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BY

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BY

FRIDTJOF NANSEN.

A GEOLOGICAL SKETCH OF CAPE FLORA AND ITS NEIGHBOURHOOD.

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The geology of Cape Flora and its neighbourhood bas been subjected to special researches by Dr. REGINALD KŒTTLITZ, the geologist of the Jackson-Harmsworth Expedition, who stayed there for three years (1894—1897). The results of his important investigations have been most ably described by Dr. KŒTTLITZ himself[1], and his collections have been examined and described by Messrs. E. T. NEWTON and J. J. H. TEALL[2]. Much valuable information about the geology of this little-known country has thus been obtained. There are, however, still many open or doubtful questions left, which will have to wait for future researches made on the spot, if they are to be fully settled. In the mean time, I trust that every contribution, imperfect though it may be, to our knowledge in this respect, will be welcome.

During my stay at Mr. Jackson's house, Elmwood, on Cape Flora, from June 17th to August 7th, 1896, I used what little time there was left me from other important work, to study, in company with Dr. Kœttlitz, the geology of this interesting neighbourhood. Through Jackson's kindness and with Kœttlitz's valuable assistance, I thus was enabled, amongst other things, to make a collection of fossils and rocks from the Jurassic deposits of this locality.

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[1] Dr. Reginald Kœttlitz. „Observations on the Geology of Franz Josef Land." Quarterly Journal of the Geological Society, vol. LIV (1898), pp. 620—645. See also his „Brief Sketch of the Geology". Geographical Journal, vol. IX (1898), pp. 132—135.

[2] E T. Newton and J. J. H. Teall. „Notes on a Collection of Rocks and Fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894—1896." Quart. Journ. Geol. Soc. vol. LIII (1897), pp. 477—519; and also *ibid.* vol. LIV (1898), pp. 646-651.

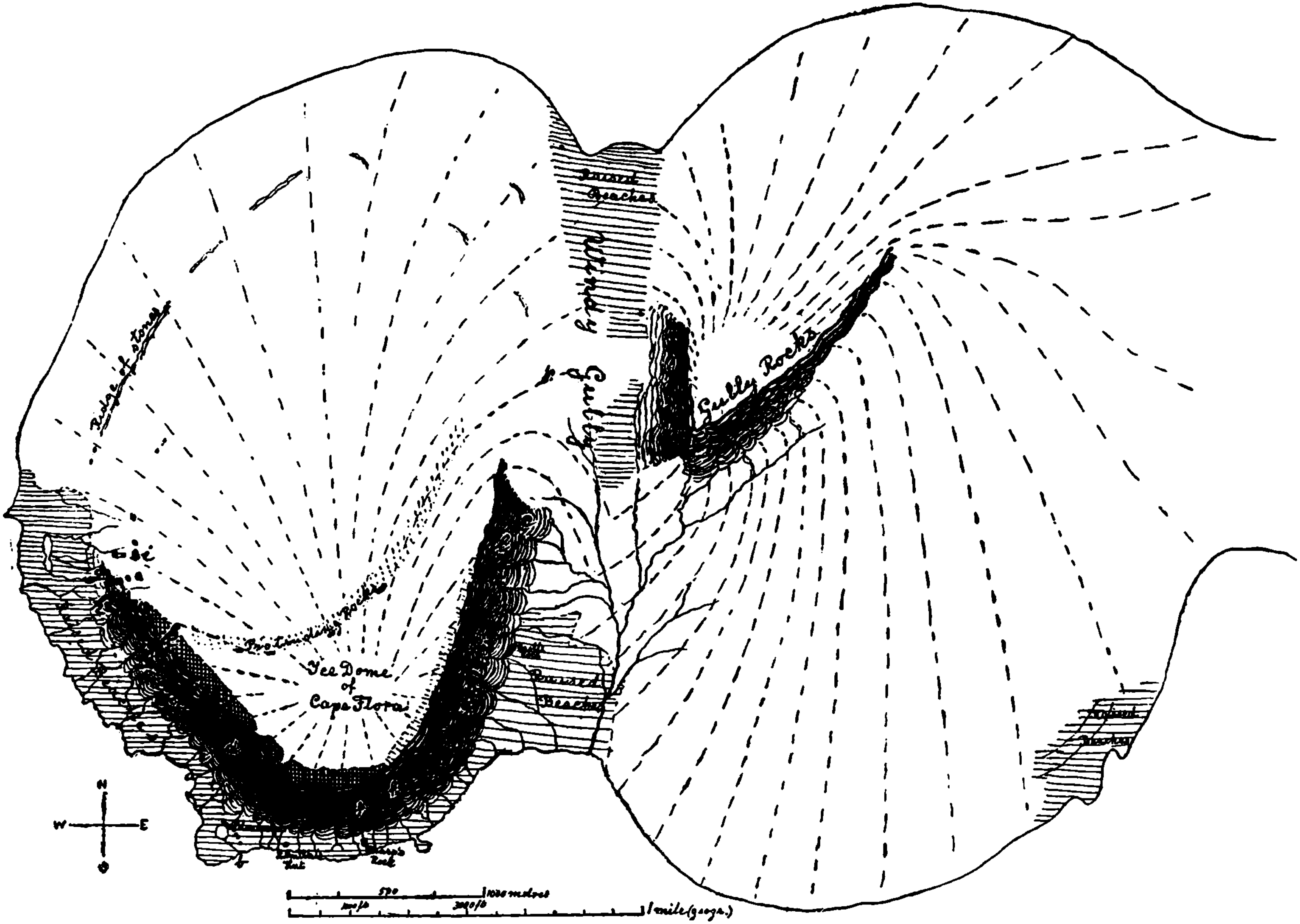

Fig. 1. *Diagrammatic sketch of Cape Flora and Gully Rocks with glaciers, based principally on maps by Mr. Jackson, Lieut. Armitage, and Dr. Kœttlitz.* The dotted lines indicate the trend of the glacier-slopes; the horizontal strokes indicate bare, low land, mostly raised beaches. The hachure indicates the talus, and the dark, thick lines and dots the basalt. The cross lines indicate a ledge plateau on top of the basalt, which is bare in the summer. Rocks and ridges protruding through the glacier-covering are marked by black dots or lines. The letters *a—l* indicate the localities where the Jurassic strata are exposed or where fossils have been found.

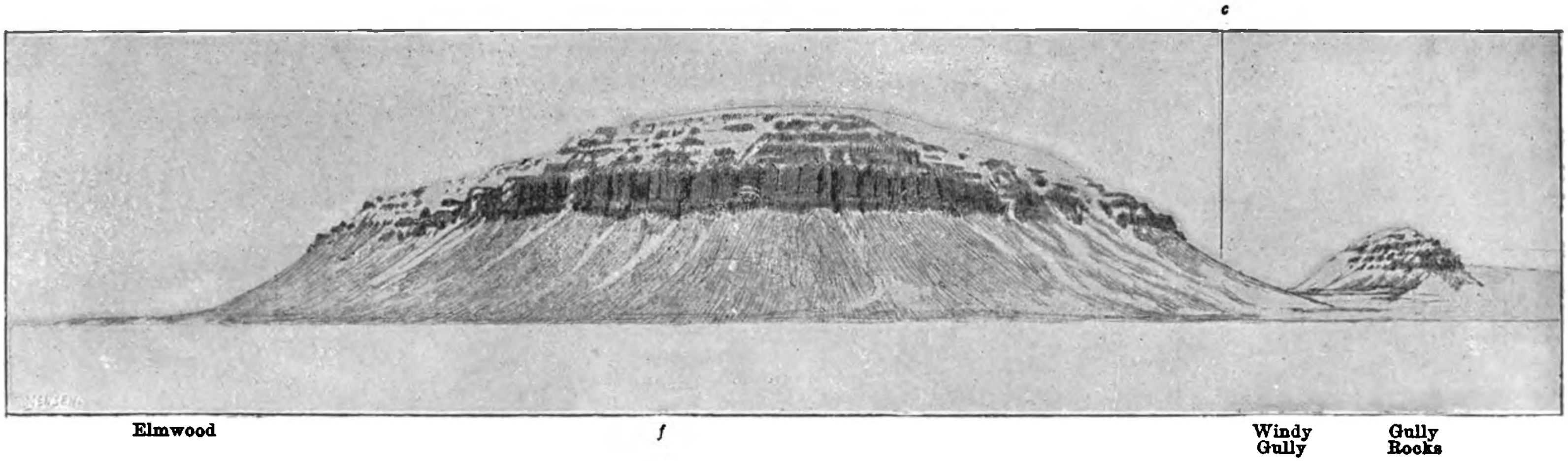

Fig. 2. *Cape Flora and Gully Rocks seen from the south. Drawing from photographs by F. N.*
c. Locality at south end of Windy Gully, visited on July 14th, 1896. *f.* Place at the base of the basalt visited July 24th, 1896.

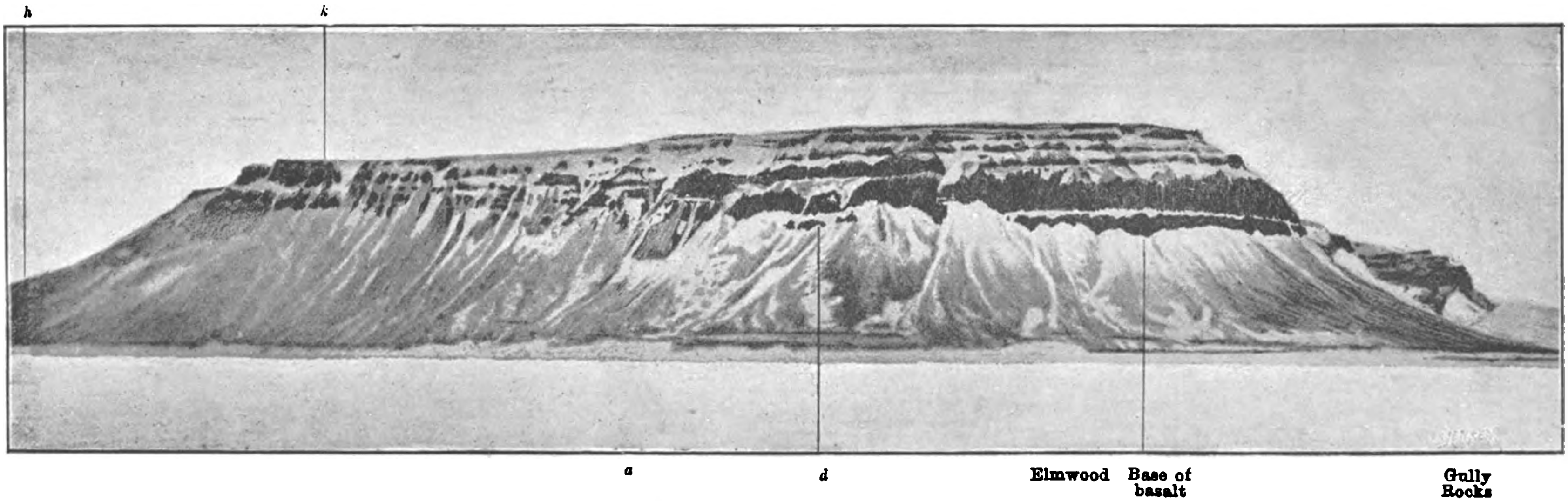

Fig. 3. *Cape Flora, seen from the south-west. From a photograph by F. N.*
a. Place near the shore where fossils were found August 2nd, 1896. *d.* Locality visited July 16th 1896. *h.* Behind this ridge is the locality visited July 12th, 1896.
k. On the ledge plateau here (about 900 ft. above sea-level) Kœttlitz found plant fossils, 1897.

Dr. J. F. Pompeckj undertook the examination of this collection, which, however, does not contain much that has not been found by Kœttlitz. But as Pompeckj does not agree with Mr. E. T. Newton, who has described Kœttlitz's collection of fossils, on several rather important points as regards the determination of the fossils, and the exact horizon of the various strata, etc., I hope his paper will throw some additional light on the subject, and may be read with much interest.

Dr. Pompeckj has asked me to accompany his paper with a sketch of the general features in the geological structure of Cape Flora, and the description of the localities where the fossils were found. In doing this, I feel it to be my pleasant duty, first of all to express my sincere thanks to Mr. Frederick Jackson for the kind way in which he helped me in my geological researches while I was his guest at Elmwood. I also use this welcome opportunity of thanking Dr. Reginald Kœttlitz for his most valuable assistance and companionship. He took me to the places where, before my arrival, he had already found fossils, or had observed anything of importance; and had it not been for him, I should certainly not have been able to do what little I did, during the few days which were at my disposal.

I agree with Kœttlitz on all essential points, and have nothing new of importance to add to what he has already said. In some respects this sketch may, however, supplement his descriptions, and thus help to explain more fully the conditions and circumstances under which the most northern Jurassic fossils ever known have been found.

Cape Flora, situated in circ. 79° 56' N. Lat. and circ. 49° 40' E. Long. is the western extremity of the long and narrow peninsula which forms the south-western part of Northbrook Island.

A deep valley, *Windy Gully,* the bottom of which is only 16·8 metres (55 feet)[1] above the sea, passes from north to south straight across this narrow peninsula, about three kilometres east of its western extremity, thus separating the mass of Cape Flora from the eastern part of the island, and making it an isolated hill of no great extent.

[1] Dr. Kœttlitz says that Windy Gully „is about 1 mile long and 500 yards wide, with a general surface about 100 feet above the sea. Some parts, however, rise to greater elevations. The floor is covered over with rounded, water-worn, subangular and angular stones and boulders, together with a dark, tenacious mud" (l. c. p. 623). I suppose these 100 feet are not meant for the actual bottom of the valley, for this, according to my measurements, was 55 feet at its highest level.

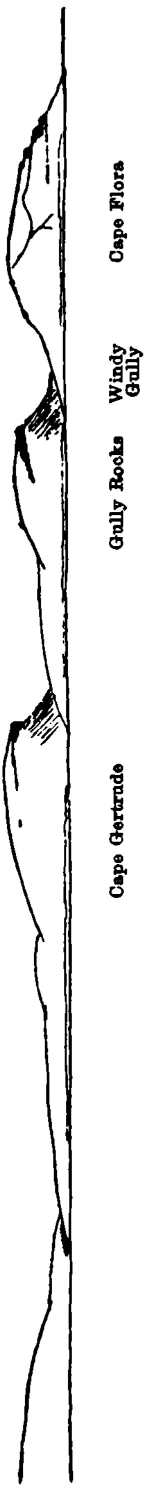

Fig. 4. Cape Flora, Gully Rocks, and Cape Gertrude, as seen from near Windward Island, 6 miles to the north. From a sketch by Dr. Kœttlitz, March 28th, 1897.

Fig. 1 is a rough diagrammatic sketch of Cape Flora, based principally on Mr. Jackson's map of Franz Josef Land, Dr. Kœttlitz's sketch of Gully Rocks (l. c. p. 624), and on an excellent and elaborate geological map of the south coast of the cape by Lieut. Armitage and Dr. Kœttlitz of the Jackson-Harmsworth Expedition, which the latter has had the great kindness to send me with permission to use it. My photographs have also helped to make the sketch correct. The north coast is principally done from memory. This part of the sketch cannot therefore claim to approach correctness, but may perhaps, in spite of this, be an aid to the verbal description[1].

Figs. 2 and 3 are two views of the cape seen from the south and the south-west. Fig. 4 is a sketch of the cape and the hills to the east seen from the north. It is made from a sketch by Dr. Kœttlitz.

By the aid of these figures and the map, it will probably be easy to form a fairly correct idea of the topographical conditions of the place.

Like most parts of Franz Josef Land, Cape Flora has the character of a plateau. It is a flat-topped hill, capped with a considerable sheet of basalt which in most places is nearly horizontal.

There is a striking difference between the southern and northern sides of this hill. While it is highest in its southern part, and the face here is steep, with exposed, partly vertical cliffs above, and a steep talus below (see figs. 2 and 3), the hill slopes more or less gently down to the sea towards the north and north-west,

[1] I sent a copy of this diagrammatic sketch to Dr. Kœttlitz just as these pages went to press. I have received the copy back with his corrections and remarks, which he has kindly made as exactly as he could from memory, being away from home on an expedition in Abyssinia. His suggestions have been introduced in fig. 1, and I wish here to express to him my gratitude for his pains-taking interest, shown even when he was engaged in a new expedition.

and is here almost entirely covered with ice and snow (see fig. 4). This glacial covering extends over the whole of its central and northern part (see fig. 1), leaving the rocks uncovered only along the south-eastern, southern, and south-western margins of the cape, and also more or less isolated rocks (nunataks) protruding through the ice-sheet.

On these southern sides, the glacier ends at or near the upper edge of the basaltic cliffs, at an altitude of from 300 to 340 metres (1000 to 1100 feet). From this edge, the surface of the glacier rises inwards towards the summit of the hill, arching in a regularly shaped dome over the highest plateau of the basaltic cliffs. From the summit of this dome, the glacier slopes more or less gently in a north-westerly and northerly direction to the shore, the gradients being, according to Kœttlitz, from 5° to 16°.

The fact that the northern side of Cape Flora, like that of the nearest hills farther east, is lower than the southern, may perhaps to some extent be explained by a possible dip of the basaltic beds in a northerly direction, which may have been caused by dislocations (see later).

On the south-western, southern, and south-eastern faces of the hill, the basalt cap ends abruptly in steep walls, and is 150 to 165 metres (500—540 feet) thick. On the southern face near Elmwood it is composed of 6 or 7 successive tiers, placed nearly horizontally, perhaps with a very slight northerly dip for some distance, which may be seen in fig. 3[1]. The number of tiers is less to the north-west, as the uppermost ones gradually disappear in this direction, in several shallow terraces, sloping gently one below another. The height of the basalt, therefore, is lower here. One kilometre (1/2 mile) northwest of Elmwood (at fig. 1,*k*; and fig. 3, *k*.) there are, according to Kœttlitz, not more than 3 or 4 tiers, and the upper edge of the basalt is about 900 feet (275 m.) above the sea. If this is right, it indicates a slight dip of the basalt tiers in this direction, for above Elmwood, the height of the third tier from below is 950 feet (290 m.) above sea-level, according to my photographs, and that of the fourth tier is 1000 feet (300 m.).

The tiers can be seen even at a distance, having well marked lines between them, their faces rising one above another, in nearly vertical

[1] A little farther east, at Cape Gertrude, and also at Gully Rocks, the northerly dip of the basalt layers is more conspicuous (see later).

cliffs in the form of steps or terraces, which each have a short steep talus descending on to the one below. These terraces are intersected by small watercourses coming from the ice-covering above (cf. figs.)[1]. The same tier may vary in thickness at different places. The second tier from below is the thickest, being, according to my photographs, from 45 to 60 metres (150—200 feet) on the southern face of the hill, probably becoming somewhat thinner for some distance towards the northwest (cf. fig. 3). The others are from 10 to 30 metres (35—100 feet). The upper tiers are, on the whole, of smaller proportions as compared with the lower. Whether the tiers, especially the thicker ones, are composed of several flows of basalt, I cannot say decisively, but I regard it as highly probable.

The highest point reached by the basalt on Cape Flora is 338 metres (1111 feet) above the sea, according to the measurements of the Jackson-Harmsworth Expedition, and the lower edge of the basalt cap, on the south-western side of the promontory, above Elmwood, is about 175 metres (575 feet) above sea-level.

Below these basaltic terraces is the *talus*, which slopes downward from the base of the basalt (about 175 metres above sea-level), at first at a very steep angle, 35°—40°, then gradually more easily, and at last descending gently on to the nearly horizontal raised beaches near the shore (see figs. 2 and 3). The surface of the talus is „composed almost entirely of basaltic débris, and is traversed by the watercourses streaming down from the rocks above.“ (see fig. 3). The basaltic débris almost completely hides the strata forming the floor of the basalt, making it extremely difficult to examine them, as they are only exposed in some few places, more especially along the watercourses. Fortunately, however, such places were found at various heights, and they proved that the whole formation underlying the basalt, from a height of about 175 metres (575 feet) down to the sea, is composed of *Jurassic strata*, chiefly soft clay or sandy clay, in which numerous large and small hard nodules of clay-sandstone, argillaceous limestone, marl, etc. are embedded, especially in certain horizons.

Below the talus, between it and the sea, there was, as a rule, a succession of comparatively recent, well-marked terraces or raised beaches; the

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[1] Cf. Kœttlitz's description, l. c. p. 621.

heights of the most prominent ones were: 2·7, 9—10·6, 12·5—14·9, and 23·5—24·4 metres (9, 30—35, 41—49, and 77—80 feet) above sea-level.

Elmwood is situated on a well-marked beach of this description, from 12·5 to 15·1 m. (41—49½ feet) high. The bottom of Windy Gully has a similar succession of terraces at heights of 2·7, 9·1—10, and 14 metres (9, 30—33, 46 feet). The bottom of the valley at the highest place was 16·8 m. (55 feet) above sea-level. As we thus find these most prominent beaches at the same level on both sides of Cape Flora, it is probable that the upheaval of this hill in recent times has been the same on all sides.

These raised beaches are in most places covered with a layer, generally one or two feet thick or even more, composed to a great extent of rounded and water-worn boulders and pebbles of basalt, of all sizes. Under this layer the stratified clay on sandy clay deposits, with nodules of sandstone, etc. embedded in it, were found. These beaches, or old shore-lines, must therefore to a great extent have been washed, and cut out by the sea in the soft Jurassic clay or sand, and have been covered by stones falling from the basalt cliffs above. These stones have been washed and worn by the swell near the shore, and they now protect the soft clay and sand underneath.

The order of succession of the geological formations on the southern face of Cape Flora, commencing from the summit, will be as follows:

370 m. (1200 feet) to 340 „ (1100 „)	*snow* and *ice*;
340 „ (1100 „) to 175 „ (575 „)	*basalt*, composed of 6 or 7 tiers, between which thin strata, some with plant-remains, are intercalated;
175 „ (575 „) to 0 (0)	soft *Jurassic strata*, chiefly soft clay or sandy clay, in which hard stone nodules (clay, clay-sandstone, argillaceous limestone, marl etc.) are embedded.

The Jurassic Strata of Cape Flora.

Wherever I had an opportunity of examining the Jurassic strata underlying the basalt, they were composed principally of *a bluish grey or brownish grey, soft and tenacious clay*, or sandy clay (and in one place of clayey sand). The clay was of about the same softness as the clay deposits on the bottom of our fjords, or the clay used in our brick manufactories, but less pure, being more sandy. Whether this soft consistency is the real one prevailing all through the strata, or only exists near the surface, where it is caused by moisture, frost, thaw and weathering, I cannot say decisively. But down to whatever depth we were able to dig, I found the same softness, only that everywhere the strata were frozen from a short distance below the surface, which made digging more difficult. In one place, in the bank near shore, just south of Elmwood, Kœttlitz tried for a long time to dig very deep by suspending his work at intervals, during which he allowed the sun to thaw the freshly exposed frozen strata. Here, however, he found nothing but soft clayey sand, containing some few pebbles, and interstratified with thin, black, bituminous or carboniferous, sandy strata.

Where I had an opportunity of examining the clay deposits more closely, I found, as a rule, numerous concretionary nodules of hard stone embedded in them. These nodules had generally a rounded lentoid or spheroidal shape, and varied in size from some two feet in diameter to very small ones. They were, as a rule, ferruginous, and having been exposed a little to weathering, they had a yellow-brown or rust-brown crust. Pompeckj has divided these hard stone-nodules into 7 types, according to the material of which they are composed. (See his description, chap. II).

Upon looking at a view of Cape Flora, it may seem strange that the heavy weight of the 150 m. thick basalt cap does not squeeze the soft clay beds underneath out to all sides, and that the basalt does not thus sink down to sea-level. This would probably also happen to some extent, if the temperature in the interior of the clay-beds were to rise above freezing-point. They would then no longer be able to form such steep talus slopes (of 35^0—40^0) as they do at present, and would slowly ooze out under the weight of the masses above. By being frozen all through they have acquired the consistency of hard rock. This condition, however, would be very essentially altered if the climate of Franz Josef Land were to become a more genial one than it is at present; and the shape and height of Cape Flora hill might then, with comparative suddenness, be entirely altered.

The Jurassic strata underlying the basalt at Cape Flora are very rich in fossils. These are somtimes lying free, embedded in the soft clay, but are more generally enclosed in the hard argillaceous stone nodules.

Comparatively few fossils were actually found *in situ*. Many more were found lying loose on the surface of the clay exposures, evidently weathered, or washed out of the clay near the place where they were lying. They could not, at any rate, have been carried very far.

A good many fossils, however, mostly enclosed in fragments of the stone nodules, were found lying loose on the talus at all heights, from the base upwards, and scattered among the basaltic débris. These fossils had evidently fallen from above, or had been carried down by water, or avalanches from some place higher up, where they had originally been washed out of the clay. They were found especially at, or near the water-courses.

Beginning from below, I will mention the principal localities where exposures of the Jurassic strata were examined, or where fossils were found.

1. *Lowest horizon* 7—10 metres (23—33 feet) above sea level. Fig. 1, *a*, *b*.

(a) Along the bank of the raised beach upon which Elmwood is situated the stratified deposits are exposed from sea-level to 12 or 15 metres (40 or 50 feet) above it, and from a place a few hundred metres south-east of Elmwood, to more than that distance north-west of it. Some 300 metres north-west of Elmwood, there was a narrow ravine or gully, cut by a watercourse into these strata (fig. 1, *a*; fig. 3, *a*). The sides of this ravine had just been thawed out when I examined the place on August 2nd, 1896. In the bank on its northern side, and just above the shore, between 7 and 10 metres (23 and 33 feet) above sea-level, I found various fossils, all of which were *in situ*.

In my diary, there is the following entry on the subject of this find: „Sunday, August 2nd, 1896. Collected some shells and belemnites in the clay deposits about 30—40 feet (?) above the shore. Knocked off several pieces of stone with impressions of shells from two nodules of „claystone“[1] (with rounded edges), which were embedded in the clay.“

I may add to this description that some of the fossils, shells and belemnites, were lying on the surface, half embedded in the clay, or protruding from it, the surface having been comparatively recently exposed; for it was evident that small landslips would be constantly falling into

[1] According to Pompeckj's description, it is *„hard, gray or dark gray, finely grained, sandy marl“* (see below chap II).

the water-course, thus causing fresh exposures. Some too, were dug out of the clay, and they were consequently all of them found *in situ*. These fossils were embedded free in the clay, and were very fragile, especially a large lamellibranch which I at first thought was a *Pecten*, but which appears to be an *Avicula (Pseudomonotis)* (see Pompeckj later). Some valves of this genus were found fairly entire in the clay, but no sooner were they dug out than they fell to pieces, and were extremely difficult to preserve[1]. The two nodules of marl, containing fossils, were also found *in situ*, and were dug out of the clay. They were a foot or more in diameter, and were not so lentoid or rounded as the nodules found at higher horizons in the strata, but had rounded edges. I did not find any other nodules embedded in the clay in this place. This locality was also visited by Dr. Kœttlitz, and some fossils from it are described by Newton[2].

(b) In the same bank above the shore, from 0 to 13.7 metres (45 feet, above sea-level, and only some 400 metres to the south-east (just south of Elmwood, fig. 1, *b*; fig. 2, *b*), it might naturally be expected that the deposits exposed would be exactly similar. These beds, however, show a striking difference; they have a much more distinctly stratified appearance, and are considerably more sandy in their composition. They are composed of sand, or clayey sand, and partly pebbles, interstratified with thin, black, carboniferous, to some extent sandy bands, generally less than half an inch thick, and sometimes containing small carbonized remains of wood. No fossils were found in these strata, although Dr. Kœttlitz dug into them for some distance (see above p. 10).

These strata (b) are evidently estuarine (or fresh water) deposits, or are at any rate deposited in quite shallow sea, and probably belong to a lower horizon than the clay beds with fossils, just described, only some 400 or 500 metres farther to the north-west. There may have been a slight dislocation, bringing these strata to a somewhat lower level to the north.

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[1] They had a white coating, which, according to Pompeckj, is composed of crystals of gypsum.

[2] L. c. 1897, pp. 501–502; and 1898, p. 650. Kœttlitz's description, l. c. (1898), p. 637, may give the impression that these lowest strata with marine fossils „were traced for some distance both eastward and westward from Elmwood;" but this has certainly not been his opinion, as they have only been found north-west of Elmwood, and are distinctly different from the strata (b) found south or south-east of this place.

Information which Dr. Kœttlitz gives me in a letter, seems to confirm this view. He says:

„In one place, close to Leigh Smith's hut at Cape Flora[1], I found a small exposure running NW in the raised beach bank, and there I found that the strata had a decidedly greater dip towards the NNW than toward the NNE. I found it to be from 5° to 6° in the first direction — but this is the only place where I found an opportunity to take the dip on that side."
If we assume a universal dip of these strata, of as much as 5° to the NNW, this would carry a layer about 8 metres lower for every 100 metres towards the NNW; and a layer which, in the bank south of Elmwood, is 15 m. above the sea, would thus, only 400 metres farther to the NNW, be about 17 m. below sea level.

2. *Medium horizon*, 113 to 137 metres (370—450 feet) above the sea (and probably about 37 metres (120 feet) below the base of the basalt(?)).
Fig. 1, *c*; fig. 2, *c*.

One day in the beginning of July 1896, Dr. Kœttlitz took some of his comrades and myself to what he calls „a shoulder of rock", which projects from the cliff at Windy Gully, and whose height I estimated to be 400 feet (122 m.) above the sea. According to later measurements by Kœttlitz, it is from 370 to 450 feet (113—137 m.)[2]. This locality is situated at the southern end of Windy Gully, on its western side, some two and a half kilometres north-east of Elmwood. The fossils collected on that occasion have been described by Newton and Teall[3].

On an excursion through Windy Gully July 14th 1896, I also came to the same place, and found a few fossils which have been submitted to Pompeckj (see his description). I find the following remark about the locality in my diary for that day: „It is a ridge or shoulder of clay (or sandy clay), cut through by a watercourse, and showing horizontal stratification. The height is about 400 feet above sea-level. The surface of the ridge is strewn with fragments of reddish brown „clay-sandstone"[4]. Found a good ammonite and some other doubtful fossils".

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[1] This was some few hundred paces south-east of Elmwood.
[2] L. c. 1898, p. 638.
[3] L. c. 1897, p. 500. See also l. c. 1898, pp. 649—650.
[4] These stones, according to Pompeckj, are *„hard phosphoritic clay nodules*, and *yellow*, or *gray and greenish, hard, calcareous, sandy stone marl"* (see chap II).

Kœttlitz says that the strata dip from 1^0 to 3^0 towards the NNE.

Some fossils collected on the first occasion and described by Teall and Newton were actually found *in situ*, and were dug out of the clay in the freshly exposed surface of the bank above the water-course. Some of these fossils (some of them guards of belemnites?) were, however, so fragile and brittle, that they almost fell to pieces when they were touched, and they could therefore hardly stand transportation.

A good many more fossils were found on the surface of the ridge only a few feet above the place or bank, where the first-mentioned were dug out. Some were lying loose on the surface, others enclosed in the numerous fragments of stone-nodules found there. The fossils brought back by me from this locality, were all found thus. These fossils and stone-nodules had evidently been weathered or washed out of the clay-beds, on the surface of which they were now lying, or at some place just above, and could not have been carried very far; they had perhaps for the most part originally been embedded at a somewhat higher level than the spot where they were now found. No stone-nodules were, as far as I remember, actually found *in situ* on digging in to the clay. The reason of this may be that they come from strata situated a little higher than the fresh exposure where I had an opportunity of digging. Judging from their quantity, however, they must be fairly numerous in the clay.

3. *Upper horizon*, about 150 to 165 metres (500—550 feet) above sea level, and near the base of the basalt. Fig. 1, *d*; fig. 3, *d*.

On July 16th, 1896, Dr. Kœttlitz and I visited a place at the top of the talus behind Elmwood, and just below the base of the basalt[1]. At this place, — I say in my diary — „I was for the first time fully convinced that the beds of clay (and sand), with fossils and nodules of clay-sandstone, etc. („mudstone-nodules"), found at Cape Flora, are really in place, and form a deposit at least 500—600 feet thick (not reckoning what is below sea level), underlying the basalt".

Under the base of the basalt, the lower part of which was quite rotten

[1] See Newton and Teall, l. c. 1897, p. 496.

and crumbling, there was a horizontal bed of clay 3 feet thick. In this bed I found no fossils and no hard stone-nodules[1].

Under it there was an apparently almost horizontal layer of amygdaloidal basalt (of lava-structure), 6 feet thick. This basalt bed could only be traced for a short distance — I should say some twenty metres — across the exposure, as it was completely hidden by the débris of the talus on both sides. It did not give the impression of being intrusive, and this especially on account of its amygdaloidal, lava-like structure; moreover there was absolutely no indication of any alteration by heat, nor was any ordinary contact-metamorphosis to be detected in the clay strata, either underneath or above this basalt bed. It is also improbable that an intrusive mass would be able to extend itself in such a thin and regular horizontal layer in soft clay. Intrusive masses extending themselves in soft rocks generally take very irregular shapes even in much harder strata than this clay (e. g. in the alum-schists of Christiania). Judging from its structure under the microscope, Prof. Brøgger concludes that this basalt is probably not intrusive.

Below this basalt, the clay-beds again occurred, and I believe they occupy without interruption the entire height between this horizon and the sea-level. In these clay beds, and only some short distance below the lowest basalt bed, we found, *in situ* and embedded in the clay, both fossils and rounded stone-nodules[2], in which also fossils occurred. A good many more loose fossils, as well as stone-nodules, with fossils in them, were found just below, lying loose in a water-course that intersected these strata. They had evidently been washed by the water out of the strata above, where fossils and stone-nodules were found *in situ*. They were also of the same kind, but may of course belong to somewhat different horizons.

It is this place which Kœttlitz describes as follows: „Directly behind the settlement of Elmwood, and within about 50 feet of the basalt, clay-beds with

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[1] Attention may here be called to the fact that only $^1/_4$ mile (English) north-west of this point, Kœttlitz found a piece of *Ammonites Lamberti* embedded in the lower part of the decomposed basalt (l. c. 1898, p. 638; see also Newton and Teall l. c. 1898, p. 649) immediately overlying the clay bed which is probably of exactly the same horizon.

[2] According to Pompeckj, these nodules consist partly of *clay-sandstone* partly of *grey-blue*, *grey* or *yellow calcareous clay*, in hard (partly concretionary) pieces, etc. (see below chap. II). It should be understood that these pieces are all of them only fragments of originally rounded nodules.

mudstone-bands are exposed, and at this spot I found in place the small ammonite which Mr. Newton thinks is in all probability *Ammonites Tchefkini*" [1]. Kœttlitz probably also refers to the same place when he says: „Layers of hard, grey, ferruginous mudstone-nodules occur in the shales, and sometimes form bands as much as 2 feet thick" [1]. It ought to be remembered that the word „shales" here means quite soft clay or sandy clay. I am not quite certain that Kœttlitz is right when he says 50 feet below the basalt. The fossils and nodules lying loose along the water-course were certainly found as low as that, or even lower, but it seems to me doubtful whether this was the case with the fossils found *in situ*.

4. *Fossils lying loose on the talus.* Fig. 1, *e*.

As being originally derived from a doubtful height possibly from this same locality or somewhat lower, I may here mention some fossils (ammonites) found on July 10th. 1896 below this place, at a height of about 30 metres (100 feet) above the sea. They were found in fragments of stone-nodules [2], which lay scattered loose amongst the basaltic débris on the talus, and had evidently come from some higher level. Pieces of marly limestone, with cone-in-cone structure, were also found in the same place.

5. *Strata immediately below the basalt.* Fig. 1, *f*, *f*; fig. 2, *f*.

On July 24th, 1896, Dr. Kœttlitz and I visited the top of the talus (575 feet above the sea), a little east of Elmwood, above Sharp's Rock (a loose basaltic rock lying on the raised beach).

We here found the clay deposits exposed *in situ* just below the base of the basalt, and could examine their contact with the latter. No fossils were found at this spot. The clay deposits showed distinct stratification, and specimens of the various strata were taken, but no appreciable alteration by contact with the basalt could be detected. Newton and Teall have given the following description of these strata in descending order:

„(1) Black shale 4 inches thick, from just below the basalt. There is no appearance of this shale having been heated to any extent by contact with the basalt.

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[1] L. c. 1898, p. 637. See also Newton and Teall, l. c. 1897, p. 496; and 1898, p. 649.

[2] They were composed of *calcareous clay* or *calcareous*, partly sandy, *stone-marl*. See Pompeckj, chap. II.

„(2) Black material like the preceding, but broken into fine particles and powder, 1 1/2 inch thick.

„(3) Greenish-grey shale, 3 inches thick.

„(4) A lighter-coloured brownish clay-shale, the thickness of which is not recorded".

I may add to this description that the „black shale 4 inches thick" (1), immediately below and in contact with the basalt, was more solid and harder than the ordinary soft, tenacious clay underlying it. It had evidently been somewhat hardened by the basalt. I brought home some pieces of this shale with adhering pieces of the basalt, showing the contact between them. These pieces have been examimed by Prof. Brøgger, and he has not been able to find any indication of a regular contact-metamorphosis in the shale. This appears to be a decisive proof that the basalt cannot be intrusive.

The two thin layers (1 1/2 inch and 3 inches) below this shale were not much harder than the ordinary clay, but were not so tenacious, and differed somewhat in colour, being darker.

The thickness of the fourth layer, the „lighter-coloured brownish-shale", cannot be stated, as we found no difference in appearance between this layer and the underlying soft, tenacious clay which forms the chief component of the Jurassic deposits of Cape Flora.

6. *Doubtful horizon. Fig. 1, g, and h; fig. 3, h.*

In my diary for Sunday, July 12th 1896, I find the following entry: „Made, together with Dr. Kœttlitz, Johansen and Armitage, a good collection of belemnites, ammonites, etc. in a moraine(?) at the margin of the glacier west" (should be north-west) „of Elmwood (about 1 1/2 kilometres distant), 30 to 60 metres (100 to 200 feet) above sea-level. The belemnites and some ammonites were found chiefly in one small area by a water-course, just at the margin of the glacier. They were lying loose on the surface of clayey mud, probably pushed out from under the glacier(?). The slope of the latter was not steep, so that the fossils could not have fallen down from above, and could hardly, in my opinion, have been *in situ* much higher than they were found, which was about 200 feet above the sea. In the same place, I also found a short piece of a *Pentacrinus*-stem. Some fragments of belemnites and ammonites were lying loose on a bare rock, protruding through the glacier some 30 paces within its margin. On one spot, somewhat lower in the same moraine(?) or talus, the ground for some distance was completely overstrewn with large and small pieces of marly limestone with cone-in-cone structure, such as occur in great quantities in several places on Cape Flora. I have, as a rule, found this cone-in-cone limestone less than 100 feet above the sea, and hardly ever higher than 150 feet. Where it occurs, there are generally great quantities of loose fragments of it, strewn about on the surface of the talus or raised beaches; and only very rarely are fossils found amongst these loose-lying fragments, or in their immediate neighbourhood. Kœttlitz tells me, however, that he has found single ammonites on a spot where numerous pieces of this limestone occurred. On the spot mentioned above (in the „moraine") we could easily have taken away sledge-loads of this stone with cone-in-cone structure".

„Below a basalt-rock some short distance south-east of this glacier, there was a gently-sloping clay plain, which was covered with scattered pieces of „clay-sandstone"[1] amongst which ammonites and belemnites were found. This plain was hardly more than 80—120 feet above sea-level".

Thus far my diary. The words „glacier" and „moraine", in this description, are perhaps somewhat misleading, as the latter was probably only the ordinary talus, partly covered with heaps of the basaltic débris, and the „glacier" was simply the extensive sheet of snow and ice covering the ground, often to a considerable depth, and which had not melted beyond this spot that summer. But in a recent letter, Dr. Kœttlitz says that in the summer of 1897, there was „such an exceptional thaw, that much more of the ice and snow was cleared off the surface than usual everywhere, so that here those places which you describe in your diary as „a moraine at the margin of the glacier", were quite 100 yards away from its margin that summer. This place, I should say, is at least 150 feet above the sea."

It will be understood that this „glacier" or covering of ice and snow is stationary, and thus cannot at present carry any moraine material of importance, either on its surface or underneath it, and the expression „pushed out

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[1] This is only an expression used for shortness in my diary. The stones were for the most part composed of calcareous concretionary clay, or phosphoritic and calcareous clay. There was only very little clay-sandstone. See Pompeckj, chap. II.

from under the glacier" may be misleading. As the slope of the ground, or the snow („glacier"), was so gentle above the place where the fossils were found, it is hardly probable that the latter could have fallen or rolled from above at any recent date. And as they could hardly have been lying on the surface, as they were, for very long, there is a probability that the fossils found „at the margin of the glacier", and on „the clay plain", had not been removed very far from the place where they had originally been *in situ*, and where they had been washed or weathered out of the clay[1].

I wrote to Kœttlitz, and asked his opinion, and in the letter referred to above, he says; „I am strongly of opinion that the fossils we found there were weathered out of the strata immediately underneath. Since you were with us at Cape Flora, I have spent some time, and taken some trouble to investigate as thoroughly as possible this spot, and the rocks above it, and I have come to the conclusion that the cone-in-cone argillaceous limestone and the fossils we found there *do not come from above*, but are practically *in situ*, for the deeper one digs under the surface, the more of the same specimens are brought to light, and the supply is there practically inexhaustible. The only difficulty there is in getting at them is the icy condition of the rock surface".

Presuming, therefore, that the fossils found here had been *in situ* somewhere about 60 metres (200 feet) above the present sea-level, I was rather astonished to learn from Pompeckj that some of them belonged to exactly the same horizon as those from the locality 3 (see p. 14), above Elmwood, and just below the basalt at a height of about 165 metres (550 feet) above sea-level.

If Koettlitz and I are right, there must consequently have been a dislocation of some kind here. In my diary, I mention at this place a basalt rock (see above p. 18), the base of which must be at a height of some 150

[1] However, if they really did come from an originally much higher level, the following explanation is also possible, namely, that a soft, viscous material, such as the clay of these beds, might possibly flow slowly downwards, even where the slope is comparatively gentle, especially when the clay during the summer is covered with a sheet of melting snow and ice which keeps it constantly wet instead of frozen. But whether the ground underneath the snow, or the „glacier", above this place was composed of clay and not of basalt, I had no opportunity of investigating. I believe, however, that there are, as we shall see, reasons for assuming that the rock here is basalt.

feet (45 m.) above the sea. I did not get an opportunity of examining more closely whether this rock was actually in place, or whether it was a loose rock fallen from above, for which, however, it seemed to be to large and massive. Above this place, and at the margin of the glacier, I remember, also, to have seen basalt cliffs in place a good deal lower than they were above Elmwood, and this was my reason for suspecting that a dislocation had taken place. I asked Kœttlitz what he had to say about this point, and in the letter, already twice referred to, he says: „If you remember, the basalt here descends much lower than anywhere else in the immediate neighbourhood as far as can be seen. — — — There are several bosses of rock situated at this lower level, and these I have investigated a good deal. These basaltic masses“ (i. e. the low rock mentioned above, some 150 feet above the sea, and the other rocks somewhat higher) „are continuous with the basaltic rocks above, that is, there is no break by other strata between them; they are therefore *in situ*, and though I did not actually see the fault — for the rocks are here very lava-like, crumbling, and shattered — I am of opinion that there has been a dislocation of strata here, that the whole mass (basalt and stratified rock) has sunk considerably, and this accounts for these fossils having been found at such different horizons. And I quite agree with you that this spot so gradually sloping, almost flat, with no steep talus behind, could not have received these fossils upon it through their having fallen from above“. If this be the right explanation, I should say that either several dislocations have taken place, or the rocks have not sunk regularly, because the fossils found at the margin of the „glacier“, were lying on clay at a higher level (about 60 m. (?) above the sea) than the basaltic rock south-east of it (about 45 m. or 150 feet (?) above the sea). But there is still the difficulty left, that at this locality are found fossils both from the medium horizon 2 (p. 13), and from the upper horizon 3 (p. 14) and even from a still higher horizon (see Pompeckj later); and between these horizons there should be a difference of height of some 40 m. (120 feet) at least. We shall perhaps after all be forced to admit the possibility of some transportation by glacial action, or by some other means, even though there may be some irregularity in the height of the strata. There is also a possibility that these low basaltic rocks may be intrusive, and may have been formed simultaneously with the dislocations.

In any case I feel convinced that the strata here must be considerably lower than near Elmwood, for if the fossils found here really have been carried down in some way or other some 120 m. (400 feet), this would be a case without a parallel, as far as we know on the whole of Cape Flora, even where there is a very steep talus behind. Even though single fossils from higher horizons may be found very low on the steep talus, especially along the watercourses, they are never found in such quantities, and spread over such an area as they were here.

7. *Inter-basaltic, fossiliferous horizon* (with plant-remains). Fig. 1, *i*, *k*. *l*.

In my diary for Friday, July 17th, 1896, I find the following entry referring to my visit to the locality (fig. 1, *i*) for this horizon: „In company with Dr. Koettlitz, I visited today a basaltic rock, or nunatak, protruding through the glacier on the north-west side of Cape Flora, about 600 or 700 feet (180—210 m.) above sea-level, and where he and Mr. Jackson had found numerous fossil plants a few days ago.

„A quantity of fragments of shale were here lying spread over the surface within two small, distinctly defined areas. Nearly every fragment showed impressions of pine-needles (chiefly) and less frequently ginkgo, fern and other leaves.

„These fragments formed a layer one or two feet thick, only a few feet broad, and perhaps 12 or 15 feet long, passing across the basalt ridge, which was bounded on both sides by the glacier; but the layer ended, as far as we could make out, before it reached the glacier on either side (the surface of the glacier was lower than that of the basalt ridge).

„It was my opinion that the existence of this shale here could only be explained by its being a fragment of an originally lower bed, and having been broken off by the formation of a dyke, and thus enclosed in the basalt. I could not, however, detect any unquestionable alteration by heat, though possibly some small amount in fragments from the deepest part of the layer[1]. Here the fragments were larger and fitted together, evidently *in situ*

[1] This was evidently a mistake, arising from the difference of colour, which, however, was not caused by heat. The shale from the deeper parts was darker blue-grey or brownish grey, simply because it had not been exposed to weathering like the fragments on the surface, which had turned a pale yellow.

and exactly in the same position in which they were left by the shattering of the shale by the frost. Immediately beside this layer of shale-fragments, the upper ends of well-developed, vertical basaltic columns, hexagonal or quadrangular, were seen. The basalt under the shale seemed to be less solid, more resembling tufa. In a protruding rock, a little farther down the glacier, the basalt was of the same rotten structure. Well-developed vesicles and amygdaloids, partly filled with minerals, were plentiful. Oblong vesicles, filled with a white mineral (calcite?), were especially conspicuous; their long axis lay in a south-south-westerly direction, as far as could be made out in the fog, and without a compass. Nodules of shale were also found enclosed in the basalt; they had evidently been altered by heat.

„The other place where fragments with plant-impressions were found, was close by the first-mentioned spot, on the same rock (a foot or two higher); but it was of smaller extent and less significance, the fragments being few and scattered".

The whole gave us the impression that what we had found in these two places were the last remains of a bed, which Koettlitz had come just in time to secure. These parts of the shale had been lying in two depressions in the basalt bed, and had thus escaped denudation a little longer than the rest; but in the highest, and consequently most exposed place, the shale was now nearly gone.

I say in my diary that the altitude of the place was about 600 or 700 feet (180—210 m.) above sea-level. Unfortunately we never got an opportunity of making an exact measurement. I see that Koettlitz states the height to be „some 750 feet" (l. c. p. 638). I do not know whether the exact height was ever measured after I left Cape Flora, but if not, I still feel inclined to believe that it was not so much, and that my estimation is nearer the truth; and I should even say that it comes narer 600 feet than 700. But at the same time, I believe the basalt goes much lower in this place, than near Elmwood (cf. above p. 20).

These plant-remains have been investigated by Prof. A. G. NATHORST, who will describe them in the next paper in this series[1]. It will there be

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[1] See also Nathorst's description in Nansen, „Fram over Polhavet", Kristiania, 1897, vol. II, pp. 519—521; and „Farthest North", vol. II, pp. 484—487.

seen that he holds the opinion that they are *Upper Jurassic* or *Lower Cretaceous* or belonging to the transition beds between the *Jurassic* and *Cretaseous* Systems and it will be seen from Pompeckj's paper that there is probably no great interval in time between the Jurassic horizon to which they belong, and that of the upper clay beds just below the basalt.

If this shale with plant-remains in it was actually *in situ,* that is, as it was originally deposited, and not broken up and lifted by intrusive basalt, it would give us a clue to the age of the basalt; the latter would then to some extent also be Upper Jurassic or Lower Cretaceous. I therefore expressed my opinion on this head, upon my return from the expedition[1], having arrived at the conclusion that the shale must actually have been *in situ.* My principal reason for this was that the basalt on which the shale was lying, could hardly be intrusive, judging from its structure, which more resembled that of a lava. Moreover, if this shale with plant remains had been raised by intrusive masses, it must have rested almost immediately on the top of the highest Jurassic clay beds we found near Elmwood, as it was only 30 m. (100 feet) higher at most (if there had not been dislocation at this place, cf. p. 20). But if so, it seems strange that we nowhere found any trace of similar deposits on the top of the clay.

There were also other reasons, which made me believe that the basalt was partly Jurassic, especially the basalt bed found in the clay at the top of the talus behind Elmwood (see above p. 15.), which was not of intrusive character. Then I also doubted that intrusive masses would be able to extend themselves in almost regular horizontal layers, some only a few feet thick, as mentioned above p. 15, in soft clay, such as we have to deal with here[2].

None of these evidences, however, were absolutely convincing, and Newton and Teall, who are so familiar with the Scottish basalts, therefore maintained, as being more reasonable, that the basalts of Franz Josef Land, like other extensive basalt-flows of the northern hemisphere, are of Tertiary origin[3].

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[1] Nansen. „Farthest North“ (1897), vol. II, p. 479. See also „Some Results of the Norwegian Arctic Expedition 1893–96“. Geogr. Journal, vol. IX (1897), p. 489.

Having discussed the point with Teall, I expressed myself somewhat more cautiously in the Norwegian edition of my book, which was finished more than half a year later than the English edition. See „Fram over Polhavet“, Kristiania, 1897, vol. II, pp. 515–517 See also the German edition, „In Nacht und Eis“. Neue revidirte Ausgabe. Leipzig, 1898, vol. II, pp. 486–488.

[2] „Fram over Polhavet“, vol. II, p. 516. „In Nacht und Eis“. Neue revid. Ausgabe. Leipzig, 1898, vol. II, p. 487.

[3] L. c. 1897, pp. 490, 519.

But if this be so, it follows that the plant-bed must have been lifted by intrusive masses, and if not all, at any rate the lower horizontal tiers of the basalt at Cape Flora must be intrusive. I have already above, pp. 15 and 17, pointed out that there are almost decisive proofs that these basalt beds cannot be intrusive.

Kœttlitz and I looked in vain for similar plant-bearing deposits below or between the tiers of basalt in other places on Cape Flora. But since my departure, Kœttlitz has been fortunate enough to find what he supposes to be the same plant-bearing bed in the cliffs above Windy Gully, on the opposite side of the Cape Flora hill, (about two kilometres distant from the locality mentioned above) and about 700 feet (210 m.) above sea-level (see fig. 1, *l*). Although this bed was only from 18 inches (45 cm.) to 2 feet (60 cm.) in thickness, it could be traced almost horizontally „for 500 to 600 yards between the second and third tiers of the basalt" (counting from below)[1]. If Kœttlitz's estimation of the height is correct, the second and third tiers must be lower near Windy Gully than above Elmwood, where the top of the second tier is about 880 feet above the sea. Kœttlitz tells me „that a thick layer of tufa(?) underlies this stratum, and it has all the appearance of being undisturbed". Even though this plant-bed is probably of nearly the same age as the one visited by Kœttlitz and myself[1], I do not consider it likely that they are actually parts of the same bed, the rocks composing them seem to be too dissimilar. According to communications from Kœttlitz, the plant-bed above Windy Gully is composed of a silicious rock, which Mr. Teall decribes as „brown, laminated, silicious rock"[2] (SiO_2 91·4%, Al_2O_3 and Fe_2O_3 3·9%; loss on ignition 2·4%. Another specimen he found to be SiO_2 73·8, Al_2O_3 and Fe_2O_3 10·7; loss on ignition 12·3%). Portions of this stratum or bed were „soft grey argillaceous rock" which „sticks to the tongue like bauxite". The plant-remains seem to have been found in the first-named kind of rock[3], and this is evidently quite different from that of the bed from which Kœttlitz and I collected plant-fossils, this last being an argillaceous shale.

A third place where Dr. Kœttlitz tells me that he „found similar plant fossils was upon the summit of the rocks of Cape Flora cliff, upon almost

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[1] See Newton and Teall, l. c. 1898, p. 649.
[2] L. c. 1898, p. 649.
[3] Cf. Newton and Teall's description l. c. 1898, p. 649.

the highest part, about 900 feet (275 m.) or 950 feet above sea-level (see fig. 1, *k* and fig. 3, *k*). These were in fragments of brown sandy rock which Mr. Teall found to be composed of „grains of quartz, fragments showing plant structure, and a few flakes of white and brown mica". These pieces were loose, in a slight hollow, as though caused by a runlet of water. They appeared to have been washed loose out of a bed of similar, but frozen rock underlying them"[1].

These fossils may perhaps belong to a stratum which is situated higher in the basalt than the bed before mentioned, perhaps between the third and fourth or between the fourth and fifth tiers of basalt (counting from below). Judging from Newton and Teall's description, this brown sandy rock seems to be more like that of the plant-bed on the nunatak to the north, visited by Kœttlitz and myself, though it „is somewhat coarser", and then our shale to the north contains very little sand. That they are found at different heights may be accounted for by the possibility that there has been a dislocation just north of the place where these fossils were found; and as we know nothing as to the height above the base of the basalt, of the plant-bearing bed overlying the nunatak to the north, it may very well be that it has been situated between the same, or nearly the same tiers. The fossils from these two localities can hardly, however, belong to exactly the same horizon, as I think the distance between them (see fig. 1) is too small to account for the difference in the deposit in which they are preserved.

I quite agree with Kœttlitz when he does not consider it probable that these plant-bearing strata have been lifted by intrusive sheets in such extensive and horizontal thin beds; nor can I understand how the flows of basalt could have become so regular and horizontal, if they had been intrusive masses extending themselves in soft clay, like that of Cape Flora. A glance at the regular, horizontal basalt-beds in figs. 2 and 3 will hardly, I think, make one feel inclined *a priori* to assume such a possibility.

It would also be extremely difficult, as Kœttlitz points out, to explain how the tree-trunks and branches now carbonized or „charred into charcoal" (also partly silicified) could have been enclosed in the basalt sheets which underlie the plant-bearing beds, if the basalt is intrusive. I think with Kœttlitz that there cannot be much doubt that these tree-trunks have chiefly belonged

[1] See also Newton and Teall, l. c. 1898, p. 648 (a).

to conifers growing on the soil over which these basalt flows were discharged during the Upper Jurassic or Lower Cretaceous Age; and they have „been charred by being overwhelmed in a surface-flowing mass of lava". Some of this wood must, according to Kœttlitz, have been growing on the first or lowest tier of basalt[1].

A conclusive proof that at any rate the lowest tier of the basalt cannot be intrusive and consequently must be Jurassic, seems to me to be given by Teall himself, when he says that „evidence that pauses occurred during the formation of the plateau-basalt . . . is furnished by a specimen of a conglomeratic rock, mainly composed of basaltic débris, and containing rounded pebbles, found some 50 feet above lowest rock near Cape Flora"[2]. This is on the top of the lowest tier of basalt, and this basalt, as well as the basaltic conglomerate, is consequently lower than the plant-bearing beds mentioned, and must also be older, as the basaltic conglomerate cannot be intrusive.

Moreover, it may also be remembered that neither the clay, or shale, immediately below the basalt, nor the plantbearing strata between the tiers of basalt, show any appreciable alteration by heat, or any contact-metamorphosis (see pp. 15, 17, 21).

Taken together, these facts appear to me to be conclusive, and we must assume with Dr. Kœttlitz, that these plant-bearing beds have actually been deposited, probably as lake-deposits, between the different discharges of the flows of basalt. If then, these beds are Upper Jurassic or transition beds to the Lower Cretaceous, *the greater part of the basalt is also of Upper Jurassic or Lower Cretaceous age.*

It is extremely interesting to learn that Prof. Nathorst has apparently found the same basaltic and Jurassic formations on *Kong Karl's Land* (Wiche Land) during his expedition last summer.

Nathorst tells me that he believes the basaltic beds of Kong Karls Land to be Upper Jurassic or Lower Cretaceous and that they are not intrusive. He says:

„1°, the basalt forms real flows or beds, being remains of old lava streams".

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[1] Kœttlitz, Geogr. Journal, 1898, p. 134.
[2] Newton and Teall, l. c. 1897, p. 490.

„2°, the basalt in some places is so intimately connected with the fossiliferous strata, that it is impossible to assume that the lava flows could have extended over these strata in the manner they have done, if they had been discharged as late as during Tertiary times".

I have said before that the tiers of basalt at Cape Flora are possibly not quite horizontal, but dip perhaps a little towards the north. This seems to be still more the case a little farther east, in the *Gully Rocks* and on *Cape Gertrude*, which is only 3 or 4 miles (6—7 kilometres) east of Cape Flora.

Fig. 5. *Cape Gertrude. Drawn from a photograph by F. N.*

That such is the case is indicated in a rough sketch, by Dr. Kœttlitz, of Cape Flora, Gully Rocks, and Cape Gertrude, taken from near Windward Island, 6 miles to the north (fig. 4, p. 6), which sketch he has kindly placed at my disposal together with a good many others.

Fig. 5, which is a drawing I have made from one of my photographs of Cape Gertrude, shows distinctly this dip of the basalt, and its exact dimensions.

This dip of the basalt flows may perhaps be sufficient to account for the fact that, according to Kœttlitz, the basalt reaches down to the sea, on the North side of the peninsula, at the bay (fig. 6, *6*) — „the head of Günther Bay" — north-east of Cape Gertrude[1], at the north end of the valley separating the hill of Cape Gertrude from the east part of Northbrook Island. If we assume the distance between these two places to be as much as 5 or 6 kilometres (3 miles) and the base of the basalt at Cape Gertrude to be 180 metres (600 feet) above the sea the dip found in the photograph represented in fig. 5, which is about 33 metres for every kilometre in a northerly direction, would alone be sufficient to account for this fact.

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[1] See Kœttlitz, Quart. Journ. Geol. Soc., 1898, p. 635.

Farther south in this valley east of Cape Gertrude, however, (on the east side of the valley) there is „a line and ridge of detached nunataks, composed of basalt, and averaging 320 feet above sea-level“. „This line of nunataks continues through the whole of this valley, about 2 or 3 miles“ [1]. Possibly the low position of the basalt here, may be owing to a dislocation of some kind.

Upon the whole there is apparently not much regularity in the position of the basalt, and the height of its base above sea-level on Northbrook Island. At Cape Gertrude, according to Kœttlitz, its base is masked by the talus heaps but may be some 180 to 210 m. (600—700 feet) above sea-level. At an exposed rock (fig. 6, *3*) some seven kilometres farther east along the south

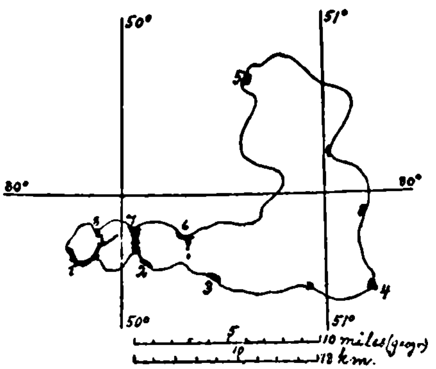

Fig. 6. ***Northbrook Island, based on Mr. F. Jackson's map of Franz Josef Land.*** The places where the underlying rock projects through the ice-covering are indicated in dark colour. *1* Cape Flora. *2* Cape Gertrude. *3* Cliffs east of C. Gertrude. *4* Cape Barentz. *5* Camp Point. *6* Valley east of C. Gertrude. *7* Valley east of Gully Rocks. *8* Windy Gully.

coast, (east of the valley mentioned above) there are „several bosses of basaltic rock protruding from the general talus-slope, and apparently *in situ*“ [1]. They are perhaps some 90 or 120 m. (300 or 400 feet) above the sea. At Cape *Barentz*, at the south-east corner of the island, and at *Camp Point*, at its northern extremity, the basalt cliffs reach the sea. In both these places, the upper edge of the basalt is only some 45 m. (150 feet) above sea-level [2].

The probability is that various dislocations have occurred in the neighbourhood of Northbrook Island, as elsewhere in Franz Josef Land, and that this, to some extent, is the cause of this land being broken up, as it is, into islands, with numerous sounds and fjords. But then it ought also to be remembered, that it is not *à priori* probable, that the basalt flows were poured out over

[1] Communicated by Dr. Kœttlitz.
[2] Kœttlitz, l. c. 1898, p. 625.

absolutely horizontal ground, and that thus the basalt flows were originally absolutely horizontal.

The Jurassic deposits of Northbrook Island beyond Cape Flora, are very little known. They have been examined almost exclusively at Cape Gertrude[1]. The sedimentary beds here were investigated by Dr. Kœttlitz at various heights where they are exposed, from sea-level to 24 m. (80 feet) above, and again from 75 to 150 m. (250 to 500 feet) above. These strata differ remarkably from the strata (clay-beds) underlying the basalt at Cape Flora. „They yield *no fossils* except fossil wood and lignite, and are for the most part composed of sand in thin layers, extraordinarily variable in colour. Among the sand layers are many strata containing pebbles of quartzite, radiolarian chert, jaspis, „ironstone-nodules“, etc. „Thin strata of soft clay-shales also occur frequently. Bands of lignite, or of brown, decomposed fossil wood, an inch or two thick, are frequent. Here and there the sand-strata seem to harden locally into a very hard, calcareous, grey sandstone, in which ripple-marks were found. These sandstone masses protrude from the inclined section in great bosses[2]“.

The only part of the Jurassic beds at Cape Flora to which in my opinion these sediments of Cape Gertrude may correspond, is the strata of sand with black carboniferous seams (fig. 7,*b*) in the bank above the shore south of Elmwood (see p. 12 (b)), which are probably underlying the 150 to 175 m. (500 to 570 feet) thick clay beds containing Jurassic marine fossils. As far as we know, the horizon of these clay beds does not seem to be represented at Cape Gertrude, the sediments of which, in my opinion, may be of an earlier age, and the horizon of the highest of them the same or similar to that of the sand strata with carboniferous seams south of Elmwood[3]. This would imply either a fault or a dip in the lower Jurassic strata (which has also actually been observed going NNW. see p. 13.) which has been anterior to the discharges of the basalt above. The dip or fault in these deposits, which have evidently been formed in very shallow water, or to some extent perhaps in freshwater, may also very well be anterior to the deposition of the Jurassic clay beds containing numerous marine fossils, found at Cape Flora.

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[1] Newton and Teall, l. c. 1897, p. 503.

[2] Communicated by Dr. Kœttlitz.

[3] Seams of lignite, or similar strata of sand (possibly of freshwater origin) have not been found at any higher level (45 feet above the sea) or in any other locality at Cape Flora, as far as I know.

The composition of these two formations also seems to point to quite different conditions of deposition, which in my opinion makes it impossible that they should belong to the same horizon. The clay beds at Cape Flora, as far as I have seen, are, compared with these sand strata, considerably more uniform in their composition all through, from sea-level up to the base of the basalt; and the conditions of deposition, though varying, seem to have been considerably less so during their formation. They seem to have been deposited in comparatively shallow sea, and there is little indication of great oscillations of level. Not so with the sand strata south of Elmwood, and the sediments at Cape Gertrude. The extraordinary number of thin beds of diverse character in these formations points, as Newton and Teall say[1], „to rapidly varying condition of depositions, and possibly to oscillations of level, while the beds of lignite indicate, to some extent at least, a fresh-water origin". I do not consider it possible, if the conditions of deposition varied so rapidly at Cape Gertrude, that there should be no indication of this rapid variation in the corresponding deposits at Cape Flora hardly 4 miles (7 kilometres) off; and if there have been oscillations of level, they must have occurred in both places.

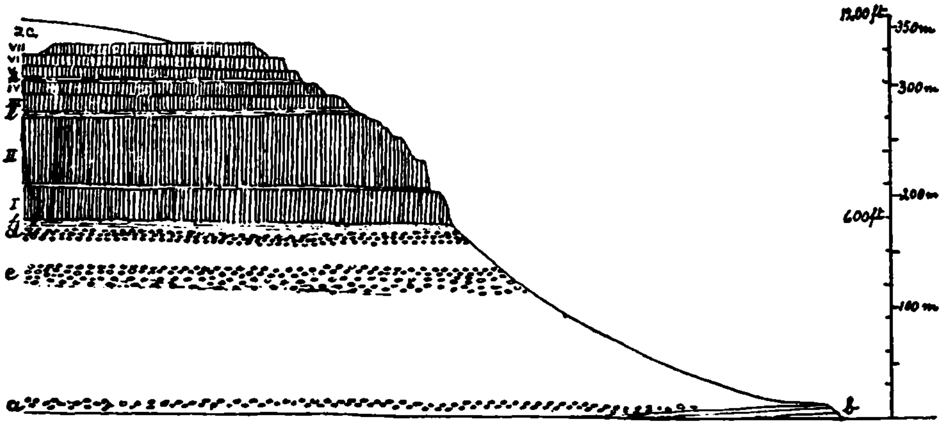

Fig 7. ***Diagrammatic section through the southern face of Cape Flora, illustrating the succession of geological formations.*** *a* Lowest fossiliferous horizon (see p. 11). *b* Thin alternating strata of sand with black carboniferous seams, probably underlying the former horizon *a* (see p. 12). *c* Medium fossiliferous horizon (see p. 13). *d* Upper fossiliferous horizon (see p. 14). *f* Strata immediately underlying the basalt (see pp. 15, 16—17). *I—VII* Successive tiers of basalt. *l* Plant-bearing bed between second and third tiers (see p. 24). *k* Plant-bearing bed probably between third and fourth, or between fourth and fifth tiers (see p. 25). *I. C.* Ice-Cap.

[1] L. c. 1897, p. 503.

According to what has been said before in this sketch, there should probably be the following succession of Jurassic sedimentary strata at Cape Flora, in descending order (cf. fig. 7):

280 m. (900 feet)	A plant-bearing bed of sandstone, probably between fourth and third, or betweeu fifth and fourth tiers of basalt (fig. 7, *k*).		On top of Cape Flora cliffs, north of Elmwood (fig. 1, *k*), (The plant-fossils found on a nunatake farther north (fig. 1, *i*) belong perhaps to nearly the same horizon).
210 m. (700 feet)	A plant-bearing bed, principally of silicious rock, between third and second tiers of basalt (fig. 7, *l*).		In the cliffs above Windy Gully (fig. 1, *l*).
200 m. (660 feet)	In the soil on top of the first or lowest tier of basalt, a Jurassic forest has been growing, branches and trunks of which have been found, in a carbonized or charred condition, enclosed in the second tier of basalt (fig. 7, between I and II).		On the south face of Cape Flora cliffs.
175 m. (575 feet)	Base of the basalt.	A specimen of ***Ammonites Lamberti*** (Newton) was found (by Kœttlitz) enclosed in the basalt.	Above Elmwood (near fig. 1 *d*).
175 m. (575 feet)	Black shale 4 inches (in contact with the basalt and somewhat hardened). Black shale $1^1/_2$ inch (not so much hardened). Greenish grey shale 3 inches (not so much hardened). A lighter coloured brownish soft clay, the depth of which was masked by the talus heaps (fig. 7, *f*).	No fossils found.	East of Elmwood (fig. 1, *f*, *f*).
175 m. (575 feet)	Soft clay 3 feet thick, immediately below the basalt (fig. 7, *f*); and under this clay a bed of basalt with lava-like structure, 6 feet thick.	No fossils found, but ***Quenstedtoceras*** (see Pompeckj) and ***Amm. Lamberti*** possibly originate somewhere near this horizon.	Above Elmwood (fig. 1, *d*).
168 m. (550 feet)	Soft clay beds of great thickness, with bands of nodules of clay-sandstone (fig. 7, *d*).	Fossils found ***in situ***, described by Newton as ***Amm. (Cadoc.) Tschefkini*** etc., see Pompeckj's descriptions later.	Above Elmwood (fig. 1, *d*).

137 m. (450 feet) to 113 m. (370 feet)	Soft stratified clay with bands of concretionary nodules of hard, very calcareous, (to some extent sandy) stone-marl and hard phosphatic and calcareous clay (fig. 7, *c*).	Fossils found *in situ*, described by Newton as *Amm. Ismae* var. *arcticus*, see Pompeckj later.	South end of Windy Gully (fig. 1, *c*).
? m. (? feet)	Marly limestone with cone-in-cone structure. Not found *in situ*, but may probably come in somewhere here (if not above the last horizon).		Found loose on the talus in various places round Cape Flora.
10 m. (33 feet) to 7 m. (23 feet)	Soft clay with nodules of sandy marl (fig. 7, *a*).	Fossils found *in situ*. *Pseudomonotis, Lingula, Discinea, Ostrea, Belemnites*, see Pompeckj's descriptions later.	Some 300 m. north of Elmwood (fig. 1, *a*).
14 m. (45 feet) to 0 m. (0 feet)	Thin alternating strata of sand of varying colours (with pebbles), interstratified with thin black carboniferous seams. Probably underlying the horizon above, and possibly corresponding to the upper sedimentary strata at Cape Gertrude (?) (fig. 7, *b*).	No fossils found except carbonized wood.	About 100 m. south of Elmwood (fig. 1, *b*).

Lysaker, *December*, 1898.

FRIDTJOF NANSEN.

THE JURASSIC FAUNA OF CAPE FLORA.

PREFACE.

During his stay on Northbrook Island in the Franz Josef Land Archipelago — from June 17th until August 7th 1896 — Professor Fridtjof Nansen collected a large number of rocks and fossils. Part of this collection comprising Jurassic marine fossils, was submitted to me for examination. The results of the investigation of this valuable material are described in the following pages.

MUNICH, *September* 1898.

J. F. POMPECKJ.

I.

PREVIOUS LITERATURE REFERRING TO THE JURA OF FRANZ JOSEF LAND.

From what we know at present about the geology of the arctic archipelago, known by the name of Franz Josef Land, strata of Jurassic age have only been observed in the southern parts of these islands.

On Northbrook Island, at least on its narrow southwestern peninsula, Jurassic deposits have a considerable share in the geological structure of the country. Owing to the researches and collections of the Jackson-Harmsworth Expedition and Prof. Nansen, this part of Northbrook Island may be considered the best known district of the Franz Josef Land Archipelago with regard to its geological structure. Except on Northbrook Island, Jurassic strata have probably only been found in the neighbourhood of *Eira Harbour*, situated between Mabel and Bell Islands. In other more westerly and easterly parts of the archipelago, the occurrence of Jurassic strata is not yet proved with certainty.

The following examination of the publications referring to the Jura of Franz Josef Land shows that the successful expeditions of recent years have contributed very considerably to the extension of our knowledge of the geology of this archipelago.

1876 (1873). It cannot be positively ascertained whether *Julius Payer*, the discoverer of Franz Josef Land, found Jurassic sediments in the southeastern and eastern parts of the archipelago, which were visited by him. Payer uses the following expressions[1] concerning the sedimentary rocks which he found on Franz Josef Land:

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[1] J. Payer, 'Die Oesterreichisch-ungarische Nordpol Expedition in den Jahren 1872—1874'. Wien 1876, p. 268.
English edition, 'New Lands within the Arctic Circle'. London 1876, vol. II, p. 82.

Whitish sandstone with small grains of quartz, and a white clayey cement, — pale gray, very finely grained sandstone — yellowish gray, finely laminated clay slate, with numerous small scales of white mica and small lignitic particles with plant-structure, — sandstone containing lignite.

Payer mentions no fossils except silicified wood. The sandstones with clayey cement might possibly be of Jurassic age. Blocks of clay-ironstone with Jurassic fossils have been found in abundance in the district of Cape Flora (Northbrook Island) both by the Jackson-Harmsworth Expedition and by Nansen. But, as no fossils in any way characteristic were found among the specimens of rocks collected by Payer, it is of course almost useless to try and find the age of these rocks from their petrographic resemblance.

1881 (1880). The *first certain* information of the occurrence of Jurassic strata on Franz Josef Land we find in the account of the Eira polar expedition under Leigh Smith[1]. In the neighbourhood of *Eira Harbour*, about 10 miles west of Northbrook Island, Mr. W. G. A. Grant found silicified wood and some other fossils on the hill overhanging the harbour. (August 22, 1880). Among these fossils Etheridge identified two *belemnites* as belonging to the *Oxford Clay*. Unfortunately, the exact locality of these, the first recorded Jurassic fossils from Franz Josef Land, cannot be ascertained. Judging from the description of the surroundings of Eira Harbour (l. c. p. 133) the locality might be Mabel Island, situated to the north of the harbour; while according to the statement of the height of the hill where the fossils were found, (1040 feet) Bell Island, situated to the south of the harbour, might also be the place (the mountain forming the apex of Bell Island is reported to be 1400 feet).

1895. Fifteen years after the discovery of the first Jurassic fossils on Franz Josef Land, the 'Windward' brought to London some geological material from the Jackson-Harmsworth Expedition. The specimens had been collected at Cape Flora on Northbrook Island. Among these specimens were some

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[1] C. A. Markham, 'The voyage of the Eira, and Mr. Leigh Smith's Arctic Discoveries in 1880'. Proceed. of The Roy. Geogr. Soc. London 1881, vol. III. p. 134, 135, 147.
M. Neumayr, 'Die Geographische Verbreitung der Jura-formation'. Denkschr. d. Wiener Akad. 1885, vol L. p. 90.
A. Montefiore. 'A note on the Geography of Franz Josef Land'. Geograph. Journ. London 1894, vol. III. p. 495.

pieces of a coarse calcareous grit in which Mr. E. T. Newton[1] identified petrified wood and other plant-remains, "probably coniferous, but for the most part too much altered to speak of with certainty". Newton also mentions a fragment of a belemnite which cannot be determined, and the impression of an ammonite which is said to resemble *Amm. macrocephalus*[2]. No exact statements of the age of these first fossils sent home by the Jackson-Harmsworth Expedition could be made.

1897. After his safe return from his great North Polar Expedition, Prof. Fridtjof Nansen gave an account of his expedition and its results before The Geographical Society in London on February 8th 1897[3]. In the report printed in the Geographical Journal he also mentions the occurrence of Jurassic deposits in the Franz Josef Land Archipelago. At Cape Flora, on Northbrook-Island, he says the Jackson-Harmsworth Expedition had discovered, under a heavy cap of basalt, "an immense formation of clay" unquestionably of mesozoic age. The fossils found in it point to the Lamberti-zone, with a development resembling that of the Russian Jura.

At the same time, Nansen called attention to a discovery made by Dr. Reginald Kœttlitz, the physician and geologist of the Jackson-Harmsworth Expedition. Mr. Jackson and Dr. Kœttlitz found, on a basalt rock protruding from a glacier on the north side of Cape Flora, pieces of sandstone containing numerous fossil plant-remains. Nansen and his bold companion, Lieut. Johansen, collected a large number of these plant-fossils, which, after their return, were submitted to Prof. Nathorst in Stockholm for examination. Prof. Nathorst identified these plant-remains as "belonging to the upper, White Jura, rather than to the more medium Brown Jura".

In the same year (1897) Nansen gave some further particulars about the occurrence of Jura at Cape Flora, in his book on the expedition, the German Edition of which: 'Durch Nacht und Eis', is before me. From this report, and from the Norwegian edition[4] of the same book, we learn that

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[1] Arthur Montefiore, 'The Jackson-Harmsworth Expedition: An Account of its first winter and of some discoveries in Franz Josef Land'. Geograph. Journ. London 1895, vol. VI. p. 519 (Note by Mr. E. T. Newton).

[2] Newton has since (1897) identified this piece with *Macrocephalites macrocephalus* Schloth sp.

[3] Fridtjof Nansen, 'Some Results of the Norwegian Arctic Expedition 1893—96'. Geograph. Journ. London 1897, vol. IX. pp. 489—490.

[4] The details taken from the Norwegian edition I owe to a communication which Dr. Joh. Kiær of Christiania kindly made to me.

under the basalt at *Cape Flora*, there is *a soft gray-blue clay of 500—600 feet in thickness, in which numerous large and small nodules of reddish-brown clay sandstone are imbedded.* Nansen noticed solitary thin strata of basalt in the clay. The occurrence of thin strata of lignite is also mentioned as having been observed by Kœttlitz in several places[1]. Judging from the fossils, mostly included in the sandstone-nodules, but also lying free in the clay, Prof. Nansen characterises *the age* of the *clay*, underlying the basalt of Cape Flora, as approximately identical with that of the *Oxford Clay*[2].

In December 1897 Messrs. E. T. Newton and I. I. H. Teall[3] published their investigations of the new material sent to England by the Jackson-Harmsworth Expedition; and this paper is of great importance to our knowledge of the geology of Franz Josef Land. By help of this collection, and statements by Dr. Kœttlitz, Newton ascertained that in the neighbourhood of Cape Flora on Northbrook Island, Jurassic deposits "chiefly clay interstratified with shales and bands of ironstone, lignite etc." of a considerable thickness (about 600 feet) underlie a cap of basalt extending over the whole district. Enormous heaps of talus débris and gravel almost entirely cover the strata underlying the basalt, and very seldom allow of an examination of the outcrop of these strata *in situ*.

Newton describes Jurassic fossils from different localities in the neighbourhood of Cape Flora.

1. *Elmwood*, on the south side of Cape Flora (station of the Jackson-Harmsworth Expedition):

Amm. (*Cadoceras*) *Tchefkini?* d'Orb[4].

Amm. (*Cadoceras*) *modiolaris* Luid.

— — — var.

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[1] This statement may refer specially to the district round Cape Gertrude, east of Cape Flora. At Cape Flora lignite is found only in the lowest horizon — 1 (b) — south of Elmwood; cf. the geological sketch by Prof. Nansen, p. 12 and 28.

[2] See the Norwegian edition and also the second edition of the German translation. vol. II p. 482 et seq.

[3] E. T. Newton and I. I. H. Teall, 'Notes on a collection of Rocks and Fossils from Franz Josef Land made by the Jackson-Harmsworth Expedition during 1894-1896,' Quart. Journ. of The Geolog. Soc. London 1897. vol. LIV p. 477—518.

[4] I quote here the names used by Newton. From the remarks in the descriptive part of this paper, it may be seen how far the determination of the fossils, published by Newton, is to be changed or accepted.

Amm. (*Macrocephalites*) *macrocephalus*, Schloth.

Belemnites Panderi, d'Orb.

Pecten cf. *demissus*.

Gorgonia (?)

2. *Windy Gully*, north-east of Elmwood.

Amm. (*Macrocephalites*) *Ishmæ* (Keys.) var. *arcticus*.

Amm. (*Macrocephalites*) *Ishmæ*, Keys. inflated variety.

Amm. (*Macrocephalites*) *Ishmæ*, Keys. smooth variety.

Belemnites 3 sp. indet.

3. *500 yards west of Elmwood.*

Ammonites sp. (fragment of an ammonite allied to *Amm. Gowerianus*, but too imperfect to be determined).

Belemnites div. sp. indet.

Avicula sp. cf. *inæquivalvis*.

4. *On the north side of Cape Flora*: Fossil plants (cf. l. c. pp. 493—495). This is the same locality as that in which Nansen made the collection of fossil plants, which was examined by Prof. Nathorst. It is worthy of notice that Newton also mentions cycads from this place (*Podozamites* sp. probably allied to *P. lanceolatus*) while Prof. Nathorst, in the material examined by him, only found conifers and ferns [1].

In addition to these, silicified wood is also mentioned as having been found in several places, but it is not yet proved with certainty that these pieces, generally found loose on the talus, are of Jurassic age.

The greater number of the fossil forms described by Newton were included in loose blocks picked up from the talus. Only some few specimens are reported as having been found *in situ*.

Amm. (*Cadoceras*) *Tchefkini?*, d'Orb. (l. c. Pl. XXXIX Fig. 5) from Elmwood, 50 feet below the basalt.

Avicula sp. cf. *inæquivalvis* *Amm.* sp. (?? *Amm. Gowerianus*) *Belemnites* sp. sp. indet.	500 yards west of Elmwood, 30—40 feet above the sea.

[1] A new publication by Prof. Nathorst proves, that the material collected by Prof. Nansen also contains cycad-remains; cf. A. G. Nathorst, 'Zur mesozoischen Flora Spitsbergens'. K. Svenska Vet.—Akad. Handl., vol. 30, No. 1. 1897, p. 74.

Amm. (*Macrocephalites*) *Ishmæ*, Keys. var. *arcticus* of Newton, from the locality of Windy Gully (300 feet, or according to Kœttlitz, more than 400 feet above the sea) is perhaps also found *in situ*.

Judging from the occurrence of *Amm.* (*Cadoceras*) *Tchefkini?*, d'Orb. and *Amm.* (*Macrocephalites*) *macrocephalus*, Schloth. Newton concluded that the "*Lower Oxfordian and probably the equivalent of the British Kellaways Rocks*" is represented in the Jurassic strata underlying the basalt at Cape Flora. He is of opinion that *Amm.* (*Macrocephalites*) *Ishmæ* Keys. var. *arcticus* of Newton may possibly correspond with the *Cornbrash*.

As to the age of the fragments of Avicula and Belemnites found west of Elmwood, Newton could draw no certain conclusions.

Nor does he express any very certain opinion with regard to the age of the plant-remains found on the north side of Cape Flora, and which Prof. Nathorst declared to be probably Upper Jurassic (White Jura).

The age of other strata containing plant-remains in the Franz Josef Land Archipelago, Newton[1] also leaves undecided. West of Cape Flora, at Cape Stephen, and between this place and Cape Grant (in the South of Alexandra Land), hard calcareous sandstone with carbonized plants, bituminous paper-shales and lignite occur. The flora of this horizon, perhaps the lowest of the Franz Josef Land Archipelago, according to Newton, most resembles that of the lower Tunguska district described by Schmalhausen "as of Oolitic age". According to later researches[2] the plants of the lower Tunguska are perhaps however of Permian age. Thus the plant-bearing strata of Cape Stephen are possibly also of Permian and not of Jurassic age, provided that they correspond with those of the lower Tunguska.

1898. Dr. Reginald Kœttlitz gave in 'a brief sketch of the Geology'[3] a report of the results of the geological researches which he had made as a member of the Jackson-Harmsworth Expedition. According to his observations, sandstones and shales containing plant remains, "beds of lignite, and other evidences of littoral and estuarine conditions" are among the lowest of the

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[1] E. T. Newton and I. I. H. Teall, l. c. pp. 503—506, 513.

[2] R. Zeiller, 'Remarques sur les flores fossiles de l'Altai etc'. Bull. de la Soc. géol. de France S. 3. vol. XXIV, 1896, pp 471—482, 484.

[3] F. G. Jackson, 'Three years exploration in Franz Josef Land. Appendix: Dr. Reginald Kœttlitz: Brief sketch of the Geology'. Geograph. Journ. London 1898, vol. XI, pp. 132—135.

beds of stratified rocks in the southern part of Franz Josef Land. These beds are "succeeded by strata of purely marine origin the age of which can be plainly stated" (according to Newton's determinations) by the occurrence of *Amm. macrocephalus* and *modiolaris*. As evidence of frequent oscillations of sea-level during Jurassic times, Dr. Kœttlitz points out "the extraordinary number of different-coloured thin strata of clay, shale and sand, the last-named being often false-bedded, and frequently having many rounded, water-worn pebbles of all kinds embedded among it".

Unfortunately too few references to exact localities are given in this sketch. The occurrence of plants in the lower strata of the sedimentary formation in the southern part of Franz Josef Land is probably to be referred to the neighbourhood of Cape Stephen (southern side of Alexandra Land) the Jurassic age of which is not definitely determined (*vide* above). The very frequent changes in the petrographic structure of the various layers seem, according to Newton's statements, which were based upon previous communications from Dr. Kœttlitz, to point more especially to the neighbourhood of Cape Gertrude, east of Cape Flora, and to the bank 10—40 feet above the shore, just south of Elmwood; cf. p. 12, "lowest horizon 1 *b*". The strata with ammonites (belemnites, pectens and avicula-remains) must occur at Cape Flora itself.

The basalt covering the Jurassic sediments in a thickness of 500—600 feet, does not, at Cape Flora, according to Dr. Kœttlitz, appear as a homogeneous mass; it is rather composed of a series of separate layers (tiers) "to the number of seven or eight or more". Between these separate tiers "one can frequently find thin layers or strata of clay and sandstone, generally from 1, 2 to 4 feet in thickness, similar in every respect to those one finds underneath". "In one of these strata, between the second and third tier, and a hundred feet or more above the lower edge of the basalt formation", Dr. Kœttlitz found fossil plants similar to those which he and Dr. Nansen collected on the north side of Cape Flora, on the isolated basalt-rock ("Nunatak") protruding from the glacier. Dr. Kœttlitz supposes that he has here found *in situ* the horizon of the plants identified by Prof. Nathorst as Upper Jurassic (White Jura) [1].

[1] Cf. 'Geological Sketch of Cape Flora and its neighbourhood' by Fridtjof Nansen, pp. 21—24. This sketch, which Prof. Nansen has kindly added to the present paper, contains the newest statements of the geological structure of Cape Flora, and thus it supplements in every way the previous work done in the geology of Cape Flora.

The researches of Dr. Kœttlitz and Messrs. E. T. Newton and I. I. H. Teall are of great value in the investigation of the fossils collected by Prof. Nansen.

The *paleontological and stratigraphical results*, however, at which Newton arrived by the investigation of the material of the Jackson-Harmsworth Expedition will be subject to many alterations, made necessary by the examination of the material described in the following pages.

II.

THE JURASSIC SEDIMENTARY ROCKS AT CAPE FLORA.

According to Prof. Nansen as well as to Dr. Kœttlitz, Messrs. E. T. Newton and I. I. H. Teall, *clay* — a soft gray-blue clay — 500—600 feet thick forms the principal part of the strata underlying the basalt at Cape Flora. Other rocks, such as shales, ironstone (?), clay-sandstone and lignite, are only mentioned as elements of secondary importance in the composition of the Jurassic strata in this region.

Among the specimens of sedimentary rocks of Jurassic age collected by Nansen and submitted to me for examination, pieces of clay are but rare; the majority cannot even be called pure clay.

No. 1. *Grey-blue, grey and yellow calcareous clay* in compact (to some extent hard, concretionary) pieces with from reddish-brown to black weather crust. This crust is rich in hydroxide of iron, so that externally the pieces have the appearance of argillaceous ironstone[1]. Veins of calcite occur, and irregular, to some extent swollen accumulations of brown-ironstone, arising from pyrite. The stones contain partly calcified, partly pyritis ammonites (with nacreous shells), fragments of belemnites, and indeterminable isolated remains of small lamellibranchs. The greater number of pieces were found on July 12th 1896, at a height of 100—200 feet (30—60 m.), 1½ kilometer NW. from Elmwood; cf. p. 17, "Doubtful horizon". One piece, of July 16th was found at a height of about 550 feet (150 m.) directly behind Elmwood; cf. p. 15, "Upper horizon". Other pieces collected on July 10th, were

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[1] Newton and Teall often mentioned "ironstone" (l. c. pp. 493—495). I have not found in the material before me, pieces which ought to be described directly as "ironstone".

found lying loose on the talus at a height of 100 feet (30 m.) behind Elmwood; cf. p. 16, No. 4.

Judging from their state of preservation, none of these pieces have been found *in situ.*

No. 2. A similar grey-brown, hard, phosphoritic clay found loose at a height of ca. 370—450 feet (113—127 m.) on July 14th 1896, south-western end of Windy Gully; cf. p. 13, "Medium horizon". This piece furnished the calcareous ammonite figured on pl. II. fig. 12.

No. 3. Phosphoritic (and calcareous) *clay nodules* are numerous in the material before me. They vary from the size of a nut to that of a clenched fist. They are composed of a dark brown or black nucleus of phosphorite, and a lighter gray or brown soft crust of clay which, evidently owing to weathering only, is free from phosphorite.

a). Phosphoritic nodules with light-gray argillaceous weathered crust. Organic remains can only be proved in a few (2) pieces. (Ammonite- and Serpula-remains). A quantity of pieces were found loose on July 12th 1896, 100—200 feet (30—60 m.) above the sea, 1½ klm. NW. from Elmwood, "doubtful horizon", cf. p. 17. Others were found loose on July 14th 1896, at a height of ca. 370—450 feet (113—137 m.) at the south-western end of Windy Gully, "Medium horizon", cf. p. 13.

b). Phosphoritic nodules with darker argillaceous weathered crust, from July 14th 1896, found loose at a height of 400 feet, south-western end of Windy Gully. The nodules contain pieces of the phragmocones of a large species of belemnites. I have nothing to add to the description of the microscopic examination of the phosphoritic nodules, given by Messrs. Newton and Teall[1].

Mr. A. Schwager, chemist at the "königlich bayrisches Ober-Berg-Amt", Munich, had the kindness to examine specimens of phosphoritic nodules. The examination proved that besides phosphate of lime, 8% $CaCo_3$ and 7·32% SiO_2 the nodules contain a ferruginous, argillaceous substance to an amount corresponding to SiO_2, and little organic substance[2].

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[1] E. T. Newton and I. I. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. 53. p. 499. Pl. XXXVII. fig. 6.

[2] I here take the opportunity of tendering to Mr. Schwager my warmest thanks for his kind assistance.

No. 4. Hard dark-gray, finely-grained, sandy marl, with small, irregular accumulations of pyrite. The stone is much broken and traversed by veins of calcite. Some pieces contain small portions of *pale-gray, very soft marl* (no. 4 a), which was also found unconnected with the hard marl. The sandy hard marl is very rich in shells of lamellibranchs, which, however, are partly very much broken and crushed, partly preserved only in indeterminable sections. In addition to these, there are inarticulate brachiopods and belemnites. These brachiopods and belemnites, and some fragments of indeterminable lamellibranchs, are also included in the pale-gray, soft marl, (no. 4 a) occurring together with the sandy, hard, dark-gray marl, and found loose in isolated pieces.

Both the pieces of sandy, dark-gray, hard marl, and those of soft marl found loose, were collected on August 2nd 1896. They were found at a height of about 23—33 feet (7—10 m.) above sea-level, 300 m. NW. from Elmwood; cf. p. 11, No. 1 a, "lowest horizon". Judging from the state of preservation of the generally rather large blocks of sandy, dark-gray, hard marl, they have most probably been found *in situ.*

No- 5. Yellow or gray and greenish hard calcareous, to some extent *sandy marl ("Steinmergel").*

Most of the pieces, which were found loose, show a soft, brown or rusty red weathered crust. Some pieces of the rock are quite compact, uncommonly hard, with a conchoidal fracture; the fractured surface is glossy black and of a greasy appearance. Other pieces are of coarser grain; but upon the whole, they are always quite finely grained, with an earthy fracture. By containing more sand and being less calcareous, this rock gradually passes over into clay sandstone (No. 6).

The rocks contain numerous impressions and fragments of ammonites (with nacreous shells) and indeterminable remains of belemnites; and, very rarely, remains of lammellibranchs are found. Besides indications of plant-remains, one of the pieces contains traces of a coal-like substance.

These pieces were found loose on the talus, on July 10th 1896, at a height of 100 feet (30 m.) above sea-level, behind Elmwood, cf. pag. 16, and on July 14th 1896, at a height of about 370—450 feet (113—137 m.), at the south-western end of Windy Gully, cf. p. 13.

No. 6. There are also numerous pieces of *cone-in-cone structure* (*"Tutenmergel, Nagelkalk"*) corresponding, petrographically, in every respect with the above-mentioned rock-type. They were found loose on the talus, on July 10th 1896, at a height of 100 feet (30 m.) above the sea, behind Elmwood, and on July 12th about 100—180 feet above sea-level, $1^1/_2$ klm. NW. from Elmwood.

No. 7. *Clay-sandstone.* From finely-grained to extremely finely-grained, compact, to some extent calcareous, clay-sandstone, with tiny lamellæ of white mica, is represented by a large number of specimens. In an unweathered state, the stone is hard, gray or dark-gray. Most of the pieces are surrounded with a brown, or rusty red weathered crust of varying thickness. A few pieces, owing to the great amount of weathering they have undergone, are soft, and dyed through and through, from a rusty brown to red. Pyrites and its derivative limonite, occur in small irregular accumulations partly as fossilising material, especially of ammonites.

The finely grained varieties very much resemble the more sandy varieties of the rock of type, No. 4.

Most of the pieces contain fossil remains, ammonites especially (partly pyritic) being of frequent occurrence, their shells glittering like mother-of-pearl (partly only impressions of small specimens and broken impressions of very large ones); next, less frequent fragments of belemnites, and then a number of species of lamellibranchs, each represented usually by but one or two specimens. Most of the lamellibranchs described in the following chapter are embedded in clay sandstone. Indistinct traces of plants (?) also occur.

The greater number of pieces of clay sandstone were collected on July 16th 1895, at a height of 500—550 feet (150—165 m.) above sea-level, behind Elmwood, cf. p. 14, "Upper horizon"; and of this majority again, most were found loose, for they were surrounded with a weathered crust, and must therefore have been subjected to weathering for a considerable time on the talus.

Some few pieces without, or with only a thin and imperfect weathered crust, have been found *in situ* about 550 feet above sea-level, or have fallen down from their bed a comparatively short time before. There is no doubt that at Cape Flora, there are nodules of clay sandstone in places at an average height of 500—550 feet above sea-level, and near the lower edge of the basalt at Elmwood on the southwest side of Cape Flora, Newton and Teall[1] also mention clay sandstone *in situ*, about 50 feet below the basalt, that is to say, at a height of about 550 feet above sea-level. The most important of the clay sandstone fossils which Newton describes from this height, can be identified with the clay sandstone fossils examined by myself.

A very much weathered piece of clay sandstone was also found loose on the talus on July 12th, 1896, 100—200 feet above the sea, $1^{1}/_{2}$ klm. NW. from Elmwood, cf. p. 17, "doubtful horizon".

A small portion of the material before me consists of fossil fragments without adhering rock. These pieces, at any rate to some extent, can be recognized as having been weathered out of several of the types of stone here mentioned. I shall return to these pieces in the last section of this treatise.

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[1] E. T. Newton and J. J. H. Teall, l. c. p. 496.

III.

THE FAUNA OF THE JURASSIC SEDIMENTS AT CAPE FLORA.

1. STATE OF PRESERVATION OF THE FOSSILS.

Judging from the material submitted to me by Prof. Nansen, some portions of the Jurassic sediments at Cape Flora must be called rich in fossils. Particularly, rock of type 4, mentioned in the last chapter, is in some places thickly interspersed with fossil remains, especially of lamellibranchs.

Unfortunately the fossils are generally very imperfect. They consist of broken and crushed specimens, or of imperfectly preserved internal casts and impressions.

The greater number of the *lamellibranchs*, which are very numerous, judging from the preserved remains, could not be determined at all. In some of them, the genus could hardly be determined, and *the species could be identified only in a few specimens.* The results obtained by the examination of the lamellibranchiata are in consequence not very satisfactory.

The few *brachiopods* (2 species) are also mostly in broken fragments, though sufficiently well preserved for identification. The most perfect remains, in comparison, are those of cephalopods. Although they are chiefly only fragments and impressions of some quite young specimens of *ammonites* that occur, they could be identified with a very fair amount of certainty. The nacreous shells of the ammonites, generally inclosing a cast of pyrite or brown ironstone, strongly recall the manner of preservation of the ammonites in the Russian Jura. Fragments of *belemnite* guards found loose, occur in numerous pieces, and are, to a certain extent, easily identified

The state of preservation of some remains of belemnites and Pseudomonotis found on August 2nd, 30 feet above the sea level, is peculiar. They were lying free in the clay (*in situ*) together with stone-nodules of type 4. The greatly broken pieces are covered with a crust of crystals of gypsum.

Considering the state of preservation of the fossils in conjunction with the petrographic character of the rocks, the Jurassic strata of Cape Flora give the impression of deposits having been formed near the shore. In the rough water near the shore, the hard parts of the animals were easily broken. The pressure of the heavy masses above, and fractures in the rock, then accomplished what was still wanting to make the state of preservation of the animal-remains embedded in clayey, marly and sandy masses, as bad as it could possibly be.

2. DESCRIPTION OF THE FOSSILS.

ECHINODERMATA.

CRINOIDEA.

The Echinoderms are only represented by a single fragment of a crinoid stem, in the material collected by Prof. Nansen. This belongs to the genus

PENTACRINUS, Miller s. str.

and was determined as:

Pentacrinus sp. ex. aff. ***bajociensis*** (d'Orb.) P. de Loriol.

Pl. I. fig. 1.

(Cf. 1886 ***Pentacrinus bajociensis*** d'Orb., P. de Loriol: Crinoides. Paléontologie française. Terr. jur. vol. IX. p. 144, pl. 150, 151, figs. 1—4).

The fragment of stem before me consists of 6 joints. The alternating joints are somewhat different in shape and size. The larger and longer joints are pentagonal in outline with rounded corners; they are not incurved in the interpetalous regions, or only very slightly. The joints alternating with them are a little smaller and shorter. Their contour is also rounded pentagonal, but in the interpetalous regions they are slightly incurved at obtuse concave angles. The outer side of all the joints is inflated and arched, almost carinated. The outer surface is thickly tuberculated. Near the sutures, the tubercles are closer and finer than along the middle of the inflated side. The tuberculating has to some extent become indistinct from weathering.

The sutures between the different joints, situated in depressed grooves, are finely crisped. In the interpetalous regions rounded depressions occur ("interarticular pores" H. Carpenter). Owing to these depressions, the smaller and shorter joints are somewhat narrowed in the interpetalous regions from above and below, whereas the larger joints are not subjected to any such narrowing.

The cirri-bearing joints ("nodal joints" Wyville Thomson) are not to be found on the piece here figured. The upper articulating surface of the uppermost (smaller) joint (Pl. I. fig. 1, *c*, *d*.) which is developed to form a syzygial surface, shows that the succeeding joint must have been a nodal joint.

On the syzygial surface the petalous parts are separated by shallow, but comparatively broad grooves. At the opposite end of the stem-fragment, the remains of an ordinary articulating surface is to be seen. Here the interpetalous grooves are in the form of very narrow, scarcely depressed lines. The coarse crenation of the broad low ridges surrounding the shallow petalous furrows is scarcely interrupted by the grooves between any two petala. The interarticular pores, mentioned above, communicate with these interpetalous grooves.

Judging from the appearance of the interarticular pores, the piece figured must have belonged to the upper part of a stem, as a comparison with the living pentacrinites will show. It cannot, however, have come from the immediate vicinity of the calyx, for the piece is destitute of the deep inward curvatures in the interpetalous regions that are characteristic of this part of the stem.

Pentacrinus sp. ex. aff. bajociensis (d'Orb.) P. de Loriol was found loose, without adhering rock, on July 12th 1896, at the margin of the glacier northwest of Elmwood, and about 150—200 feet above the sea.

The piece is composed of dark, almost black calcite.

Remarks. The relationship of the form described with ***Pentacrinus bajociensis*** (d'Orb) P. de Loriol is most probably, in so far as this species is known, a very close one. The piece figured by P. de Loriol (l. c. Pl. 150, fig. 9) in particular, bears a great resemblance to our form, if we leave out of consideration the missing nodal joints of our specimen. The differences between this and the species described by Loriol, several pieces of which from the Bajocien of Feuguerolles (Calvados) are now before me, are confined to the following points:

1. In our form, the joints are considerably longer and less incurved in the interpetalous regions;
2. The interarticular pores in *Pentacrinus bajociensis* are broader than in our stem-fragment.

I am not able to determine with certainty whether these differences are specific, and not merely individual, or whether they are only to be attributed to the fact that the stem-fragment here figured corresponds to another region, more distant from the calyx than those described from *Pentacrinus bajociensis* and fragments of which are before me. Doubtless in *Pentacrinus bajociensis*, as in all Pentacrinus species, the joints farther from the calyx are longer, less incurved, and thus more similar to the fragment described from Cape Flora.

Our piece differs from *Pentacrinus Nicoleti, Desor*[1], a species from the Bathonian, closely allied to *Pentacrinus bajociensis*, in the considerably larger dimensions of the corresponding parts of the stem, situated far away from the calyx, and accordingly analogously formed, in the more prominent inflation and carination of the joints, and in the less slender petalous furrows. The formation of the interarticular pores of some of the pieces of *Pentacrinus Nicoleti*[2] figured by P. de Loriol, is the same as that of the above-described fragment of *Pentacrinus sp. ex. aff. bajociensis* (d'Orb.) P. de Loriol; in other pieces it is different.

VERMES.

SERPULA, Linné.

Serpula flaccida, Goldf.

1826—34. *Serpula flaccida.* A. Goldfuss, 'Petrefacta Germaniae', I. p. 25 4. pl. LXIX. fig. 7.

1856. „ „ F. A. Quenstedt, 'Der Jura.' p. 393, (S. gordialis s. p.) pl. 53, fig. 16.

1865—68. „ „ E. d'Eichwald, 'Lethaea Rossica. Per. moy.' vol. II. p. 269, pl. XVIII. fig. 13.

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[1] P. de Loriol, l. c. p. 165, pls. 154—161.
[2] P. de Loriol, l. c. pl. 157, fig. 3b, pl. 158, fig. 1b.

On the casts from the umbilicus of an indeterminable *Cadoceras* there are some irregularly curved, thin casts of a Serpula which cannot be distinguished from *Serpula flaccida* Goldf.

The pieces were found loose near the margin of the glacier west of Elmwood on July 12th 1896, 100—200 feet above the sea. They are embedded in nodules of pale-gray phosphoritic clay.

MOLLUSCOIDA.

BRACHIOPODA.

Among the fossils collected at Cape Flora the brachiopods are only represented by the species:

Lingula Beani Phill. and *Discinareflexa* Sow. sp. of the genera Lingula and Discina, belonging to the *Inarticulata.*

The remains of these two species occur together, and are confined to the two following rock-types:

(1). Gray, finely-grained, sandy hard marl, type No. 4 of the rocks; and

(2). Pale gray, argillaceous marl, of which small portions are embedded in rock of type No. 4 and are found in conjunction with it.

Several loose pieces of both species could be recognized as being derived from this marl, by the fragments of rock adhering to them.

In other stones collected at Cape Flora, the presence of brachiopods could not be proved.

Some of the shells of the brachiopods are black and shiny; others have the appearance of coal, while in some the whitish layers of the shells are destroyed. The greater number of pieces are unfortunately much damaged, crushed and broken.

LINGULA, Bruguière.

Lingula Beani Phill.

Pl. I. figs. 2—5. Letterpress fig. 8.

1829. *Lingula Beani.* J. Phillips, 'Illustrations of the Geology of Yorkshire,' part I. p. 157, pl. XI. fig. 24.

1850. „ „ Th. Davidson, 'Monograph of the British fossil Brachiopoda,' vol. I. part III. 'A Monograph of the British Oolitic and Liassic Brachiopoda,' p. 8. e. p. (not pl. I. fig. 1.).

1844. *Lingula Beani*. J. Morris, 'Catalogue of the British Fossils.' 2nd edit. p. 138.

1856. „ „ A. Oppel, 'Die Juraformation,' § 53, No. 248.

1856. „ „ F. A. Quenstedt, 'Der Jura,' p. 352, pl. 47, fig. 17.

[1861. „ „ ? H. Trautschold, 'Recherches géologiques aus environs de Moscou.' Bull de la Soc. impér. des Natural. de Moscow, p. 68, pl. V. fig. 1].

[1861. „ „ ? H. Trautschold, 'Der Moskauer Jura verglichen mit dem westeuropaeischen.' Zeitschr. der Deutsch. geol. Ges. p. 389].

1869. „ „ O. Terquem et E. Joudry, 'Monographie de l'Étage Bathonien dans le département de la Moselle.' Mém. de la Soc. géol. de France (2), vol. IX. p. 135.

1869. „ „ D. Brawns, 'Der mittlere Jura im Nordwestlichen Deutschland,' p. 292.

1871. „ „ F. A. Quenstedt, 'Petrefactenkunde Deutschlands.' II. Die Brachiopoden, pl. 60, figs. 80—82 (not 83).

1875. „ „ R. Lepsius, 'Beiträge zur Kenntniss der Jura-Formation im Unter-Elsass,' p. 45, pl. II. fig. 2.

1876. „ „ Th. Davidson, 'Monograph of the British fossil Brachiopoda.' Vol. IV. Suppl. to the British Jurassic and Triassic Brachiopoda, p. 78, pl. IX. figs. 10—12, (14 ?).

1882. „ „ H. Haas und C. Petri, 'Die Brachiopoden der Juraformation von Elsass-Lothringen.' Abhandl. z. geol. Spezialkarte v. Elsass-Lothringen, vol. II. p. 311, pl. XVII. figs. 5—10.

Remains of *Lingula Beani* Phill. occur in abundance, but generally only in fragments. The most perfect, and, for purposes of specific identification, most important pieces are figured on Pl. I. figs. 2—5.

The external surfaces of these pieces, which vary considerably in size (up to 25 mm in length), show the close-set narrow but distinct lines of growth. On the large valve of full-grown individuals, the mesial longitudinal ridge, issuing from the beak along the middle, can be clearly distinguished. From this ridge the valve slopes gently towards the lateral edges. In the middle of the length of the valve, this ridge turns into a flat area, gradually widening towards the frontal margin (Pl. I. fig. 2).

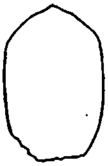

Fig. 8. *Lingula Beani*, Phill. Outline of Pl. I, fig. 2, for correction of fig. 2 a Nat. size.

For the identification of our pieces with the frequently mentioned species from the Lower Dogger, it was important to examine the formation of the interior of the valves (Pl. I. figs. 3—4).

The inside of each valve shows a broad, slightly raised, rather flat rounded mesial ridge, extending from the beak to the middle of the length of the valve. (On the cast, Pl. I. fig. 3, this appears as a shallow groove). In the large valve, this ridge is accompanied on the right and left by a thread-like fillet or ridge, which, under the lens appears to be double, on account of an extremely fine longitudinal furrow. Pl. I. fig. 4a and b further shows some of the very superficial muscular impressions of the large valve. The posterior edge of the blended impressions of the anterior adductor and of the external protractor muscles is produced into three unequal lobes. The left and right muscular impressions, divided only by the mesial longitudinal ridge of the valve, are connected in front by the horse-shoe-like impression of the central protractors which surround the anterior extremity of the mesial ridge of the valve. The shape of the muscular impressions of the smaller valve could not be distinctly seen.

Remarks. The above-mentioned pieces of *Lingula Beani* Phill. correspond perfectly in form and sculpturing with the specimens from the lowest Dogger of Yorkshire and from the Sauzei-zone (Br. Jura γ) from the neighbourhood of Mietesheim, Gundershofen, Griesbach in Lower Alsace. The more prominent longitudinal convexity of the larger valve (Pl. I. fig. 2) may especially often be observed in the specimens from Alsace.

The form of the muscular impressions in the larger valve — unfortunately only visible in a single specimen — differs somewhat from that we have hitherto been acquainted with in Lingulidæ. It differs especially from the drawing which Quenstedt[1] gives as that of the inside of *Lingula Beani*, but Quenstedt's figure does not represent the inside of a true *Lingula Beani* Phill.

[1] F. A. Quenstedt, 1871, l. c. pl. 60, figs. 83, 84.

The figure in question is the copy of a drawing to which Davidson[1] formerly gave the name of *Lingula Beani* Phill., but which was subsequently[2] identified by the same author as belonging to the Liassic species *Lingula sacculus* Dew.

In one of the specimens of *Lingula Beani* Phill. from Yorkshire, a successful preparation brought out the muscular impressions of the larger valve quite distinctly. The impressions of the anterior adductors and of the external protractors are *considerably deeper here* than in our specimen from the neighbourhood of Cape Flora. The posterior margin of these impressions, in the British specimen also, is not entire. It exhibits three incipient lobes directed backwards, but all less distinct than in the Arctic specimen. In the British specimen, the middle lobe is broader and shorter, those on each side of it smaller, and the curves shorter and shallower than on Pl. I. fig. 4. In specimens of the *Lingula Beani* Phill. from Alsace, the muscular impressions, which are *considerably more superficial here* than in British specimens, did not allow of being so well prepared. As far as I could see in the Alsace specimens the posterior edges of the muscular impressions (anterior adductors and exterior protractors) are more lobed here than in British specimens, and correspond better with the figure given on Pl. I. fig. 4.

It appears from the material examined that the difference in the shape of the muscular impressions probably depends upon the depth which these impressions have had in the valves. After observing this, I have no hesitation in identifying the lingulid form from Franz Josef Land, now before me (with shallow, posteriorly deeply lobed muscular impressions) with *Lingula Beani* Phill. from the lowest Inferior Oolite of England (with deep, only slightly lobed muscular impressions) and from the Sauzei zone of Alsace (with shallow, more deeply lobed muscular impressions), as the size, form and sculpturing of the individuals of the most different localities agree.

Lingula brevirostris, Meek and Hayden[3], from the Jura of the Black Hills of Dakota is closely allied to our species by the straight lateral edges. The American species differs from *Lingula Beani* Phill. in having longer posterior margins and a more pointed umbo.

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[1] Th. Davidson, 1850, l. c. pl. I, fig. 1.
[2] Th. Davidson, 1876, l. c. p. 79.
[3] H. Newton and W. P. Jenny, 'Report on the Geology and Resources of the Black Hills of Dakota, U. States' g. a. g. Surv. of Rocky Mts. Region. 1880. p. 346, pl. III. figs. 4, 5.

DISCINA, Lamarck.

Discina reflexa Sow. sp.

Pl. I. fig. 6, 7, 8, 9, (10?).

1829. *Orbicula reflexa* J. D. C. Sowerby, 'Mineral Conchology of Great Britain,' vol. VI. p. 4, pl. DVI. fig. 1.

1850. „ „ Davidson, 'Monograph of the British fossil Brachiopoda,' vol. I. part III. 'A monograph of the British Oolitic and Liassic Brachiopoda,' p. 10, pl. X. fig. 8.

1856. *Disoina* „ A. Oppel, 'Die Juraformation,' § 53, No. 247.

1856. *Orbicula* „ F. A. Quenstedt, 'Der Jura,' p. 325, pl. 45, fig. 2.

[1861. „ „ ? H. Trautschold, 'Der Moskauer Jura verglichen mit dem westeuropäischen,' Zeitschr. d. Deutsch. geol. Ges. p. 390].

1871. „ „ F. A. Quenstedt, 'Petrefactenkunde Deutschlands,' II. Die Brachiopoden. p. 660, pl. 60, fig. 97—101.

1875. *Discina* „ R. Lepsius, 'Beiträge zur Kenntniss der Juraformation im Unter-Elsass,' p. 46.

1876. „ „ Th. Davidson, 'Monograph of the British fossil Brachiopoda,' vol. IV. Suppl. to the British Jurassic and Triassic Brachiopoda, p. 82, pl. X. figs. 1—6.

1876. „ „ R. Tate and J. F. Blake, 'The Yorkshire Lias.,' p. 414, pl. XV. figs. 5, 6.

1898. „ „ E. W. Benecke, 'Beitrag zur Kenntnis des Jura in Deutsch-Lothringen.' Abh. z. geol. Spez.-Karte v. Elsass-Lothringen, N. F., part I. 1898, p. 22, pl. I. fig. 1.

Convex valves of *Discina reflexa* Sow. sp. were found together with *Lingula Beani* Phill. but less frequently than that species.

The specimens before me correspond for the most part closely with English specimens from Yorkshire. The form of the valves both in the English specimens and in those found in the neighbourhood of Cape Flora, is very variable; side by side with high, more conical specimens with a steeper inclination from the apex to the posterior margin, (Pl. I. figs. 7, 8) occur lower, cup-shaped forms (Pl. I. fig. 6). The shell is ornamented with close-set, fine, distinct lines of growth. The upward curve of the shell and of the lines of growth at the posterior margin (Pl. I. figs. 7, 8) completes its similarity to the English specimens.

The places of the attachment of the muscles, which permitted of being prepared in one of the specimens (Pl. I. fig. 6) correspond as nearly as possible with those of specimens from Yorkshire. In fig. 6 (6a) a rather long reniform impression may be seen on the cast on both sides beneath the apex. The impressions become slighter towards the frontal side of the valve, so that their anterior extremity is not very distinctly marked. The impressions on the casts correspond with thickenings on the inside of the valves which in *Discina* serve as attachments for the muscles. Upon the plain, extending from the apex to the frontal margin, two broad, quite smooth radial, elevations may be observed.

On the casts, both here and in specimens from Yorkshire, may be observed extremely fine ribs radiating from the apex to the frontal margin.

The form represented in fig. 9 is particularly flat, and hence recalls *Discina Etheridgei* Dav.[1] from the Inferior- Oolite-Sands of Nailsworth. It differs from that species in the distinctly marked apex (broken off in this specimen). Judging from the form of the attachments of the muscles, *Discina Etheridgei* Dav. is only a flatter variety of *Discina reflexa* Sow. sp. without distinctly marked apex.

The fragment (cast) represented in fig, 10 differs somewhat in the position and form of the apex from the other pieces, and also from other specimens of *Discina reflexa* Sow. sp. which have been examined. The apex is perfectly central, curving somewhat towards the posterior margin (the piece is reversed in the drawing). Owing to the imperfect condition of this piece it is impossible to determine with certainty whether it should be identified with *Discina reflexa* Sow. sp. or not.

MOLLUSCA.

LAMELLIBRANCHIATA.

It is only in the hard, grey, sandy marl (No. 4), that lamellibranchs occur in any great quantities. Unfortunately, however, none of the numerous forms contained in this rock, with the exception of the new Pseudomonotis

[1] Th. Davidson, 1876, l. c. p. 86, pl. X, fig. 20.

described below, can be determined, as the specimens only consist either of crushed and broken fragments, or imperfect impressions and sections.

Casts and impressions of species of various genera (Pseudomonotis, Pecten, Limea, Lima, Leda, Macradon) occur, moreover, in pieces of clay sandstone, especially in somewhat coarse-grained pieces; but they are only to be observed occasionally in these rocks, their remains not having accumulated here in nearly such abundance as in the rock of type No. 4.

Now and again, traces of indeterminable lamellibranchs occur in pieces of argillaceous rock, and of stone marl.

PSEUDOMONOTIS, Beyrich.

Pseudomonotis Jacksoni, n. sp.

Pl. I. figs. 13—16. Letterpress fig. 9.

1897. *Avicula* sp. cf. *inæquivalvis*, E. T. Newton and J. J. H. Teall: l. c. Quart. Journ. Geol. Soc. London, vol. 53, p. 502, pl. XL, fig. 4.

In gray, hard, sandy marl (Aug. 2nd, 1896, 30 ft. above sea-level, ca. 300 m. north-west of Elmwood), are embedded numerous broken and crushed shells, flattened by compression, of a remarkably large Aviculid form. Fragments of the same species were also found loose, weathered out of the rock (also Aug. 2nd, 1896).

The approximate outline of the shell, as far as it can be reconstructed from the broken pieces, has been drawn by Newton, l. c.

The valves are comparatively not very oblique. The long hinge is straight. The apex lies near the anterior margin and projects only slightly, if at all, over the hinge. The posterior wings are large, and their posterior edge seems to me to be very slightly concave. The anterior wings are also rather large, although considerably smaller than the posterior ones. The valves are thick.

The left valve is moderately convex, with the exception of the flat wings. It exhibits a system of straight radial ribs. The wide spaces between the 15—20(?) coarse main ribs, show 2, 3, 4, or more finer ribs, of which the one in the middle is generally the most distinct. Near the inferior edge, nearly all the ribs are equally coarse. The posterior wing is covered thickly with

[1] Named in honour of the leader of the Jackson-Harmsworth Expedition.

fine radial ribs. On some fragments, slight indications of very fine, close, concentric grooves are to be seen.

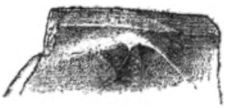

Fig. 9. *Pseudomonotis Jacksoni.* n. sp. Interior of the specimen Pl. I, fig. 15, showing the oblique ligament groove on the area; nat. size.

The right valve is flatter. It shows concentric, leaf-shaped lamellae (fig. 14a), or very faint radial ribs. In pieces that have been weathered out of the rock, the interesting construction of the inside (Pl. I, fig. 14b, c, and letter-press fig. 9) may be observed. On the broad area, a shallow, triangular ligament-groove extends obliquely from the umbo towards the back (Letterpress fig. 9).

Below the area lies a rounded or triangular, deep, cup-shaped groove, growing shallower towards the back. The long incision for the byssus, extending obliquely along the valve, becomes obliquely covered up, to some extent altogether closed by an interior thickening of the valve of the anterior wing. Fig. 14c shows the remarkably thick, swollen margins of the byssus fissure in profile.

Remarks. Newton compares the form in question with *Avicula inæquivalvis*, Sow. from the Callovian, but points out, as a difference, that the ribs are coarser than in Sowerby's species. Apart from the fact that *Avicula inæquivalvis* Sow. of so large a size as the species before us, is unknown, there is also the fact that the left valve of *Avicula inæquivalvis* Sow. is always considerably more oblique, and more elongated. *Avicula inæquivalvis* has, moreover, fewer ribs, and the spaces between the 14 ribs are almost, if not quite smooth.

The sculpturing of the valves recalls more strongly that of the so-called *Avicula Münsteri* Goldf. Apart from the difference in size between the two forms, identification with this species is impossible, on account of the construction of the inside of the valve.

The inside of the right valve, especially in the deep, cupshaped impression (of the anterior muscle), shows some affinity to the subgenus "Meleagrina Lam". A similar deep impression was observed by Fr. Teller, on the *Avicula (Meleagrina) Tundræ* Tell[1], described from the East Siberian Trias.

[1] Fr. Teller, 'Die Pelecypoden-Fauna von Werchojansk in Ostsibirien' (in E. Mojsisovics von Mojsvar: Arktischc Triasfaunen) Mém. de l'Acad. impér. des sciences de St. Pétersbourg. Sér. VII. vol. XXXIII, no. 6, 1886, p. 133. pl. XIX, fig. 9.

The differences between it and the few known Mesozoic, and more recent Meleagrines, are the size of the anterior wing, the consequent length of the byssus-fissure, and the marked radial sculpturing of the left valve, which, as far as I know, has not before been observed to such a degree of clearness in Meleagrines. On account of the slight obliquity in the outline of the valves, of the ornamentation of the valves by radial ribs, of the shape of the anterior wing and of the direction of the byssus-fissure, the species before us must be separated from *Meleagrina* and reckoned as *Pseudomonotis*. Though the oblique ligament-groove does not agree with the known species of *Pseudomonotis*, all the other characteristics of our species agree completely with this genus; especially the cupshaped, deep groove below the ligament-area is also to be seen in the right valve of *Pseudomonotis*, e. g. *Pseudomon. echinata* Sow. sp. On account of the large size and of the degree of ornamentation the species before us must be regarded as a new one.

Pseudomonotis sp. (cf. *ornati* Quenst. sp.)
Letterpress fig. 10.

In grey-brown, weathered clay sandstone July 16th, 1896, 500—550 ft above sea level, north of Elmwood, several fragments and impressions of a Pseudomonotis were found, of which the most perfect are figured here.

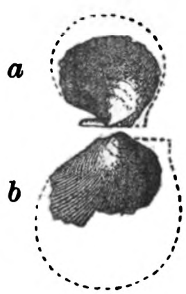

Fig. 10 *Pseudomonotis* sp. (cf. *ornati* Quenst. sp.) *a* right, *b* left valve; figured from a waxcast, 2 × enlarged,

The smaller right valve is moderately convex, and exhibits an indistinct, concentric striation. The larger, highly convex left valve is thickly ornamented with fine unequal radial ribs. Here, too, the concentric sculpturing is but faintly developed.

A similar, perhaps corresponding form, I found with *Cadoceras Nanseni* (Pl. II. fig. 6.) in greyish yellow, argillaceous stone marl (July 14th, Windy Gully 400 ft).

Remarks. Judging from the greater convexity of the right valve, and the fine radial sculpturing of the left valve, the present *Pseudomonotis* sp. is related to *Pseudomonotis ornati* Quenst. sp[1]. On account of the imperfect material, it cannot be

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[1] F. A. Quenstedt, 'Der Jura', p. 553, pl. 72, fig. 33. A similar form, but from the Oxfordian from Viel-St -Remis (Ardennes), is before me.

ascertained whether it agrees with this species of the Suabian "Ornaten"-clay or not. Up to the present, no similar Pseudomonotis is known from the Russian Jura, or from the Arctic regions[1]. The North American species, *Pseudomonotis (Eumicrotis) curta* Hall sp.[2] and *orbiculata* Whitfield[3], appear to be allied to the present form in their delicate sculpturing.

PECTEN, Klein.

(*Camptonectes,* Agassiz)

Pecten Lindströmi Tullberg.

Pl. I. fig. 12.

1881 (1880) *Pecten Lindströmi.* S. A. Tullberg, 'Ueber Versteinerungen aus den Aucellen-Schichten Nowaja Semljas'. Bihang till K. Svenska Vet. Akad. Handl. vol VI. No. 3, p. 24, pl. I, figs. 1—5.

The present specimen is the impression of a moderately convex left valve. Contour oblique oviform, sides somewhat unequal. Height scarcely one sixth greater than the length of the valve. The partly broken and displaced anterior wing is large: the posterior, smaller wing is very imperfect. The surface is densely ornamented with fine, concentric lines, which appear very distinctly on the wing, while on the valve itself they are only visible under the lens. The concentric sculpturing is crossed by a system of extremely fine, close, radial lines. These correspond (on the *positive* of the shell) with fine, rather long, very narrow depressions, arranged in radial rows, and occurring in the interspaces between the concentric lines. Near the lateral margins, and especially on the wing, the radial lines appear more distinctly than elsewhere on the valve, where they are only visible in a good light. (In fig. 12b, the radial lines of the valve have not been clearly brought out.) Towards the edge of the valve, the radial lines are curved.

The specimen of *Pecten Lindströmi* Tullb. was found in a loose block of rusty-coloured, weathered, clay sandstone, on July 16th, 1896, north of Elmwood, 500—550 ft above the sea.

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[1] The *Pseudomonotis subechinata* Lah. described by Lahusen (Die Fauna der Jurassischen Bildungen des Rjasanschen Gouvernements, p. 85, pl. II, figs. 6, 7), judging from its coarse sculpturing, is closely allied to *Pseudomonotis echinata* Sow. sp.

[2] F. B. Meek and F. V. Haydn, 'Paleontology of Upper Missouri', part I. 1864, pl. III. fig. 10.

[3] H. Newton and W. P. Jenny, 'Report on the Geology and Resources of the Black Hills of Dakota', U. S. G. a. G. Survey of Rocky Mts. Region, 1880, p. 356, pl. III. figs. 17-19.

A fragment of an almost smooth pecten, possibly also belonging to *Pecten Lindströmi*, lies embedded in hard, greyish yellow stone marl, found loose, July 14th, Windy Gully.

Remarks. The present piece entirely agrees with the description given by Tullberg, of *Pecten Lindströmi* from the Aucellen strata of Skodde Bay, on the south island of Novaja Semlja (south-west end of Matotschkin Scharr).

According to the form of the wings, and to its fine sculpturing, *Pecten Lindströmi* Tullbg. is a *Camptonectes*, and is allied to *Pecten lens* Sow. and *Pecten rigidus* Sow. *Pecten Lindströmi* differs from the ordinary forms of *Pecten lens* in the considerably less distinct radial sculpturing, and in the relatively more distinct and regular concentric striation. Among the forms described as *Pecten lens*, there is one — figured by Lahusen from the strata of *Perisphinctes mosquensis* Fisch. (Upper Callovien) from Tschulkowo[1] — which is rather closely allied to our species, by reason of the more distinct concentric, and fainter radial sculpturing. The radial sculpturing, however, is more distinct in this species of the Russian Jura, than in *Pecten Lindströmi* Tullb.

Among the numerous specimens of *Pecten rigidus* Sow. from the Dogger of Balin (referred to by G. C. Laube as *Pecten lens*)[2], a few forms approximate very closely to *Pecten Lindströmi* Tullb. in the faint radial sculpturing.

Pecten subannulatus Schlippe[3] from the "Hauptoolith" of Alsace, possesses, according to the given figure (l. c.) of a *right* valve, radial sculpturing similar to that of *Pecten Lindströmi*, viz. elongated grooves arranged in rows. In his description of the species, however, Schlippe speaks of radial ribs, and radially arranged ridges. *Pecten subannulatus* Schlippe is more equilateral, and on the anterior wing exhibits a less distinct concentric sculpturing than *Pecten Lindströmi* Tullb.

Pecten (*Camptonectes*) *stygius* White[4], from the Upper Jura of Utah exhibits a sculpturing similar to that of *Pecten Lindströmi*. In addition to fine,

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[1] J. Lahusen, 'Die Fauna der jurassischen Bildungen des Rjasanschen Gouvernements'. Mém. du Com. géol. St. Pétersbourg, vol. I. No. I. pl. II. fig. 2 (not fig 1).

[2] G. C. Laube, 'Die Bivalven des Braunen Jura von Balin'. Denksch. d. Wiener Akad. vol. XXVII. 1867, p. 12 (20).

[3] A. O. Schlippe, 'Die Fauna des Bathonien in oberrheinischen Tieflande'. Abhandl. zur geol. Spezialkarte von Elsass-Lothringen, vol. V. part IV. 1888, p. 128, pl. II. fig. 3a, b.

[4] C. A. White, 'Report upon the invertebrate Fossils' in Report upon the G. a. G. Explorat. and Surv. West of the 100th Meridian', 1875, p. 164, pl. XIII, fig. 2.

concentric lines of growth, White mentions very fine radial lines, visible only in a very favourable light. The American species differs from our own in the greater length of the valve.

LIMEA, Goldfuss.

? *Limea* cf. *duplicata* Goldf.

Pl. I. fig. 11.

Cf. 1834—40 *Limea duplicata* Goldfuss, 'Petrefacta Germaniæ', vol. II. p. 103, pl. CVIII. fig. 9.

The coarse, straight ribs mark the figured cast as being that of a right valve of a species of Limidæ. The same relation that is found here between the ribs and the broad, smooth intercostal spaces, is observed in the genus Limea, especially in the both horizontally and vertically widespread species, *Limea duplicata* Goldf.[1] The present piece is probably closely allied to this species. Small, oblique impressions in the upper part of the vertical, scarcely hollowed-out Lunula, which correspond in position to the small, lateral denticles of the Limea, confirm me in my opinion that the present fragment is a Limea.

Our piece cannot be identified with *Limea duplicata*. *Limea duplicata* is generally smaller, more equilateral, and as a rule has more ribs — from 2 to 17, generally 16 on the valve, and 13 or 14 on the cast (our form has only 11 ribs on the cast).

Lima consobrina d'Orb.[2], which resembles our form in outline, is too flat, and too closely ribbed to be compared with the piece before us. Moreover, d'Orbigny's species is a true Lima, and no Limea. Neither can the *Lima* cf. *duplicata* Sow. sp.[3] from Spitzbergen, figured by Lundgreen, be connected with our form, as it exhibits on the cast sharp-edged ribs.

[1] Upper Bajocian to Oxfordian; Western Europe, Balin and Koscielec near Krakow (G. C. Laube, 'Die Bivalven des braunen Jura von Balin.' Denkschr. d. Akad. d. Wiss. Wien, vol. XXVII. p. 13 [21], gives only *Lima duplicata* Sow. sp. From Laube's list of synonyms, it is evident that he also classes *Limea duplicata* Goldfuss with this species. At Balin and Koscielec occur both *Lima duplicata* and *Limea duplicata*), Popielany in Lithuania, the island of Andö, Central Russia, Novaya Zemlya, Cape Stewart in East Greenland.

[2] Murchison, Verneuil et Keyserling, 'Géologie de la Russie,' vol. II. Paléontologie, p. 477, pl. XLII. fig. 5, 6, 7.

[3] B. Lundgreen, 'Bemerknungen über die von der Schwedischen Expedition nach Spitzbergen 1882 gesammelten Jura- und Trias-Fossilien.' Bihang till K. Svenska Vet.-Akad. Handl. vol. 8, No. 12, p. 18, pl. 2, fig. 10.

Limea cf. *duplicata* Goldf. was found in grey, clayey sandstone, on July 16th, 1896, 500—550 ft. above the sea, north of Elmwood.

LEDA, Schumacher.

Leda cf. *Nuda* Keys. sp.
Letterpress fig. 11.

1846. *Nucula nuda* Keyserling, in A. Graf Keyserling und P. von Krusenstern, 'Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land im Jahre 1843,' Petersburg, 1846, p. 307, pl. 17, figs. 7—9.

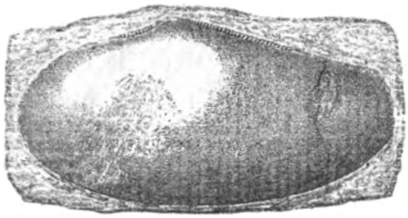

Fig. 11. *Leda* cf. *nuda* Keys. sp. Cast of the left valve showing the impressions of cardinal denticulation. 2 × enlarged.

The cast here figured of a flat, elongated left valve, agrees very well in outline and in dimensions (length circ. 25 mm., height circ. 12 mm.) with the *Leda* (not *Nucula*) *nuda* found by Count Keyserling at the mouth of the Ischma, and at Poluschino in Petschora Land. Count Keyserling states that the cardo denticles in his species are very long and numerous — more than 16 along the posterior margin. In the present form, the impressions of more than 30 hinge denticles may be counted behind the umbo. This difference prevents me from directly identifying our specimen with the species described from Petschora Land.

Leda nuda Keys. sp. is also recorded by Lindström[1] and Lundgreen[2] from Spitzbergen. From Lindström's figure, however, it appears to be doubtful whether this species really also occurs in Spitzbergen. Lindström's *Leda nuda* shows a very much more sharply projecting umbo.

Leda (*Nucula*) *Phillipsi* Morris[3] from the Oxford Clay of Wiltshire, and

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[1] G. Lindström, 'Om Trias- och Juraforsteningar från Spitzbergen'. K. Svensk. Vetensk. Akad. Handl. vol. 6, 1865, p. 12, pl. II. fig. 16 (compare reference to *Nucula nuda* Phillips, 'Geology of Yorkshire.' I. pl. V. fig. 5).

[2] B. Lundgreen, 'Bemerknungen über die von der schwedischen Expedition nach Spitzbergen 1882 gesammelten Jura- und Trias-Fossilien'. Bihang till K. Svenska Vetensk.-Akad. Handl. vol. 8, No. 12, p. 12.

[3] J. Morris, 'List of Organic Remains etc.' in R. N. Mantell, 'An Account of the Strata and Organic Remains exposed in the Cuttings of the Branch Railway, . . . etc. . . Wiltshire'. Quart. Journ. Geol. Soc. London, 1850, p. 318, pl. XXX. fig. 1.

Leda de Geeri Lundgreen[1] from Spitzbergen, are very similar to our form in outward appearance, differing, however, in their shorter length.

Leda cf. nuda Keys. sp. is embedded, together with *Cadoceras* sp. ex. *aff. Cad. Nanseni* (n. sp.), in a piece of rusty brown, weathered clay sandstone. The piece was found loose on July 12th, 1896, near the margin of the glacier north west of Elmwood.

CUCULLÆA, Lamarck.

SUB-GEN. MACRODON, LYCETT.

Macrodon Schourovski F. Rouillier sp.
Pl. I. fig. 17.

1847. *Cucullæa Schourovskii* F. Rouillier, 'Etudes progressives sur la Paléontologie des environs de Moscou'. II Et. Bull. de la Soc. Impér. des Natural. de Moscou, 1847, I. 2, p. 428, pl. H, fig. 39.

The figured cast (with fragments of shell) of a right valve, agrees perfectly in its outline, in the position of the apex, and in the sculpturing (fine concentric lines), with the species figured by Rouillier from his "seconde étage" of the Jura of Moscow, as *Cucullæa Schourovski*. The edge running, in the drawing, from the umbo to the lower posterior angle, and the depression extending from the apex to the inferior margin, has only been produced by oblique pressure of the valve. In uncompressed specimens, this edge and depression do not exist, as I was able to convince myself by a second, unfortunately in other respects more imperfect piece. In this second specimen, remains of the cardo may be recognised — in front of the apex are oblique, not very short, behind the apex long, almost perfectly horizontal lateral denticles, with distinct, close serrations.

Unfortunately, Rouillier has not drawn the hinge in his figures. Judging from the hinge-line visible in fig. 39b (l. c.), Rouillier's species is either a Cucullæa, or a Macrodon. Trautschold[2] places Rouillier's *Cucullæa Schourovskii* with *Cucullæa elongata* Sow.[3], that is to say, in the sub-genus Macrodon. As the cardo of the pieces from Cape Flora now before me has thus proved to be a Macrodon cardo, and as the pieces agree perfectly in form

[1] B. Lundgreen, l. c. p. 13, pl. 2, figs. 3 & 4.
[2] H. Trautschold, 'Der Moskauer Jura verglichen mit der Westeuropäischen'. Zeitsch. d. Deutsch. geol. Ges. 1861, p. 408.
[3] Sowerby, 'Mineral Conchology', pl. 447, fig. 1.

and sculpturing with the Russian species *Cucullæa* (*Macrodon*) *Schourovskii* F. Rouillier, I do not hesitate to identify the pieces before me with the species figured by Rouillier.

In classing our species and *Cucullæa elongata* Sow. among the Macrodons, it must be observed that on account of the longer and less vertical anterior lateral teeth[1], this species differs somewhat from the type of the genus Macrodon (*M. Hirsonense* Lyc. *Keyserlingi* Lah. *Rouillieri* Trautsch.), and approaches nearer to Cucullæa.

Macrodon Schourovski F. Rouillier sp. is embedded in grey, rusty brown clay sandstone. Both pieces were found loose, the piece figured on Pl. I. fig. 17, at a height of circ. 500—550 feet north of Elmwood, the other on July 12th, 1896, near the margin of the glacier, north west of Elmwood.

In addition to the fragments of Lamellibranchiata here described, a piece of clay sandstone with *Cadoceras* sp. indet (July 16th, 1896, 500—550 feet above the sea, north of Elmwood) contains a fragment of a

Lima sp. indet. (Pl. II. fig. 8a), whose shell-sculpturing consists of very fine, close radial ribs.

Among the numerous bivalve fragments occurring together with *Pseudomonotis Jacksoni* in hard, grey, sandy marl (Aug. 2nd, 1896, 30 ft above the sea, north west of Elmwood), certain pieces point towards the genus *Pleuromya*. This, however, cannot be settled with any certainty.

GASTROPODA.

AMBERLEYA, Morr. and Lyc.

Amberleya sp.

Letterpress fig. 12.

In the material collected at Cape Flora Gastropoda are represented by a single specimen only, belonging to the genus *Amberleya*, Morr. and Lyc.

The last whorl is broken off and the outer layers of the shell are lacking, therefore specific determination of the specimen is impossible. The side of the (last preserved) whorl bears three rounded, obtuse, spiral keels, which — as far as can be seen on the imperfect remains of the outer layers of the shell — had been crossed by (squamons?) radial striæ (fig. 12 b). A fourth

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[1] And also because the height of the shell is the same in front of, and behind the umbo.

keel becomes visible in the suture of the following whorl. Base of the whorls ornamented with smaller keels. Aperture of the (last preserved) whorl rounded, somewhat greater in height than width (fig. 12 a).

a b

Fig. 12. *Amberleya* sp. nat. size.

Amberleya sp. belongs to the group of *Amberleya capitanca* Münst. sp. The occurrence of this group in jurassic deposits of arctic regions is already noted by Tullberg (*Turbo capitaneus* from the Oxfordian of Besimennaja Bay, Novaja Semlja).

The specimen described was found at the margin of the glacier, 80—100 ft. above the sea, north-west of Elmwood, on July 12th, 1896. As no remains of the rock, where the shell originally was embedded, are preserved, *Amberleya* sp. might have been washed out from the soft clay, which constitutes the greater part of the strata underlying the basalt at Cape Flora.

CEPHALOPODA.

AMMONOIDEA.

Judging from the number of species and individuals, Ammonites are the group of animals most largely represented among the fossils collected at Cape Flora.

The material before me shows that the different rock-types from the neighbourhood of Cape Flora are, in varied degrees, rich in ammonites. While ammonite fragments occur very often in the pieces of clay sandstone, clay, and stone marl, I found no trace of ammonites in the hard, finely-grained, very sandy marl No. 4 containing numerous lamellibranchiate, brachiopod, and belemnite fragments. From this fact, however, it cannot without hesitation be asserted that this rock is entirely destitute of ammonites. Newton[1] mentions a fragment of an undetermined ammonite ("allied to *A. Gowerianus*"), which was found among the loose fossils weathered out of the strata "west of Elmwood", where this rock occurs in place at an inconsiderable height above sea-level. Possibly this ammonite fragment originated in the sandy, hard marl.

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[1] E. T. Newton and J. J. H. Teall, l. c. p. 502.

Among the material collected by Prof. Nansen, three genera of ammonites may be pointed out — *Macrocephalites* v. Sutner, *Cadoceras* Fischer, and *Quenstedtoceras* (Hyatt) Nikitin. If Newton's designation of the above-mentioned fragment is correct, a fourth genus, *Cosmoceras* Waagen (sub-gen. *Kepplerites* Neum.), is further represented in the Jura of the neighbourhood of Cape Flora.

MACROCEPHALITES, V. Sutner.

GROUP OF MACROCEPHALITES ISHMAE Keys. sp.

Macrocephalites Kœttlitzi [1] n. sp.

Pl. II. fig. 12 a—e.
Letterpress fig. 12.

There is only one, to some extent weathered cast preserving small fragments of the shell. It belongs to a form with a very narrow umbilicus, and almost completely encircling whorls, and exhibiting the following dimensions:

Diameter		60 mm.	= 1.
Width of the umbilicus		7 „	= 0.12.
Height	of the last whorl	30 mm.	= 0.50.
Thickness	of the last whorl	34 „	= 0.57.

On the flanks, and on the external surface, the whorls are broadly convex, while they incline steep and suddenly towards the umbilicus. At the last two whorls the thickness is somewhat greater than their height. The greatest thickness is at a point a little below half the height of the whorls. The section of the whorls is approximately horse-shoe shaped. The inner whorls encroach so largely upon the succeeding ones that the height of the outer whorls, measured in the median plane, is less than half the height of the entire whorl.

The umbilicus is very narrow (12% of the diameter) and deep, with almost vertical walls. In the umbilicus nothing is to be seen of the inner whorls but the steep umbilical surface.

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[1] Named in honour of Dr. Reginald Kœttlitz, member of the Jackson-Harmsworth Expedition, merited by his most valuable researches of the geology of Franz Josef Land, and especially of Cape Flora.

Only a little of the sculpturing has been preserved. Up to a size of about 50 mm. in diameter the whorls are ornamented with strong ribs extending over the flanks in broad curves, open towards the front. The outside is crossed by the ribs in broad curves, convex towards the front. The ribs that have been preserved fork at about half the height of the whorls. Upon the umbilical surface the ribs are scarcely indicated; upon the lower half of the whorl they are rather distinct, and comparatively narrow. After bifurcating, the ribs become lower, broader, and have a more rounded cross-section.

The ribs, as before mentioned, are only found to a size of 50 mm. in diameter. Subsequently their place is taken by perfectly flat, scarcely perceptible lines. The whorls become quite smooth, or nearly so, as we see on the anterior of the specimen before us, which is partly covered with the shell.

Only a very small fragment of the body-chamber was preserved.

Fig. 12. *Macrocephalites Kœttlitzi* n. sp. Lobe-line as far as to the 2nd lateral lobe; the first lateral saddle is somewhat weathered. Nat. size.

The lobe-line was only to some extent distinctly visible. Lobes and saddles are much and deeply cleft. The siphonal lobe is deep; its slender branches run parallel. The tripartite first lateral lobe is only slightly deeper than the siphonal lobe, and the second lateral lobe a little shorter. The deeply cleft external saddle is divided by a very deep secondary lobe into two unequal parts, one broader outer part, and one narrower inner part. The first lateral saddle is lower than the external saddle, and the succeeding, badly preserved saddles are low, broad, and bipartite. The auxiliary lobes (3) are narrow and short.

To judge from the substance filling the body chamber and the umbilicus, the piece evidently originated in the hard, gray-brown, phosphoritic clay, found on July 14th, 400 feet above the sea-level; Windy Gully north-east of Elmwood.

Remarks. The very narrow umbilicus, the form and curvature of the ribs and the lobe-line mark *Macrocephalites Kœttlitzi* n. sp. as being allied to *Macrocephalites Ishmae* Keys. sp.[1]

[1] A. Graf Keyserling (and P. von Krusenstern), 'Wissenschaftliche Beobachtungen auf einer Reise in das Petschora Land im Jahre 1843', St. Petersburg, 1846, p. 331, pl. XX. figs. 8—10, pl. XXII. fig. 15.

The chief lobes and saddles in particular agree very well with those of the species described from the Ishma in Northern Russia. The drawing, however, which Count Keyserling gives of the lobes of his *Amm. Ishmae* (l. c. Pl. 22 fig. 15) shows a very different character. I was nevertheless able to convince myself that the drawing in question is inaccurate. A splendidly preserved specimen of *Macrocephalites Ishmae* from Petschora Land, that I examined, shows a lobe-line, which, up to the second lateral lobe, agrees perfectly with the above drawing of the lobe-line of *Macrocephalites Kœttlitzi* n. sp. (On this piece also, the auxiliary lobes are distinct.) The species in question differs from *Macrocephalites Ishmae*:

1. In the form of the whorls. In *Macrocephalites Ishmae*, the height of the whorls is greater than their width, the whorls are more slender, and that to at a size corresponding to that of the specimen of *Macrocephalites Kœttlitzi* before us.

2. In the sculpturing. Even in large specimens *Macrocephalites Ishmae* is coarsely ribbed. The specimen examined by me still showed quite distinct ribs up to a diameter of 105 mm., while *Macrocephalites Kœttlitzi* loses the ribs as early as at 50 mm.

From Windy Gully, north-east of Elmwood, Cape Flora, Newton described[1] several ammonites as varieties of *Amm. (Macrocephalites) Ishmae* Keys. Of these ammonites the "smooth variety" might agree with the species before us; (l. c.) the outer whorl of a small specimen is stated to be "nearly smooth". The drawing of this form (l. c. Pl. XL. fig. 3) shows another section than our fig. 12b on Pl. II, but we must not forget, that the drawing given by Newton contains no accurate profile of the whorls. The inner whorls in this specimen are not bisected in the plane of the greatest diameter.

Newton's fig. 1 shows a coarse sculpturing at a diameter of about 70 mm.; and not until then does the whorl begin to become smooth; but whether the smoothness of the whorl beginning there is due to weathering of the piece in question, or whether it corresponds with an actual disappearance of the sculpturing, Newton does not say. At any rate, fig. 1 of Newton's *Amm. (Macrocephalites) Ishmae* Keys. *var. arcticus* is more closely allied to the

[1] E. T. Newton and J. J. H. Teall, l. c. p. 500, pl. XL.

type of the species described by Count Keyserling, than to our *Macrocephalites Kœttlitzi* n. sp.

When Newton points out that in his *Amm. Ishmae* Keys. *var. arcticus.* the inner whorl "encroaches more upon the outer one" than in *Macrocephalites Ishmae* Keys., this is a mistake, for in Newton's *var. arcticus* the encroachment is the same as in the one figured by Count Keyserling and in the specimen of *Macrocephalites Ishma* Keys. examined by me. In all these pieces the encroachment is somewhat smaller than in the above described species of *Macrocephalites Kœttlitzi* n. sp.

The proportion of the diameter (a) to the entire height of the whorl (b) and to the height of the whorl in the median-plane (c) is in

	a	b	c
Macrocephalites Ishmae Keys sp.	100:	53:	24.
„ „	100:	52:	22.
„ „ var. *arcticus* Newt.	100:	49:	24.
„ *Kœttlitzi* n. sp.	100:	50:	21.

The slight differences in the above-mentioned proportions of the various forms would be of little value, if these differences were not at the same time combined with differences in sculpturing. The fact that the whorls so soon become smooth, distinctly characterises *Macrocephalites Kœttlitzi.*

From the character of the sculpturing, the "inflated variety" of *Amm.* (*Macrocephalites*) *Ismae* Keys. (var. *arcticus*) Newton (l. c. p. 501, Pl. XL. fig. 2.) is not allied to *Macrocephalites Ishmae* Keys. at all. The above-mentioned form belongs to *Macrocephalites pila* Nik. [1].

Macrocephalites sp.

Pl. II. fig. 11. Letterpress fig. 13.

The fragment here delineated of a chambered whorl, belongs to the young form of a *Macrocephalites* that still has a wide umbilicus.

The whorl is more broad than high. The low convex flanks pass into the broadly convex external side without a break. The flanks incline towards the umbilicus in a steep curve.

From the umbilicus issue strong primary ribs (upon the fragment preserved there are eight), generally maintaining a radial direction. Near the

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[1] S. Nikitin, 'Der Jura der Umgegend von Elatma', part 1. Nouv. Mém. de la Soc. impér. des Nat. de Moscou, vol. XIV. 1881, p. 11, pl. VIII. (X) figs 45, 46.

umbilicus, the ribs describe a short umbonal curve; up to half the height of the whorls, they lean a little. Hence the ribs describe a flat curve, concave towards the front. Across the outside they run straight, or are almost imperceptibly bent forward. Long and short secondary ribs are interpolated from the outside. At about half the height of the whorls they meet the primary ribs, or they stop short near the primary ribs. Through the interposition of the secondary ribs, most of the primary appear to be bifurcate. Where the secondary ribs commence, the primary are particularly strong, and on well-preserved shells almost sharp-edged.

Fig. 13. *Macrocephalites* sp. Lobe-line of Pl. II, fig. 11. 2 × enlarged.

The adjacent lobe-line is a perfect representation of a greatly simplified lobe-line of *Macrocephalites Kœttlitzi* n. sp. (cf. p. 71 letterpress fig. 12.) The first lateral saddle, and both the succeeding small saddles, are bipartite, and the lobes tripartite.

Remarks. Judging from the lobe-line, the piece figured very probably belongs to a young form of *Macrocephalites Kœttlitzi* n. sp., or to the varieties of *Macrocephalites Ishmae* Keys. sp. described by Newton from Windy Gully. As the early stages both of this form, and of *Macrocephalites Ishmae* Keys. sp. are not known, the piece before us cannot be specifically determined.

Apart from the resemblance of its lobe-line to that of *Macrocephalites Kœttlitzi*, it is clear that the figured piece is a *Macrocephalites*, from the character of the sculpturing on the doubly curved primary ribs.

The same general character is to be observed in the sculpturing in young forms of *Macrocephalites macrocephalus* Schloth. sp., *Herveyi* Sow. sp., *tumidum* Rein sp. etc. from the Callovien of Suabia and Franconia, and moreover, in the young specimen of a *Macrocephalites pila.* Nik. from Czenstochau in Poland[1], of which Bukowski gives an illustration. The same character is also to be seen in the sculpturing of the numerous young specimens of *Macrocephalites*, which Waagen describes from the Jura of Kutch in India. It is worthy of remark in all these young forms, that the young specimens of Waagen's group of "*Macrocephali Rectecostati*" also *always* have *curved* ribs.

[1] Gejza Bukowski, 'Über die Jurabildungen von Czenstochau in Polen. Beiträge zur Palaeontologie Oesterreich-Ungarns etc. 1887', vol V. pl. XXVI. (II) fig. 17.

In spite of the resemblance in the formation of the sculpturing, and in the double curve of the ribs in our form and in young forms of the *Macrocephalites macrocephalus* Schloth. sp., the piece before us cannot be referred to this species itself, nor to the species nearly allied to it (*Herveyi* Sow. sp. *tumidum* Rein. sp. *Pila* Nik.). In the young form of all these species, the ribs are considerably finer and closer, and furthermore the whorls of a corresponding size in these species are broader and lower. The lobe-line, moreover, in the above-named species, has a more slender external saddle, which does not exceed the first lateral saddle in size as much as in the present form from Cape Flora.

The figured fragment of *Macrocephalites* sp. was found loose without any adhering rock — on July 12th, 1896, near the margin of the glacier, north-west of Elmwood. It is a cast of pyrite turned into brown ironstone, with an almost perfect nacreous shell.

CADOCERAS, Fischer.

In the ammonites before us, the genus *Cadoceras* is the one most abundantly represented, both as regards the number of species, and the number of specimens. There are, with few exceptions, only specimens of inconsiderable size, and these are generally greatly deformed by compression, especially of the body chambers. Frequently nothing but impressions of the different species remain.

Juvenile forms of *Cadoceras* have hitherto been somewhat neglected in ammonite literature. For the determination of young forms such as these we are limited almost entirely to the works by Nikitin on Russian Cephalopoda. This author, however, gives comparatively little attention to the *development* of the juvenile forms, of the sculpturing and the lobe-lines. From Nikitin's descriptions, and from the diagrams given in the description of the Cephalopoda of Elatma, it would appear that the young stages of nearly all Russian *Cadocerates* are almost identical.

The descriptions of young forms from the Jura of Central and Western Europe are still more imperfect than the descriptions of those of Russian Cadoceras. As far as I know, no young stages of *Cadoceras* species from strata of Central and Western Europe have hitherto been described, with the exception of the very imperfect accounts in Sowerby's *Amm. sublævis*. In one of the small forms, which he designates *Amm. Königii* Sow., Quenstedt[1] states that it may perhaps be a young form of his *Amm. sublœvis* (under which name several *Cadoceras* species are comprised, but none of them identical with *Amm. sublœvis* Sow.) These small ammonites, however, are neither young forms of the species comprised in *Amm. sublœvis* Quenst. nor do they belong to the genus *Cadoceras* at all. They belong to the specimens designated by Quenstedt as *Amm. Königii* Sow.[2], and are probably identical with the species described by Morris and Lycett[3] as a young form of *Amm. subcontractus* Morr. a. Lycett. These are forms with peculiar, irregularly divided ribs, and much undulated on the outside, which have to some extent very distinct parabolic lines and nodes. From their form, sculpturing and lobe-line, these ammonites — together with an undescribed species now before me from Lower Bavaria — cannot be designated as Cadocerates; they ought rather to be regarded as a new, hitherto not particulary characterised group of the Stephanoceratidac.

The very sensible deficiency in the ammonite literature, in the present case was fortunately, to some extent, made up by the rich treasures of the Munich Museum. I succeeded in obtaining the innermost whorls of, in some cases very early stages of a large number of species:

Cadoceras sublœve Quenst. sp. (now Sow. sp.) — from the Suabian Jura.
„ *Tchefkini* d'Orb sp.
„ *Milaschewici* Nik.
„ *Elatmae* Nik.
„ *Frearsi* (d'Orb) Nik.
} from the Russian Jura,
„ *sublœve* Sow. sp.
„ *modiolare* d'Orb sp.
} from the English Jura.

Only by the help of this material was it possible to determine the *Cadocerates* from Franz Josef Land that I have before me. At the same time,

[1] F. A. Quenstedt, 'Ammoniten des Schwäbischen Jura.' p. 674, pl. 72, figs 9—15, especially fig. 10.

[2] F. A. Quenstedt, l. c. pl. 87, figs. 31, 32—7. I Siemiradzki (O mieczakach glowonogich brunatnego jura W. Popielanach, etc. Cracow, 1889, p. 6.) designates both these pieces as *Quenstedtoceras carinatum* Eichw. sp. Form, sculpturing and lobe-line absolutely preclude the possibility of regarding these specimens as juvenile forms of Eichwald's *Amm. carinatus.*

[3] Morris and Lycett, 'Monograph of the Mollusca from the Great Oolite,' p. 11, pl. II. fig. 2.

the examination of the young whorls of the above-named species, proved that in the early stages of even closely-allied species, distinguishing features in the formation of the sculpturing and of the lobe-line, furthermore in the proportions of growth, may be more accurately observed and determined than appears from the works of Nikitin.

According to the statements of the contributors to the English Geological Survey[1] only one species of *Cadoceras* occurs in the "Kellaways Rock" (and Oxford Clay) of England. In the official reports this species is designated *Cadoceras modiolare* Luid. sp.[2] and to it is added *Amm. sublævis* Sow. sp.[3] as a synonym. The collection of Cadocerates from Wiltshire, now before me, shows that various species occur, differently developed from their early stages. It is also probable that Luidius's "*Nautilites modiolaris*" from "Kellaway Bridge in Wiltonia" may be found among these forms, but owing to the imperfect description which Luidius gave of his ammonite, it cannot be decided, which of the forms in question should be called by the name he created. The specific name "*modiolaris*" being moreover, employed by d'Orbigny and Nikitin for two different and easily recognisable species, I consider it better to drop the specific designation "*modiolaris* Luid." and to go back principally to Sowerby's descriptions for the designation of the English species from the Kellaways Rock and Oxford Clay.

In the English materials of Cadocerates the following forms may be distinguished:

1. A species, slender at an early stage, with a narrow umbilicus, closely-encircling whorls, narrow external surface and falciform ribs[4]. The advanced stage of this form, which, even when full-grown, has a very narrow umbilicus, is shown in the large specimen figured by Sowerby (l. c. Pl. 54). To *this* form I confine the name *Amm.* (*Cadoceras*) *sublævis* Sow.
2. Young forms with thicker and somewhat convex whorls, and a broader

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[1] 'The Jurassic Rocks of Britain', vol. I. pp. 277, 279, vol. II. p. 242, vol. V. p. 11, 361.
[2] E. Luidius 'Lithophylacii Britannici Ichnographia'. p. 18, pl. IV. fig. 292.
[3] J. Sowerby, 'Mineral Conchology of Great Britain', vol. I. p. 117, pl. 54.
[4] According to Newton's report (E. T. Newton and J. J. H. Teall, l. c. p. 497) young forms like these are classed in English museums as a variety of *Amm.* (*Quenstedtoceras*) *Mariæ* d'Orb.

external side with coarser, less curved ribs. The advanced stage of this form has been illustrated by d'Orbigny[1] as *Amm. modiolaris.* In the above-mentioned publications of the English Geological Survey, this form has been delineated as *Amm. modiolaris* Luid. The full-grown specimens of this species differ from those of *Cadoceras sublæve* Sow. sp. in having a wider umbilicus, and the whorls being in transverse direction less closely encircling, and hence lower (with a coarser sculpturing in the medium stages of growth). This second species of the English Jura I designate *Amm.* (*Cadoceras*) *modiolaris* d'Orb.

3. Nikitin[2] reports that be has observed *Cadoceras Tchefkini* d'Orb. sp. from the English Kellaways Rock in English museums.
4. Yet another form of Cadocerates from the Wiltshire Kellaways Rock — n. sp. indet. — is before me. Up to a diameter of 60 mm. it is characterised by remarkably flat whorls, with a narrow umbilicus and close-set fine ribs with a decided flexure forwards. From its outward shape, it should be placed between *Cad. sublæve* Sow. sp. and *Cad. stenolobum* (Keys.) Nik.

The two first-named species are the Western European representatives of two large groups of Cadocerates, which, especially in the Russian Callovien attain a particularly high degree of development,

Upon *Cadoceras sublæve* Sow. sp. follow all those forms which are characterised in their earlier stages by a narrow umbilicus and high-mouthed whorls with fine falciform ribs. Even in advanced stages these forms generally have a narrow umbilicus, e. g.:

Cadoceras n. sp. indet. (No. 4 on p. 72).
„ n. sp. indet., a similar form from the "Ornatenthon" of Suabia.
„ *Seebachi* Behr. (*Amm. sublaevis* v. Seeb.)[3]
„ *placenta* (Bean, m-s.) Leck. sp.
„ *Tchefkini* d'Orb. sp.
„ *Wosnessenski* Grew.
„ *stenolobum* (Keys.) Nik.
„ *Nanseni* n. sp. (see below)

[1] A. d'Orbigny, 'Paléontologie française'. Terr. jur. I. p. 468, pl. 170.
[2] Bulletin de la Soc. Belg. de Géologie etc. vol. III. p. 34.
[3] Different allied forms, yet undescribed, occur in the "Ornatenthon" of north western Germany, as I have seen in the Göttingen Museum.

Cadoceras Milaschevici Nik. (= *compressum* Nik.)
„ *patruum* Eichw. sp.
„ *galdrinum* d'Orb. sp.(?)

From the two most important species I designate this *group* as that of "*Cadoceras sublæve* Sow. *sp.* and *Tchefkini* d'Orb. sp".

A series of other species is closely allied to *Cadoceras modiolare* d'Orb. sp. being characterised in their earlier stages by thicker whorls with a wider umbilicus, and generally coarser and less distinctly falciform ribs. At more advanced stages of growth also, coarser ribs and a wider umbilicus remain characteristic of these species:

Amm. sublævis macrocephali Quenstedt (Cephalopoden p. 177, Pl. 14, fig. 6.)
„ „ Quenstedt (Amm. d. Schwäb Jura Pl. 79, figs. 2, 3, 4.)
Amm. sublævis Quenstedt (l. c. Pl. 79, fig. 5) according to Nikitin an intermediate form between *Cadoceras Frearsi* d'Orb. sp. and *Surense* Nik.
Amm. sublævis Quenstedt (l. c. Pl. 79, fig. 6.) = *Cadoceras modiolare* Nik. this species is entirely different from *Cad. modiolare* d'Orb. sp., as the ribs become very broad even at an early stage.
Amm. sublævis Quenstedt. (l. c. Pl. 79. fig. 7.) = *Cadoceras* cf. *modiolare* Nik.

Furthermore they are joined by the kindred species of *Cadoceras Elatmae* Nik. from the Russian Jura:

Cadoceras Elatmae Nik.
„ *Frearsi* (d'Orb.) Nik.
„ *modiolare* Nik. non d'Orb. sp.
„ *Surense* Nik.

To these belongs perhaps also *Cadoceras sublæve* E. Desl.[1] non Sow. sp. from the Lamberti strata of Villers-sur-mer, with a rather narrow umbilicus. From the most important species, this *group* may be designated as the *Cadoceras modiolare d'Orb. sp. and Elatmæ Nik.*[2] Group. Both these briefly sketched groups are also represented in the collection of Cadocerates from Cape Flora, now before me.

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[1] E. E. Deslongchamps, 'Rapport sur les Fossiles oxfordiens de la collection farry' Bull d. l. Soc. Linnéenne de Normandie, 1889, (Extr.) p. 26, pl. I. figs. 1—4

[2] Owing to the scarcity of material, I was not able to determine to which group *Cad. subpatruum* Nik. *Schumarowi* Nik. ought to be referred.

GROUP OF CADOCERAS SUBLAEVE SOW. SP. AND TCHEFKINI D'ORB. SP.

Cadoceras Tchefkini d'Orb sp.

Pl. II. fig. 7. Letterpress fig. 14, 15.

1845. (44) *Ammonites Tchefkini* A. d'Orbigny; Murchison, Verneuil et Keyserling, 'Géologie de la Russie. Vol. II. Paléontologie', p. 439, pl. XXXV. figs. 10—15.

1846. *Ammonites Tchefkini* A. Keyserling; Krusenstern und Keyserling, 'Wissenschaftliche Beobachtungen auf einer Reise in das Petschora Land', p. 329, pl. XX. fig. 6; pl. XXII. figs. 11—12.

1878. *Amaltheus Tchefkini* S. Nikitin, 'Ammonitengruppe des Amaltheus funiferus'. Bull. de la Soc. impér des Natural. de Moscou, vol. L III. 2, p. 132, fig. 11.

1881. *Stephanoceras Tchefkini* S. Nikitin, 'Die Juraablagerungen zwischen Rybinsk, Mologa und Myschkin an der oberen Wolga'. Mém. de l'acad. impér. des Sc. de St. Pétersbourg, sér. VII. vol. XXVIII. No. 1, p. 64, pl. III. figs. 21—24.

1881. *Stephanoceras Tschefkini* S. Nikitin, 'Der Jura der Umgegend von Elatma Lfg. 1.' Nouv. Mém. de la Soc. impér. des Natural. de Moscou, vol. XIV. p. 38.

1883. *Stephanoceras Tchefkini* J. Lahusen, 'Die Fauna der jurassischen Bildungen des Rjasanschen Gouvernements'. Mém. du com. géol. St. Pétersbourg. Vol. I. No. 1. p. 52.

1884. *Cadoceras Tchefkini* S. Nikitin, 'Allgemeine geologische Karte von Russland. Blatt 56 (Jaroslawl, etc.)' Mém. du Com. géol. St. Pétersbourg, vol. I. No. 2, pp. 68, 142, 145, pl. III. fig. 15.

1884. *Cadoceras Tchefkini* S. Nikitin, 'Die Cephalopodenfauna der Jurabildungen des Gouvernements Kostroma'. Verhandl. d. K. Mineralog. Ges. St. Petersburg, vol. XX. 1885, p. 22.

1885. *Cadoceras Tchefkini* S. Nikitin, 'Der Jura der Umgegend von Elatma. Lfg. 2.' Nouv. mém. de la Soc. impér. des Natura. de Moscou, vol. XV. p. 22.

1897. *Ammonites* (*Cadoceras*) *Tchefkini* d'Orb.? E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. 53, p. 496, e. p. pl. XXXIX. fig. 5. (not fig. 4 and 6).

1897. *Ammonites* (*Cadoceras*) *modiolaris* Luid. E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. 53, p. 497, e. p. pl. XXXIX. figs. 7, 8 (not figs. 9 and 10).

The species so widely spread in the middle Callovian of Russia is represented in the material collected by Prof. Nansen at Cape Flora, besides the figured specimen by a number of impressions of young and by two fragments of body chambers, most probably to be classed here.

The well preserved specimen — Pl. II. fig. 7 — broke so favourably, in being prepared, that it permits of a considerably more accurate description of the young whorls of this important species than has hitherto been given by d'Orbigny and Nikitin.

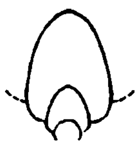


Fig. 14. *Cadoceras Tchefkini* d'Orb. sp. Diagram of Pl. II. fig. 7; nat. size.

The young whorls — up to a diameter of 40 mm — are moderately convex, and very involute. Four fifths of the height of each whorl is covered by the next whorl. On account of the great involution, the umbilicus is very narrow and comparatively deep. (conf. the accompanying diagram).

The specimen figured on Pl. II. fig. 7 shows at a diameter of 30 mm. the following dimensions:

Diameter:		30	mm.	= 1.
Width of the umbilicus		5·4	"	= 0·18.
Height	of the last	15	„	= 0·50.
Thickness	whorl	13	„	= 0·43.

These measurements correspond to the young specimen of *Cadoceras Tchefkini* which Nikitin in 1881 figured[1] from the Jura of the Upper Volga (Rybinsk, etc.).

The section of the innermost whorls — up to a diameter of about 10 mm. — is thick, shortly oval. At a diameter of about 20—25 mm., the section becomes higher. The greatest thickness of the whorl is then at about half its height. Towards the exterior the transverse section of the whorl becomes smaller. The outside is narrow but rounded[2].

[1] l. c. pl. III. fig. 23.

[2] As in the illustration given by d'Orbigny: l. c. pl. XXXV. fig. 11.

The whorls gradually grow broader. At a diameter of about 30—35 mm. the previously low wall of the umbilicus becomes higher. The greatest thickness of the whorls is then situated near the umbilicus, and the outside becomes broader. The further development of the form is not to be observed in any of the pieces from Cape Flora before me. In the specimen figured on Pl. II. fig. 7, the fragments of a body chamber pressed quite flat are to be seen.

The innermost whorls, and those up to a diameter of about 6 mm. are smooth and without any sculpturing whatever. Then slight wrinkles with a decided flexure forwards, become visible on the flanks. At a diameter of about 10 mm., the wrinkles on the flanks become more distinct, and at about half the height of the whorls generally bifurcate into two lower, less distinct wrinkles, which, bending slightly forwards, run over the outside. At a size of 15—25 mm. in diameter, the whorl is covered with narrow, rather sharp ribs, distinctly falcate — Pl. II. fig. 7 b —[1]; near the outside, the ribs show an especially distinct forward flexure. On the outside, the ribs from both flanks run towards one another at an angle of about 90°; they do not, however, meet at an angle, but in a short curve — Pl. II. fig. 7 c. On the lower half of the whorls, the ribs are somewhat sharper and higher than in the upper half.

Some of the ribs run over the whole whorl without any bifurcation; to some extent, however, secondary ribs from the outside are interposed before or behind a primary rib. At half the height of the whorls, or a little nearer the umbilicus, the secondary ribs meet with the primary ribs, or only approach the latter, and terminate indefinitely. In this way more or less distinctly bifurcated ribs are produced. There is no fixed rule in the distribution of the divided and undivided ribs. If *a* indicates an undivided rib, b_1 a divided rib where the secondary rib joins the primary rib from behind, b_2 a divided rib where the secondary rib joins the primary rib in front, we have the following formula for the sculpturing on the first half of the last whorl (from 14—20 mm. in diameter) of the specimen figured on

[1] In this point our form agrees better with the figures given by d'Orbigny than with the imperfect illustration by Nikitin, mentioned above.

Pl. II. fig. 7 b: *a*, b_1, b_2, *a*, b_1, *a*, b_1, b_1, b_2, *a*, *a*, b_1, b_{2a}, b_2, *a*, b_2. (17 ribs on the umbilicus — 7 entire ribs, 10 bifurcated ribs —, 27 ribs on the outside). At about 30 mm. in diameter, the sickle form disappears. The ribs, almost straight, run across the flanks in a flat curve; near the external side, however, they continue to be much bent forward. At this size the ribs on the wall of the umbilicus begin to become less distinct, no longer radiating from the umbilicus-seam, but beginning somewhat higher.

At 9 mm. of the height of the whorl (about 18 mm. in diameter), the somewhat asymmetrical lobe-line exhibits the development represented in the letterpress fig. 15 a. The narrowing at the base of the second lateral saddle and of the first auxiliary saddle is worthy of notice. The narrowing becomes still greater, as the growth proceeds, as letterpress fig. 15 b shows, corresponding to the lobe-line of the size with a diameter of 35 mm. The lobe-line — letterpress fig. 15 a b differs from the drawing, which Count Keyserling gives of a young specimen in the greater narrowness of the saddles[1]. On the other hand, the letterpress figure 15 b agrees very well with the lobe-line of a specimen of similar size from the Russian Jura (from Rybinsk). The fact that the auxiliary saddles are narrowed to a considerable degree in the present specimens from Cape Flora, is owing to the asymmetry of the lobe-line. The drawing — letterpress fig. 15 a — is taken from the side of the suture, somewhat shortened on account of the asymmetry of the lobe-line; the other side could not be observed[2].

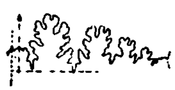
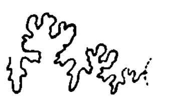


Fig. 15. *Cadoceras Tchefkini* d'Orb. sp.
a) Lobe-line of Pl. II. fig. 7 b, at a height of the whorl of 9 mm. 2 × enlarged.



b) Lobe-line of Pl. II. fig. 7 a, from the 2nd lateral lobe, at a height of the whorl of 16 mm. 2 × enlarged.

Of larger specimens of *Cadoceras Tchefkini*, there are only two fragments of smooth body-chambers among the material collected by Prof. Nansen at Cape Flora. The larger of the two agrees well in its transversely great

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[1] Krusenstern and Keyserling: l. c. pl. XXII. fig. 11.

[2] The second lateral saddle only widens with the commencement of the increased widening of the whorls, and then it shows the form so well figured by Count Keyserling — l. c. pl. XXII. fig. 12. In larger specimens the edge of the umbilicus passes through the second lateral saddle. Even in large specimens the auxiliary saddles remain narrow.

convexity, broad exterior side, and flat flanks with a marked downward flexure with Nikitin's [1] drawing of a *Cadoceras Tchefkini.* It is a fragment corresponding to half the width of the whorl. On both the interior and the exterior sides very faint, flat, broad lines, curving sharply forwards, are visible as the remains of the sculpture, which becomes very indistinct in large specimens [2]. On the outside of the fragment, at its anterior extremity, part of a broad, moderately deep contraction, with a distinct forward flexure has been preserved. *Cadoceras Tchefkini,* like *Cadoceras Elatmae* Nikitin and also like *Cad. sublœve* Sow. sp. [3], bears a contraction behind the edge of the mouth.

Among the specimens from Elmwood described and figured by Newton as *Ammonites* (*Cadoceras*) *Tchefkini*? d'Orb., the exceedingly involute form with very narrow umbilicus [4] figured l. c. Pl. XXXIX. fig. 5, is no doubt identical with our specimen [5].

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[1] S. Nikitin, 1881, Rybinsk, etc. pl. III. fig. 21.

[2] Judging from a large specimen from Rybinsk determined by Nikitin in the Munich Museum, *Cadoceras Tchefkini* does not become quite smooth, as one might think from the drawings of d'Orbigny and Nikitin; but at a more advanced age the ribs loose their distinctness and turn into very faint, flat lines. The decrease in distinctness seems to commence at very different periods in different specimens.

[3] According to a large specimen from Wiltshire (Munich Museum).

[4] In the anterior part of the last whorl, the umbilicus of the above-mentioned specimen suddenly widens, probably through crushing of the piece. — Newton's measurement of the width of the umbilicus — l. c. p. 496 — only agrees as far as the last fifth of the last whorl is concerned. Where the umbilicus is entire, its width agrees with that generally met with in *Cadoceras Tchefkini.*

[5] Newton's *Amm.* (*Cad.*) *Tchefkini*? d'Orb. l. c. pl. XXXIX. fig. 4, agrees in proportions and sculpturing (entire ribs appear to be absent) with *Cadoceras stenolobum* (Keyserl.) Nikitin. *Amm.* (*Cad.*) *modiolaris* Newton, Pl. XXXIX. fig. 9. represents a full-grown specimen of this species. The proportions agree in every respect with *C. stenolobum* Nikitin (Der Jura der Umgegend von Elatmae. 1. Pl. V. fig. 29), and the sculpturing too agrees with this species. Newton refers in his fig. 9 to *C. modiolare* Nikitin from the Lower Callovian of Elatma (Nikitin, l. c. 2, pl. XI. fig. 48). In this species as well as in *C. modiolare* Luid. of the English authors (= *C. sublœve* Sow. sp. and *modiolare* d'Orb. sp.), the radial ridges on the umbilical margin, and farther in the primary ribs on the umbilical wall, are distinctly visible. Newton's specimen cannot be made to agree with any of these "*modiolaris*" species, as the umbilical margins and walls appear smooth until far back. The great width of the umbilicus prevents the reconciling of the piece in question with *C. Tchefkini;* it can therefore only be regarded as *C. stenolobum.*

The differences reported by Newton between his *Ammonites Cadoceras Tchefkini ?* d'Orb. and *Cadoceras Tchefkini* of d'Orbigny and Nikitin are not differences in distinguishing features of different species but differences in age in different sized specimens of the same species. In full-grown specimens of *Cadoceras Tchefkini,* the number of ribs on the exterior side is a considerably larger one than in smaller specimens, a larger number of secondary ribs from the exterior surface being interspersed in the larger specimens than on the whorls of younger stages. Newton is wrong in calling the ribs around the umbilicus in *Cadoceras Tchefkini* "distinctly larger than those on the back". *In youth and on the shell* they are not "larger" around the umbilicus, but *higher* and *sharper*, and towards the external side they become lower and broader. Only in larger specimens — of a diameter of 40 mm. and upwards — and on internal casts, when tripartite ribs appear, do the ribs on the margin of the umbilicus become flatter and somewhat broader

Among the specimens from Elmwood at Cape Flora, which Newton figures as *Amm.* (*Cadoceras*) *modiolaris* Luid., figs. 7 & 8 on Pl. XXXIX. are undoubtedly to be referred to *Cadoceras Tchefkini* d'Orb. sp.

If we complete the fragment in figs. 7, 8, which, according to the lobeline, corresponds almost exactly to half the width of a whorl, we get a cross-section agreeing entirely with the transverse section of a whorl of a large specimen of *Cadoceras Tchefkini* as drawn by Nikitin [1].

Moreover the lobe-line of fig. 7 (especially as regards the development of the second lateral saddle), agrees entirely with that of a specimen of *Cadoceras Tchefkini* from Rybinsk before me. The lobe-line differs from those, which are to be observed in *Cad. modiolare* Luid. of the English authors (*Cad. sublœve* Sow. sp. and *modiolare* d'Orb. sp.), as the latter species of a corresponding size shows a considerably more developed second lateral saddle.

While Newton maintains that the cast of the umbilicus of one of his specimens just fits the umbilicus of "A. modiolaris" from the Kellaways Rock, we maintain in the first place, that among the English Cadocerates Nikitin has also

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[1] S. Nikitin: Rybinsk, etc. 1881, pl. III. fig. 21.

demonstrated[1] *Cad. Tchefkini* d'Orb. sp., secondly, that *Cad. sublœve* Sow. has a narrow umbilicus similar to that of *Cad. Tchefkini*, and, that in consequence, this observation of Newton is but of slight importance.

The specimens of *Cadoceras Tchefkini* d'Orb. sp. collected by Prof. Nansen are partly embedded in yellowish-gray clay, of a rusty colour through weathering (Pl. II. fig. 7, several impressions, and the above-mentioned fragments of body-chambers). Most of the specimens were found loose on July 12th 1896, near the margin of the glacier, north west of Elmwood. One fragment of a body-chamber was found at a height of ca. 550 feet, north of Elmwood, and an impression of a small specimen on the talus 100 feet above the sea.

Newton's *Amm.* (*Cadoceras*) *Tchefkini* d'Orb. l. c. Pl. XXXIX. fig. 5, was found *in situ* in "clay-sandstone" — at Elmwood, 50 feet below the basalt, consequently at a height of about 550 feet above sea-level.

Cadoceras Nanseni n. sp.

Pl. II. figs. 1—3, 5, 6. Letterpress figs. 16, 17.

1895. "Ammonite . . . . nearly resembles some of the varieties of *A. macrocephalus*". E. T. Newton; in A. Montefiore, 'The Jackson-Harmsworth North Polar Expedition. etc.' The Geographical Journal, London, 1895, vol. VI. p. 519.

1897. *Ammonites* (*Macrocephalites*) *macrocephalus* Schloth. E. T. Newton; E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. 53, p. 497, pl. XXXIX. figs. 1, 2.

1897. *Ammonites* (*Cadoceras*) *Tchefkini?* d'Orb. E. T. Newton; E, T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. 53, p. 496, c. p. pl. XXXIX. fig. 6.

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[1] S. Nikitin, 'Rapports entre les céphalopodes jurassiques russes et les originaux correspondants dans les collections de l'Europe occidentale'. Bull. de la Soc. Belg. de Geologie, etc. 1889, vol. III. p. 34.

1897. *Ammonites* (*Cadoceras*) *modiolaris* Luid., "flattened variety". E. T. Newton; E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. 53, p. 497, pl. XXXIX. fig. 10.

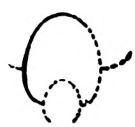
Several young individuals with flattened body-chambers, numerous impressions of young pieces and fragments of a larger specimen cannot be identified with any of the Cadoceras species hitherto described. I call the new species after the bold explorer of Franz Josef Land, and beg Prof. Nansen to see in this a token of my gratitude.

Up to a diameter of 30 mm. the Ammonite shows a flat, disc-like growth. The whorls are moderately thick. In cross section they are nearly elliptical, with the greatest width a little below half the height of the whorls. The involution is considerable; more than the half though not quite $^2/_3$ of the inner whorls are covered by the outer.

In young specimens the umbilicus is rather narrow and not very deep.

The sculpturing consists of closely placed rather sharp ribs, with a forward inclination. They are either in shallow curves, or slightly falciform.

a.



b.

Fig. 16. *Cadoceras Nanseni* n. sp.

a. figured from a wax-cast of an impression, body chamber compressed and broken; nat. size.
b. constructed diagram.

Near the external side the ribs are somewhat more bent forward. They cross the external side in a broad curve without forming any angle. With regard to the first appearance of sculpturing, the mode of bifurcation of the ribs (interpolation of the secondary ribs from the outside), and the irregular alternation of single and divided ribs, *Cadoceras Nanseni* is similar to *Ca-*

doceras Tchefkini d'Orb. sp. Pl. II. fig. 3b shows (much enlarged) the sculpture of the innermost whorls; single ribs do not appear until later — see the second half of the last whorl on Pl. II. fig. 3a, fig. 2, 1 and letterpress fig. 16 a.

Occasionally it is to be observed, that a primary rib, issuing from the umbilicus, is replaced at about half the height of the whorls by two secondary ribs rising from the outside, and passing behind and before the primary rib — letterpress fig. 16 a, at the place marked by the arrow.

In larger sizes than those with a 30 mm. diameter, the ribs gradually become coarser, and the intervals wider; the ribs run almost straight across the flanks, with a considerable forward inclination.

Besides the impression of a small specimen, there is a fragment of a large individual, embedded in a fragment of gray, very finely-grained, and sandy hard marl (partly impression) which on account of this simultaneous occurrence must be regarded as an old specimen belonging to the young forms just described. In its sculpturing, this specimen agrees perfectly with that described by Newton — l. c. Pl. XXXIX. fig. 10 — as *Amm.* (*Cadoceras*) *modiolaris* Luid., "flattened variety". Both specimens show that *Cadoceras Nanseni* n. sp. is subject in old age, to the same broadening of the whorls as most of the Cadoceras (Exception: *Cad. galdrinum*, *patruum*). The umbilical margin in this size is broad and obtusely rounded. On the wall of the umbilicus, the primary ribs still go rather close to the umbilical seam; on the flanks the ribs are mostly bifurcated; single ribs or trifurcate ribs are of less frequent occurrence. On the umbilical margin, the ribs are rather sharp but not swollen or coarsely tubercular.

The lobe-line could only be observed in young specimens. It is characterised by narrow lateral and auxiliary saddles. The siphonal lobe is nearly as deep as the tripartite, first lateral lobe. The second lateral lobe is small and short, scarcely extending so far down as the inner branch of the first lateral lobe. There are two narrow, short, auxiliary lobes and also a little denticle near the umbilical seam. The ends of the two lateral lobes and of the auxiliary lobes lie in a line inclining slightly towards the umbilicus. The external saddle is high, broad and obliquely tripartite. The first lateral saddle is unsymme-

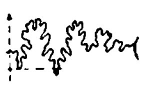


Fig. 17.
Cadoceras Nanseni n. sp. Lobe-line of Pl. II, fig. 1, at a height of the whorl of 7 mm. 2 × enlarged.

trically bipartite, and its larger inner portion is again bipartite. The narrow, second lateral saddle is symmetrically bipartite, as well as the small, first auxiliary saddle.

The lobe line is slightly asymmetrical.

Among the ammonites, which *Newton* described from Franz Josef Land, ***Amm.* (*Macrocephalites*) *marocephalus*** Schloth. (l. c. Pl. XXXIX. fig. 1) may first of all be identified with *Cadoceras Nanseni.* Newton calls this specimen (the first ammonite known from Franz Josef Land) "The true *Ammonites macrocephalus*". Newton says further in his description: "In these specimens the ribs pass outward from the small umbilicus and after bifurcating run over the back without any forward flexure". Newton's figures contradict these words. In Newton's fig. 1 the ribs in the first half of the last preserved whorl are distinctly curved, as in the figures of our *Cadoceras Nanseni.* When the ribs in the second half of the last whorl of Newton's fig. 1. appear to be straight and arranged radially, this — as is clearly visible in the above-mentioned figure — is due to the fact that the anterior half of the whorl is not intact, but is obliquely compressed. I examined numerous specimens of all sizes of the typical *Macrocephalites macrocephalus* Schloth. sp. (principally from Franconia); and none of them agrees with Newton's *Amm. macrocephalus.* The umbilicus in *Macrocephalites macrocephalus* Schloth sp. is always narrower, the involution greater than in *Amm. macrocephalus* Newton—*Cadoceras Nanseni* n. sp. Furthermore, the ribs in *Macrocephalites macrocephalus* Schloth. sp. are always finer and closer together in young forms, always with a forward flexure in the middle, and externally always less distinctly inclined forward than in *Amm. macrocephalus* Newton—*Cadoceras Nanseni.* It never happens in *Macrocephalites macrocephalus* Schloth. sp. that besides the bifurcate and trifurcate ribs, which always fork after the type mentioned under *Macrocephalites sp.* (cf. p. 68), such a number of single ribs are interpolated as in *Amm. macrocephalus* Newton (in Newton's fig. 1, five single ribs in the first half of the last whorl). Single ribs, extending down to the umbilicus, are of the rarest occurrence in the true *Macrocephalites macrocephalus* Schloth. sp. I could only prove their existence in very few young specimens. Newton's reference to *Stephanoceras* *macrocephalum* Nikitin[1] is incorrect; the umbilicus there is much narrower, the ribs have a more radial direction, and single ribs seem to be altogether absent (l. c. fig. 44 b).

If Newton's figures do not agree with *Macrocephalites macrocephalus.* Schloth. sp., they agree perfectly in form and sculpture with *Cadoceras Nanseni* n. sp. here described. This is especially the case with regard to Newton's fig. 1; but Pl. XXXIX. fig. 2 in Newton, might also be identified, from the sculpturing, with our species. The umbilicus in fig. 2 is most probably incorrectly drawn, as also the centre of the umbilicus in fig. 1 (l. c. Pl. XXXIX. fig. 3 with more inflated whorls, Newton only refers, with reservations, to *Amm. macrocephalus.* From the sculpture and the width of the umbilicus, neither can this specimen be referred to *Macrocephalites macrocephalus* Schloth. sp. It is a *Cadoceras* bearing a strong resemblance in its sculpturing to *Cadoceras Nanseni* n. sp., but which, on account of the thicker whorls should rather be regarded as separate [*Cadoceras* sp. indet. Pl. II. fig. 8].)

Amm. (*Cadoceras*) *Tchefkini* (d'Orb.) E. T. Newton e. p. — l. c. Pl. XXXIX. fig. 6 — cannot be referred to *Cadoceras Tchefkini* d'Orb. sp., on account of the wider umbilicus, the lower whorls, and the less pronounced involution, but must be associated with *Cadoceras Nanseni* n. sp.

The fact that the full-grown stage of *Cadoceras Nanseni,* which Newton determined as *Amm.* (*Cadoceras*) *modiolaris* Luid. — l. c. Pl. XXXIX. fig. 10, differs from those species of *Cadoceras modiolaris* Luid. of English Authors, was expressed by Newton in the words "flattened variety", "more compressed", etc.

Remarks. Judging from its form and sculpturing, and the lobe-line of the young whorls, *Cadoceras Nanseni* n. sp. is very closely allied to *Cadoceras Tchefkini* d'Orb. sp. As regards the young whorls, the new species differs from *Cadoceras Tchefkini*: (1st) in the greater width of the umbilicus — compare letter-press fig. 16 a and Pl. II. fig. 7 —; (2nd) in the somewhat

[1] S. Nikitin, 'Der Jura der Umgegend von Elatma'. Lfg. 2. Pl. VIII. fig. 44.

broader external side of the whorls, — compare the diagrams of letter-press figs. 14 and 16 b —; (3rd) in the less distinct sickle shape of the ribs, or its total absence; (4th) in the less marked forward flexure of the ribs near the external side; (5th) in the lobe-line. The second lateral saddle and the auxiliary saddles are scarcely narrowed at all in *Cadoceras Nanseni*. The full-grown specimens of *Cadoceras Nanseni* differ from those of *Cadoceras Tchefkini* principally, in that in the former species the sculpturing continues distinct for a considerably longer time than in *C. Tchefkini*, and also in the usually flatter form of *Cadoceras Nanseni* n. sp.

The young whorls of *Cadoceras Nanseni* differ from *C. sublæve* Sow. sp. in being less involute, with lower, externally broader whorls, with finer and closer, less distinctly falciform ribs.

As compared with the young whorls of *Cadoceras modiolare* d'Orb. sp., those of *Cadoceras Nanseni* are lower and considerably more slender, with considerably closer and finer ribs, and a wider umbilicus.

The sculpture of the young whorls of *Cadoceras Nanseni* n. sp. resembles somewhat that of *Cadoceras Elatmæ* Nikitin[1]. The young whorls of both species, however, differ widely in this particular, the young whorls of *Cadoceras Elatmæ* Nik. increase considerably in breadth at a very early stage, when their diameter measures no more than about 25 mm.[2] Moreover, the lobe-line in *Cadoceras Elatmæ* is quite different from that in *Cadoceras Nanseni*. The saddles are all considerably lower, the second lateral lobe in *Cadoceras Elatmæ* Nik. is remarkably small, and the next saddle very broad and low. Full-grown specimens of both species cannot be mistaken for one another.

The specimens of *Cadoceras Nanseni* n. sp. now before me are for the most part embedded in clay-sandstone, partly in less sandy, marly rock. The

[1] S. Nikitin, 'Der Jura der Umgegend von Elatma'. Lfg. 2, p. 14. From a large specimen of *Cadoceras Elatmæ* Nikitin, from Elatma, I prepared the inner whorls, so that I was enabled to examine the Russian species at stages of growth corresponding to the figs. 2 and 3 on Pl. II.

[2] S. Nikitin, l. c. fig. 2, Pl. VIII (X), fig. 47.

pieces were found in loose blocks, most of them on July 16th, north of Elmwood, at a height of 500—550 feet, and also on July 14th, at Windy Gully at 400 feet, and on July 10th, on the talus at 100 feet above the sea. The pieces of *Cadoceras Nanseni* described under various names by Newton, come from Elmwood, on Cape Flora, and might be from a height of 500—550 ft. One of the individuals, Newton's *Amm. macrocephalus* — l. c. Pl. XXXIX. fig. 1. —, was stated in 1896 to be from "calcareous shale".

Cadoceras sp. ex. aff. *Cad. Nanseni* (n. sp).

Pl. II. fig. 4 a, b, c, Letter-press fig. 18.

The specimen represented in fig. 4 of Pl. II — chambered cast, with half a whorl of body-chamber — agrees in the character of the sculpture with *Cadoceras Nanseni* n. sp. It differs from the preceding species in the somewhat greater width of umbilicus, in the less pronounced involution (little more than half of each whorl is concealed by the succeeding one), and moreover, in the somewhat asymmetrical lobe-line. The saddles are a little less slender than in *Cadoceras Nanseni* n. sp., and here the second auxiliary lobe lies closer to the umbilical seam, while in *Cadoceras Nanseni* n. sp. there still follows a slight in-curving of the lobe-line after the second auxiliary lobe, before the seam. (Conf. letter-press fig. 18 with p. 88. letter-press fig. 17.) The lobes of the inner side can be seen very distinctly. The antisiphonal lobe is long and narrow, ending in a single point.

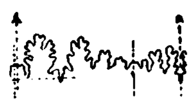


Fig. 18. *Cadoceras* sp. ex aff. *Cad. Nanseni* (n. sp.) Lobe-line of Pl. II fig. 4, at a height of the whorl of 7 mm, 2× enlarged.

I have not before me sufficiently large and well-preserved materials of *Cadoceras Nanseni* to enable me to determine the limits up to which the young forms of this species may vary. For this reason — and because the full-grown stage of the form in question is not known — I must leave it undecided whether this form represents a new species, or whether it is only an individual variation of *Cadoceras Nanseni*. As, however, some differences, though only slight ones, may be detected, I consider this specimen separately.

Cadoceras sp. ex. aff. *Cad. Nanseni* (n. sp.) was found together with *Leda* cf. *nuda* Keys. sp. in a loose block of reddish-brown, somewhat coarse-grained clay sandstone, July 12th, near the margin of the glacier northwest of Elmwood.

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2. GROUP OF CADOCERAS MODIOLARE D'ORB. sp. AND ELATMÆ NIK.

Cadoceras Frearsi (d'Orb. sp.) Nik.

Pl. II. fig. 10.

Letter-press fig. 19.

1845 (1844). *Ammonites Frearsi* d'Orbigny; Murchison, Verneuil et Keyserling, 'Géologie de la Russie', Vol. II. Paléontologie p. 444. Pl. XXXVII. figs. 1, 2.

1881. *Stephanoceras Elatmæ* S. Nikitin, 'Der Jura der Umgegend von Elatma'. Lfg. 1. Nouv. Mém. de la Soc. des Natural. de Moscou. Vol. XIV. p. 34 e. p. Pl. XI. fig. 22 a, b (not 20, 21, 23).

1885. *Cadoceras Frearsi* S. Nikitin, 'Der Jura der Umgegend von Elatma'. Lfg. 2. Nouv. Mém, de la Soc. des Natural. de Moscou. Vol. XV. p. 15. Letter-press fig. 3.

We have before us the fragments of two whorls, of a young specimen. The figured fragment of a whorl is as broad as high. The cross section of the whorl is a short, broad oval, diminishing rapidly towards the upper end of the line of symmetry. The greatest thickness lies closer to the umbilicus than to the outside. The arched flanks converge rather rapidly towards the outside, which is obtusely rounded.

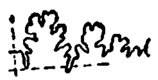

Fig. 19. *Cadoceras Frearsi* (d'Orb sp.) Nik. Lobe-line of Pl. II fig. 10 a. 2 × enlarged.

The whorl is ornamented with coarse ribs, which exhibit a forward flexure, and are only slightly curved. Bifurcating ribs and single ribs alternate almost regularly.

The lobe-line is somewhat asymmetrical, so that the form of the auxiliary lobes on both sides of the whorl is not quite identical. The course of the lobe-line agrees perfectly with that of a young specimen, now before me, of *Cadoceras Frearsi* (d'Orb. sp.) Nik. from Elatma. In a size like that of the figured piece, the saddles are still low. Close to the seam of the umbilicus, two small auxiliary lobes occur[1].

The corresponding fragment of the enclosed whorl is broad, low, and also already somewhat coarsely ribbed. The fragment of *Cadoceras Frearsi* (d'Orb. sp.) Nik. — cast of pyrites altered to brown iron-stone — was found loose, without any adhering rock, on July 12th, 1896, near the margin of the glacier, northwest of Elmwood.

Remarks. With regard to the juvenile forms of *Cadoceras Frearsi* (and in contradistinction to *Cadoceras Elatmæ*) Nikitin (1885, l. c. p. 16), states that "the ribs are more curved, and in the small volutions even somewhat falciform". In the specimen before me, the sickle form is as little perceptible as in the young specimen (first determined as *Cadoceras Elatmæ*), which Nikitin figured 1881, l. c. Pl. XI. fig. 22; or in a specimen of *Cadoceras Frearsi* before me, from the Russian Jura of Elatma (Munich Museum).

Cadoceras sp. indet.
Pl. II. fig. 8.

1897. *Ammonites* (*Macrocephalites*) *macrocephalus* Schloth. *var.* E. T. Newton; E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London. Vol. 53, p. 498. Pl. XXXIX. fig. 3.

The impression given in fig. 8 of Pl. II belongs to the widely umbilicated juvenile form of a Cadoceras with thick whorls. The rapid increase in thickness of the whorls points towards an affinity to the group of *Cadoceras modiolare* d'Orb. and *Cadoceras Elatmæ* Nik., but even this cannot be positively asserted.

From the thickness of the whorls, the width of the umbilicus, and the form of the sculpturing, Newton's *Amm.* (*Macrocephalites*) *macrocephalus*

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[1] It is a characteristic of *Cadoceras Frearsi* (d'Orb. sp.) Nik. that the second lateral lobe is pushed rather near the umbilical seam, and that for this reason the saddles and the auxiliary lobes after the second lateral lobe become comparatively very small. In succeeding whorls, the second lateral lobe is pushed towards the blunt upper margin of the umbilicus. On this point, *Cadoceras Frearsi* even in its early stages, differs not only from the more remote species, *Cad. sublæve* Sow. sp., *Tchefkini* d'Orb. sp., *Nanseni* n. sp., *stenolobum* (Keys.) Nik., but also from the more closely allied *Cadoceras Elatmæ* Nik., *modiolare* Nik., and the other Cadocerates allied to these species.

Schloth. *var.* is almost certainly identical with the form in question. Unfortunately, Newton states nothing with regard to the lobe-line of his specimen, so that his data do not permit of a determination of the form There is no doubt whatever, that the piece figured by Newton belongs as little to *Macrocephalites* (or is as little allied to *Macrocephalites macrocephalus* Schloth. sp.) as do the specimens figured by him, l. c. Pl. XXXIX. figs. 1 & 2. The width of the umbilicus, the involution and sculpture, speak against Macrocephalites and for Cadoceras.

The form before me — in grey clay sandstone, weathered a brown red, — was found at Cape Flora, at a height of 500—550 feet, north of Elmwood, Newton's specimen is also stated to be from Elmwood.

Among the impressions and smaller fragments of Cadocerates, other forms than those recorded here may possibly be represented. Their condition, however, is too imperfect for certain identification.

In a smaller fragment from light phosphoritic clay, found near the margin of the glacier, northwest of Elmwood, on July 12th, 1896, I was struck by the small elevation of the principal saddles, which call to mind *Cadoceras Elatmæ* Nik. I am not, however, able to determine whether *Cadoceras Elatmæ* is really represented in the collection before me.

Two casts of umbilici (with *Serpula flaccida* Goldf. in light, phosphoritic clay, July 12th, 1896) belong to a species of *Cadoceras* which, with an umbilicus still 18 mm. in width, shows closely disposed ribs on the umbilical wall, extending to the umbilical seam. The width of the umbilicus is equal to an angle of from 45° to 50°. It cannot be determined with certainty to which species these pieces belong; it is possible they belong to *Cadoceras Nanseni* n. sp., perhaps also to a species allied to *Cadoceras Elatmæ* Nik.

QUENSTEDTOCERAS, (Hyatt) Nikitin.[1]

GROUP OF QUENSTEDTOCERAS MOLOGÆ-RYBINSKIANUM NIK.

The genus Quenstedtoceras in the material before me is represented by a single specimen only. To judge from its sculpture, it belongs to the group *Quenstedtoceras Mologæ-Rybinskianum* so widely spread in the Upper Callovian of Russia, and it may be identified with a species likewise described from the Russian Jura, viz.:

***Quenstedtoceras vertumnum* Sintz.**

(*Non vertumnum Leck. Lah., etc.*)

Pl. II. fig. 9. Letter-press figs. 20, 21.

1888. ***Quenstedtoceras vertumnum.*** I. Sintzow, Carte géol. génér. de la Russie. F. 92. Saratow — Pensa. Mém. du Com. géol. St. Petersbourg. Vol. VII. No. 1, p. 109. Pl. I. fig. 5.

Fig. 20. *Quenstedtoceras vertumnum* Sintz, Section of the whorl of Pl. II. Fig. 9. Nat. Size.

The young form figured is flat, discoid, involute, and with a rather narrow umbilicus. The section of the whorls is oval, higher than it is broad, diminishing towards the outside. The greatest thickness is at about half the height of the whorls. The ventral area is not sharp, but bluntly rounded. At a diameter of 19 mm. the specimen shows the following proportions of dimensions:

Diameter	19 mm.	1
Width of the umbilicus . . .	6 „	0.32
Height } of the last whorl .	8 mm.	0.42
Width } of the last whorl .	7 „	0.34

The moderately convex whorls are thickly covered with rather coarse ribs. In the lower half of the whorls, the ribs are sharper, towards the outside, they become more rounded. They have a slightly falciform curve. In the last third of the present whorl, dichotomous ribs alternate with single ribs; on the preceding part of the whorl, there are more dichotomous ribs. They run across the ventral area in curves, with the convexity towards the front. The intervals between the ribs are *not* filled up on the external surface, so that *no* keel-formation takes place.

[1] Hyatt first wrote *Quenstedioceras* (Proceed. Boston Soc. Nat. Hist. XVIII. p. 391); this is evidently a printer's mistake. The correct spelling of the name is *Quenstedtoceras* and not *Quenstedticeras*, as used by most authors.

A small fragment of the next succeeding whorl (Pl. II. fig. 9 a) shows of widely-separated, coarse ribs, running over the obtusely rounded ventral remains area in a broad curve.

Fig. 21. *Quenstedtoceras vertumnum* Sintz. Lobe-line of Pl. II. fig. 9, at a height of the whorl of 7.5 mm. 2 × enlarged.

The lobe-line shows the slender, high saddles, and principal lobes characteristic of young Quenstedtocerates, and in its slender second lateral saddle, it more closely approximates the *Mariæ* than the *Lamberti* form. The exceedingly deep external lobe is worthy of attention. The two small auxiliary lobes, together with the small second lateral lobe, form almost a kind of suspensive lobe.

The present specimen is embedded in rusty brown weathered clay. It was found near the margin of the glacier, NW. of Elmwood, 100—200 ft. above the sea, on July 12th, 1896.

Remarks: The form here described agrees well in the shape of the whorls, in the sculpturing, and in the outward form, with *Quenstedtoceras vertumnum*, described by Sintzow. It is somewhat more involute than the above-mentioned form, but it cannot on this account be separated as a new species. *Quenstedtoceras vertumnum* Sintzow is not identical with *Quenstedtoceras vertumnum* (Bean ms.) Leckenby sp.[1] Sintzow mentions indeed that Leckenby's species differs in its considerably coarser ribs, and a further difference exists in the more angular section in *Quenstedtoceras vertumnum* Leck. sp. Leckenby's *vertumnum* is probably only a modification of a *Quenstedtoceras Mariæ* d'Orb. sp. with a wider umbilicus, leading on to the still wider-ribbed *Quenstedtoceras vertumnum* Lah.[2] and Damon[3]. Nikitin[4] classes the latter forms and *Quenstedtoceras carinatum* Sintzow[5] (not *Amm. carinatus* Eichwald[6]) together as *Quenstedtoceras Damoni* Nik.

[1] J. Leckenby, 'On the Kellaway Rock of the Yorkshire Coast'. Quart. Journ. Geol. Soc. London, 1859, p. 21. Pl. I. fig. 3.

[2] J. Lahusen, 'Die Fauna der Jurassischen Bildungen des Rjasanschen Gouvernements'. Mém. du Com. géol. St. Petersbourg, vol. I. No. 1. p. 46, Pl. IV. fig. 9 (not 8 = *Mariæ* d'Orb. sp.).

[3] R. Damon, 'A Supplement to the Geology of Weymouth', etc., London, 1880. Pl. 1. figs. 3, 3 a.

[4] S. Nikitin, 'Rapports entre les Céphalopodes jurassiques russes et les originaux correspondants dans les collections d'Europe occidentale'. Bull. de la Soc. Belg. de Géol. etc., vol. III. 1889, p. 35.

[5] I. Sintzow, l. c. p. 109. Pl. I. fig. 4.

[6] E. d'Eichwald, 'Lethæa Rossica'. p. 1073. Pl. 34, fig. 8.

As *Ammonites vertumnus* Leckenby is synonymous with *Quenstedtoceras Mariæ* d'Orb. sp., the form described by Sintzow. and the one here described from Franz Josef Land may both be designated as *Quenstedtoceras vertumnum* Sintzow.

Sintzow states in his work (written in Russian) that his *Quenstedtoceras vertumnum* resembles the early stages of *Quenstedtoceras Mologæ* Nikitin [1]. I can only judge of the early stage of the latter species from a figure given by Nikitin [2]. According to this figure, the whorls in *Quenstedtoceras Mologæ* Nik. are thicker and more evolute, and the ribs more curved than in *Quenstedtoceras vertumnum* Sintzow. A further difference may be noticed from Nikitin's description [3]. According to it, *Quenstedtoceras Mologæ* has a dichotomous second lateral lobe (in Nikitin's drawing of the lobes of a larger specimen, the second lateral lobe is trichotomous [4], the second lateral lobe in *Quenstedtoceras vertumnum* Sintzow being also trichotomous). *Quenstedtoceras vertumnum* Sintzow and *Mologæ* Nik. agree in having no keel-formation, even in the very earliest stages known.

Judging from its greater involution, *Quenstedtoceras vertumnum* Sintzow is also allied to *Quenstedtoceras Rybinskianum* Nik. In this respect, special prominence should be given to the form [5] described by Lahusen as *Cardioceras Rybinskianum*. To judge from Lahusen's figures, however, *Quenstedtoceras Rybinskianum* Nik. differs in its greater thickness, in the absence of single ribs, and in the keel-formation in a size corresponding to that of our specimen, i. e. the filling up of the interspaces between the ribs in the median line of the ventral area [6].

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[1] S. Nikitin (Notes sur les dépôts jurassiques des environs de Sysran et de Saratov. Extract from Bull. du Com. géol. St. Petersbourg, vol. VII. p. 29) confirms this remark of Sintzow's but seems to regard *Quenstedtoceras vertumnum* Sintzow and Leckenby as identical, on which point I cannot agree with him.

[2] S. Nikitin, Allgemeine Geologische Karte von Russland. Blatt 56 (Jaroslawl, etc.) Mem. du Com. géol. St. Petersbourg, vol. I. No. 2, 1884, p. 59. Pl. 1. fig. 3. The young form here figured does not agree in its ribbing with the inner whorl of the piece figured by Nikitin, 1881 (Rybinsk. etc.), Pl. 1. figs. 11, 12.

[3] S. Nikitin, 1881. Rybinsk. etc. p. 51.

[4] S. Nikitin, 1881. Rybinsk. etc. Pl. 1. fig. 10.

[5] J. Lahusen, l. c. Pl. N. figs. 13—16, especially 13, 14.

[6] W. Weissermel (Beitrag zur Kenntniss der Gattung Quenstedticeras. Zeitschr. d. Deutsch. Geol. Ges. 1895, p. 327) here uses the very apt term "Kielstreifen".

I wish to point out that the form from the Russian Jura, which d'Orbigny at first[1] determined as *Amm. Leachi* subsequently[2] as *Amm. Mariæ* is allied to our *Quenstedtoceras vertumnum*, but differs from it in its finer sculpturing, — without single ribs, — and in its lower saddles (provided d'Orbigny's drawing is correct). Nikitin[3] refers the form in question to the synonyms of *Quenstedtoceras Lamberti* Sow. sp. It is probable that both d'Orbigny's and Nikitin's determinations are wrong, and that this *Amm. Leachi* d'Orb. non Sow. = *Amm. Mariæ* d'Orb. e. p. = *Quenstedtoceras Lamberti* (Sow.) Nik. e. p., belongs to the group of *Quenstedtoceras Mologæ-Rybinskianum.*

Quenstedtoceras vertumnum Sintzow and *Mologæ* Nik. are the Quenstedtoceras in which one of the generic characters — the formation of the keel-line — is quite suppressed, or perhaps only nearly so, i. e. with the exception of the whorls of still younger stages than those hitherto studied. These forms have consequently still more resemblance to the Cadocerates than all other species of Quenstedtoceras, which in adult stages also become broad and depressed.

In the material collected by Professor Nansen in the neighbourhood of Cape Flora, the following forms of Ammonites may be recognized after the above investigations:

Macrocephalites Kœttlitzi n. sp.
" sp.
Cadoceras Tchefkini d'Orb. sp.
" *Nanseni* n. sp.
" sp. ex. aff. *Nanseni* (n. sp.)
" *Frearsi* (d'Orb. sp.) Nik.
" sp. (? *Elatmæ* Nik.)
" sp. indet.
Quenstedtoceras vertumnum Sintz.

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[1] Murchison, Verneuil et Keyserling, 'Géologie de la Russie' Vol. II. Paléontologie, p. 438. Pl. XXXV. fig. 7–9.
[2] 'Paléontologie française' Terr. jur. I, Pl. 179. fig. 7–9.
[3] S. Nikitin, 1881. Rybinsk etc. p. 46.

BELEMNOIDEA.

BELEMNITES LISTER.

Only some of the numerous Belemnite fragments from various rocks can be approximately determined.

The best preserved fragments belong to a species of the group "Explanati" (A. Pawlow).[1] Judging from its form, this species combines to a certain extent the characteristics of two species of the Russian (and Central European) Jura, viz. *Belemnites subextensus* Nik. and *Belemnites Panderi* d'Orb. These characters will be taken account of in the following description.

Belemnites* m. f. *subextensus Nik. — Panderi d'Orb.

Pl. I. figs. 18—21 b.

1897. *Belemnites Panderi* E. T. Newton; E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol, 53, p. 498. Pl. XXXIX. figs. 11—14.

[Cf. 1884. *Belemnites subextensus* S. Nikitin, 'Die Cephalopoden der Jurabildungen des Gouvernements Kostroma'. Verhandl. d. k. Mineralog. Ges. zu St. Petersburg, vol. XX. p. 61. Pl. VI. fig. 28.

1845 (44). *Belemnites Panderianus* A. d'Orbigny; Murchison, Verneuil et Keyserling, 'Géologie de la Russie'. Vol. II. Paléontologie, p. 423. Pl. 30.]

The guard is rather short, and comparatively slender (figs. 18 a and 19 are so put together from other pieces, that the apex of the guard and the beginning of the alveole are at a correct distance from one another). The alveole occupies scarcely half the lenght of the rostrum. The rostrum ends in a short, somewhat obtuse, eccentrically situated point (figs. 20 b, 21 b). On the somewhat flattened ventral side, a short, rather narrow groove, becoming rapidly broader and flatter anteriorly, issues from the apex. The flanks of the rostrum — behind the alveolar part — are flattened by very shallow, broad, imperfectly preserved grooves (figs. 20 b, d). The section of the guard varies. Behind the alveolar part, the dorso-ventral axis is

[1] A. Pawlow et G. W. Lamplugh, 'Argiles de Specton et leurs équivalents'. Bull. de la Soc. Impér. des Natural de Moscou. 1891. Sep. copy, p. 91.

considerably greater than the width of the guard. The section here varies from a rounded quadrilateral to a rounded trapezoid (in figs. 20c, d, 21b, special attention is to be paid to the inner rings of growth in fig. 20c). In the alveolar part the section becomes more and more circular (fig. 18b); the dorso-ventral axis here is at first only very small, afterwards scarcely greater than the thickness of the guard, the flanks, moreover, here being no longer flattened.

The beginning of the alveole, and the apical line are very eccentric in position, and very near the ventral side. The distance of the apical line from the ventral side of the rostrum varies in the different specimens (figs. 18 a, 19, 20 c) from one fourth up to one third of the dorso-ventral axis.

A fragment of a small rostrum (with eccentric radiation), from brownish clay, probably also belongs to the above-mentioned species. It shows the phragmacone in a good state of preservation, and even remains of the crushed pro-ostracum (?) are visible.

The figured pieces correspond in size with the greater number of the specimens; larger ones are rare.

Belemnites m. f. *subextensus* Nik. — *Panderi* d'Orb. was found loose on July 12th, 1896, near the margin of the glacier NW. of Elmwood in numerous pieces weathered out of the rock. One fragment lies embedded in grey, brownish-weathered clay (like *Cadoceras Tchefkini* d'Orb. sp. and *Quenstedtoceras vertumnum* Sintz.).

Some specimens are in clay-sandstone (No. 7) found July 16th, 1896, above Elmwood 550 ft.

Newton records our species from Elmwood and from the "western end of Cape Flora".

Remarks. There is no doubt that the species here described agrees with the *Belemnites Panderi* which Newton described from Cape Flora. Newton bases his determination on a comparison with belemnites from the Russian Jura, which Professor Pawlow had determined as *Bel. Panderi.* Professor Pawlow, to whom I had the opportunity of showing my materials, told me that they might well be determined as *B. Panderi* d'Orb., the more so as Russian geologists include under this name several species which are to be separated. On comparing the present species, however, with the original description and the figures which d'Orbigny has given of his *Belemnites*

Panderianus, we find, besides much that corresponds, some important differences. The section of the rostrum agrees with *Belemnites Panderi* d'Orb. in the post-alveolar part, the shortness of the ventral groove, the somewhat drawn-out apex, and the great eccentricity of the apical line in some of the pieces (fig. 19). The inconsiderable width of the ventral groove, and still more the transverse section in the alveolar region of the rostrum are points against the alliance with *Belemnites Panderi*. In *Belemnites Panderi* this transverse section always remains distinctly laterally compressed, while in our piece, it is almost an exact circle.

The characteristics which separate our species from *Belemnites Panderi* d'Orb. consequently bring it nearer to *Belemnites subextensus* Nik.

In common with this species — not very thoroughly described by Nikitin — our own has the circular section in the alveolar region, the slender form and the narrow ventral groove (Nikitin, l. c. Pl. VI. fig. 28 a).

According to the single specimen which Nikitin has figured of *Belemnites subextensus*, the transverse section of the guard in the post-alveolar part is more rounded in this species than in most of the pieces of the form in question. Moreover, the apex of the guard in this species is not at all drawn out, and besides, the ventral groove Nikitin's fig. 28 b shows numerous longitudinal furrows near the apex, which do not occur in our species, or possibly are only not preserved.

It is sufficiently clear from the reasons stated above, that our Belemnite species from Cape Flora cannot be identified — as has been done by Newton — with *Belemnites Panderi* d'Orb. From a morphological point of view our form rather stands between *Belemnites Panderi* d'Orb. and *B. subextensus* Nik. as far as we can judge about the latter species. Sufficiently rich and well preserved material of both our species and *B. subextensus* Nik. might possibly prove the necessity of an identification of the two species.

Belemnites sp. indet. 1.

In phosphoritic clay boulders (found on July 14th, 1896, Windy Gully ca. 400 ft.), some fragments of phragmacones of a Belemnite species which must have attained considerable dimensions are embedded. One of these fragments corresponds to a phragmocone diameter of about 65 mm.: the siphuncle has a thickness of more than 6 mm., and the distance between the septa thus becomes 10 mm. or more. These are dimensions which are scarcely surpassed by the largest individuals known of ***Belemnites giganteus*** Schloth.

E. T. Newton mentions phragmacones of large species in phosphatic nodules from Windy Gully (l. c. p. 501), without being able to contribute anything towards their determination.

Belemnites sp. (cf. ***Beyrichi*** Opp.)

Pl. I. figs. 22, 23.

cf. 1856. ***Belemnites canaliculatus gracilis*** F. A. Quenstedt. 'Der Jura', p. 484. Pl. 65, figs. 23.

1857. ***Belemnites Beyrichi*** A. Oppel, 'Die Juraformation' § 61, No. 1.

1870. ***Belemnites Beyrichi*** F. Römer, 'Geologie von Oberschlesien.' p. 228 Pl. 17, figs. 31, 32.

1870. ***Belemnites Beyrichi*** M. Neumayr, 'Die Cephalopodenfauna der Oolithe von Balin'. Abhandl. d. K. K. Geolog. Reichsanst. Wien Bd. V, H. 2, p. 25.)

There are numerous fragments of guards (without alveoles), for the most part badly preserved. They belong to a species of Belemnite with a long slender, slightly club-shaped guard. It appears from several specimens (e. g. fig. 23) that the guard diminishes somewhat towards the alveolar region. Posteriorly the guard is gradually produced to a long apex. Unfortunately the apex is never preserved intact; in fig. 23, to judge from the course of the lines of growth, it is drawn too obtuse.

The transverse section of the rostrum is circular, or nearly so. The apical line is central or very slightly eccentric.

Grooves are not observable in pieces corresponding to fig. 23.

A very much weathered fragment was found together with the figured specimens, showing the beginning of a groove, also a central axis and concentric radiation. Judging from the direction of the lines of growth, this groove deepens towards the alveolar region.

If the above-mentioned fragments belong to one species — which is very probable — this species might best be compared with ***Belemnites Beyrichi*** Opp. of the group of the "Hastati" (Zittel). The pieces generally agree well, with the originals of Oppel[1] from the Bathonian of Württemberg, and with several specimens of *B. Beyrichi* Opp. from Gnaszyn, near Czenstochau in Poland, which are now before me. The state of preservation, however, does not suffice for the identification of the pieces from Cape Flora with *B. Beyrichi*, nor to class them as decidedly different from that species.

Among the "Belemnites sp." which Newton (l. c. p. 502) records from "west of Elmwood", "the third form" ("cylindrical, concentrically radiated, and with comparatively acute apex") most probably belongs to our species.

Most of the pieces of *Belemnites* sp. (cf. *Beyrichi* Oppel) were found along with *Pseudomonotis Jacksoni*, loose, weathered out of the rock, on August 2nd, 1896, at a height of about 23—33 ft. above sea-level. The species, moreover, lie, together with *Pseudomonotis Jacksoni*, embedded in gray, finely-grained sandy marl (Aug. 2nd, 1896, 23—33 ft.). Fragments and sections, corresponding to our species, may also be seen, as also *Lingula Beani* Phill. and *Discina reflexa* Sow. sp., in light gray, soft marl occurring together with the hard sandy marl NNW. of Elmwood.

A few loose fragments of Belemnites were also found together with *Belemnites* sp. (of *Beyrichi* Opp.), showing traces of grooves and somewhat eccentric radiation, and perhaps allied to *Belemnites canaliculatus* Schloth. They are pieces which probably belong to the other fragments noted by Newton (l. c. p. 502), from "west of Elmwood".

Yet another small fragment is worthy of attention, as being that of a

Belemnites sp. indet. 2.

Pl. I. fig. 24.

Found loose; statement of locality, date and height wanting. The piece shows an elliptical section. The dorso-ventral axis is shorter than the width of the rostrum. The beginning of the alveole is somewhat eccentric, near the ventral side (fig. 24c). Any determination of the piece appears to be impossible.

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[1] The figure which agrees best with Oppel's originals of *B. Beyrichi* is the one which Quenstedt gives in "Jura" of his *B. canaliculatus gracilis*.

3. SUMMARY.

From the above descriptions, a fauna of at least 26 forms may be demonstrated in the Jurassic Sedimentary Rocks collected by Professor Nansen in the Cape Flora district.

The abundance of forms contained in the rocks is not, however, exhausted by these 26 different species, as there are also numerous fragments of other species — as has been already frequently mentioned — differing from the forms described, for whose approximate determination, even, there is no sufficient clue.

It appears from an inspection of the collection of the Jackson-Harmsworth Expedition, described by Newton, that the abundance of Jurassic animal fossils at Cape Flora is greater than would appear from the material collected by Professor Nansen. According to Newton's account, the entire number of the species (of the fauna) of the Jura of Cape Flora, amounts to at least 31.

In the following list, the fossils collected by Professor Nansen are placed opposite to those described by Newton. In so far as any criticism of Newton's determinations of the fossils is possible from his descriptions and illustrations, it will be found in the descriptive part of the present work; its results are apparent from the following table.

Comparative Table

of the

JURASSIC FOSSILS AT CAPE FLORA.

(FRANZ JOSEF LAND.)

Collected by Prof. *Fridtjof Nansen* and described in the present work.		Collected by the *Jackson-Harmsworth* Expedition and described by *E. T. Newton* in Quart. Journ. Geol. Soc. London 1897. Vol. 53.[1]
1. *Pentacrinus* sp. *ex. aff. bajociensis (d'Orb.) P. de Lor.* pag. 51. Pl. I. Fig 1. 2. *Serpula flaccida* Goldf. pag. 53. 3. *Lingula Beani* Phill. pag 54. Pl. I. Fig. 2–5. 4. *Discina reflexa* Sow. sp. pag. 58. Pl. I. Fig. 6–9. 5. *Discina* sp. pag. 59. Pl. I. Fig. 10.		27. *Gorgonia* (?) pag. 498. Pl. XXXIX Fig. 15[2]
6. *Pseudomonotis Jacksoni* n. sp. pag. 60. Pl. I. Fig. 13–16.	=	Avicula sp. cf. inaequivalvis pag. 502. Pl. XL Fig. 4.
7. *Pseudomonotis* sp. (cf. *ornati* Quenst.). pag. 62. 8. *Pecten Lindströmi* Tullbg. pag. 63. Pl. I. Fig. 12.		28. *Pecten cf. demissus* pag. 498[3].
9. ? *Limea* cf. *duplicata* Goldf. pag. 65. Pl. I. Fig. 11. 10. *Lima* sp. indet. pag. 68. Pl. II. Fig. 8a, 11. *Leda* cf. *nuda* Keys. sp. pag. 66. 12. *Macrodon Schourovski* F. Rouill. sp. pag. 67. Pl. I. Fig. 17. 13. *Amberleya* sp. pag. 68.		
		29. *Macrocephalites pila* Nik. (= Amm. (Macrocephalites) Ishmae, inflated variety, pag. 501, Pl. XL, Fig. 2) [73] 30. *Macrocephalites Ishmae* Keys. var. *arctica,* E. T. Newt. pag. 500, Pl. XL, Fig. 1.
14. *Macrocephalites Kœttlitzi* n. sp. pag. 70. Pl. II. Fig. 12.	=	Amm. (Macrocephalites) Ishmae, smooth variety, pag. 501, Pl. XL, Fig. 3. [72]
15. *Macrocephalites* sp. pag 73. Pl. II Fig. 11		
16. *Cadoceras Tchefkini* d'Orb. sp. pag. 80. Pl. II. Fig. 7.	=	Amm. (Cadoceras) Tchefkini (?) d'Orb. e. p. pag. 496, Pl. XXXIX, Fig. 5. [84] Amm. (Cadoceras) modiolaris Luid. e. p. pag. 497, Pl. XXXIX, Fig. 7, 8. [85]
		31. *Cadoceras stenolobum* (Keys) Nik. (Amm (Cadoceras) Tchefkini (?) d'Orb. e. p. pag. 496, Pl. XXXIX, Fig. 4. [84] Amm. (Cadoceras) modiolaris Luid. e. p. pag. 497, Pl. XXXIX, Fig. 9. [84]

[1] The figures enclosed in [ ] refer to those passages of the present work which contain critical remarks on the descriptions of Newton.
[2] Very doubtful; questionable whether of organic origin at all.
[3] Newton's description offers no clue as to whether the form in question is different from our *Pecten Lindströmi* or agrees with it.

17. *Cadoceras Nanseni* n. sp. pag. 86. Pl. II. Fig. 1—3, 5, 6.	=	Amm. (Macrocephalites) macrocephalus Schl. pag. 497, Pl. XXXIX, Fig. 1, 2. [89] Amm. (Cadoceras) Tchefkini (?) d'Orb. e p. pag. 496, Pl. XXXIX, Fig. 6. [90] Amm. (Cadoceras) modiolaris Luid., flattened variety, pag. 497, Pl. XXXIX, Fig. 10. [90]
18. *Cadoceras* sp. *ex. aff. Nanseni* (n. sp.) pag. 92. Pl. II. Fig. 4.		
19. *Cadoceras Frearsi* (d'Orb.) Nik. pag. 93. Pl. II. Fig. 10.		
20. *Cadoceras* sp. indet. pag. 94. Pl. II. Fig. 8.	=	Amm. (Macrocephalites) macrocephalus, Schl. e. p. pag. 498, Pl. XXXIX, Fig. 3. [94]
21. *Cadoceras* sp. (? *Elatmae* Nik.) pag. 95.		
22. *Quenstedtoceras vertumnum* Sintz. pag. 96. Pl. II. Fig. 9.		
		(32) ? ? Cosmoceras (Kepplerites) sp. "allied to Amm. gowerianus", ? ? pag. 502.[1]
23. *Belemnites m. f. subextensus* Nik. — *Panderi* d'Orb. pag. 100. Pl. I. Fig. 13—21.	=	Belemnites Panderi d'Orb. pag. 498, Pl. XXXIX, Fig. 11—14. [101]
24. *Belemnites* sp. indet. 1. pag. 102.	=	Belemnites sp. e. p. pag. 501.
25. *Belemnites* sp. (cf. *Beyrichi* Opp.) pag. 103. Pl. I. Fig. 22, 23.	=	Belemnites sp. (the third form) pag. 502.
(*Belemnites* sp. perhaps group of Canaliculati) pag. 104.)	=	? Belemnites sp. pag. 502, (the other forms there mentioned).
26. *Belemnites* sp. indet. 2. pag. 104. Pl. I. Fig. 24.		

In the first place, this comparison shows that, judging from Professor Nansen's collection, the Jurassic fauna of the neighbourhood of Cape Flora proves to be considerably more abundant (26 species) than might be supposed from the results of the Jackson-Harmsworth Expedition (14 species). Among the 26 species collected by Professor Nansen, there are 17 which, as against the results of the Jackson-Harmsworth Expedition, are new, while in the collection described by Newton, there are 5 species which are wanting in Nansen's collection, Ten of the species recorded in the table could be directly identified with species already known from other localities; 7 could be recognised as being allied to known species, or similar to them. Of the remaining forms, 5 are new; the rest may perhaps also be new, but they are in so imperfect a state of preservation, that their exact determination seems in the meantime to be impossible.

In the Jurassic fauna of Cape Flora, the Cephalopods and the Lamellibranchs occupy an exceedingly predominant position.

It is especially worthy of note, that as far as can be judged, the Gastropods are extremely rare, a fact to which we must give our attention later on.

[1] Not described.

IV.

STRATIGRAPHIC RESULTS.

The Jurassic fauna of Cape Flora is distinguished by the prominent part which the Ammonite genus *Cadoceras* plays in its composition. One species, *Cadoceras Nanseni* n. sp. allied to *Cadoceras Tchefkini* d'Orb. sp., is represented by a particularly large number of specimens. In addition to Cadoceras, the two genera *Quenstedtoceras* and *Macrocephalites* must be mentioned as being stratigraphically most important representatives of the Ammonites in our fauna.

The occurrence ot these three genera of Ammonites proves that the marine fauna of the Jura of Cape Flora contains representatives of the

Callovian.[1]

Are other horizons of marine Jura than the Callovian possibly represented at Cape Flora?

More recent marine horizons have certainly not been formed at Cape Flora, as far as I can judge from the collection of fossils before me. The absence of the Lamellibranch genus Aucella, which is peculiarly characteristic of the Upper Jurassic strata of northern regions, would be sufficient to prove that the Oxfordian[2] and all more recent Jurassic horizons do not occur as marine deposits at Cape Flora. Not only Aucella, but all other forms characteristic of the higher Jura, are absent.

The question whether marine Jura deposits *older* than the Callovian are developed at Cape Flora, demands a careful discussion, which will follow below.

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[1] The term *Callovian* is here always used in the sense in which the German, French and Russian authors use it. I write Callovian and not "Kellaway", in order to avoid the confusion of our Callovian with the non-identical "Kellaways Rock" of English authors.

[2] "Oxfordian" again in the sense in which the German, French and Russian geologists use the term, not equivalent with the "Oxford Clay" of English authors.

Distribution
of
the Jurassic Fossils
collected by
Prof. Nansen at Cape Flora with reference to the different localities and rocks.

	Elmwood, NW. of the hut. 23—33 ft 1°	*Talus NNW. of Elmwood.* 100 ft. 2°	At the margin of the glacier, NW. of *Elmwood*. 100 ft., 200 ft. 3°	South-western end of *Windy-Gully*, ca. 400 ft. 4°	Above Elmwood, *water-course* below the basalte, ca. 550 ft. 5°	Hard. gray, sandy marl	Light, soft marl	Stone-marl ("Steinmergel")	Clay-sandstone	Clay	Phosphoritic clay	Phosphoritic nodules	Without adherent rock
Pentacrinus sp. *ex. aff. bajociensis* P. de Lor	—	—	+	—	—	—	—	—	—	—	—	—	+
Serpula flaccida Goldf.	—	—	+	—	—	—	—	—	—	—	—	+	—
Lingula Beani Phill.	+	—	—	—	—	+	+	—	—	—	—	—	—
Discina reflexa Sow. sp.	+	—	—	—	—	+	+	—	—	—	—	—	—
— sp. indet	+	—	—	—	—	—	+	—	—	—	—	—	—
Pseudomonotis Jacksoni n. sp.	+	—	—	—	—	+	—	—	—	—	—	—	—
— sp. (cf. *ornati* Quenst.)	—	—	—	+	+	—	—	+	+	—	—	—	—
Pecten Lindströmi Tullbg.	—	—	—	—	+	—	—	—	+	—	—	—	—
? ***Limea*** cf. ***duplicata*** Goldf.	—	—	—	—	+	—	—	—	+	—	—	—	—
Lima sp. indet.	—	—	—	—	+	—	—	—	+	—	—	—	—
Leda cf. ***nuda*** Keys. sp.	—	—	+	—	—	—	—	—	+	—	—	—	—
Macrodon Schourovski F. Rouill. sp.	—	—	—	—	+	—	—	—	+	—	—	—	—
Amberleya sp.	—	—	+	—	—	—	—	—	—	—	—	—	+
Macrocephalites Kostlitzi n. sp.	—	—	—	+	—	—	—	—	—	—	+	—	—
— sp.	—	—	+	—	—	—	—	—	—	—	(?)	—	+
Cadoceras Tchefkini d'Orb. sp.	—	+	+	—	+	—	—	—	—	+	—	—	—
— ***Nanseni*** n. sp.	—	+	—	+	+	—	—	+	+	—	—	—	—
— sp. *ex. aff.* ***Nanseni*** n. sp.	—	—	+	—	—	—	—	—	+	—	—	—	—
— ***Frearsi*** (d'Orb.) Nik.	—	—	+	—	—	—	—	—	—	—	(?)	—	+
— sp. indet.	—	—	—	—	+	—	—	—	+	—	—	—	—
— sp. (? ***Elatmae*** Nik.)	—	—	+	—	—	—	—	—	—	—	—	+	—
Quenstedtoceras vertumnum Sintz.	—	—	+	—	—	—	—	—	—	+	—	—	—
Belemnites m. f. subextensus Nik. — ***Panderi*** d'Orb.	—	—	+	—	+	—	—	—	+	+	—	—	+
— sp. indet. 1	—	—	—	+	—	—	—	—	—	—	+	+	—
— sp. (cf. ***Beyrichi*** Opp.).	+	—	—	—	—	+	—	—	—	—	—	—	+
— sp. (? *Gr. of* ***Canaliculati***)	+	—	—	—	—	+	—	—	—	—	—	—	+
— sp. indet. 2	+	—	—	—	—	(?)	—	—	—	—	—	—	+

In the above table there is specified the occurrence in the various localities given by Professor Nansen, of the marine fossils collected by him, and described in the present work.

The successive order of the localities according to their height above the sea, is as follows:

1. *Elmwood, some 300 metres NW. of the hut*; — 23—33 ft. (2nd Aug. 1896).
2. *Talus NNW. of Elmwood*; — 100 ft. (10th July, 1896).
3. *At the margin of the glacier, NW. of Elmwood*; 100 ft., 200 ft. (12th July 1896).
4. *South-western end of Windy Gully* (NE. of Elmwood); — 370—450 ft. (14th July, 1896).
5. *Watercourse below the basalt just above* (*N. of*) *Elmwood;* — about 500—550 ft. (16th July, 1896).

This must *not* be apprehended as though the different localities correspond to different successive (according to given altitude) horizons in the profile of the Jura of Cape Flora.

Fossils were found *in situ* in the following localities:

1. Elmwood, ca. 300 metres NW. of the hut; — 23—33 ft. (12th Aug. 1896).
4. South-western end of Windy Gully; — 370—450 ft. (14th July 1896).
5. Watercourse below the basalt N. of Elmwood; — about 550 ft. (16th July, 1896).

The fossils and rocks collected in the localities 2 and 3 were found oose, some on the talus, and others at the margin of the glacier. With regard, therefore, to the stratigraphy of the Jura at Cape Flora, the rocks and fossils collected at the localities 1, 4 and 5 must be considered first.

In the first place, it appears from the above table that the fauna of locality 1, "Elmwood, some 300 m. NW. of the hut", with its Brachiopoda, Lamellibranchiata and Belemnites, shows an essential difference from the fauna of the other localities. Judging from the material before me, the Ammonites are here entirely absent, while in the other localities, they were found in considerable numbers. For the present we will leave out of consideration the fauna of locality 1, where the fossiliferous layer, occurring at the lowest altitude in the neighbourhood of Cape Flora, was observed *in situ* and occupy ourselves with the rocks and fossils of those localities containing Ammonites, these being fossils ot the greatest value for determining the stratigraphy of the Jura.

In locality 4,

South-western end of Windy Gully,

(cf. p. 13 "Medium horizon" and Letter-press fig. 1, c; fig. 2, c)

"about an hour's walk north-eastwards from Elmwood", Professor Nansen, observed, on July 14th, 1896, at a height of about 400 feet (370—450 ft.) above sea-level, "a clayey ridge with horizontal layers". Some of the fossils collected here were, according to both Prof. Nansen and Dr. Koettlitz[1], found *in situ.*

I have before me from this locality,

Macrocephalites Kœttlitzi n. sp. in gray-brown phosphoritic clay;
Belemnites sp. indet. 1. — Fragments of large phragmacones in dark, hard, phosphoritic nodules with a gray, clayey weather-crust and numerous phosphoritic nodules without fossils.

Among the material which E. T. Newton describes from this locality, the following species, in addition to *Macrocephalites Kœttlitzi* n. sp. *(Amm. [Macroceph.] Ishmæ* "smooth variety"), and the Belemnite fragments, ought to be specially noticed:

Macrocephalites Ishmæ var. *arctica* E. T. Newton, and
„ *pila* Nik. (= Amm. [Macroceph.] Ishmæ "inflated variety" E. T. Newton cf. p. 73).

Being a new species, the present *Macrocephalites Kœttlitzi* n. sp. *a priori* as little permits of any certain determination of the horizon as does *Macrocephalites Ishmæ* var. *arctica* Newton. Both species are allied to *Macrocephalites Ishmæ* Keys. sp., whose exact vertical position in the Petchora basin is not yet known, although there is no doubt that the latter

[1] E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, 1897. vol. LIII. p. 500.

species belongs to the Callovian[1]. But *Macrocephalites pila Nik.* occurs at Windy Gully together with *Macrocephalites Kœttlitzi* n. sp. and *Ishmæ* var. *arctica*: This species belongs to the *Lower Callovian* in the Russian[2] government Tambow (Elatma) in the Crimea, in the south-western part of Ustj-Urt. It further occurs in the corresponding horizon of the Jura of Württemberg[3]. Bukowski[4] indeed, records *Macrocephalites pila* from Poland, from the *Upper* Callovian of Czenstochau, but with the remark that the form described does not quite agree with Nikitin's species.

By the discovery of Macrocephalites pila Nik. at the south-western end of Windy Gully, the occurence of the

Lower Callovian = zone of Macrocephalites macrocephalus Schloth. sp.

= zone of Cadoceras Elatmæ Nik.

was proved in this locality, at a height of about 400 ft. above the sea. At the same time, the age of *Macrocephalites Kœttlitzi* n. sp., and *Ishmæ* var. *arctica* E. T. Newton, as well as of the remains of large belemnites found at Windy Gully in *phosphoritic nodules*, is thereby determined as Lower Callovian[5].

[Besides phosphoritic clay with *Macrocephalites Kœttlitzi*, and the phosphoritic nodules, Prof. Nansen also collected at Windy Gully several pieces of hard, yellowish-gray marl ("Steinmergel") containing

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[1] E. von Eichwald (Geognostisch Paleontologisch Bemerkungen über die Halbinsel Mangischlak und die Aleutischen Inseln, p. 146. Pl. VIII, figs. 4–5; Pl. XI, fig. 5; Pl. X, figs. 3–7) records an *Ammonites Ishmæ* from the Neocomian from Alaska, and from the Chinese bay north of Cape Unalischaglak. The forms in question certainly do not belong to *Macrocephalites Ishmæ* Keys sp., but are allied to *Cadoceras Tchefkini* d'Orb. sp. Moreover, they do not belong to the Neocomian, but, together with *Cadoceras* (not *Olcostephanus*, as Neumayr believed) *Doroschini* Eichw. sp. to the Callovian.

[2] The best information upon the distribution of the Ammonites in the various zones of the Russian Callovian is to be had from the following works:

S. Nikitin, 'Ueber die Beziehungen zwischen der russischen und westeuropaeischen Juraformation', Neues Jahrb. f. Min. etc. 1886. vol. II, pp. 212–230.

B. Szemenoff, 'Versuch einer Anwendung der statistischen Methode zum Studium der Verteilung der Ammoniten im russischen Jura'. Annuaire géol. et min. vol. II. Book VI.

[3] F. A. Quenstedt, 'Die Ammoniten des Schwäbischen Jura'. Pl. 76, figs. 12, 13. S. Nikitin, 'Quelques excursions dans les musées et dans les terrains mésozoiques de l'Europe centrale'. Bull. de la soc. Belge de Géol. etc. vol. III. 1889. p. 36.

[4] G. von Bukowski, 'Ueber die Jurabildungen von Czenstochau in Polen'. Beitr. z. Palaeontologie Oesterreich-Ungarns, etc. 1887 ol. V. p. 126. Pl. XXVI, fig. 17.

[5] It is thus very probable that *Macrocephalites Ishmæ* Keys. sp. from the Petchora basin also belongs to the Lower Callovian.

Cadoceras Nanseni n. sp., and
Pseudomonotis sp. (cf. *ornati* Quenst. sp.)

There are no fragments of *Macrocephalites* in this rock.

The pieces of this marl have rolled down from above, and are surrounded with a red weather-crust (Hydroxide of iron). They certainly do not come from the same height as *Macrocephalites Kœttlitzi*; they have rather fallen from a greater height. Very similar, only more sandy rocks have been found *in situ* in locality 5, near the lower limit of the basalt, at a height of 500—550 ft. above the sea. *Cadoceras Nanseni* n. sp., — as will be seen below — also points to a more recent faunistic horizon than that of the Lower Callovian.]

The next locality where rocks and fossils were observed *in situ* is 5.

Watercourse below the basalt, just above (N. of) Elmwood — 500—550 ft.
[cf. p. 14. "Upper horizon" Letter-press Fig. 1, d, fig. 3, d.]

This is the locality which, in the report of the Jackson-Harmsworth Expedition, is mentioned as "a watercourse at the back of Elmwood" [1].

According to Prof. Nansen, rocks *in situ*, clay-sandstone and hard, finely-grained stone marl were found in this locality at a height of circ. 550 ft. above the sea — according to the report of the Jackson-Harmsworth Expedition, 50 ft. below the basalt.

From the various, partly coarse-grained, partly more compact, less sandy pieces of clay-sandstone, more like the stone-marl (p. 47), of which only some were found *in situ*, some loose, weathered out of the rock, the following fossils are before me:

Pseudomonotis sp. (cf. *ornati* Quenst. sp.)
Pecten Lindströmi Tullbg.
?*Limea* cf. *duplicata* Goldf.
Lima sp. indet.
Macrodon Schourovski F. Rouill. sp.
Cadoceras Nanseni n. sp.
" sp. indet.

[1] E. T. Newton and J. J. H. Teall, l. c. p. 496. Under "3 Elmwood" two localities are comprehended. Only the one under the above mentioned designation is identical with our locality 5. The locality of *Cadoceras Tchefkini* (? d'Orb.), mentioned l. c. as "the side of the glacier at the western end of Cape Flora," according to Professor Nansen, is our locality 3, $1^1/_2$ kilometre north-west of Elmwood.

Belemnites m. f. *subextensus* Nik. — *Panderi* d'Orb.

Among the fossils described by Newton from Elmwood, the following species come from our locality, and out of clay-sandstone:

Cadoceras Tchefkini d'Orb. sp.[1]
" *Nanseni* n. sp.[2]
" sp. indet.[3]
Pecten cf. *demissus* E. T. Newton. l. c. p. 498.

From the considerable difference in height between the appearance of clay-sandstone with numerous Lamellibranchs and the very numerous specimens of *Cadoceras Nanseni* n. sp. above Elmwood at 550 ft., and the clay at Windy Gully at height of about 400 ft. above the sea, containing *Macrocephalites Kœttlitzi, pila*, etc. — the representatives of the Lower Callovian — it may *a priori* be assumed that the two different rocks belong to different zones. This assumption is supported and ultimately proved by the fauna of the clay-sandstone, which is wholly different from that of the clay at the south-west end of Windy Gully. Instead of *Macrocephalites*, we here find *Cadoceras* as the Ammonite of most common occurrence. *This* difference in the fauna is here not the consequence of different facies, but the result of temporal changes upon the fauna.

The occurrence of *Cadoceras Tchefkini* d'Orb. sp., which, according to Newton's description, is affirmed to be in this locality and in the clay-sandstones, is of great importance in determining the age of the clay-sandstones. *Cadoceras Tchefkini* d'Orb. sp. in northern and central Russia[4], together with *Cadoceras Milaschewici* Nik., belongs to the very characteristic fossils of the Middle Callovian, of the Zone of *Cadoceras Milaschewici* of Nikitin = *Zone of Reineckia anceps* of Oppel.

By means of *Cadoceras Tchefkini* d'Orb. sp., the Ammonites occurring together with it:

Cadoceras Nanseni n. sp.

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[1] = *Amm.* (*Cadoceras*) *Tchefkini* E. T. Newton, l. c. Pl. XXXIX, fig. 5.
[2] = *Amm.* (*Macrocephalites*) *macrocephalus* E. T. Newton l. c, Pl. XXXIX, figs. 1, 2. + *Amm.* (*Cadoceras*) *Tchefkini*? d'Orb. E. T. Newton, l. c. Pl. XXXIX, f. fig. 6.
[3] = *Amm.* (*Macrocephalites*) *macrocephalus* (var.) E. T. Newton l. c. Pl. XXXIX fig. 3
[4] Petchora basin, Gov. Rjasan, Tambow, Twer, Jaroslaw, Kostroma, Samara and Orenburg. S. Nikitin (Quelques excursions dans les Musées et dans les terrains mésozoiques de l'Europe occidentale etc. Bull. de la Soc. Belge de Géol. etc. vol. III, p. 34) also mentions *Cadoceras Tchefkini* d'Orb. sp. from the Callovian of England, and further as a rarity, from the Upper Callovian of the Upper Volga (Mém. de l'acad. imp. d. Sc. St. Pétersbourg, S. VII, T. XXVIII, N. 5, pp. 20, 21, 26).

Cadoceras sp. indet. —

are also proved to be of the age of the Middle Callovian.

Owing to the fact, that the *Belemnites m. f. subextensus* Nik. — *Panderi* d'Orb., now before me (also from clay sandstone) is closer related to *Belemnites subextensus* Nik. than to *Belemnites Panderi* d'Orb. (which species only becomes more frequent in the Oxfordian, and continues up to the Volga-Stufe), the determination of the clay-sandstone as Middle Callovian also appears justifiable.

Without the accompanying Ammonites, the Lamellibranchiata in the clay-sandstone would afford no certain clue to the age of the rocks — the Lamellibranchiata in the Jura being, as a rule, less qualified for an exact determination of age than are the Ammonites. *Pecten Lindströmi* Tullberg[1], and *Macrodon Schourovski* F. Rouill. sp.[2] would point towards the Upper Jura-Malm. *Pseudomonotis* sp. (cf. *ornati* Quenst. sp.)[3] admits of an alliance with the Middle and Upper Callovian and, through its relationship to *Limea duplicata* Goldf., ? *Limea* cf. *duplicata* permits of determinations from the Bathonian to the Oxfordian. Generally, however, the Lamellibranchiata from the clay-sandstone of locality 5 — watercourse below the basalt, just above (N. of) Elmwood — agree very well with the determination of age: Middle Callovian.

Besides clay-sandstones with the above-mentioned fossils I have before me, from the same locality, and from a height of about 550 ft, a fragment, embedded in gray-brown *clay*, of a body-chamber of *Cadoceras Tchefkini* d'Orb. sp., a species characteristic of the Middle Callovian. This piece affords evidence — which can also be obtained in other ways — that the Middle Callovian in the district of Cape Flora is not only in the form of beds of clay-sandstone, but that clayey strata also share in its composition.

As *Cadoceras Nanseni* n. sp. is considered to be a species belonging to the Middle Calovian, the

hard, gray or *yellow stone-marl* ("Steinmergel")

(p. 47) in which the presence of *Cadoceras Nanseni* n. sp.[4] and (once) *Pseudo-*

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[1] Only known, so far, from the Aucella strata of Novaja Semlja.

[2] From the Virgati strata of the Moscow Jura.

[3] *Pseudomonotis ornati* was described by Quenstedt from the Ornaten-Clay of Württemberg.

[4] Also a fragment of an indeterminable *Pecten*.

monotis sp. (cf. *ornati* Quenst. sp.) was proved, must also be designated Middle Callovian. These stone marls do not appear to have been observed *in situ*. The pieces before me are surrounded by a rusty-brown weather-crust; they were found *loose* on the talus in the localities

2. NNW. of Elmwood, 100 ft. above the sea;

4. South-western end of Windy Gully, ca. 400 ft. above the sea.

Doubtless the pieces have fallen out of layers which are at a greater height than 400 ft. Probably the stone marls with *Cadoceras Nanseni* are also *in situ* at a height of 550 ft. I have some pieces of rock before me from this level, which, petrographically, come between the stone-marls and the clay-sandstones.

In proving the presence of the

Lower Callovian at the south-western end of Windy Gully, at ca. 400 ft. and the

Middle Callovian above Elmwood at 550 ft.

the occurrences of Callovian in the region of Cape Flora are not exhausted.

On July 12th, 1896, Prof. Nansen collected a large number of fossils at locality 3

"At the margin of the glacier NNW. of Elmwood, 100—200 ft. above the sea", at a distance of 1½ kilometres from Elmwood [cf. p. 17. "Doubtful horizon". Letter-press Fig. 1, g, h, Fig. 3, h]. These were:

Cadoceras Frearsi (d'Orb.) Nik. *Macrocephalites* sp.	free, probably from clay.
Cadoceras sp. indet. (casts of umbilici). *Serpula flaccida* Goldf.	in phosphoritic nodules.
Cadoceras sp. *ex. aff. Nanseni* n. sp. *Leda* cf. *nuda* Keys. sp.	in clay sandstone.
Cadoceras Tchefkini d'Orb. sp. *Belemnites* m. f. *subextensus* Nik.-*Panderi* d'Orb.[1] *Quenstedtoceras vertumnum.* Sintz.	in gray, hard clay with a brownish weather crust.

[1] Only one specimen of these Belemnites still shows traces of the surrounding clayey rock; all the other numerous pieces were found loose, washed out of the rock.

Pentacrinus sp. *ex. aff. bajociensis* P. de Lor.
Amberleya sp.
} loose, without adhering rock.

Moreover a large number of *phosphoritic nodules* without fossils, and several specimens of "cone-in-cone" (Tutenmergel) were found there.

None of the pieces in question have been taken from rocks *in situ* they were rather gathered, some from the "*moraine*" *at the side of the glacier* (circ. 200 ft. above the sea), some *from a projecting rock*[1] *within the glacier*, and some *a little to the south-west of the glacier, below a basalt-rock* at a height of 80—120 ft. above the sea, where the "clayey ground" was covered with loose pieces of "clay-ironstone".

As the various places of this locality cannot be distinguished from the labels of Prof. Nansen's collection (the labels bear only the inscription "12th July, 1896"), and as, moreover, a separation of the various places in which these loose specimens were found, is of no great importance, the fossils of July 12th, are here treated of as if originating from one locality.

The locality now to be discussed is that described in the report of the Jackson-Harmsworth Expedition[2], under "3. Elmwood", as "the side of the glacier at the western end of Cape Flora"; it is moreover, most probably identical with the locality specified in the above-mentioned report as "from the talus near Elmwood".

Newton includes under "3. Elmwood" both the place where the rocks collected from the "moraine" were found, and that where the clay-sandstones of the Middle Callovian were found, which rocks are *in situ* above Elmwood at about 350—450 ft. higher.

Among the fossils which Newton describes l. c. under "3. Elmwood", the following species refer to the locality "at the margin of the glacier":

Cadoceras Tchefkini d'Orb. sp.[3]
„ *stenolobum* (Keys.) Nik.[4]
„ *Nanseni* n. sp.[5]

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[1] There is unfortunately no record of the nature of this rock.
[2] E. T. Newton & J. J. H. Teall, l. c. Quart. Journ. vol. LIII, pp. 496, 497.
[3] = *Amm. (Cadoceras) modiolaris* E. T. Newton, Pl. XXXIX, figs. 7 & 8.
[4] = *Amm.* (*Cadoceras*) *Tchefkini* ? d'Orb. E. T. Newton, Pl. XXXIX, fig. 5 + *Amm.* (*Cadoceras*) *modiolaris* E. T. Newton, Pl. XXXIX, fig. 9.
[5] = *Amm.* (*Cadoceras*) *modiolaris*, "flattened variety" E. T. Newton. Pl. XXXIX, fig. 10.

Belemnites mf. subextensus Nik. — *Panderi* d'Orb.[1]
Gorgonia(?) E. T. Newton.
(Phosphatic nodules).

The various fossils which were found loose belong to *various faunistic horizons.*

In the first place, *Cadoceras Frearsi* (d'Orb.) Nik.[2] p. Pl. II, fig. 10, must be referred to the *Lower Callovian*; probably also *Macrocephalites* sp. p. 73 Pl. II. fig. 11 (from its affinity to *Macrocephalites Kœttlitzi* n. sp. and therefore to the group of *Macrocephalites Ishmæ* Keys. sp.). The two forms, of each of which there was only one specimen, were found without very much rock adhering to them. Judging from the nature of the nuclei, however, they have doubtless come from clayey rocks. These two Ammonites here represent the horizon that was found at the south-western end of Windy Gully, at a considerably higher level — ca. 400 ft. above the sea — i. e. the zone of *Macrocephalites macrocephalus.*

To the same horizon most probably belong a few casts of umbilici of *Cadoceras* sp. indet., consisting of blackish phosphorite with a pale gray, clayey weather crust. In these umbilical casts, I found, besides *Serpula flaccida* Goldf., a small fragment of a *Cadoceras,* whose lobe-line recalls the characteristic species of the Lower Callovian of Russia, viz. *Cadoceras Elatmæ* Nik.

To the *Middle Callovian* belongs a piece of *clay-sandstone,* containing *Cadoceras* sp. *ex. aff. Nanseni* n. sp. (p. 92, Pl. II, fig. 4), which is nearly allied to our *Cadoceras Nanseni,* and *Leda,* cf. *nuda* Keys. sp. (p. 66, fig. 11). *Leda nuda* Keys. sp. has, indeed, been found in the Petchora basin in the Upper Jura, and moreover, is mentioned from Spitzbergen, from the Aucella strata. Our form could not, however, be directly identified with *Leda nuda* Keys. sp.; it was only admitted that it resembled that species. The rock agrees perfectly with several pieces of the clay-sandstone *in situ* above Elmwood, 550 ft. above the sea, which we have decided is Middle Callovian. I therefore have no hesitation in also referring the rock with *Cadoceras* sp.

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[1] = *Belemnites Panderi* E. T. Newton. Pl. XXXIX, figs. 11—14.
[2] Known from the Lower Callovian of the Russian government Tambow (Elatma), and of the Petchora basin.

ex. aff. Nanseni and *Leda* cf. *nuda* Keys. sp. to the Middle Callovian. Fragments of *Belemnites m.f. subextensus* Nik. — *Panderi* d'Orb., a species we already know as belonging to the Middle Callovian, were especially numerous in the "moraine" at the side of the glacier. Most of the pieces are without any adhering rock, and only one piece is enclosed in *gray clay, weathered a yellowish brown.* In the same rock, besides several quite indeterminable fragments of ammonites (*Cadoceras* ?) there were also various pieces of *Cadoceras Tchefkini* d'Orb. sp., of which the best is figured on Pl. II, fig. 7. *Cadoceras Tchefkini* — as already stated — is one of the most important fossils of the *Middle Callovian* of central and northern Russia.

Just as I now have before me fossils of the Middle Callovian from the débris at the edge of the glacier NW. of Elmwood, so also does the material which Newton examined from the same locality contain fossils of the same horizon. Newton, as far as one can judge of the material described by him, seems *only* to have had fossils of the *Middle* Callovian from this locality. Besides *Cadoceras Tchefkini* d'Orb. sp., *Nanseni* n. sp., and *Belemnites mf. subextensus* Nik. — *Panderi* d'Orb. sp., which I have before me, there is also *Cadoceras stenolobum* (Keys.) Nik. a very characteristic species of the Middle Callovian of Russia.

The most interesting of the fossils collected on July 12th, 1896, at the margin of the glacier, is unquestionably

Quenstedtoceras vertumnum, Sintzow [1].

(P. 96 Pl. II, fig 9.)

from gray clay, weathered a brownish yellow.

Sintzow records this species from the *zone of Quenstedtoceras Lamberti*, therefore from the

Upper Callovian

of the Russian geologists, from the Sukhaïa Jelchanka in the government Saratow.

[1] *Quenstedtoceras vertumnum* was the first fossil that I was able to determine after having received the material. Upon the occurrence of this species, I supported my first statement (communicated to Professor Nansen) of the occurrence of the Lamberti zone in the Jura of Cape Flora.

Quenstedtoceras vertumnum Sintzow belongs to the group of *Quenstedtoceras Mologæ* and *Rybinskianum*. Wherever this group occurs, it never appears earlier than in the Upper Callovian, as in Russia in the Jura of the Governments Rjasan, Twer, Jaroslaw, in the Lithuanian Jura, in Württemberg[1], and in France (Calvados)[2].

Even though *Quenstedtoceras vertumnum* Sintzow is the *only* fossil which is known to be of the age of the Upper Callovian, it is so characteristic that it proves without doubt the presence of this zone, i. e.

the strata with Quenstedtoceras Lamberti of the Russian geologists,

the zone of Peltoceras athleta of the German and French geologists,

in the Jura of the Cape Flora region.

Besides the above-mentioned fossils, the fragment of a stem of a *Pentacrinus sp. ex. aff. bajociensis* P. de Lor, discussed on p. 54 (Pl. I, fig. 1) was found on July 12th, immediately at the margin of the glacier at a

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[1] *Amm. Lamberti inflatus* Quenst. 'Ammoniten' Pl. 90, fig. 16 from the "Lamberti Knollenschicht", and *Lamberti pinguis*, Pl. 90, fig 22 from the Upper "Ornaten-Thon" of Beuren belong to this group.

[2] *Quenstedtoceras* appears nowhere earlier than in the zone of *Peltoceras athleta* This can, of course, only be proved where a faunistic stratigraphic-separation between the zones of *Reineckia anceps* and *Peltoceras athleta*, with their respective equivalents, is possible, i. e. in most of the Jura districts of central and northern Russia, in Hanover, Württemberg and France. The Savoy and England are apparently exceptions to this rule.

Parona and Bonarelli (Sur la faune du Callovien inferieur de Savoie. Mém. de l'acad. de Savoie vol. VI, 1895, p. 93. Pl. II, fig. 4) record a *Quenst. primigenium* n. sp. from Savoy, from the Lower Callovian (Chanazien). I cannot regard this form as a *Quenstedtoceras*; judging from its shape, involution and sculpturing (the lobe-line is not known), it is rather a *Cardioceras* and allied to *Cardioceras Chamussetti* d'Orb. sp.

From Yorkshire in England, Quenstedtocerates are mentioned both from the Kellaways Rock and from the Oxford Clay. To some extent, the determinations of some forms, e. g. *Quenstedtoceras Mariæ* d'Orb. sp. from Wiltshire, are incorrect. These are simply young *Cadoceras sublæve* Sow. sp. To some extent the occurrence of *Quenstedtoceras* in the Kellaways Rock, partly coinciding with the Macrocephalus zone, together with the other Ammonites (viz. *Peltoceras athleta* Phill. sp., *arduennense* d'Orb. sp. *Aspidoceras perarmatum* Sow. sp., *Cosmoceras Jason* Rein. sp., *Gulielmi* Sow. sp., *Hecticoceras lunula* Rein. sp,, *Oppelia Beaugieri* d'Orb. sp. *Oekotraustes crenatus* Brug., sp., *Cardioceras excavatum* Sow. sp., *Quenstedtoceras Lamberti* Sow. sp., *flexicostatum* Phill. sp., *Mariæ* d'Orb. sp. etc., cf. 'The Jurassic Rocks of Britain.' vol. II, p. 236, etc., vol. V, p. 359, etc.) proves that the Kellaways Rock of the English geologists is not really everywhere, and especially not in Yorkshire, Lower Callovian, and Oxford Clay Upper Callovian. The Kellaways Rock and the Oxford Clay may be petrographically different facies of faunistically corresponding strata, and in both the Kellaways Rock (especially that of Yorkshire) and the Oxford Clay, the different zones of the Callovian, as they may be observed on the continent, cannot be separated.

height of 200 ft. above the sea, a fact which Prof. Nansen calls especial attention to in his diary. This piece, found together with fossils of the Callovian, shows in a most remarkable manner a closer affinity to species of the Bajocian than to more recent species. Whether it ought nevertheless to be referred to the Callovian, I cannot determine, as the piece, which is composed of dark, gray calcite, was found without any trace of adhering rock.

Amberleya sp. (p. 68) from the same locality probably belongs also to the Callovian; the more precise age of this form cannot be determined.

The fossils found loose on July 12th, 1896, at the margin of the glacier NW. of Elmwood, 100—200 ft. above the sea, are, as has already been shown, the faunistic representatives of the three separately-established zones in the Callovian of Russia, Württemberg (and Franconia), France, the Swiss Jura and Hanover, viz. those of:

(3) *Peltoceras athleta,*
(2) *Reineckia anceps,*
(1) *Macrocephalites macrocephalus.*

While farther east, the zones of the Lower Callovian (south-western end of Windy Gully 400 ft.) and of the Middle Callovian (above Elmwood, 500—550 ft,) are distributed over a series of layers at least 150—200 ft. thick, and are *in situ* at a much higher level, we here find at the margin of the glacier NW. of Elmwood, the rocks and fossils of the Lower and Middle (and of the Upper) Callovian, *at an inconsiderable height above the sea* — 100 ft. — 200 ft. —consequently at least 200 ft. (up to 300) beneath the Lower Callovian at Windy Gully, and spread in loose blocks *over a considerably smaller vertical area.* This occurrence at a lower level, and *over a smaller vertical extent,* can be explained by a sinking of the strata west of Elmwood (vide p. 19), if it is in conjunction with a more pronounced dip[1] of the strata towards the north and north-west, than has been observed. The accumulation of the different rocks and fossils of the various zones can here also be partly due to the movement of the glacier. NW. of Elmwood, the glacier descending rapidly westwards and towards the sea can have carried rocks and fossils from various higher levels to this lower level.

[1] Professor Nansen records "horizontal layers" at the south-western end of Windy Gully, and Newton and Teall write (l. c. p. 512): "The sedimentary strata in the south of Franz Josef Land are believed to be regularly horizontal with only a slight dip to the north-east".

The clay containing *Quenstedtoceras vertumnum* must certainly have come originally from higher strata. Granted that the strata above Elmwood are undisturbed, this clay of the Upper Callovian, must there be *in situ* at a still greater height above the sea than the clay-sandstones, etc. with *Cadoceras Nanseni, Tchefkini* and the Lamellibranchiata belonging to the Middle Callovian. As the latter were observed above Elmwood, *in situ* at a height of about 550 ft. above the sea, the clay of the Upper Callovian with *Quenstedtoceras vertumnum* must here be situated immediately, or almost immediately below the basalt. According to Prof. Nansen the most commonly occurring rock of the Jura underlying the basalt at Cape Flora, is clay. The report of the Jackson-Harmsworth Expedition[1] records east of Elmwood "just below the basalt" (only about 8½" below it) "lighter coloured, brownish clay-shale, the thickness of which is not recorded". The Jackson-Harmsworth Expedition found no fossils in the latter. Most probably this clay, lying above the clay-sandstone and clay (with *Cadoceras Tchefkini*) of the Middle Callovian, belongs to the zone of *Quenstedtoceras Lamberti* of Russian geologists.

I cannot, of course, determine whether distinct stratigraphic limits can be drawn between the Middle and the Upper Callovian in the region of Cape Flora. The clay of the Middle Callovian with *Cadoceras Tchefkini* d'Orb. is not petrographically different from the clay of the Upper Callovian with *Quenstedtoceras vertumnum* Sintzow. Although the clays with *Cadoceras Tchefkini* etc. occur above the clay-sandstones of the Middle Callovian with *Cadoceras Nanseni* n. sp. etc., a limit petrographically recognisable could hardly be drawn between the Middle and the Upper Callovian. We are, however, not so much concerned with this matter, since our chief duty is the determination of the age only of the marine Jurassic strata occurring at Cape Flora.

There are still two types of sedimentary rocks to be mentioned, belonging to the Callovian of Cape Flora:

1. *Phosphoritic nodules.*

These were collected in various sizes, from that of a nut to that of a fist, on July 14th, at the south-western end of Windy Gully, at a height

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[1] E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. LIII. p. 496.

of 400 ft., and on July 12th, at the margin of the glacier, at a height of 100—200 ft. above the sea. As some of these nodules, from the fossils they contained, viz.

Belemnites sp. indet. l.

Cadoceras sp. indet. (? *Cad. Elatmæ* and others)

Serpula flaccida Goldf.,

were recognised as Lower Callovian, it seems natural also to refer the far more numerous nodules without fossils to the Lower Callovian. Thus from their occurrence in Windy Gully, the phosphoritic nodules would be confined to a height of about 400 ft. above the sea.

2. *Cone-in-cone (Tutenmergel, Nagelkalk).*

Several pieces were found loose on the talus on July 10th, NNW. of Elmwood, 100 ft., and on July 12th, at the margin of the glacier, 100 to 200 ft. above the sea. Petrographically the pieces agree perfectly with the stone marl of the Middle Callovian (with *Cadoceras Nanseni* n. sp.). Possibly for this reason, they also belong to the *Middle Callovian.* No pieces were observed *in situ.* Judging from their occurrence as débris on the edge of the glacier, at a height of about 200 ft., they must have been *in situ* at a higher level.

After becoming acquainted with the faunistic representatives of the *entire Callovian,* in the "clay formation" below the basalt at Cape Flora, the next point is to establish the age of the rocks and fossils of locality 1.

On Aug. 2nd, 1896, Professor Nansen found *in situ* at

Elmwood NW. *from the hut,* at a height of 23—33 ft.,

hard, gray, sandy marl (with small agglomerations of pyrites), *together with light gray, soft marl* (cf. p. 11 "Lower horizon," Letter-press fig. 2, 1 a and p. 47. No. 4).

The material which Prof. Nansen collected at this locality contains:

Lingula Beani Phill.

Discina reflexa Sow. sp.

" sp. indet.

Pseudomonotis Jacksoni n. sp.

Belemnites sp. (cf. *Beyrichi* Opp.)

" " (? *Canaliculati* group)

" " indet. 2 (?).

With the exception of *Discina* sp. indet. and *Belemnites* sp. indet. 2, specimens of all the forms were found in large numbers, and, with the exception of these two forms, the species were all found both *in situ* and also loose, weathered out of the rock.

There are, moreover, very numerous remains of Lamellibranchs, but in so bad a state of preservation, and so fragmentary that they cannot be determined.

In the report of the Jackson-Harmsworth Expedition[1], mention is also made of

Avicula sp. cf. *inæquivalvis* (*Pseudomonotis Jacksoni,* n. sp.)
Belemnites div. sp. indet.

from the same locality, "SW. of Elmwood," "sandy shale."

Newton further mentions from this locality an "indeterminable" fragment of an Ammonite, which he determines as "allied to *A. Gowerianus*". As neither description nor figure of this specimen is given, it is, of course, impossible to judge how far Newton's determination is correct. As no trace of Ammonites was to be found in the rather abundant rock-material which I examined from this locality, I am of opinion that the fragment mentioned by Newton does not originate from the rocks lying 23—33 ft. above the sea, but that it may have fallen from higher beds. Moreover, as Newton does not take this ammonite fragment into stratigraphic consideration at all, we may also ignore the reference to the Callovian, made on account of the "affinity" to *Cosmoceras* (*Keppleritis*) *Gowerianum* Sow. sp. (if Newton's determination be correct), in the discussion of the age of the strata lying at a height of 23—33 ft. above the sea.

The great vertical distance between these beds and those of the Lower Callovian, situated at a height of 400 ft. above the sea, would *a priori* justify the supposition that here at Elmwood *older* horizons are developed than the Lower Callovian at the south-west end of Windy Gully. As far as the fossils from our locality No. 1 were determinable, the fauna fully confirms this opinion. It shows a composition wholly different from that with which we are acquainted in the fauna of the Callovian of Windy Gully, above Elmwood, and at the edge of the glacier.

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[1] E. T. Newton and J. J. H. Teall, l. c. Quart. Journ. Geol. Soc. London, vol. LIII, p. 502.

The fauna of the strata found NW. of Elmwood near the shore is distinguished by the particularly abundant remains of *Pseudomonotis Jacksoni* n. sp. The frequent occurrence of a Pseudomonotis might lead to the supposition that we have before us deposits of Triassic age, as Pseudomonotis species play a very important role in the Trias strata of the Pacific and Arctic regions (Siberia, Spitzbergen). But apart from the fact that our species shows no correspondence with such Triassic Pseudomonotis, its occurrence together with Belemnites also proves, that we cannot have to do here with deposits of Triassic age. The Elmwood deposits, which lie a short distance NW. of the hut, at a height of from 23 to 33 feet above the sea, must belong to the Jura. In the Jura also, the Pseudomonotis are of no uncommon occurrence; in certain horizons they even preponderate: I may mention *Pseudomonotis substriata* in the Upper Lias, *Pseudomonotis elegans* in the Bajocian, *Pseudomonotis echinata* in the Bathonian.

Pseudomonotis Jacksoni is worthless, as a new species, for the accurate determination of the horizon.

The Brachiopoda found together with Pseudomonotis Jacksoni are of greater importance. Although, on the basis of these forms, it is not possible to determine with absolute certainty a single faunistic zone, yet they point to the *Brown Jura*, but *not the Callovian.*

Lingula Beani Phill. is not confined to a single faunistic zone. In Yorkshire it occurs in the Blea Wyke Beds, and perhaps also in the so called "Dogger", consequently in the zones of *Leioceras opalinum* and *Ludwigia Murchisonae.* Brauns records it from the zone of *Trigonia navis* of north-western Germany. Quenstedt mentions it from the zone of *Ludwigia Murchisonae* of Württemberg. Lepsius and Haas found it in the zone of *Sphæroceras Sauzei* of Lower Alsace. Terquem and Joudry record *Lingula Beani* from the zone of *Amm. subfurcatus* and *Niortensis,* in the department Moselle. Trautschold claims to have found *Lingula Beani* even in the "Couches de Mniowniki" of the Jura of Moscow. The imperfect illustration and description which Trautschold gives of his *Lingula Beani* does not suffice for determination as to whether the true *Lingula Beani* really does occur in such high horizons. *Lingula*

Beani Trautsch. is, moreover, otherwise interpreted from Lahusen and Eichwald[1][2].

Leaving the last, unauthenticated occurrence, out of consideration, *Lingula Beani* Phill. is principally distributed in various, especially lower, zones of *Bajocian.*

Discina reflexa Sow. sp. has a similar distribution[3]. It perhaps occurs already in the Lias of England; it is especially frequent in the Blea Wyke Beds, and is perhaps also found in the "Dogger" of Yorkshire. Quenstedt mentions it from the Opalinus Clay of Boll in Württemberg, and Lepsius has found it in strata of the same age at Gundershofen in Alsace[4]. Trautschold's statement that *Discina reflexa* occurs in his middle stratum of the Jura of Moscow, is as doubtful as is the same author's statement about the *Lingula Beani* Phill.

As we have seen, *Discina reflexa* Sow. sp., as also *Lingula Beani* Phill. is principally confined to the *Bajocian.*

The two species, Lingula Beani Phill. and Discina reflexa Sow. sp., have hitherto never been found together, except in the Blea Wyke Beds of Yorkshire, i. e. in the very lowest zones of the Bajocian (*viz. in the Aalénien May.-Eym. Haug.* e. p.).

The *Belemnite remains* from the sandy hard marl and the light gray marl of Elmwood, are too imperfect to allow of any accurate specific determination. Only this much can be stated with certainty, that they agree neither with the species from the Callovian of Cape Flora, nor with species from the Callovian on the whole, of arctic regions, Russia and other parts.

If the best preserved (and most frequently occurring) remains of Belemnites, which were compared with *Belemnites Beyrichi* Opp. in the description of the fauna, are really closely allied to this species, this would indicate the

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1 Conf. the works cited on p. 54 & 55, and A. Pavlow, 'Études sur less couches jurassiques et crétacées de la Russie, I, Jurassique supérieure et Crétace inférieure de la Russie et de l'Angleterre'. Bull. de la Soc. Imp. des Natural. de Moscou, 1889, No. 1, p. 42.

2 Fiebelkorn (Zeitschr. d. Deutsch. Geol. Ges. 1893, p. 445) unites *Lingula ovalis* Sow. *Beani* Phill. and *Zeta* Quenst. erroneously, however, and thus gives to *Lingula Beani* the same wide distribution as Trautschold.

3 Conf. works cited on p. 58.

4 H. J. Haas makes a new species of this Alsatian form, viz. *Disc. Quenstedti.* (cf. Haas and Petri, 'Die Brachiopoden der Juraformation von Elsass-Lothringen', 1882, p. 306).

Bathonian. It must not, however, be forgotten that kindred species (from the group of the Hastati) also occur in the Bajocian; in the Upper Bajocian *Bel. Württembergicus* Opp. (= *fusiformis* Quenst. non Park.), and in the Lower Bajocian, in the zone of *Trigonia navis* among the Belemnites generally designated as *Bel. subclavatus* Voltz, specimens may be found which are decidedly Hastati, and which appear very similar to *Bel. Württembergicus* and *Beyrichi*.

Still less than *Belemnites* sp. (cf. *Beyrichi* Opp.), the fragments possibly belonging to the group of the Canaliculati can serve for the determination of the age of the rocks west of Elmwood. The small, detached fragment of *Belemnites* sp. indet. 2 (Pl. I. fig. 24), possibly does not come from the stratum here under consideration, but may have fallen from higher strata.

Thus only the two Brachiopods, *Lingula Beani* Phill. and *Discina reflexa* Sow. sp. furnish any clue to the determination of the age of the deposits containing *Pseudomonotis Jacksoni* n. sp., and an abundance of Lamellibranchs. They point to the

Bajocian.

As it has hitherto only been in the Blea Wyke Beds (and in the "Dogger") of Yorkshire that the two species have been observed occurring together, we might probably also designate the strata exposed NW. of Elmwood at a height of 23—33 ft. above the sea, in which these two species occur together, as

Lower Bajocian,

almost corresponding to the zone of Leioceras opalinum and Ludwigia Murchisonæ. The great vertical distance — circ. 350 ft. — from the hard, sandy marl and soft marl containing Pseudomonotis Jacksoni, Lingula Beani, Discina reflexa, etc. to the clay of the Lower Callovian (at Windy Gully), lying at a height of 400 ft., may be mentioned as an additional support to our determination of the age of the strata west of Elmwood.

Marine Jura deposits other than those here mentioned cannot be observed in the material before me.

The study of the fossils and rocks collected by Prof. Nansen, and the critical examination of the fossils from the Jackson-Harmsworth Expedition, described by Newton, give the following results with regard to the Jura occurring below the basalt at Cape Flora.

As far as the slight exposures of rocks *in situ* permitted of observation, the Jura deposits of Cape Flora are composed of clay and slate-clay, interstratified with hard sandy marl, beds of stone marl and clay-sandstone, with "cone-in-cone", and phosphatic nodules, and thin layers of lignite and basalt.

The lowest[1] fossiliferous beds correspond with the

Bajocian,

and probably with the *Lower Bajocian.* At a height of from 23 to 33 feet above the sea, to the north-west, only some 300 metres from Elmwood, there occur gray, hard, sandy marls, and light gray, soft marl, in which were found:

Lingula Beani Phill.
Discina reflexa Sow. sp.
„ sp. indet.
Pseudomonotis Jacksoni n. sp.
Belemnites sp. (cf. *Beyrichi* Opp.)
„ sp. (?Group of *Canaliculati*).
Numerous fragments of indeterminable Lamellibranchs.

The upper third of the sedimentary strata below the basalt — from 370 to 575 feet above the sea — contains deposits of the age of the

Callovian

and the three divisions of the Callovian are all recognisable, viz:

the *Lower Callovian*

(= zone of *Macrocephalites macrocephalus,* = zone of *Cadoceras Elatmæ*).

At a height of 370—450 feet above the sea, there occur clays which are partly phosphoritic, and contain scattered phosphatic nodules (south-western end of *Windy Gully*). The fossils of the Lower Callovian, some found *in situ,* some loose near the margin of the glacier north-west of Elmwood, are:

[1] The thin alternating estuarine strata of sand with carboniferous seams, about 100 m. S. from Elmwood, possibly corresponding with the Cape Gertrude strata [cf. p. 12 (b), Letter-press fig. 1, b and p. 32], are certainly older than the Bajocian beds with *Lingula Beani* etc., but the true age, of these layers cannot be made out with certainty.

Serpula flaccida Goldf.
Macrocephalites Kœttlitzi n. sp.
" sp.
1* " *Ishmæ* var. *arctica* E. T. Newton.
* " *pila* Nik.
Cadoceras Frearsi (d'Orb.) Nik.
" sp. sp. (? *Elatmæ* Nik.)
Belemnites sp. indet. 1.

The *Middle Callovian*

(= zone of *Reineckia anceps,* = zone of *Cadoceras Milaschewici*).

Above *Elmwood,* at a height of 500—550 feet above the sea, lie beds of clay-sandstone of the Middle Callovian; and at the same locality, loose pieces of a clay of the same age were found. Pieces of clay-sandstone, clay and stone marl, which, judging from the fossils they contain, belong to the Middle Callovian, were moreover found loose at various heights, in several parts of the talus heaps. The occurrences of "cone-in-cone" may also be reckoned as belonging to the Middle Callovian.

The fossils of the Middle Callovian of Cape Flora are:

Pseudomonotis sp. (cf. *ornati* Quenst).
Pecten Lindströmi Tullberg.
* " cf. *demissus* E. T. Newton.
? *Limea* cf. *duplicata* Goldf.
Lima sp. indet.
Leda cf. *nuda* Keys. sp.
Macrodon Schourovski F. Rouill. sp.
Cadoceras Tchefkini d'Orb. sp.
* " *stenolobum* (Keys.) Nik.
" *Nanseni* n. sp.
" sp. ex. aff. *Nanseni* n. sp.
" sp. indet.
Belemnites m. f. *subextensus* Nik. — *Panderi* d'Orb.

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1 The fossils marked by an asterisk are taken from the (revised) descriptions by E. T. Newton.

The *Upper Callovian*

(= zone of *Peltoceras athleta*, = zone of *Quenstedtoceras Lamberti*).

Information concerning this zone has hitherto only been obtained from a piece of clay found loose *near the margin of the glacier NW. of Elmwood*, and containing *Quenstedtoceras vertumnum* Sintzow. Rocks of this zone have not hitherto been observed *in situ* with any certainty, but it is probable that the clays near the lower limit of the basalt above Elmwood, at a height of 575 feet above sea-level, are to be referred to the Upper Callovian.

From the foregoing remarks, we may draw up the following table (p. 131) of the stratigraphic proportions of the Jura in the Cape Flora district.

It is impossible from the material before me to determine whether the great gap between the (Lower) Bajocian and the Lower Callovian in this profile includes a representation of the younger Bajocian and the Bathonian. Apparently no exposures of rocks *in situ* have been observed between the (Lower) Bajocian — from 23 to 33 ft. above the sea — and the Lower Callovian — 370—450 ft. —; as everything here appears to be covered by talus heaps.

It is also impossible to determine the true thickness and limits of the different zones. We can only show that the Callovian in the district of Cape Flora has a thickness of at least 200 ft., which is a thickness seldom attained by the Callovian of Europe and which is only surpassed by the deposits of the same age in England and NW. France.

The results of our investigations differ in no slight degree from those which Newton arrived at from his examination of the Jackson-Harmsworth-Expedition material[1].

In his stratigraphic inferences, Newton starts from his locality "3. Elmwood" e. p. (our locality 5, watercourse below the basalt above Elmwood, Here, at a height of about 550 ft. above the sea (according to Dr. Kœttlitz), interstratifications of clay-sandstone are exposed, which, according to our determination, belong to the Middle Callovian. I here quote from Newton: "At this spot a bed (No. 3) was found *in situ*, and from it a small ammo-

[1] Quart. Journ. Geol. Soc. London, vol. LIII, p. 512.

1200 ft. to 1100 ft.	Glacier and snow-cap.		
1100 ft. to 575 ft.	Basalt; at 660, 700 ft. and 900 ft. plant-bearing beds, belonging to the White Jura.		
575 ft.	Clay and slate-clay, interstratified with hard, sandy marl, stone marl, clay-sandstone, phosphatic nodules, "cone-in-cone", lignite, basalt. For the most part covered by talus heaps.	At 575 ft. —	*Upper Callovian*, [Clay with *Quenstedtoceras vertumnum* Sintz.]
		550 ft. — 500 ft. — [above Elmwood.]	*Middle Callovian*, Clay with *Cadoceras Tchefkini* d'Orb., *Belemnites m.f. subextensus* Nik. — *Panderi* d'Orb. Clay-sandstone with *Cadoceras Nanseni*, *Tchefkini* d'Orb. sp. etc. and Lamellibranchs. Stone marl with *Cadoceras Nanseni* n. sp. "Cone-in-cone".
		450-370 ft. — [Windy Gully]	*Lower Callovian*, Clay with *Macrocephalites pila* Nik., *Kœttlitzi* n. sp., *Cadoceras Frearsi* (d'Orb.), Nik. Phosphatic nodules.
Sea-level.		33-23 ft. — [NW. from Elmwood].	*(Lower) Bajocian*, Sandy, hard marl and soft marl with *Pseudomonotis Jacksoni* n. sp., *Lingula Beani* Phill., *Discina reflexa* Sow. sp.

nite was obtained, which is probably *Ammonites Tchefkini.* In the water-course below this exposure, similar ammonites were found, together with *A. modiolaris* and *A. macrocephalus.* These suffice to settle the age as Lower Oxfordian, and probably the equivalent of our own Kellaways Rock; and although only one ammonite was found *in situ,* yet it is sufficiently certain that the others, if not from the same place, came from beds but little lower in the series. Similar fossils to these occur in the talus at many places around Cape Flora, showing that the same beds in all probability occur all around the Cape."

A few lines further on, Newton settles the age of these fossils as the "Ammonites macrocephalus horizon."

Newton's determination of the fossils from this locality is erroneous in some cases; his *Amm. macrocephalus* is *Cadoceras Nanseni* n. sp.; his *Amm. modiolaris* is partly *Cadoceras Tchefkini* d'Orb. sp., partly *Cadoceras stenolobum* (Keys.) Nik.; his *Amm. Tchefkini* ? d'Orb. is partly really *Cadoceras Tchefkini* d'Orb. sp., partly *Cadoceras stenolobum* (Keys.) Nik. All the fossils, like those from this locality that I have examined, point to the Middle Callovian, the zone of *Reineckia anceps* or of *Cadoceras Milaschewici, not to the Lower Callovian,* nor to the "Ammonites macrocephalus horizon." *Macrocephalites macrocephalus* Schloth. sp. *is not among the fossils* hitherto known from the region of Cape Flora.

Newton must consequently declare the beds at the southwest end of Windy Gully — *in situ,* according to Prof. Nansen and Dr. Kœttlitz, 50—180 ft. deeper — to be older than his "Ammonites macrocephalus horizon". He described them as "perhaps of the age of the *Cornbrash*" (l. c. p. 513). We recognised in them representatives of the *Lower Callovian,* of the zone of *Macrocephalites macrocephalus* of Oppel, or of that of *Cadoceras Elatmæ* of Nikitin.

Newton's paper contains no information as to the occurrence of the Upper Callovian in the region of Cape Flora.

Concerning the age of the hard, sandy marls, and the light, soft marls lying at a height of 23—33 ft. above the sea, which we designated as (Lower) Bajocian, Newton expresses no opinion.

After we have thus partly revised Newton's stratigraphic results through the evidence of the Lower and Middle Callovian, partly supplemented them through the evidence of the (Lower) Bajocian and the Upper Callovian, the gap disappears, which, according to Newton's results, existed between the youngest marine strata of the Jura below the basalt, and the sandstones containing land-plants found north of Elmwood, and, belonging to the White Jura according to Professor Nathorst.

Newton (l. c. p. 512) supposes that the Belemnites found at Eira Harbour during Leigh Smith's expedition, and which Etheridge declared to be of Oxfordian age, are probably of the same age as the Macrocephalus horizon of Cape Flora (according to Newton's intepretation). If the Belemnites found at Eira Harbour agree with *Belemnites m. f. subextensus* Nik. — *Panderi* d'Orb., frequently found at Cape Flora, they must belong to the Middle, and not to the Lower Callovian.

V.

FACIES, FAUNISTIC CHARACTERS AND RELATIONS TO OTHER JURA FAUNAS.

In his sketch of the geology of Franz Josef Land, Dr. Kœttlitz[1] demonstrated frequent changes in the petrographic facies of the strata composing the Jura in the south of the Archipelago. Littoral and estuarine deposits alternate with beds of marine character: the southern part of the archipelago (especially Northbrook Island) must have belonged to a Jurassic coast region.

The examination of the material collected by Prof. Nansen confirms the statement regarding frequent change in the petrographic and faunistic characters, in the Jura region of Cape Flora.

The hard, sandy marls with the very numerous remains of Lamellibranchiata in the (Lower) Bajocian, represent the deposits of a littoral region or of a shallow sea near the coast. In the same way, the beds of clay sandstone of the Middle Callovian with *Cadoceras Nanseni* n. sp. and numerous Lamellibranchs may be interpreted as typical littoral deposits. The formation of the Lower, and of a part of the Middle and Upper Callovian in the shape of clayey and marly sediments, shows a less typicál littoral character. But in the formation of these layers also, terrigene materials have a share. If we cannot directly declare the littoral region itself to have deposited these strata, yet we can imagine them to have been formed in shallow water, and indeed, at no great distance from the shore, as is proved by the traces, however indistinct, of vegetation in the stone marls of the Middle Callovian and by the occurrence of phosphatic nodules in the Lower Callovian.

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[1] The Geographical Journal, London, 1898, vol. XI. p. 33.

The frequent petrographic changes in the Jura of Cape Flora to which Dr. Kœttlitz first called attention, indicate repeated oscillations of level in our region during Jurassic times. It is only in littoral regions and shallow seas that oscillations of sea-level with the consequent displacement of the coast line can exert so strong an influence upon petrographic facies, as for instance in the Callovian of Cape Flora (clay, stone marl, clay-sandstone, clay).

The last oscillations of level which took place in our region in Jurassic times, are indicated by the sandstones containing Upper Jurassic land-plants which occur north of Cape Flora, above the basalt, and according to Dr. Kœttlitz, at the south side of the Cape, between the second and third basalt flows. These sandstones characterise a period of upheaval of our region. The southern portion of Franz Josef Land rose out of the sea in Upper Jurassic times.

It is a peculiar fact that in all the known fossils from the marine jura of Cape Flora, the Gastropoda are represented by a single specimen only.

It may be that the collections are still imperfect, and do not therefore give an accurate or complete idea of the composition of the Jurassic fauna here: but in any case, they may be presumed to be sufficiently perfect to justify the conclusion that in comparison with the predominating Lamellibranchs and Cephalopods, the Gastropods play an unimportant role in the Dogger fauna of Cape Flora.

Great scarcity of Gastropods appears to be generally characteristic of the Jurassic fauna of the arctic regions, for, as far as we are acquainted with such faunas in East Greenland, the island of Andø, Spitzbergen, Cape Flora, Novaja Semlja, the Petchora basin, arctic Siberia, Alaska and the arctic archipelago of North America, the Gastropods in several of these faunas are considerably behind the other groups as regards numbers; and in others appear to be wholly absent.

With regard to the scarcity of Gastropoda, the Jurassic Fauna of Cape Flora, like the arctic Jurassic fauna generally, shows a great resemblance to that of the Russian Jura, in which also the Gastropods are in considerably smaller numbers than the Cephalopods and Lamellibranchs.

If we ask about the relations existing *between the fauna of the Jura of Cape Flora, and the faunas of other Jurassic regions,* we cannot yet obtain an altogether satisfactory answer.

With regard in the first place to the *Bajocian*, we cannot of course think of any comparison with the geographically adjacent Jura districts of Russia; for in the whole of east and north central Russia the series of marine Jura deposits only begins with the Callovian.

It is uncertain whether deposits of the age of the Bajocian occur only at Cape Flora, or also in other arctic regions. Toula [1] describes from Kuhn Island in East Greenland a Jurassic fauna, rich in Lamellibranchs, which he designated "Middle Dogger". The occurrence in this Dogger fauna of a Belemnite resembling *Belemnites fusiformis* Quenst., is interesting; and we have already seen that our *Belemnites* sp. (cf. *Beyrichi* Opp.) from the Bajocian of Cape Flora was allied to *Bel. fusiformis* Quenst. = *Württembergicus* Opp. It is extremely doubtful whether we ought to conclude from the occurrence of such a Belemnite, that a close affinity exists between the fauna of the Bajocian at Cape Flora, and the Dogger of Kuhn Island, from whence Toula, moreover, mentions *Goniomya Vscripta* Sow. i. e. a species already occurring in the Lower Bajocian. The circumstance worthy of notice is that both in the Dogger of Kuhn Island, and in the Bajocian of Cape Flora — that is in high arctic regions — the group of hastate Belemnites occurs, which, according to Neumayr, is wanting in the boreal and Russian Jura [2].

There is only one more region within the polar circle, where Jura deposits older than the Callovian, certainly occur, Wilkie Point, Prince Patrick's Island, from which Haughton [3] described a few fossils as Lias. Neumayr [4] declared them to "belong probably to the middle region of the Lower Oolite." In this faunula, an Aviculid form, *"Monotis" septentrionalis* Haught. occurs, which however shows no similarity to our *Pseudomonotis Jacksoni* n. sp. from the Bajocian of Cape Flora.

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1 F. Toula, 'Beschreibung mesozoischer Versteinerungen von der Kuhn-Insel. 2. Dogger der Kuhn-Insel'. (Die zweite Deutsche Nordpolarfahrt in den Jahren 1869 und 70, vol. II. 2, pp. 505–507.)

2 M. Neumayr, 'Ueber klimatische Zonen während der Jura- und Kreidezeit'. Denkschr. Akad. Wien, vol. XLVII. 1883, pp. 12, 13.

3 M'Clintock, 'Reminiscences of arctic ice-travel in search of Sir John Franklin and his companions, with geological notes and illustrations by S. Haughton.' Journ. R. Dublin Soc., vol. I. 1856, 57, Sep. copy pp. 56, 62, 63.

4 M. Neumayr, 'Die geographische Verbreitung der Juraformation'. Denkschr. Akad. Wien, vol. L. 1885, pp. 38, 85.

In the fauna, which Lundgreen[1] described from Cape Stewart in East Greenland, there are possibly species of older zones, besides those of the Callovian. No affinity to our Bajocian, however, is discernible. The *Lingula* sp. described by Lundgreen is certainly not *Lingula Beani* Phill., and Lundgreen's *Avicula Münsteri* is different from our *Pseudomonotis Jacksoni.*

While the fauna of the *Bajocian* of Cape Flora is without analogy in the arctic regions, it shows, on the other hand, distinct affinities to the *Central European Jura. Lingula Beani* Phill. and *Discina reflexa* Sow. sp. are Central European species. *Belemnites* sp. (cf. *Beyrichi* Opp.) also has its nearest known kin in the Central European Jura: *Belemnites Württembergicus* Opp. (*fusiformis* Quenst.) in Württemberg and Franconia; *Belemnites Beyrichi* Opp. in the same places, and also in the Silesian and Polish Jura, and in that of Balin near Cracow. It would, however, be precipitate to draw from these facts the conclusion that at Cape Flora the Bajocian is formed of a totally Central European fauna. In order to pronounce any definitive judgment in this respect, we must first become acquainted with the numerous Lamellibranchs which in addition to *Pseudomonotis Jacksoni* occur in the Bajocian of Cape Flora, but whose remains have as yet been quite indeterminable. For this purpose, we must in general have a more comprehensive idea of the entire fauna of the Bajocian of Cape Flora. Yet we must maintain that the indication towards Central European fauna, given by *Lingula Beani, Discina reflexa* and the hastate Belemnites is very important from a palæo-geographical point of view.

We are able to judge with more certainty as to the fauna of the *Callovian* of Cape Flora, than as to that of the Bajocian.

The fossils of the Callovian naturally suggest comparison first with those of the Russian Jura. The occurrence of the Ammonite genera *Macrocephalites, Cadoceras* and *Quenstedtoceras,* which are among the most typical of the Russian Callovian, indicate faunistic analogies between the Callovian of Cape Flora, and that of Russia.

Macrocephalites pila Nik.
Cadoceras Tchefkini d'Orb. sp.

[1] B. Lundgreen, 'Anmärkningar om några Jurafossil från Kap Stewart i Ost-Grönland.' Meddelelser om Grønland, vol. XIX. 1895, pp. 191, etc.

Cadoceras stenolobum [Keys.] Nik.
„ *Frearsi* (d'Orb.) Nik.
Quenstedtoceras vertumnum Sintz.

are species which are also peculiar to the Callovian of central and northern Russia.

Macrocephalites Kœttlitzi n. sp.
„ *Ishmæ* var. *artica* E. T. Newton.
Cadoceras Nanseni n. sp.
„ sp. ex. aff. *Nanseni* n. sp.

are forms which are very closely allied to Russian ones, especially those from the Callovian of the Petchora region.

Belemnites m. f. *subextensus* Nik. — *Panderi* d'Orb., which is of frequent occurrence in the Middle Callovian of Cape Flora, is remarkable for its close affinity to a species of the Russian Middle Callovian, *Belemnites subextensus* Nik.

Among the Lamellibranchiata of the Callovian,
Macrodon Schourovski F. Rouill. sp.
Leda cf. *nuda* Keys. sp.
Pecten Lindströmi Tullbg.

point partly to the Russian fauna, partly, like *Pecten Lindströmi*, to a fauna similar to the Russian.

These facts will be sufficient to place the fauna of the Callovian of Cape Flora very near to that of the *Russian* Callovian. *Our Callovian fauna is nothing but a part of the fauna of the Russian Callovian.*

Close faunistic relations exist, moreover, to the fauna of the Callovian of *Alaska* from which district we are acquainted, through Grewingk[1] and Eichwald[2], with Ammonites that have the closest affinity to *Cadoceras Tchefkini* d'Orb. sp. — i. e. *Cadoceras Wossnessenski* Grew. sp., *Cadoceras Doroshini* Eich w, sp., *Cad. Ishmæ* Eichw. sp. (not *Macrocephalites Ishmæ* Keys. sp.).

[1] C. Grewingk, 'Beitrag zur Kenntnis der orographischen und geognostischen Beschaffenheit der Nordwestküste Amerikas mit den anliegenden Inseln.' Verhandl. d. Russ. Kais. Mineral. Ges. St. Petersburg, 1848, 49, p. 344.

[2] E. v. Eichwald, 'Geognostisch-Palaeontologische Bemerkungen über die Halbinsel Mangischlak und die Aleutischen Inseln.' 1871.

It is very remarkable that there is scarcely any faunistic affinity between the fauna of the Callovian of Cape Flora and that of the Callovian of Cape Stewart in East Greenland. Among the numerous Lamellibranchs, which Lundgreen describes from this place, *Pecten Rinki* Lundgr. is perhaps near to our *Pecten Lindströmi* Tullbg. Otherwise, I find no species in the fauna of Cape Steward, which even approximately corresponds to any of the species from the Callovian of Cape Flora.

As far as we can tell from our present knowledge, the very same words apply to the Callovian of Cape Flora as those with which Trautschold[1] characterised the affinity of the Aucella strata of Novaja Semlja to the Russian Jura. He says: "Generally speaking there is no doubt that the Jura-facies of the northern islands are the same as those of the Russian Jura, and that this northern Jura is nearest to that of the Petschora and Wytschegda, which is also very natural".

This can naturally, only apply here in the restricted sense of our *Callovian.*

[1] S. A. Tullberg, 'Ueber Versteinerungen aus den Aucellen-Schichten Novaja-Semljas', Bihang t. K. Svensk. Vet. Ak. Handl., vol. VI, No. 3, 1881, p. 5.

VI.

PALÆO-GEOGRAPHICAL REMARKS.

The Jura of Cape Flora will be of the greatest importance to the geography of the Jurassic system.

Here, in 80° N, Lat., we make acquaintance with the most northerly Jura region of the earth[1].

One point of particular importance is the formation of ***marine Bajocian*** at Cape Flora. ***Hence the existence of a Bajocian sea in the north of the Eurasian Juracontinent is proved beyond all doubt.*** The occurrence of true European species such as ***Lingula Beani*** Phill., ***Discina reflexa*** Sow. sp. also of ***Belemnites sp.*** (cf. ***Beyrichi*** Opp.) at Cape Flora proves undeniably the connection of this arctic Bajocian sea with the central and western European sea of the Bajocian period, and especially a connection with the Bajocian sea of Yorkshire, and England generally. A connection of this kind is only possible in the west of the Eurasian continent, west of its Scandinavian part. Thus, ***as early as the Bajocian period, there existed a "Shetland Straits"*** (Neumayr), ***which separated the Eurasian continent existing through the Lias period until the end of the Bathonian, from the nearctic Juracontinent*** (Neumayr).

The Shetland Straits of the Bajocian must have extended westwards from the Lofoten island Andø, for Lundgreen[2] recently proved with certainty that the marine Jura fossils of Andø cannot be older than the Oxfordian.

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[1] The Jura of Spitzbergen extends from about 77°, 40′ to 78°, 20′ N. Lat. During his last polar expedition, at about 79° Prof. Nathorst discovered Jura on Kong Carl's Land. The Jura of Kuhn Island lies in about 75° N. Lat., and the Jura of the arctic archipelago of N. America in 76°—77° N. Lat.

[2] B. Lundgreen, 'Anmärkningar om Faunan i Andöns Jurabildningar.' Christiania Vidensk. Selsk. Forh. 1894, No. 5.

Concerning *the extent of the Bajocian sea in the polar regions*, we can at present say but little. Whether it extended to the Greenland coast of the nearctic continent, and perhaps had its most westerly offshoots in the Dogger of Kuhn Island, cannot yet be settled. Up to the present we possess no clue as to whether, or how, the arctic Bajocian sea, of which the present Cape Flora was a part, was connected with the Bajocian(?) sea of the North American arctic archipelago.

Besides the existence of an arctic Bajocian sea, we can only prove the existence of arctic Bajocian continents, without being able to determine their border. The north of the Eurasian continent extended into the polar regions, as did also the north-east of the nearctic continent. It follows from the littoral facies and fauna of the Bajocian at Cape Flora, that a coast must have existed near this region, — there must have been a continent in the vicinity of Cape Flora.

Our knowledge of the geology of Spitzbergen leads to the supposition that in Bajocian times this group of islands was not covered by the sea.

The oldest Jurasic deposits of Spitzbergen hitherto known, are Aucella-strata with *Cardioceras Nathorsti* Lundgr. sp.[1] [= Upper Oxfordian]. From Novaja Semlja older marine Jura deposits than Aucella strata are not known. Both Spitzbergen and Novaja Semlja were mainland in Bajocian times. They were probably connected with the Scandinavian-Russian part of the Eurasian continent, and were probably also connected with one another by continuous land. Probably the arctic sea of the Bajocian flowed to the north and west of this offshoot of the Eurasian continent, which extended into the region of south Franz Josef Land.

The identification of Bajocian in the region of Cape Flora is important, because it helps to reduce the great difference which, from what we knew hitherto, appeared to exist between the extent of the Callovian sea, and that of the older Jura seas. This takes us on a step, if only a small one, in the recognition that in the distribution of sea and land upon the earth, the same state of equilibrium was maintained in the older Jura periods, as that with which we are aquainted from the Callovian period.

After proving the existence of the Callovian in the south of Franz Josef Land archipelago, the extent of the Callovian is increased by nearly 10 degrees

[1] According to a letter from Prof. Nathorst, dated Decbr. 17, 1898.

of latitude. Its most northerly occurrence hitherto known, at Cape Stewart in East Greenland, was in 70° 25′ N. Lat.

The frequent change of facies, together with the character of the fauna, gives to the Callovian of Cape Flora partly a littoral, partly a shallow-water character. For some time at least in the Middle Callovian, continents — coast regions — must have existed near the marine region of the Callovian of Cape Flora. The very close faunistic affinity of our Callovian to the Russian necessitates a marine connection of our Callovian with that of Northern Russia, especially that of the Petchora basin. Hence, as also from the facies character, we conclude that in the Callovian period, the south-west part of the present Franz Josef Land has been covered by the sea, i. e. by a branch of the Russian Callovian sea.

Nor was Novaja Semlja in the Callovian period yet covered by the sea. Most probably the whole of Spitzbergen also projected from the Callovian sea; for the *Amm. triplicatus* Sow. from Spitzbergen, described by Lindström[1], does not permit of the conclusion that this Ammonite might agree with the typical species of the Callovian: *Perisphinctes funatus* Opp. sp. = *Amm. triplicatus* Quenst. Fraas[2] also mentions an *Amm. triplicatus* from Spitzbergen, adding that it might also be called by the name of any *Perisphinctes*. I was able to examine the original of Fraas[3]. It is the impression of the inner whorls of a large *Cardioceras*, and not of a *Perisphinctes*. According to all that is known concerning it, the marine Jura of Spitzbergen begins, at the earliest, with the Upper Oxfordian.

From the above, we may imagine the connection of the Callovian of Cape Flora with that of Northern Russia to be like a continuation northwards of the Russian Callovian sea of the Petchora basin, in the form of a broad bay, which stretched between the lands of Spitzbergen and Novaja Semlja, and was partly bounded on the north by land, in the region of the present Franz Josef Land.

We do not know whether Spitzbergen was yet united to the Scandinavian-Finnish peninsula in the Callovian period. This peninsula, after the Batho-

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[1] G. Lindström, 'Om Trias- och Juraförsteningar från Spetsbergen', K. Svensk. Vet. Ak. Handl., vol. 6, No. 6, 1865, p. 10, pl. III, figs. 1, 2.

[2] Neues Jahrbuch für Mineralogie, etc. 1872, p. 203.

[3] Prof. Eb. Fraas of Stuttgart had the kindness to allow me to examine the material studied by his father. I take this opportunity of tendering him my warmest thanks.

nian, was separated, as "Scandinavian Island" (Neumayr), from the Eurasian continent, by the Russian sea. Probably Spitzbergen was connected with the Callovian land of Franz Josef Land, as seems evident from the resemblance of the Upper Jurassic floras of these regions to one another[1].

Towards the east, the above-mentioned continuation of the North Russian Callovian sea extended — probably north of Novaja Semlja — as far as Alaska. This seems evident from the occurrence in Alaska of Cadoceras species closely allied to our own.

Towards the end of the Callovian, the sea vanished from the south of Franz Josef Land towards the south. The region of Franz Josef Land became mainland, while simultaneously — during the Oxfordian — a partial overflow of Spitzbergen and Novaja Semlja took place.

Was the region of Cape Flora (and the southern part of Franz Josef Land generally) continuously covered by the sea, from the Bajocian until the end of the Callovian? This question cannot at present be answered.

Between the Bajocian exposed at Elmwood, and the Lower Callovian observed at the south-western end of Windy Gully, there lies a series of rocks several hundred ft. in thickness, from which there are no fossils that we know of. Fossils alone might give information as to whether the younger Bajocian and the Bathonian are here developed in marine formation or not.

Here it might be possible to determine whether the fauna of the Callovian of Cape Flora has sprung from the fauna of the polar Bathonian sea. Here too lies the clue to the answering of the question, whether Koken[2] is right in supposing that in the Callovian period, Russia was overflowed simultaneously from Central Europe and from the north.

The small fauna of the Callovian of Cape Flora really contains nothing which might entitle it to be called the indigenous fauna of a polar Callovian sea. At present we can only name the group of *Macrocephalites Ishmæ* Keys. sp. with its members also found at Cape Flora, as specifically northern. But this group may just as well have originated in the Russian Callovian sea, from the *Macrocephalites* that migrated thither from Central and Western Europe, as in the polar sea from the *Macrocephalites* that migrated thither from Yorkshire, through the Shetland Straits. There is no justification for

[1] A. G. Nathorst, K. Svensk. Vet. Ak. Handl., vol. 30, No. 1, 1897, p. 74.
[2] E. Koken, 'Die Vorwelt,' p. 321.

designating the genera *Cadoceras* and *Quenstedtoceras*, allied to *Macrocephalites*, as specifically northern. The group of the Belemnites excentrici (Neumayr) also, to which our *Bel.* m. f. *subextensus* Nik. — *Panderi* d'Orb. belongs, may, from its genealogy, be traced back to Western European forms, and must not be regarded as having originated in arctic regions.

Thus we see that from the fragments of the northern Bajocian and Callovian faunas now before us, we cannot yet come to any conclusion as to the continuity of the marine fauna of the Cape Flora region from the Bajocian to the Callovian.

As far as we can tell from our knowledge of the geology of Spitzbergen and Franz Josef Land, these regions were exposed to repeated and very considerable oscillations of sea-level in the mesozoic period.

Owing to an upheaval of the land *before* the Callovian period, the position of the Bajocian sea was possibly moved from the region of Cape Flora and south Franz Josef Land, to the north and west. By a subsequent sinking of the land in the Callovian period, this region was again inundated, this time by the Russian Callovian sea[1] moving hither from the south. (The connection of the Russian Jura sea with the polar sea in which the genus Aucella developed, would thus be deferred to the Oxfordian period.)

It is natural that every new occurrence of marine Jura, particularly in regions with an exposed geographical situation, should be examined, in order to find out how it stands in relation to Neumayr's theory of the climatic zones in the Jurassic period. In the discussion following the reading of Newton and Teall's work on Franz Josef Land, before the Geological Society of London, Mr. J. W. Gregory pronounced Neumayr's theory to be „now quite untenable“. Impossible as I find it to regard Neumayr's theory as correct and proved, I cannot pass the severe judgement of Gregory upon it, simply on the ground of the Jura of Franz Josef Land,

The little we know of the fauna of the Bajocian of Cape Flora certainly challenges a comparison of it with the fauna of Central Europe. The forms are, however, too indistinct, and the number of known species is as yet far too small to allow of our bringing forward any definite proofs either for or

[1] This would also explain the difference from the fauna of the Callovian of Cape Stewart in East Greenland, which has branched off in other directions — and probably also under other bionomic conditions — from west-central Europe.

against Neumayr. I would not even attach too great importance to the report of the existence of hastate Belemnites far up in the north. Nor does the fauna of the Callovian of Cape Flora as yet bring any new material which might turn the balance in favour of Neumayr's advocates or of his opponents.

If new collections in the region of Cape Flora should prove that the Bajocian in this locality really contains a fauna of decided Central-European character, the region of the Jura of Cape Flora would then supply the most weighty argument for the incorrectness of Neumayr's theory.

ADDITIONAL NOTES.

The preceding chapters were written and for the most part sent to Christiania to be translated into English and printed, when No. 216 vol. LIV. of the Quart. Journ. of the Geological Society of London came out of press (Novbr. 1898), containing two valuable contributions to the Geology of Franz Josef Land:

1. Dr. A. Kœttlitz, 'Observations on the Geology of Franz Josef Land'.
2. E. T. Newton and J. J. H. Teall, 'Additional Notes on Rocks and Fossils from Franz Josef Land'.

As to the purely geological remarks given by Dr. Kœttlitz, the points relating to Cape Flora are already taken into consideration by Prof. Nansen in the sketch of the Geology of Cape Flora, with which he kindly introduced my paper.

Among the new contributions to the Jurassic Fauna and Stratigraphy in the second paper by Mr. E. T. Newton, there are some data completing our own results.

1st. From the lowest horizon [Bajocian], *NW. of Elmwood,* 23—33 ft. above the sea, Newton figures (l. c. Pl. XXIX. fig. 1) the right valve of an "*Avicula* sp". The specimen shows exactly the outline of a true Pseudomonotis (the anterior wing being broken) and must be considered as belonging to our species *Pseudomonotis Jacksoni.*

From the same locality, Newton mentions besides remains of *Ostrea* (which genus I could not find in the material before me) Belemnite-fragments of the *Belemnites Panderi* type. If these latter indeed originate from this horizon and have not fallen from above, they may be considered as an enrichment of the fauna of the Cape Flora Bajocian.

2nd. From the south-western end of *Windy Gully,* [Lower Callovian] Mr. Newton l. c. p. 650 describes a *Belemnites* sp. as resembling the *Bel. inornatus* Phill. Perhaps the guard figured by Newton (Pl. XXIX. fig. 5) belongs to the same species as the fragments of the large phragmocones from the same locality, here noted as *Belemnites* sp. indet. 1., which seems also to be somewhat compressed. The relationship with *Bel. inornatus* Phill. is quite uncertain.

Together with this *Belemnites* sp., in the same piece of matrix, Dr. Kœttlitz found a fragment of a large shell, which Newton (Pl. XXIX. fig. 4) determined as "*Inoceramus*-like". If this form, which according to Dr. Kœttlitz was certainly *in situ,* really belongs to *Inoceramus,* this is an interesting fact, since untill today the occurrence of the genus *Inoceramus* in the Macrocephalites macrocephalus-zone of arctic regions was not known.

3rd. A quarter of a mile *NW. of Elmwood* Dr. Kœttlitz found a fragment of an Ammonite *in situ,* immediately below the basalt therefore higher in the cliff than the Middle Callovian (*Cadoceras Tchefkini* horizon) (l. c. pag. 635, 638, 649). The specimen was embedded in decomposed basalt or basaltic tuff. Mr. Newton determined the specimen as *Amm. Lamberti* (l. c. Pl. XXIX. fig. 2.), and deduces from it, that the beds below the basalt are of Oxfordian age and that the Oxford-clay occurs at Cape Flora.

Though it is impossible to decide, whether the figured fragment be the true *Amm. Lamberti* Sow., it is clear, that it must belong to the genus *Quenstedtoceras.* Therefore we have here a second proof of the occurrence of the *Upper Callovian* (Zone of *Quenstedtoceras Lamberti* = Zone of *Peltoceras athleta*), the first proof having been given by *Quenstedtoceras vertumnum* Sintz (cf. pag. 96).

4th. The occurrence of jurassic plant-remains at *Cape Richthofen,* recognized by Prof. Nathorst as corresponding with those of Cape Flora, proves that the land of post-Callovian-time in the Franz Josef Land Archipelago extended from Northbrook Island towards the North and North-East (cf. pag. 143).

ERRATA.

p. 38,	line 6,	instead of:	clayironstone,	read:	clay-sandstone
p. 45,	„ 16,	—	pyritis,	„	pyritic.
p. 46,	„ 29,	—	$CaCo_3$,	„	$CaCO_3$.
p. 48,	„ 16,	—	No. 4,	„	No. 5.
p. 49,	„ 12,	—	the last,	„	a later.
p. 51,	„ 2,	—	30 feet,	„	23—33 feet.
p. 68,	„ 32,	—	squamons,	„	squamous.
p. 69,	„ 5,	—	capitanca,	„	capitanea.
p. 70,	„ 7,	—	V. Sutner,	„	v. Sutner.

PLATE I.

PLATE I.

The Originals lie in the mineralogical Institute, Christiania.

Fig. 1. *Pentacrinus* sp. ex. aff. *bajociensis* (d'Orb.) P. de Loriol., p. 51.
1 1/2 klm. NW of Elmwood, at the margin of the glacier, 150—200 ft. above the sea.
1 *a*, side view; 1 *b*, the same, 2 × enlarged; 1 *c*, upper, syzygial surface; 1 *d*, the same, 2 × enlarged.

Fig. 2—5. *Lingula Beani* Phill., p. 54.
ca. 300 m. NW. of Elmwood, 23—33 ft. above the sea.
2, largest specimen, partly broken; *a*, from above (the exact outline is figured p. 56, Letter press fig. 8); *b*, from the side.
3, cast containing remains of the shell.
4, internal side of another specimen, showing the muscular impressions; *a*, natural size; *b*, 2 × enlarged.
5, small specimen with acute apex.

Fig. 6—9. *Discina reflexa* Sow. sp., p. 58.
ca. 300 m. NW. of Elmwood, 23—33 ft. above the sea.
6, cast of the convex valve showing muscular scars; *a*, from above; *b*, from the side.
7, convex valve of another specimen; *a* from above; *b*, from the side.
8, posterior view of a convex valve, showing the curvature of the lines of growth, enlarged.
9, convex valve of a more flattened specimen; *a*, from above; *b*, from the side.

Fig. 10. *Discina* sp. indet., p. 59.
ca. 300 m. NW. of Elmwood, 23—33 ft. above the sea.
Cast of a convex valve; *a*, from above; *b*, from the side.

Fig. 11. ? *Limea* cf. *duplicata* Goldf., p. 65.
Above, N. of. Elmwood, ca. 550 ft. above the sea.
Cast of a right valve; *a*, from above; *b*, from the anterior side.

Fig. 12. *Pecten Lindstrømi* Tullbg., p. 63.
Above, N. of, Elmwood, ca. 550 ft. above the sea.
Impression of a left valve; *a*, nat. size; *b*, anterior part enlarged.

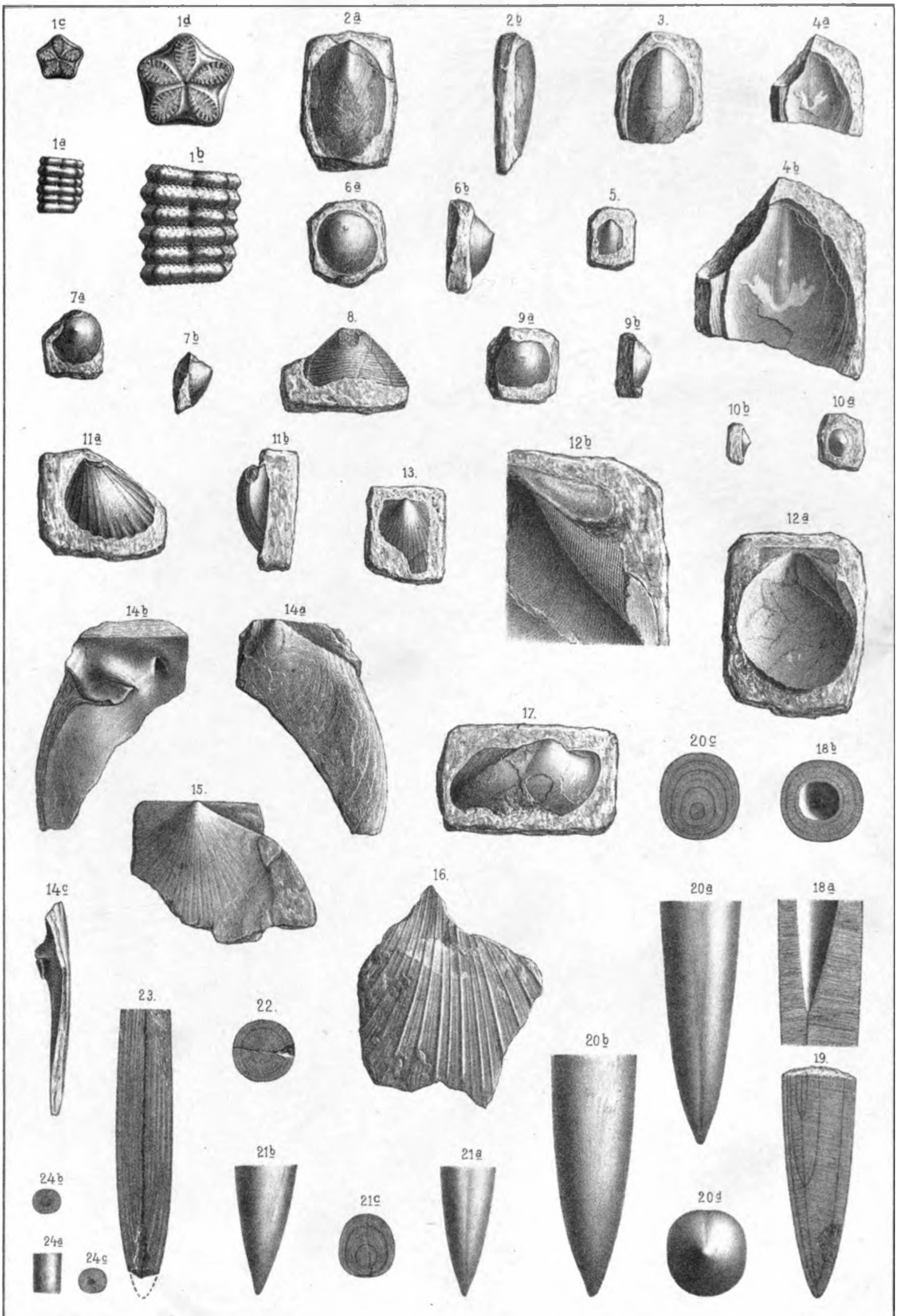
Fig. 13—16. *Pseudomonotis Jacksoni* n. sp., p. 60.
ca. 300 m. NW. of Elmwood, 23—33 ft. above the sea.
13, fragment of a young shell.
14, fragment of a compressed right valve; *a*, outside; *b*, internal view, (cf. p. 61, Letter press fig. 9); *c*, in profile.
15, fragment of a right valve with slight radiating striæ.
16, fragment showing the sculpture of a left valve.

Fig. 17. *Macrodon Schourovski* F. Rouill. sp,. p. 67.
Above, N. of, Elmwood, ca. 550 above the sea.
Right valve, partly covered with the shell.

Fig. 18—21. *Belemnites* m. f. *subextensus* Nik — *Panderi* d'Orb., p. 100.
1 1/2 klm. NW. of Elmwood, at the margin of the glacier, 100—200 ft. above the sea.
18, fragment of the anterior part of the rostrum; *a*, longitudinal section through the alveolar part; *b*, cross section.
19, longitudinal section through the postalveolar part of another fragment.
20, fragment of a rostrum with obtuse apex; *a*, ventral side with the ventral groove; *b*, side view; *c*, cross section through the postalveolar part; *d*, seen from behind.
21, fragment of a rostrum with acute apex; *a*, ventral side with the ventral groove; *b*, side view; *c*, seen from behind.

Fig. 22, 23. *Belemnites* sp. (cf. *Beyrichi* Opp.), p. 103.
ca 300 m. NW. of Elmwood, 23—33 ft. above the sea.
22, cross section through the postalveolar part.
23, longitudinal section of another individual; the apex here is restored too obtuse.

Fig. 24. *Belemnites* sp. indet. 2., p. 104.
Locality?
Small fragment; *a*, side view; *b* and *c*, the same seen from above and below, showing slight eccentrical radiation.



A. Birkmaier, lith. Klein & Volbert gedr.

PLATE II.

PLATE II.

The Originals lie in the mineralogical Institute, Christiania.

Fig. 1, 2, 3, 5. *Cadoceras Nanseni* n. sp., p. 86.
Above, N. of, Elmwood, ca. 550 ft. above the sea.
1, 2, 3, different juvenile individuals with compressed living chambers, with remains of the shell.
3 *b*, chambered part of 3 *a*, 3 × enlarged.
[Lobe-line cf. p. 88, Letter-press fig. 17].
5, somewhat larger specimen, figured after the wax-cast of an impression.

Fig. 4. *Cadoceras* sp. ex. aff. *Cad. Nanseni* (n. sp.), p. 92.
$1\frac{1}{2}$ klm. NW. of Elmwood, at the margin of the glacier, 100—200 ft. above the sea.
Chambered cast with $\frac{1}{2}$ a whorl of the living chamber, partly covered with the shell; *a*, from the side; *b*, from the front; *c*, section. [Lobe-line cf. p. 92, Letter-press fig. 18].

Fig. 6. *Cadoceras Nanseni* n. sp., p. 86.
South-western end of Windy Gully, ca. 400 ft. above the sea.
a, compressed specimen, covered with the shell; *b*, innermost whorls, enlarged.

Fig. 7. *Cadoceras Tchefkini* d'Orb., sp., p. 80.
$1\frac{1}{2}$ klm. NW. of Elmwood, at the margin of the glacier, 100—200 ft. above the sea.
a, chambered cast with compressed living chamber, from the side; *b*, the same after removal of the anterior third of the last chambered whorl; *c*, front view of 7 *b*.
[Lobe-line cf. p. 83, Letter-press fig. 15.]

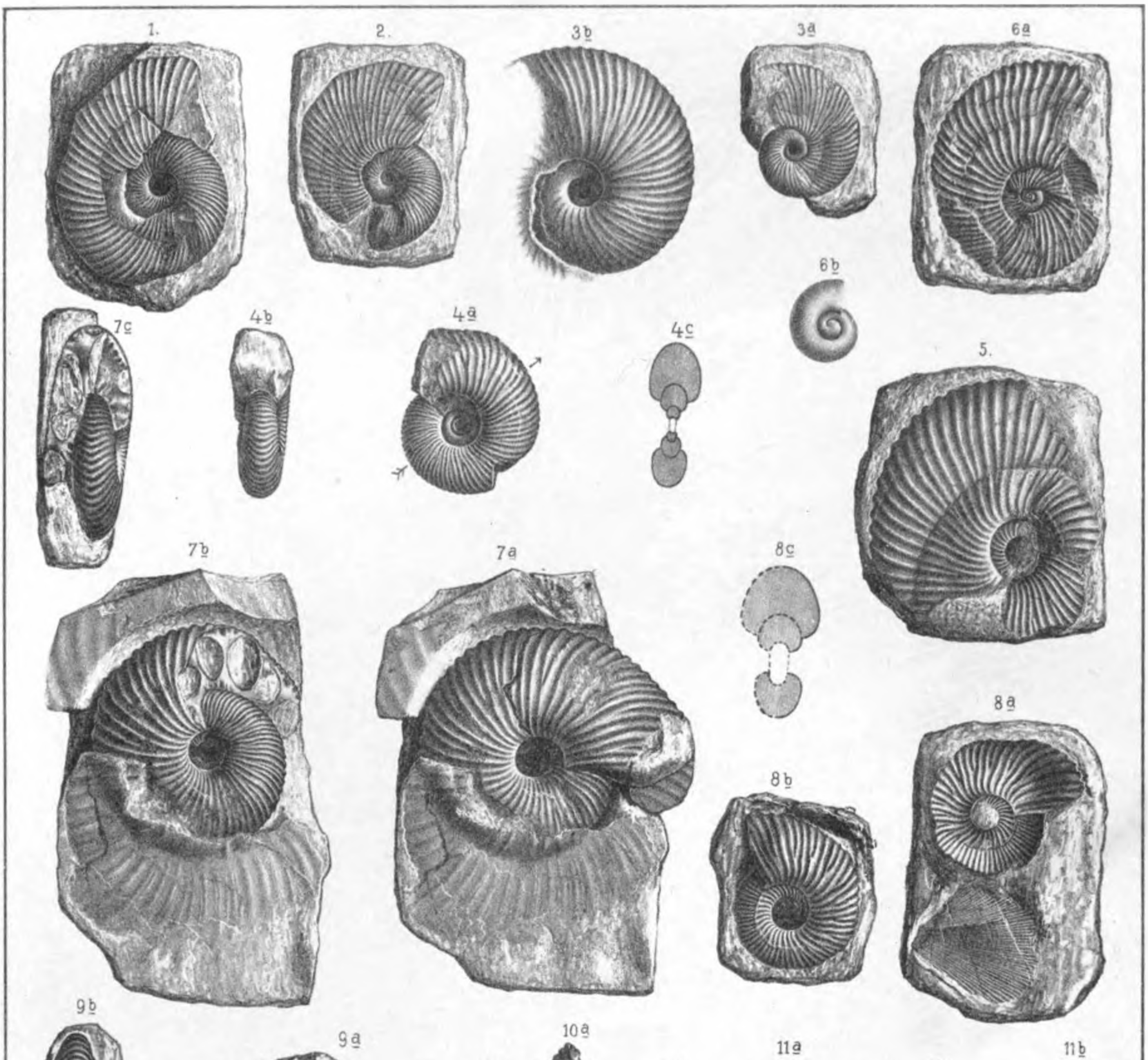
Fig. 8. *Cadoceras* sp. indet., p. 94.
Above, N. of, Elmwood, ca. 550 ft. above the sea.
a, impression with a fragment of *Lima* sp. indet. (cf. p. 68); *b*, wax-cast of the impression; *c*, reconstructed section.

Fig. 9. *Quenstedtoceras vertumnum* Sintzow, p. 96.
$1\frac{1}{2}$ klm. NW. of Elmwood, at the margin of the glacier, 100—200 ft. above the sea.
Young individual with a fragment of the subsequent whorl; *a*, side view; *b*, ventral area.
[Lobe-line cf. p. 97, Letter press fig. 21.]

Fig. 10. *Cadoceras Frearsi* (d'Orb. sp.) Nik., p. 93.
$1\frac{1}{2}$ klm. NW. of Elmwood, at the margin of the glacier, 100—200 ft. above the sea.
Pyritic cast, fragment of a chambered whorl; *a*, side view; *b*, section.
[Lobe-line cf. p. 93, Letter-press fig. 19.]

Fig. 11. *Macrocephalites* sp., p. 73
$1\frac{1}{2}$ klm. NW. of Elmwood, at the margin of the glacier, 100—200 ft. above the sea.
Fragment of a chambered whorl, pyritic cast with remains of the shell; *a*, side view; *b*, ventral area; *c*, section.
[Lobe-line cf. p. 74, Letter-press fig. 13.]

Fig. 12. *Macrocephalites Koettlitzi* n. sp., p. 70.
South-western end of Windy Gully, ca. 400 ft. above the sea.
Cast of the chambered whorls with remains of the shell; *a*, from the side, *b*, from the front; *c*, ventral area.
[Lobe-line cf. p. 71, Letter press fig. 12.]



A. Birkmaier, lith.

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