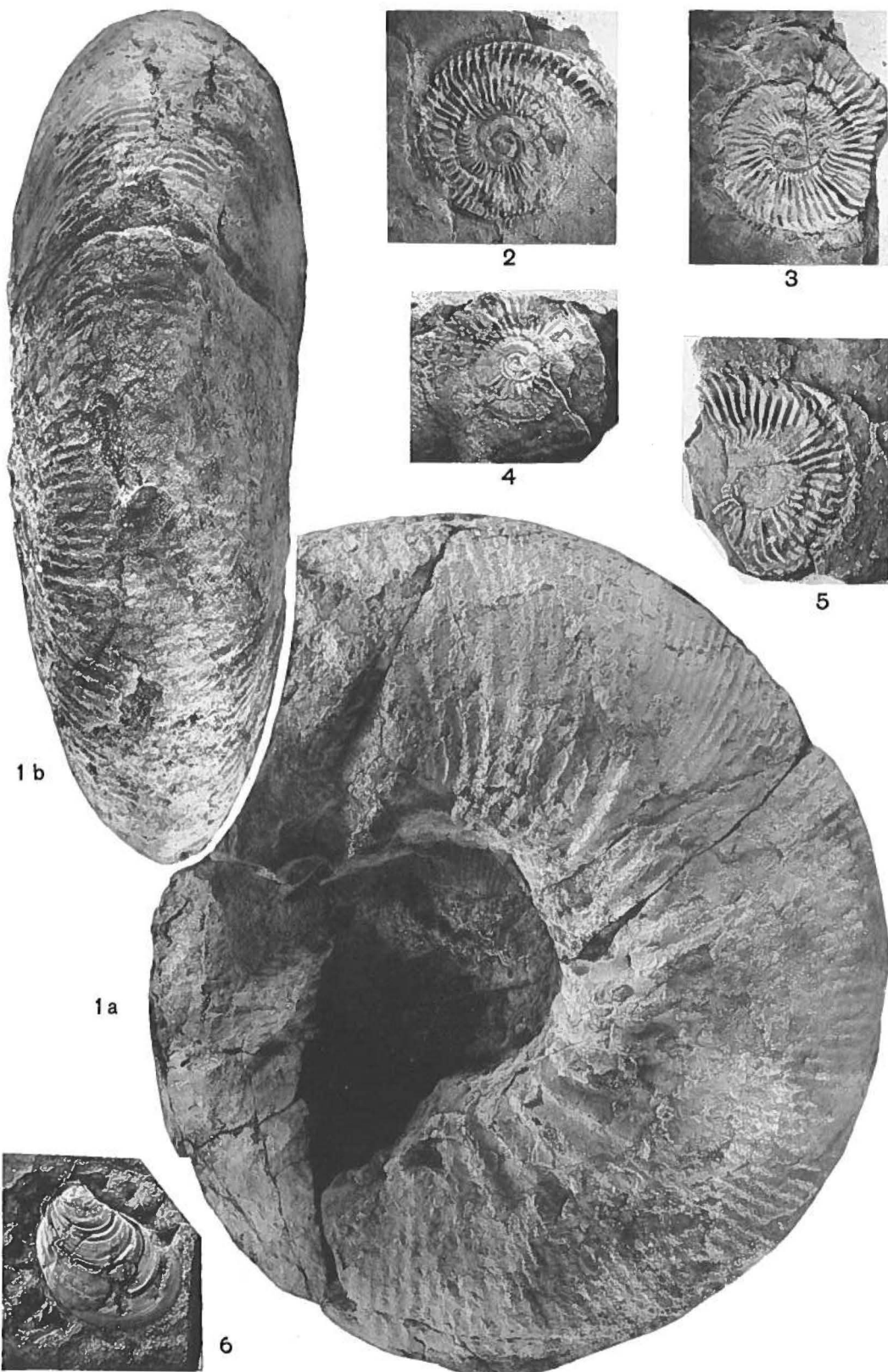


Plate 19.

- Figs. 1 a, b *Aucellina gryphaeoides* (J. de C. Sow.). Side and posterior views of an example from locality 112, ? Upper Albian.
- Fig. 2 *Pachyteuthis subquadratus* (Römer). Ventral view of an example from locality 92, Middle Valanginian.
- Figs. 3 a, b, 4 a, b. *Pachyteuthis* aff. *partneyi* (Swinerton). Ventral and right-hand-side views of examples from locality 14 (3 a, b) and locality 79 (4 a, b). Infravalanginian.
- Fig. 5. *Aucellina caucasica* (Abich). Left valve from locality 66, Middle-Upper Albian.
- Fig. 6 *Aucellina gryphaeoides* (J. de C. Sow.). Slab with several right valves. Locality 112, ? Upper Albian.
- Figs. 7, 8 *Aucellina caucasica* (Abich). 7, right valve, 8, left valve. Locality 66, Middle-Upper Albian.

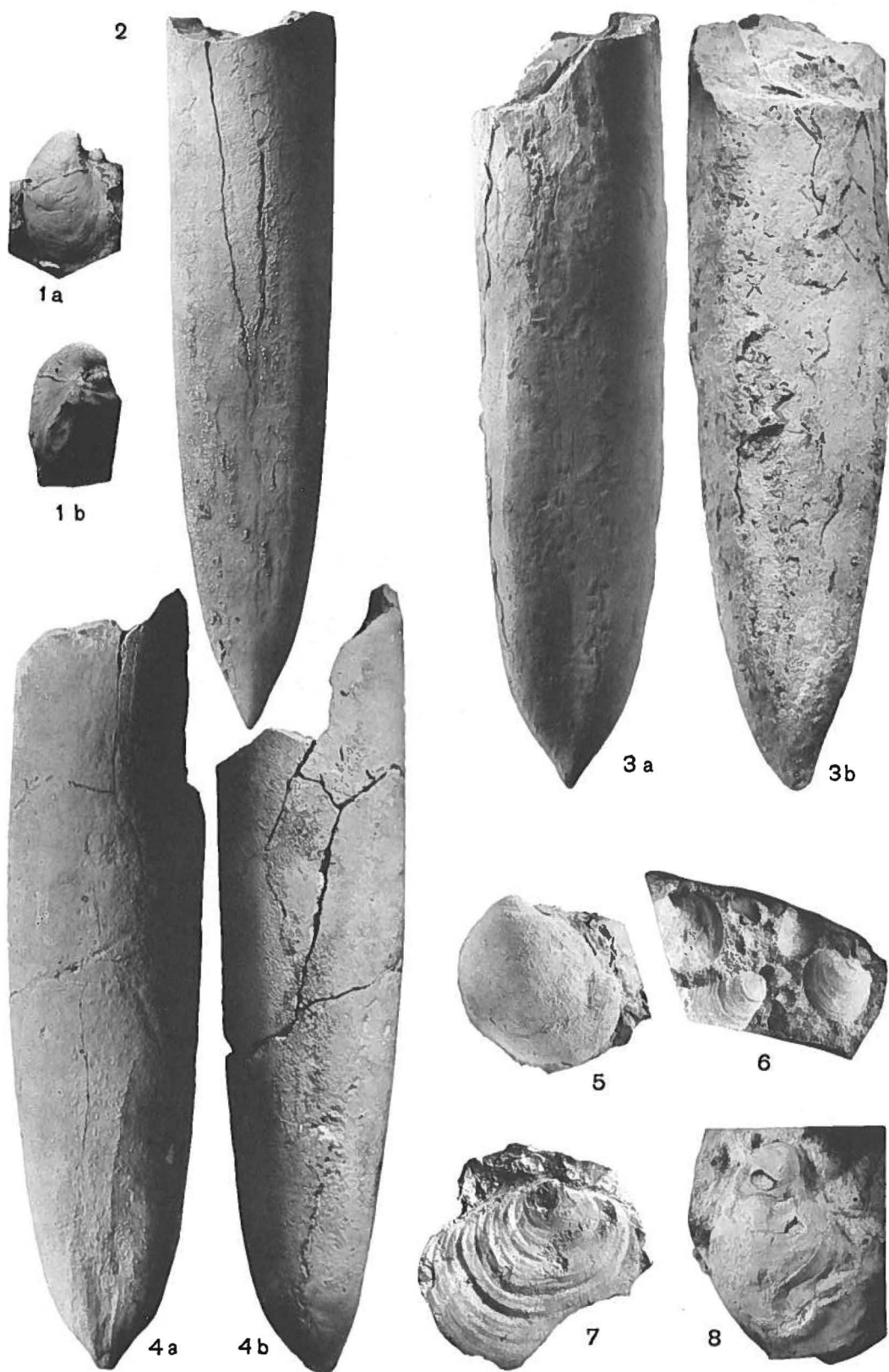


Plate 20.

- Figs. 1 a, b *Lytoceras* sp. cf. *exoticum* Uhlig. Side view and whorl-section of fragmentary specimen with part of body-chamber from locality 92, Middle Valanginian.
- Fig. 2 *Lytoceras* sp. cf. *exoticum* Uhlig. Side view of inner whorls. Same horizon and locality as figs. 1 a, b.
- Figs. 3 a, b *Lytoceras* sp. cf. *exoticum* Uhlig. Side and peripheral views of septate fragment to show suture-line. Same horizon and locality as figs. 1 a, b.
- Figs. 4 a, b *Polyptychites* sp. cf. *diptychoides* Pavlov and *variisculptus* Pavlov. Side and peripheral views of septate example from locality 92, Middle Valanginian.
- Fig. 5 *Polyptychites* *michalskii* (Bogoslovsky) aff. var. *tuberculata* (Bogoslovsky). Peripheral view of fragment from locality 92, Middle Valanginian.
- Figs. 6 a, b *Phylloceras* sp. Side and peripheral views of septate example from locality 92, Middle Valanginian.

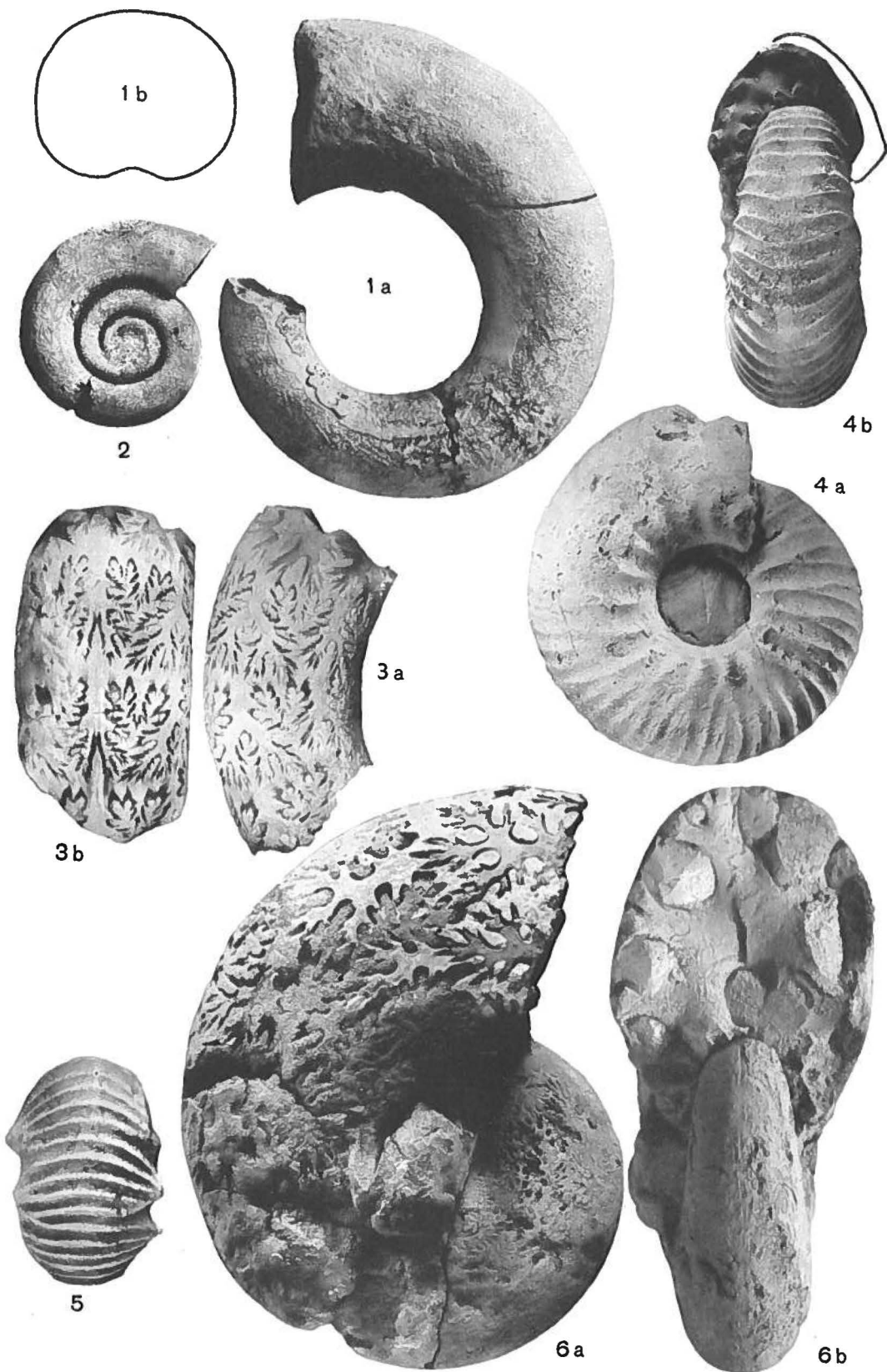


Plate 21.

- Figs. 1 a, b *Polyptychites* aff. *triptychiformis* (Nikitin). Side and peripheral views of septate example from locality 92, Middle Valanginian.
- Figs. 2 a, b *Polyptychites* cf. *middendorffi* Pavlov. Side and peripheral views of septate example from locality 92, Middle Valanginian.
- Figs. 3 a, b *Polyptychites mokschensis* (Bogoslovsky). Side and peripheral views of septate example from locality 92, Middle Valanginian.
- Figs. 4 a, b *Polyptychites* sp. II. Side and peripheral views of example from locality 92, Middle Valanginian.
- Figs. 5 a, b *Polyptychites undulatocostatus* sp. nov. Side and peripheral views of holotype. Locality 92, Middle Valanginian.
- Figs. 6 a, b *Polyptychites (Euryptychites) traillensis* sp. nov. Side and peripheral views of holotype. Locality 92, Middle Valanginian.

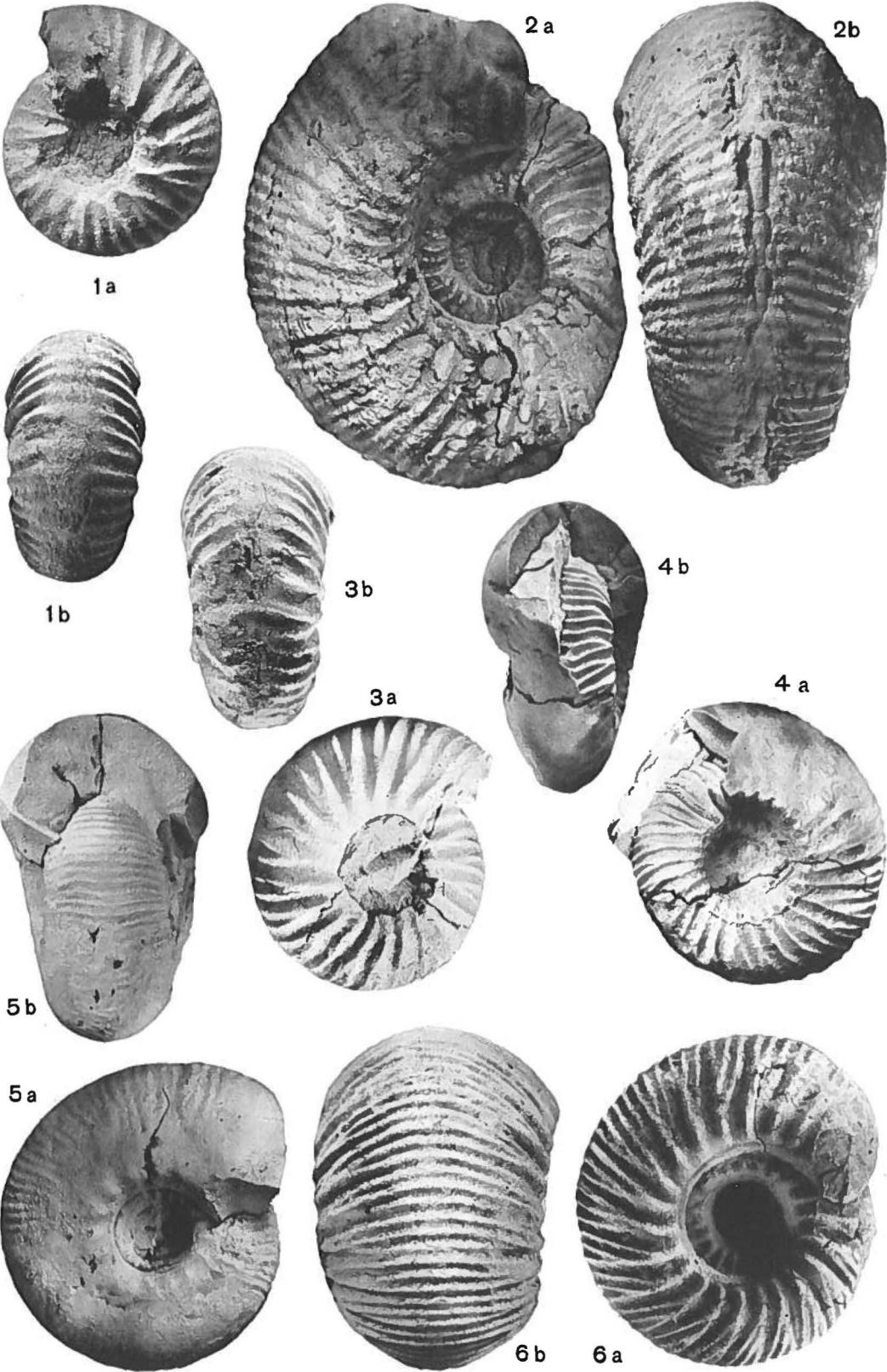


Plate 22.

- Figs. 1 a—f *Polyptychites (Euryptychites) laevis* sp. nov. Holotype. Side and peripheral views at three different sizes to show change of characters with growth. Locality 92, Middle Valanginian.
- Figs. 2 a, b *Polyptychites (Euryptychites) traillensis* sp. nov. Side views of inner whorls and detached outer whorl of example from locality 92, Middle Valanginian.
- Figs. 3 a, b *Polyptychites (Euryptychites) cf. traillensis* sp. nov. Side and peripheral views of example from locality 92, Middle Valanginian.

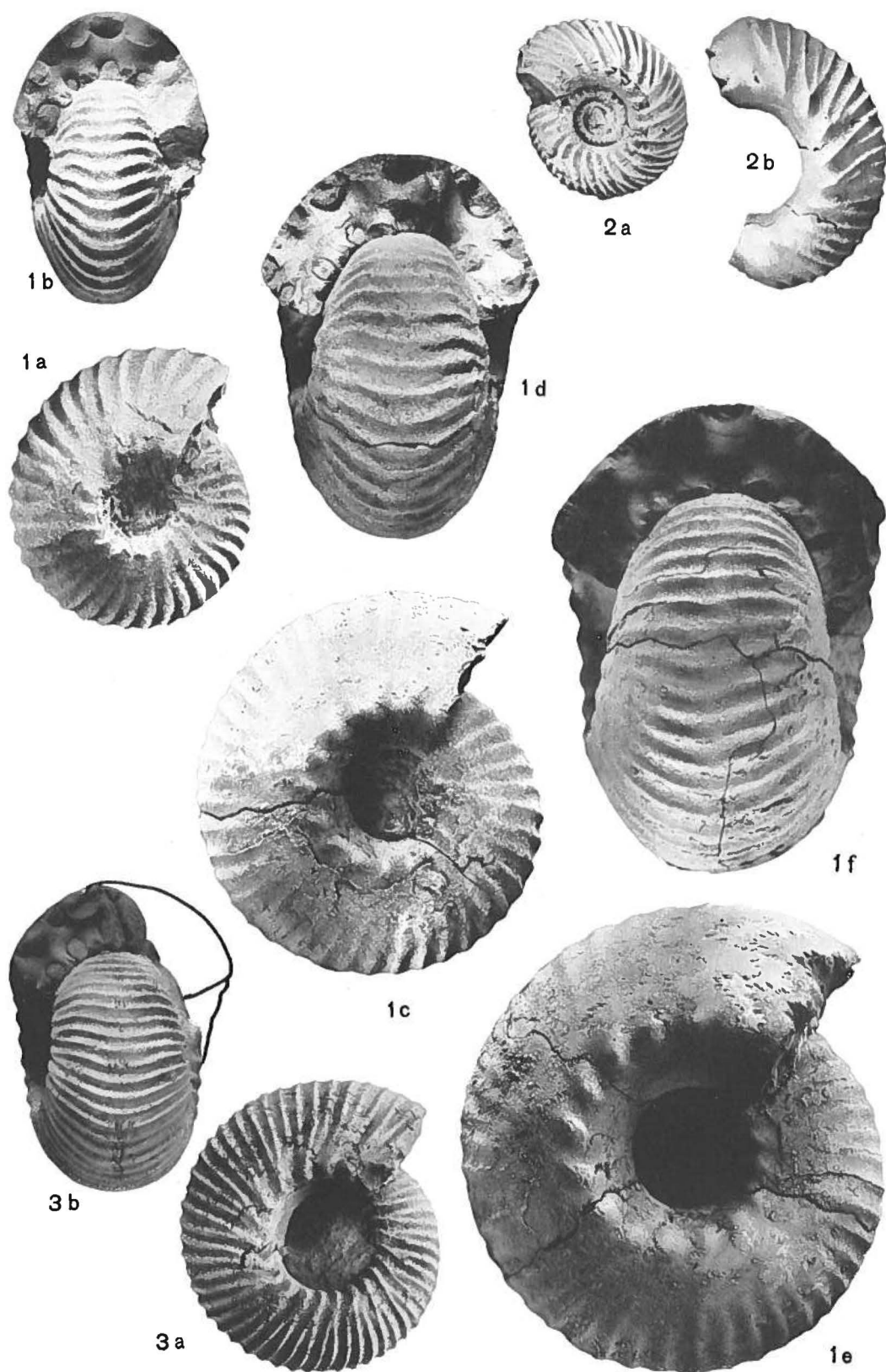


Plate 23.

Figs. 1 a, b *Dichotomites gregersenii* Anderson var. *paucicostatus* nov. Holotype. Locality 92, Middle Valanginian.

Figs. 2 a, b *Dichotomites* sp. ? nov. Side and peripheral views of example from locality 92, Middle Valanginian.

Figs. 3 a—d *Neocraspedites evolutus* sp. nov. Holotype. 3 a, b, side and peripheral views of fragment of inner whorl. 3 c, d, side view and whorl-section of outer whorl (the fragment of inner whorl figured in 3 a is shown in position in 3 c). Locality 92, Middle Valanginian.

Figs. 4 a, b *Neocraspedites greenlandicus* sp. nov. Side and peripheral views of holotype. Locality 92, Middle Valanginian.

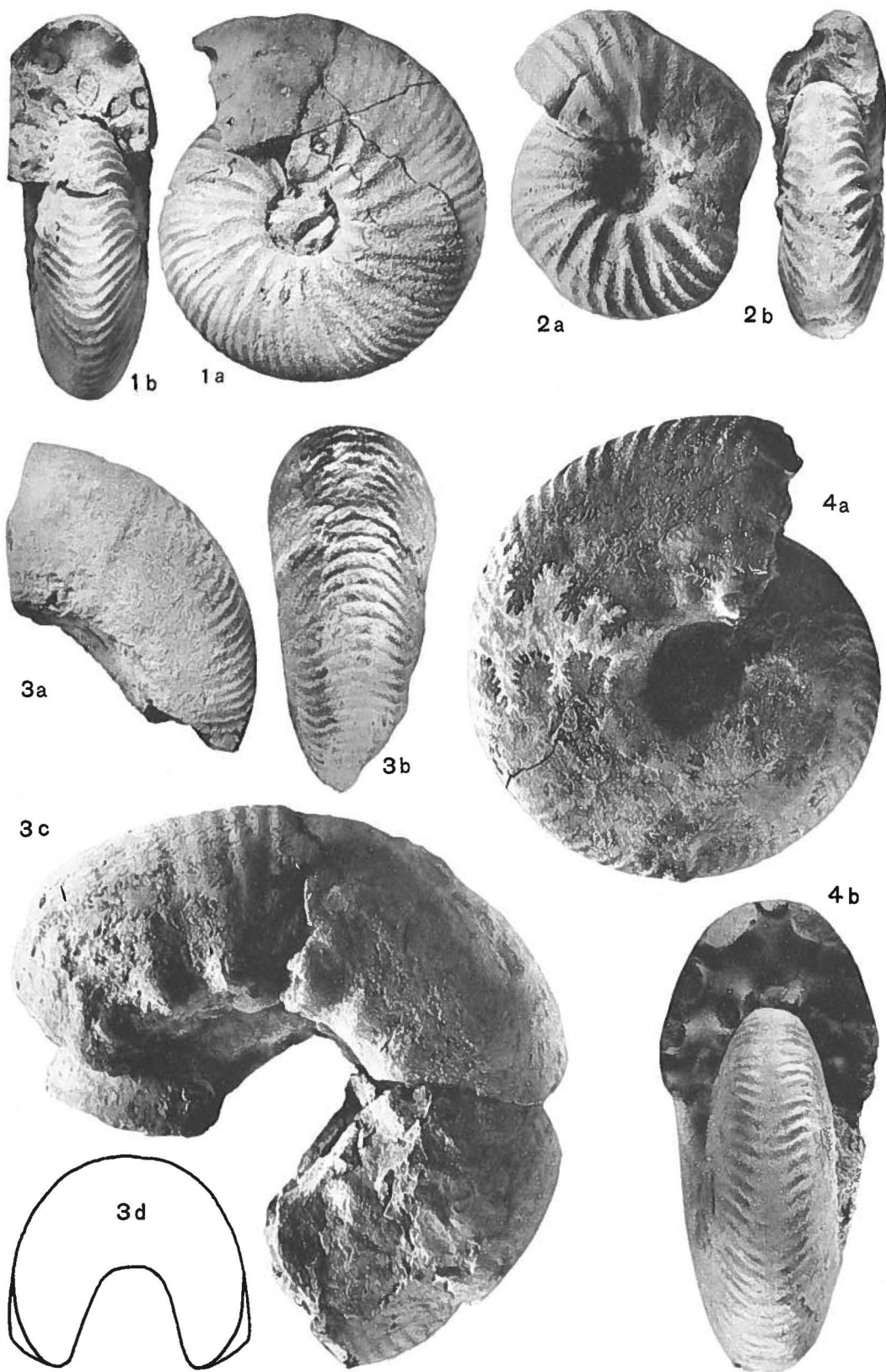
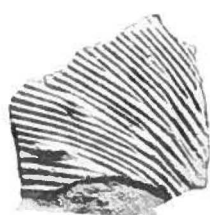
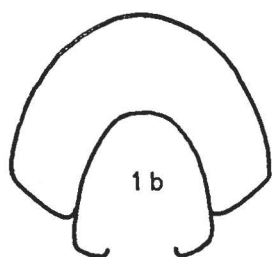
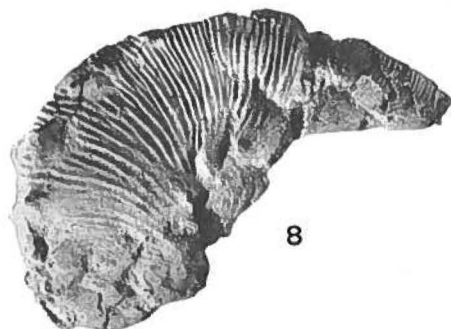


Plate 24.

- Figs. 1 a, b *Necraspedites* sp. Side view (1a) and whorl-section (1b) with outer whorl restored from fragments not shown in 1a. Locality 92, Middle Valanginian.
- Fig. 2 *Entolium* cf. *orbicularis* (J. Sowerby). Example from locality 8, Geographical Society O (see Donovan, 1949, p. 7). Lower Albian.
- Figs. 3—6 "*Puzosia*" *sigmoidalis* sp. nov. 3, holotype; the last quarter-whorl is body-chamber. 4, example with more widely-spaced constrictions than holotype. 5, 6, examples with ribs between the constrictions. All from locality 74, Lower Albian (Leymeriellan), Tardefurcata Zone.
- Fig. 7 *Sanmartinoceras* ?*haugi* (Sarasin). Crushed example from locality 9, Upper Aptian.
- Fig. 8 *Scaphites nodosus* var. *quadrangularis* Meek and Hayden. Side view of impression from natural mould of body-chamber. Locality 58, Upper Campanian.
- Figs 9, 10 *Scaphites greenlandicus* sp. nov. 9, side view of impression from natural mould of part of body-chamber. 10, fragment of body-chamber including two tubercles. Both from locality 58, Upper Campanian.



10



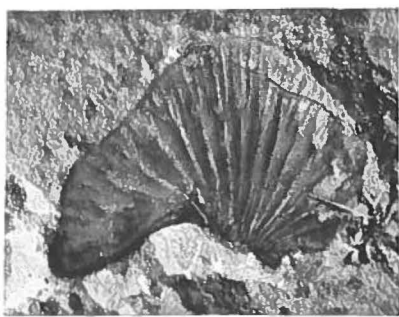
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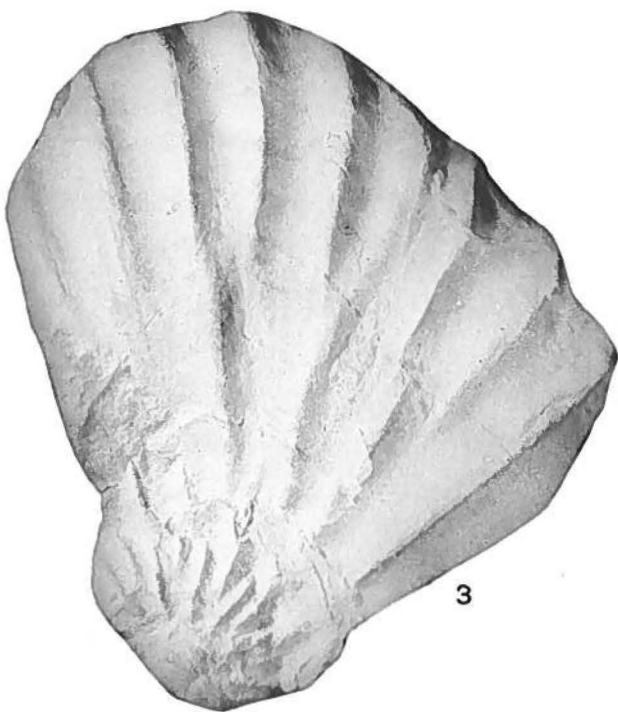
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Plate 25.

- Fig. 1 *Scaphites* sp. cf. *geinitzi* d'Orbigny. Crushed body-chamber from locality 59, Upper Turonian.
- Fig. 2 *Linuparus dülmensis* (Geinitz). Dorsal view of incomplete carapace from locality 50, Upper Santonian or Lower Campanian. $\times 2$.
- Figs. 3, 4 *Arcthoplites* sp. cf. *jachromensis* (Nikitin). Impressions from natural moulds. Locality 74, Lower Albian (Leymeriellan), Tardefurcata Zone.
- Fig. 5 *Cardioceras* sp. indet. Impression from natural mould. Locality B92, Upper Oxfordian. $\times 2$.



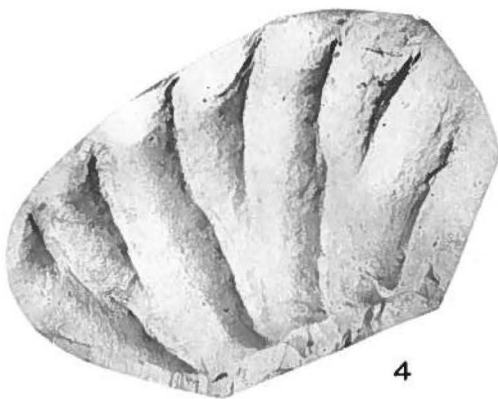
1



3



2



4



5