Meddelelser om Grønland,

udgivne af

Commissionen for Ledelsen af de geologiske og geographiske Undersøgelser i Grønland.

Ni og tyvende Hefte.

Med 14 Tavler og 1 Kort.

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III.

The Tertiary Fauna at Kap Dalton in East-Greenland.

By

J. P. J. Ravn.

Tertiary deposits have, as is well known, a rather wide extension in the northern Arctic countries, and have often been examined, but yet the stage has not been reached where we can, with sufficient certainty, determine their exact age in relation to the Tertiary formations of other places. The reason of this uncertainty consists chiefly in the fact, that in the Arctic Tertiary deposits generally fossil plants only have been found which as a rule are less satisfactory than fossil animals for the determination of age. Although in the course of time a very considerable number of well preserved fossil plants have been collected, we see nevertheless, that the views regarding their age vary very much. O. Heer, who specially occupied himself with fossil plants from the Arctic regions, arrived at the conclusion that the greater part was Miocene, while younger naturalists suppose them to be considerably older. This question can scarcely be solved with certainty, until the plant-bearing deposits are found in connection with formations containing marine fossils, sufficiently well preserved for correct determination. All Tertiary marine-fossils, found in the above named regions, will therefore be received with great interest, and must be examined as carefully as possible.

With special regard to the Tertiary deposits of Greenland, it may be remarked that the formations abounding with fossil plants from this period in the northern part of West-Greenland, have been known for a long time; however no determinable marine fossils have been found in connection with them, and their age is therefore, as above mentioned, somewhat problematical.

Tertiary deposits are known also in East-Greenland. In the years 1869—1870 the Second German Northpole Expedition brought home from Hochstetters Vorland and the Sabine Island some Tertiary fossils. In the former locality was found in a yellowish or partly brick-coloured, quartzose sandstone, about 63 m. thick, a great many marine fossils, which were however very badly preserved (as casts and moulds) so that only the genera could be determined. O. Lenz [1]), who is of the opinion that these deposits belong to the Miocene, mentions from this locality the following genera:

Lucina,
Cytherea and
Venus.

By a renewed search into the material Th. Fuchs [2]) has added a couple of other forms viz.

Astarte sp. and
Pecten sp.

In the same work Th. Fuchs gives the result of his examinations of the Tertiary fossils animals which Nathorst, during his expedition to Spitzbergen in the year 1882, had collected East of Kolbay. The fossils were here found in a sandstone lying between deposits containing impressions of leaves. They were however in a similarly bad state of preservation as the above mentioned fossils from Hochstetters Vorland, and only the genera could therefore be determined, and even

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[1]) Oskar Lenz: Specielle Darstellung der geologischen Verhältnisse Ostgrönlands. — Die zweite deutsche Nordpolarfahrt in den Jahren 1869 und 1870. 2. Bd. III. Geologie. Leipzig 1874. p. 495.

[2]) Th. Fuchs: Ueber die während der schwedischen geologischen Expedition nach Spitzbergen im Jahre 1882 gesammelten Tertiärconchylien. p. 5. — Bihang till K. Svenska Vet.-Akad. Handlingar. Bd. 8. Nr. 15. Stockholm 1883.

that with some uncertainty. Fuchs [1]) gives from here the following list of fossils:

Siliquaria sp.
Pharella sp.
Psammosolen (Macha) sp.
* ? *Psammobia sp.*
? *Thracia sp.*
* *Cytherea (Callista) sp.*
? *Venus (Circomphalus) sp.*
? *Terebratula sp.*

Moreover these fossils come from two different horizons, the two here marked with asterisks are supposed to belong to a somewhat higher horizon than the others; but though these two species are different from those that were found in the lower horizon, they do not appear to Fuchs to belong to any essentially different Fauna. The whole fauna was critically examined by him, and he came to the conclusion that it probably must be called Miocene.

M. Semper [2]) was, on account of a misapprehension, doubtful as to the presence of marine Tertiary in East-Greenland and at Spitzbergen, but Nathorst [3]) maintained the occurrence of very large Tertiary deposits with marine-shells at Spitzbergen; and after having mentioned Fuchs's examinations of the fossils from Hochstetters Vorland, he expresses himself in the following terms about the Marine Tertiary of East-Greenland: »Auch das Vorkommen mariner Tertiär-Conchylien in Ost-Grönland scheint demnach ganz sicher; und man wird wohl mit der

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[1]) Th. Fuchs: l. c. p. 7—8.

[2]) M. Semper: Das palaeothermale Problem, speciell die klimatischen Verhältnisse des Eocaen in Europa und im Polargebiet. — Zeitschr. d. deutsch. geol. Gesellschaft. Bd. 48. Berlin 1896. S. 266.

[3]) A. G. Nathorst: Marine Conchylien im Tertiär Spitzbergens und Ostgrönlands. — Zeitschr. d. deutsch. geol. Ges. Bd. 48. Berlin 1896. S. 983—86.

Annahme nicht irren, dass die marinen Tertiärlager Spitzbergens und Ost-Grönlands in demselben Meere abgelagert wurden.»

During the Swedish expedition to North-east Greenland, in the year 1899, conducted by A. G. Nathorst, some localities with Tertiary deposits were also visited. In the map which accompanies Nathorst's important work on the geology of North-east Greenland[1]), Tertiary is stated to be found in the following places: Hochstetters Vorland, Pendulum Island, Sabine Island, Flache Bay, and Jackson Island. As a new locality is here added Pendulum Island. Nathorst found here a shaly sandstone, and sand and clay covered over by basalt-sheets. No fossils were found; Nathorst nevertheless supposes these deposits to be Tertiary. On the other hand he is doubtful as to the existence of Tertiary at Flache Bay; he found nothing here to indicate it, but is more inclined to believe in the occurrence of the Jurassic at this place.

Besides the above named observations on Tertiary deposits in the Arctic regions, we find in literature also other occurrences stated, but these statements have partly proved to be wrong, and partly they are founded upon exclusively plant-bearing deposits, and are therefore of less interest to the subject which is treated here.

We have already stated the most important part of what little was hitherto known about marine Tertiary deposits in those parts of the northern Arctic-sea. The news was therefore received with great interest that the Danish expedition to the East coast of Greenland in the year 1900, brought home a collection of partly well preserved marine Tertiary-fossils from Kap Dalton. After the return of the expedition, I was charged with the examination of this material. As however, there is in Copenhagen a want of the material required for

[1]) A. G. Nathorst: Bidrag till nordöstra Grönlands geologi. — Geolog. Fören. i Stockholm Förhandl. Bd. 23. Stockholm 1901. S. 275—306.

purposes of comparison, the Carlsberg-fund granted the necessary means for a journey to Göttingen that I might, during my work avail myself of the very valuable collection in that town. The permission to do so was readily granted to me by Geheimerath, Professor V. Koenen, to whom I render my heartiest thanks.

Mag. scient. N. E. K. Hartz, who was the leader of that part of the expedition in 1900, during which these fossils were found, has already given a short description of the locality where the fossils were found [1]). Further he has communicated to me some supplementary information, of which I give here the essential part.

The fossils were discovered at Kap Dalton, (69° 24,'6 Lat. N.) on the 18th of July 1900, by Dr. O. Nordenskjöld; the greater part of the material that was brought home, was collected on the following days by Mag. N. E. K. Hartz. The fossils were found in the little point, bounding the Bay of Kap Dalton to the North, which is connected by a low ridge (about 300 meters high) with the basalt-cliff to the West of it which is about 1300 meters high. At a height of about 300 meters, on a flat mountain ridge, running almost from E. to W., at right angles to the coast, the following deposits were found, in passing from West to East:

1) A coarse whitish-yellowish sandstone devoid of fossils.

2) A brown, soft, easily crumbled argillaceous shale with numerous concretions. The greater part of these concretions contained brachyura, bits of coal, leaves, macrura etc., and likewise some partly black, partly white silicified wood, perforated by teredos; a shark's tooth was also found here. In the argillaceous shale itself, little shells and fragmentary leaves were discovered, and also a specimen of an *Aporrhais* was found.

On account of the frequent occurrence in the concretions

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[1]) «Meddelelser om Grønland». Bd. 27. Kjøbenhavn 1902. S. 158.

of a species belonging to the genus *Coeloma*, I shall in the following term this bed the *Coeloma*-bed.

3) A greenish sandstone with wood and fossil animals.

4) A sandstone which in some places was quite filled up with pelecypods and gastropods.

On account of the frequent occurrence in this bed of a species of *Cyrena*, I shall in the following pages term this bed the *Cyrena*-bed.

Of the stratigraphical relations between the Tertiary sediments and the basalt nothing is known beyond what has been related above, but as farther to the NW. considerable beds of sandstone were seen in the basalt-cliff, it may be reasonably supposed, that the fossiliferous deposits of Kap Dalton form subordinate beds in the basalt. This agrees with the fact that in the above mentioned, more northerly situated Tertiary-localities, with the exception of Hochstetters Vorland, the Tertiary deposits are in contact with the basalt.

Professor N. V. Ussing who has been kind enough to examine the Tertiary rocks occurring at Kap Dalton, has, as the results of his examinations, sent me the following communications:

«By an examination through the microscope of the Tertiary «rocks brought home by the Amdrup expedition in 1900, I have «tried to determine the question of the origin of the material. «As the age of these fragmental rocks in relation to the basalt «formation has not been finally decided at the place in question, «it might be supposed that the material of these sediments

«a) originates exclusively from the destruction of Archæan «rocks, or

«b) originates exclusively from the destruction of the vol- «canic rocks (basalts etc.) of the district, or finally

«c) that they contain detritus both from the Archæan «formations and the basalt formation.»

«The result of the petrographic examination is, that the «sediments which have been examined are found to contain — «though in very varying proportions — detritus both of ordi- «nary granite or gneiss, and of fresh basic igneous rocks. «The examination thus proves that the eruption of the basalts «had commenced before the deposition of the fossiliferous «formations.»

«The samples examined are:

«1) **The Coeloma-bed**. Marly concretion from the greyish- «brown shale (p. 99, Nr. 2).

«The colour of this concretion is grey; with the naked «eye we see besides the organic remains numerous little flakes «of muscovite.

«The microscope shows that the principal part is formed «of a dusty brown clayish material; in this material there are «enclosed, besides flakes of muscovite, a number of colourless «grains of sand having a diameter of 0,2 mm. A number of «these are grains of *quartz* (they were found to be optically «uniaxial with weak positive double refraction); others, optically «biaxial, are polysynthetic anhedra of a plagioclase with large «extinction angles. The grains of plagioclase are perfectly «transparent, and contain no alteration-products.

«2) **The Cyrena-bed.** From this bed two different samples «of sandstone were examined. Both are presumably closely «associated with each other; the sample to be mentioned first «consists chiefly of grains of quartz, while the other consists «of grains of relatively high specific gravity.

«*a*. Dark brownish-grey calcareous sandstone with nume- «rous and distinctly visible flakes of muscovite. Fossils are «very plentiful in this sandstone.

«By aid of the microscope I discerned that the grains of «sand belong to the following minerals:

«*Quartz* forms by far the greatest number of the grains;

«these grains reach a diameter of up to 0,75 mm., and have «quite sharp edges.

«*Felspar* is found rather abundantly. Some of these grains «are not quite free from alteration-products, and either have «the appearance of orthoclase or they consist of microcline. «Others, which are quite fresh, belong to a plagioclase with «sharply defined twin-lamellæ and large extinction-angles.

«*Augite*, light-greyish, of the same appearance as this «mineral often has in basalts.

«*Muscovite* in flakes of up to 1 mm.'s length.

«Besides these minerals a small number of grains were «found, consisting of rock-fragments of a micro-crystalline, «somewhat decomposed basalt.

«The *cement* consists partly of micro-crystalline calcite, «partly of brownish-green alteration-products which did not «allow of a more exact determination.

«This sandstone thus chiefly consists of detritus from the «Archæan rocks, but basaltic material forms also an essential «part of it.

«*b*. An almost black, coarsely grained calcareous sand- «stone with large fragments of brownish-grey shale or volcanic «tuff.

«Seen through the microscope this sandstone has a very «characteristic appearance, as it consists wholly of volcanic «material, especially of grains of augite. The size of the grains «is 0,6—0,9 mm.; the grains are rounded and consist partly of «mineral-fragments, partly of rock-fragments.

«*Augite* occurs in two varieties: one which is colourless or «greyish-violet, and looks like an ordinary basalt-augite, and one «which is green, and somewhat pleochroic (yellowish-green— «greyish-green). In longitudinal sections both show large ex- «tinction angles.

«*Grains of microcrystalline basalt*, rather weathered and «well rounded.

«The grains of augite and those of basalt are plentifully «represented, but those which will now be mentioned are only «sparsely represented:

«*Plagioclase* with large extinction angles.

«*Magnetite*;

«*Brown garnet* (?), brown, optically isotropic grains with «strong refraction, and of the same appearance as the dark «garnet in igneous rocks rich in alkalis;

«*Quartz*; of this mineral only one single grain was found «in two thin sections.

«The *cement* consists chiefly of calcite; but in a few places «pyrite occurs as a cement between the grains of sand. In the «above enumeration have not been included alteration products «of brown and green colour, whose exact nature has not been «determined.

«This last sample thus consists almost wholly of volcanic «material; it seems to originate from the disintegration of at «least three different rocks:

«(1) A fresh medium-grained basalt (dolerite) with violet «augite,

«(2) a very fine-grained and somewhat weathered basalt,

«(2) a basic igneous rock more rich in alkalis.»

With regard to the fossils I have only found determinable specimens in the two beds which I have above termed the Coeloma-bed, and the Cyrena-bed. On closer examination it was however proved, that though the state of preservation of the material far exceeded all that had hitherto been brought home from Greenland, yet much was left to be desired. In the best state of preservation were the Crabs occurring in the concretions, and moreover there was an abundance of these. The Mollusca, on the contrary, were almost all found in the very hard sandstone, forming the Cyrena-bed, from which it

was difficult to extract or expose the specimens. Moreover the shells were either dissolved or, for the greater part, transformed into crystalline calcite, and for this reason they were exceedingly brittle, and the preparation of them was very difficult.

In the following account, the species that were found will first be mentioned and described, and subsequently the conclusions with regard to the age and the conditions of formation of these deposits will be given. Once more I must draw attention to the unfortunate state of preservation of the material; the determinations are therefore not always so certain as could be wished.

A. Pelecypoda.

1. **Nucula similis** J. Sowerby.

Plate III, figs. 1 a—c.

1818. *Nucula similis* J. Sowerby; Mineral Conch. pl. 192, fig. 10.
1864. — — — ; S. Wood, Monogr. of the Eocene Bivalves of England. Vol. I. (Palæont. Soc.) p. 118; pl. 18, fig. 11.

A single specimen of a *Nucula* seems to belong to this species. Both valves are here in their natural position, but a little of the central part is missing. The outline and their whole form correspond well with the descriptions of *N. similis* J. Sow; thus the siphonal region is short, with the basal termination somewhat pointed, which is said to be characteristic of this species. The angle at the umbones is about 90°. The surface is weathered and thereby finely and rather irregularly concentrically furrowed, and it is also covered with radiating striae. The shell itself was originally thick.

Height 13,5 mm., length 16,5 mm. and thickness about 9 mm.

Another specimen of a *Nucula* was found among the fossils from the Coeloma-bed. It probably belongs to the same species,

but the specimen is so imperfect, that a definite decision of this question is impossible.

The Coelma-bed. One or two specimens.

Occurrence. England: Barton Beds (Wood).

2. **Mytilus affinis** J. Sowerby.

Plate III, figs. 2—3 b.

1829. *Mytilus affinis* J. Sowerby; Miner. Conch. pl. 532. fig. 1.
1861. — — — ; S. Wood, Eocene Bivalves. Vol. I. p. 61. pl. 12.

In a rather large piece of sandstone from the Cyrena-bed, which was broken up after the return of the expedition, some specimens of a little *Mytilus* were found. These resemble closely *M. affinis* J. Sow., but generally seem to be somewhat smaller. The form varies a little, some specimens are decidedly triangular (as in Wood: Eocene Bivalves. pl. 12, fig. 1 d.), while others are more rounded (as in Wood, pl. 12, fig. 1 b.); likewise the thickness seems to vary somewhat. The reason of these variations is perhaps due chiefly to the various specimens having been subjected to pressures in different directions. — The shell itself is thin, and the inner parts are probably pearly; the surface is covered by finer and coarser concentric furrows and ridges; no trace is found of radiating striae.

The best preserved specimen only measures 9 mm. from the umbo to the posterior margin and 5 mm. at right angles to that direction; in another larger specimen these measurements are relatively 21 mm. and 12 mm.

The smaller specimens seem to differ only by their size from Wood's description of *M. affinis* J. Sow. For comparison I have obtained a specimen from the Headon Beds of Colwell Bay.

The Cyrena-bed: 15 specimens.

Occurrence. England: Barton Beds of Barton. Headon Beds of Colwell Bay, Headon Hill, Whitecliff Bay, Hordwell (Wood).

3. **Modiola cfr. simplex** J. Sowerby.

Plate III, figs. 4 a—b.

1850. *Modiola simplex* J. Sowebby, in Dixon's Geol. of Sussex. p. 117 and 225; pl. 14, fig. 16.

1861. *Modiola simplex* J. Sowerby; S. Wood, Eocene Bivalves. I. p. 71; pl. 12, fig. 7.

A rather well preserved imprint of a *Modiola* was found in a concretion. Of all the forms with which I am familiar it seems to have the greatest resemblance to *M. simplex* J. Sow; however, I only know this species from figures and from a cast from Bognor. The specimen in question differs from the above mentioned species by being somewhat broader in front, and moreover it seems to be a little more inflated. The umbo is small, depressed and almost terminal. The shell has lines of growth; otherwise it is smooth.

The length is about 60 mm., the greatest height about 30 mm.

By its form the specimen in question also resembles *M. Brocchii* Mayer, but the keel is not nearly so sharp as in the latter species.

The Coeloma-bed: 1 specimen.

Occurrence. England: Eocene of Bognor, Herne Bay (Wood).

4. **Cyprina sp.**

From the Cyrena-bed we have two specimens (one right and one left valve) of a *Cyprina*. It is very flat, almost circular, and only slightly inequilateral; the beak is only slightly projecting. That the two valves really belong to a *Cyprina* is proved by the nature of the hinge. By grinding I have succeeded in demonstrating its close resemblance with the hinge of the genus *Cyprina*. The pallial line is without a sinus. No lunule.

I have not succeeded in determining the species, the material being insufficient for this purpose.

Another shell from the Cyrena-bed also seems to belong to a *Cyprina*, but most likely to another species. It is a little

more inflated, its outlines more curved and oblong, and its beak more prominent.

5. Cyprina sp.

Besides the above mentioned species of the genus *Cyprina* there has been found still another species at Kap Dalton, which differs very much from the former, but on account of its bad state of preservation it does not allow of exact determination. The only specimen we have consists of the remains of two united valves in their natural position. The shell is oblique and oblong, rather strongly inflated, the umbo is rather short and thick. The lunule is absent.

This specimen was found in the Coeloma-bed.

6. Astarte cfr. tenera Morris.

Plate III, figs. 5 a—b.

1852. *Astarte tenera* Morris, Fossil shells from the Lower Thanet Sands. Quart. Journ. Geol. Soc. vol. VIII; p. 265, pl. 16, fig. 6.
1871. *Astarte tenera* Morris; S. Wood, Eocene Bivalves. I. p. 157, pl. 24, fig. 14.

One fragment of a shell has a close resemblance to *Astarte tenera*, as described and drawn by Morris from Thanet Sands at Herne Bay. But even for a moderately certain determination the material is too insufficient.

The Cyrena-bed: 1 specimen.

Occurrence. England: Eocene of Herne Bay (Morris, Wood).

7. Cyrena Gravesi Deshayes.

Plate III, figs. 6—9.

1824. *Cyrena Gravii* Deshayes, Coquilles fos. des envir. de Paris. I. p. 120, pl. 19, fig. 3—4.
1860. *Cyrena Gravesi* Deshayes, Animaux sans vertèbres. I. p. 498.

The most frequent fossil in the material brought home is a *Cyrena*, which agrees well with *C. Gravesi* Desh. On account

of its being so plentiful, it is highly characteristic of the sandstone which I have named the Cyrena-bed.

Some specimens which I have succeeded in developing from the sandstone agree, as above mentioned, with *C. Gravesi* Desh. For comparison I have obtained specimens from France, determined by Deshayes himself. Like these the Greenland specimens are comparatively high and greatly inflated, the outline is almost circular. The umbo is large and prominent. On some specimens at any rate, there seems at the posterior region to be an intimation of a strongly rounded keel. The surface is covered by numerous irregular growth lines, that seem originally to have been fine, in most specimens they are now rather coarse, which is most likely due to the bad state of preservation. The hinge seems to correspond perfectly with the hinge of *C. Gravesi* Desh. Thus three cardinal teeth are found, and the lateral teeth (especially the posterior one) are long like those of the latter species. — The only difference I have been able to find between the French and Greenland specimens is that the latter seem to have a somewhat thicker shell than the former.

Some specimens differ somewhat from the above described form, as they are higher and their keel is more prominent. Whether they belong to the same or to several different species it is impossible for me to decide on account of the incompleteness of the material. The shells are all transformed into calcite and therefore exceedingly brittle, so that the preparation of them generally fails. As the sandstone contains calcium carbonate as cement, it is also impossible to dissolve the shells, and by means of the resulting moulds to study the construction of the hinge.

The species does not seem to attain the same size in Greenland as in France, but a few of the Greenland specimens reach the considerable length of about 40 mm., and about the same height.

It is rather common to find two united valves in their natural position.

The Cyrena-bed: Very common.

Occurrence. France: Cuisse-la-Motte. (Deshayes).

8. **Cryptodon cfr. unicarinatus** Nyst. sp.

Plate III, figs. 14 a—b.

1835. *Axinus unicarinatus* Nyst, Rech. coquil. foss. d'Anvers. p. 6, pl. 1, fig. 22.

1843. *Axinus angulatus* Sow. *pro parte*; Nyst., Coquilles et polypiers foss. de la Belgique. pl. 141; pl. 6, fig. 13.

1867. *Cryptodon unicarinatus* Nyst; v. Koenen, Das marine Mittel-Oligocän. p. 101; pl. 4, fig. 9.

A somewhat imperfect specimen of a little *Cryptodon* has been found in one of the concretions. It consists of two connected valves, of which both, but especially the left valve, are somewhat imperfect. Of the hitherto described species it most resembles the *Cr. unicarinatus* Nyst, but it perhaps belongs to a new species. The outline agrees rather well with the above named Oligocene form, and is like the former rather high. The most essential difference is, that the lunule in the Greenland specimen is comparatively longer, more lancet-shaped, and less deep, moreover the keel which runs from the umbo to the posterior margin seems to be less sharp; but these differences may possibly arise from the shell being somewhat worn. On the surface of the shell only indistinct concentric growth lines are seen.

Height 7,5 mm., length 6,5 mm. and thickness about 4,5 mm.

Also in the Cyrena-bed there has been found a single specimen of a species of *Cryptodon* which is probably identical with the species above mentioned, but unfortunately the specimen is somewhat crushed and imperfect. The lunule here seems to agree exactly with the lunule of *Cr. unicarinatus* Nyst, as it

is both shorter and deeper than in the specimen from the concretion, and in other characters, as far as can be seen, the two specimens are otherwise identical.

The Coeloma-bed: 1 specimen.

The Cyrena-bed: 1 specimen.

Occurrence: *Cr. unicarinatus* Nyst is rather plentiful in the Oligocene deposits of Belgium and Germany.

9. **Erycina sp.**

Plate III, fig. 12.

In the Cyrena-bed is found a small shell showing its interior, and the cast thereof. I have not been able to examine the hinge, but on account of its form and the thin translucent shell, I have determined the specimen as belonging to the genus *Erycina*. The pallial line is without a sinus. The surface is most probably covered by fine concentric striae. With regard to form the shell resembles most *E. striatissima* Desh. from Calcaire grossier near Paris.

Height 5 mm., length 7 mm.

The Cyrena-bed: 1 specimen.

10. **Tellina sp.**

Plate III, fig. 10.

There was also found a species of the genus *Tellina* in the material which was brought home, it was however only represented by a very imperfect specimen, and therefore not suitable for exact determination. Both the united valves are preserved, but only one allows of examination. The form is comparatively high, and the surface is covered by fine concentric striae.

Height 15 mm., length 18 mm.

The Cyrena-bed: 1 specimen.

11. Psammobia sp.?

Plate III, fig. 11.

Some shells found in the *Cyrena*-bed I consider, though somewhat doubtfully, to belong to the genus *Psammobia*.

The shell is oval, very oblong and rather flat. The umbo is only slightly prominent and is situated at about the middle of the shell. The valves seem to gape both at the front and at the back. On the surface concentric growth lines are seen; at the ends the lines are coarser and here form a moire-like ornamentation.

The species in question resembles in form somewhat *Ps. plana* Desh. but it is in too bad a state of preservation for more definite determination.

Height about 9 mm., length about 18 mm.

The Cyrena-bed: 4 specimens.

12. Donax sp.

Plate III, fig. 13.

In the Cyrena-bed has been found a single shell, which probably belongs to a species of the genus *Donax*. The shell is thin and flat, oblong-triangular, very inequilateral; narrowing in front, but yet rounded; at the posterior regions short and rounded. The surface is covered by irregular growth lines. — As I have not been able to examine the hinge and the course of the pallial line a more exact determination is impossible.

Height about 20 mm., length about 30 mm.

The Cyrena-bed: 1 specimen.

13. Teredo sp.

Some pieces of fossil wood of some foliferous tree is quite perforated by Teredos. The borings are now filled with sandstone or calcite. The perforations are more or less curved,

and vary considerably in thickness (maximum is about 11 mm.). Their surface seems to have been smooth. — As all that I have seen of the shells are a few insignificant casts, a closer determination is impossible.

The Coeloma-bed: Many specimens.

Besides the above mentioned lamellibranchs I have seen a few other species from the Cyrena-bed, which however are so imperfect, that even the determination of the genus is impossible. One has some resemblance to certain species of *Corbula*.

B. Gastropoda.

14. Natica sp.

Plate IV, fig. 3.

Some specimens of a Gastropod certainly belong to the genus *Natica*. As it is impossible to separate the shell from the sandstone only the casts are available for examination, and a more exact determination is therefore unfortunately impossible.

The Cyrena-bed: 4 specimens.

15. Aporrhais speciosa v. Schlotheim sp.

Plate IV, figs. 4—5.

1820. *Strombites speciosus* v. Schloth. *sp.*; Petrefactenkunde p. 155.
1854. *Aporrhais speciosa* — - Beyrich, Conch. des norddeutsch. Tertiärgeb. p. 170; pl. 11, fig. 1—6.
1867. *Aporrhais speciosa* Schloth.; v. Koenen, Das marine Mittelolig. Norddeutschlands. p. 14.

Four specimens from the Cyrena-bed, one rather perfect, the others casts, seem to belong to this species. This is at any rate undoubtedly the case with the specimen which is in the best state of preservation, since it shows distinctly the numerous sloping transverse ribs, and here and there parts of the spiral

ornamentation. On the last whorl the three keels with their rows of nodes are distinctly seen; on the superior keel the nodes are more strongly developed than on the others; on the lowest keel they are least developed. The distance between the lowest and the middle keel is somewhat less than between the middle and the superior keel. In this specimen it is moreover seen that the inner lip is broadly expanded, and very thick. The wing at any rate reached to the fourth whorl from the base of the shell; whether it reached higher up cannot be seen, as the shell is broken here. The prolonged part of the wing is missing in this specimen.

From the Coeloma-bed we have likewise a specimen of this species with the shell partly preserved. From the cast it is seen that on the last whorl the superior row of nodes is well developed; the middle keel is only faintly indicated, while nothing is left of the lowest keel. The slanting transverse ribs, which are characteristic for this species, are present on the middle whorls, and have left their impressions on the cast. Of the shell itself the wing is preserved, but is somewhat decayed on the surface. It is of about the same shape as in Beyrich: pl. 11, fig. 3; but the part rising along the spire seems to have been very narrow. On the surface of the wing the three stubby keels are seen; two of these are about equally strongly developed, while the lowest is very sligthly developed. The wing almost reached the apex. The aperture is considerably contracted.

This form greatly resembles the species which Gardner [1]) has described under the name of *A. Margerini* de Koninck.

According to Gardner however the wing of this form only reaches the last whorl but one or the last but three, while as mentioned, in the Greenland form it almost reaches the apex.

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[1]) J. Starkie Gardner: British eocene Aporrhaïdae. — Geol. Magazine. New Series, Decade III, Volume I. London 1884. p. 532, pl. 17. figs. 7—8.

In this respect the Greenland specimens have a stronger resemblance to *A. firma* Gardner [1]) from the Headon Series.

The Coeloma-bed: 1 specimen.

The Cyrena-bed: 4 specimens.

Occurrence: This species with its varietées is plentiful in Eocene, Oligocene, and Miocene deposits in Denmark, England, Belgium and Germany.

16. Fusus sp.

In the material from the Cyrena-bed I have found a small specimen of a *Fusus*, but unfortunately it is too imperfect for the determination of the species. It is 6—7 mm. long; partly it presents itself in a longitudinal section, and partly it shows some of the surface. The former has a small number of somewhat curved transverse ribs, and a great number of fine regularly elevated spiral ridges. The columella seems to have been without folds.

The Cyrena-bed: 1 specimen.

In the brown shale of the Coeloma-bed has been found a gastropod, which seems to be the last whorl of a *Fusus*. As the surface here has numerous quite fine transverse ribs, it cannot be the same species as the specimen from the Cyrena-bed.

17. Bulimulus sp.?

Some specimens of a gastropod I determine — though not without some doubt — as belonging to the genus *Bulimulus* Leach. The shell is rather thick, and as it is now transformed into calcite, and consequently very brittle, I have only to a slight degree been able to perform any preparation. The form is oblong-oval; the whorls slightly arched, and the suture slightly visible. The aperture is oblong. The outer lip seems to have been somewhat thickened. No folds at the

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[1]) J. S. Gardner: l. c. p. 553; pl. 17, figs. 1—2.

columella. The surface is covered by rather thick transverse striae almost as in *Glandina costellata* Sow. *sp.*

The Cyrena-bed: 11 specimens.

Besides the above mentioned gastropods I have, in the material from the Cyrena-bed which was brought home, found some other species of which, on account of their bad state of preservation, I have not even succeeded in determining the genus. Rather frequently a slender, turreted form appears, of which I have only seen sections; it looks as if it might belong to the genus *Cerithium*. Moreover I have seen a couple of specimens of a quite small form, which rather resemble certain recent species of *Planorbis*.

C. Crustacea.

18. Hoploparia groenlandica n. sp.

Plate IV, figs. 1—2.

In the concretions from the Coeloma-bed several specimens of a macrurous crustacean have been found, but only one is tolerably perfect and in a good state of preservation. This one will therefore serve as foundation for the following description. It is somewhat smaller than the other specimens which probably belong to the same species.

The carapace is rather long; its length reckoned from the posterior margin to the base of the rostrum, 44 mm. The greatest breadth of the flanks is near the middle and is 25 mm.; the greatest thickness, which is near the posterior margin, is about 17 mm.; but it has probably been a great deal larger as the shell after the animal's death has become somewhat compressed. At a distance of 18 mm. from the posterior margin is the cervical furrow which is deep and broad; it first

runs in a straight direction down the flank at a length of about 9 mm., and then rather suddenly bends forward at the same time getting flatter, by degrees it disappears long before reaching the lateral margin. A little below the point where it bends forward it sends out a short indistinct branch, which slants toward the front and disappears by degrees before it reaches as far down the lateral margin as the head branch.

In front of the lower part of the cervical furrow, and at about 5,5 mm. distance from the latter, the λ-formed hepatic furrow is found. It starts from about the same height as the ramification of the cervical furrow, runs first at a right angle to the lateral margin, deepening at the same time; then it sends forth a branch in front, which gets shallower and shallower but yet almost reaches right to the anterior margin; before reaching so far it has sent out a very fine and short branch towards the side margin. After having sent forward the above mentioned branch, the head branch of the hepatic furrow is directed somewhat backwards and is quite short.

There is a broad incision in the middle line of the posterior margin which in an even curve unites itself with the side margin. A furrow which is specially deep at the flank runs alongside it.

The length of the *rostrum* is unknown, it seems to have been slenderly constructed. At the top of the middle line is found a furrow which is continued on to the carapace itself, but here it quickly gets shallower and broader, and at last it quite disappears. This furrow is bordered by two rounded keels, which at the carapace proper, diverge from each other, and at last resolve themselves into two rows of pointed spines; these two rows later on approach each other, and may be traced almost to the cervical furrow.

The postorbital ridge ends in front with a little spine, which is now broken off. It quickly decreases in height at the back. Its distance from the above mentioned keel is 2,5 mm. from the orbit 2 mm. The part of the carapace which is

between the keel and the ridge is pretty strongly excavated. Below, and somewhat behind the spine of the ridge, there is still another spine whose distance from the border is 3,5 mm. Between the two spines the shell sinks a great deal towards the region round the lower part of the orbit.

The orbits are large and surrounded by a thickened margin.

The whole surface of the carapace seems to have been covered by rather widely spaced little oblong, somewhat squamiformed granulations.

Of the oral organs I have not seen anything preserved. On the other hand one chela (the right one) is present; it is very long and large, and projects far in front of the body. The first segment which is accessible for examination is the upper part of the arm, the length of which is 19 mm., and greatest breadth 10 mm.; its innerside is hidden, the outerside is strongly arched, the lateral margin is here accompanied by a flat furrow. At the top part of the upper arm nearest the back is seen the trace of a short spine, and at its front part is seen a strong spine directed slantingly upwards; about the middle is found another, still stronger spine, directed forwards.

Of the forearm only insignificant remains are seen; it also seems to have been provided with strong spines.

The chela itself is large and compressed, 52 mm. long, its greatest breadth is 20 mm. The outer margin of the hand and the immoveable finger form a gentle curve. The middle part of the hand itself is arched, much stronger on the inside than on the outside. On the latter there is a furrow near the outer margin which broadens in front, and almost occupies the whole breadth of the immoveable finger; towards the tip of the finger it decreases somewhat. Along the outer margin of the hand is a row of small, widely spaced, forwardly directed spines. At the inner margin of the hand a somewhat hollowed part is

seen; on the margin itself a few forwardly directed spines are visible. On the innerside of the hand there is along the outer margin a deep furrow, and here also a row of small spines occurs. The greater part of the innerside has however been inaccessible for examination. Along the inner margin of the immoveable finger, which is slightly concave, is found a row of oblong, jagged teeth or nodes whereof two are much larger than the rest.

The moveable finger is long (25 mm.) and narrow (at the utmost 6 mm. broad). The upperside is flat, the underside I have not seen. The outer margin is slightly convex, and has a row of small, forwardly directed spines; the inner margin is almost straight, and has, like the immoveable finger, oblong teeth or nodes, whereof one at any rate far exceeds the others in size. At the base of the moveable finger is a small point or node, and opposite to this, on the hand, another but larger node is seen. Whether or not these nodes formed a kind of joint cannot now be determined.

The surface of the chela seems to have been of the same nature as the surface of the carapace.

Of the rest of the walking feet I have only seen indistinct remains; they seem to have been long and rather thin.

The specimen here described has only the four first segments of the abdomen preserved. The first segment is only 8 mm. long, while the others measure 10—12 mm. On the sides it runs into two rounded plates; about 1,5 mm. from its posterior margin is a furrow which, on the sides, retreats more and more from the posterior margin, and at last ends on the epimeral plates. On the following segments the epimeral plates end in backwardly directed falcate points. Also these segments have a transverse-furrow, but here it is found nearest the anterior margin, on the sides it approaches still more the anterior margin, but reaching the epimeral plates it forms a backward curve, and at the same time it gets very deep; however it soon disappears after having united itself with an

indistinct furrow, which is found near the posterior margin of the epimeral plates. This furrow is best developed on the second segment, it disappears before reaching the transverse-furrow, and on the fourth segment I have not been able to discover it at all.

In two other concretions have been found the back part of the abdomen with the strong caudal fin. Unfortunately both specimens are in a bad state of preservation, but there seems to be a great resemblance to *H. gammaroides* Mc Coy.

In a fourth concretion remains of the new species of *Hoploparia* were found. The carapace is preserved, but in part as an imprint only. It is somewhat larger than in the above described specimen, measuring a little over 50 mm. in length. Otherwise the two specimens agree as far as can be seen. But in this fourth specimen a left chela is preserved, and this differs considerably from the above described right chela. It has a length of about 70 mm., and the greatest breadth is 17 mm. The middle part of the surface is strongly arched. Moreover it differs from the right chela by both fingers having on their inner margin very pointed spines, whereof a few are much larger than the rest, as is the case with *H. gammaroides* Mc Coy, according to Bell's description of that species.

Hoploparia groenlandica n. sp. is certainly closely related to *H. gammaroides* Mc Coy. Unfortunately I have only succeeded in getting a specimen of the latter species (from Sheppey), which is in a bad state of preservation, for comparison. I have therefore been obliged to rely on Bell's descriptions and figures [1]).

I shall therefore, from Bell's description and figures indicate in a few words the features in which the two species seem to differ.

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[1]) Bell: A monograph of the fossil malacostracous Crustacea of Great Britain. Part I. Crustacea of the London clay. p. 38. pl. 8, figs. 4—6 and pl. 9. The palaeontogr. Society. London 1857.

In the *H. gammaroides* Mc Coy the carapace is comparatively narrower both at the front and at the back, and it seems to have a deeper incision at the back in the middle line than in the Greenland species. The two keels which start from the rostrum do not reach so far back on the carapace in *H. gammmaroides* Mc Coy; moreover the cervical furrow in this species is considerably nearer the middle of the carapace, and the spine under the postorbital ridge is situated somewhat farther forward. Also the construction of the chela seems to be somewhat different, especially with regard to the right one. On account of all these little differences I consider it advisable to regard the Greenland specimens as belonging to an independent species, remarking however that, although rather improbable, I do not think it quite impossible, that by further comparison it may prove to be identical with *H. gammaroides* Mc Coy.

H. groenlandica n. sp. differs so much from *Hoploparia Klebsii* Noetling [1]) that any confusion of the two species may be considered impossible.

The Coeloma-bed: 4 specimens.

19. Coeloma bicarinatum n. sp.

Plate IV, fig. 6; plate V, figs. 1—6.

The carapace is trapezoidal, its length is about $^4/_5$ of its breadth; in a specimen in a very good state of preservation the measurements are relatively 22 mm. and 28 mm. (The following measurements of the carapace also refer to this specimen.) The greatest breadth is formed by a line between the two spines farthest back on the anterio-lateral margins; about $^3/_7$ of the length of the carapace lies in front of this line, and about $^4/_7$ of the length behind it. The upper side is rather

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[1]) F. Noetling: Die Fauna des samländischen Tertiärs. I. Th. — Abhandl. zur geol. Specialkarte von Preussen und den Thüringsch. Staaten. Bd. 6, Heft 3. Berlin 1885. p. 436; pl. 7, figs. 1—4; pl. 8; pl. 9, fig. 1.

flat, somewhat arched from the front backwards, less from side to side.

The front is broad and somewhat bent down, its breadth is about $^1/_4$ of the whole breadth of the carapace; in the above mentioned specimen it is thus 6 mm. broad. The whole breadth of the anterior margin (22 mm.) is about $^4/_5$ of the greatest breadth of the carapace. The front is somewhat prominent, projecting by about half its breadth beyond the anterior margin. The front margin ends in four short spines, separated by incurvations, they are about on the same plane, the innermost however are a little deeper than the outer ones because the sides of the front rise a little in proportion to the middle part. The outer spines are somewhat stronger than the inner ones, and directed somewhat to the side, all four spines project about equally. The distance between the two middle spines is only half as great as between one of the middle spines and one of the outer ones. After the outer spine comes a little furrow, and at the same time the anterior margin bends backwards, and forms a bowed incurvation the margin of which turns somewhat upwards; this incurvation is bordered by a small slit which extends itself into a furrow. Then follows a small slightly prominent part which is again bordered by a slit. The margin now bends forward again, and ends in a strong triangular spine where the anterior margin, and the anterio-lateral margin meet. The margin from the front to this place is the supraorbital margin which forms the border of the orbit upwards; it is surmounted by a row of small tubercles. The angle between the anterior margin, and the anterio-lateral margin is about 120°. The anterio-lateral margin is slightly convex, and has the same length (8 mm.) as the supraorbital margin. It carries five strong spines, whereof the fifth and the first are the strongest, while the second and the fourth are the weakest, and lie on a somewhat lower level than the rest. The four front spines are (in casts) flat, and directed more or less

towards the front, whereas the fifth is more round, and directed straight out to the side, and at the same time somewhat upwards. The first spine belongs to the orbital region, the second and third to the hepatic region, the fourth to the epibranchial lobe, and lastly the fifth to the mesobranchial lobe.

After the last spines of the anterio-lateral margin comes the posterio-lateral margin, the length of which (12 mm.) far surpasses that of the former margin. It is almost straight, and forms an obtuse angle with the posterior margin. The anterio- and posterio-lateral margins have not, like the anterior margin, a row of regular small tubercles.

The posterior margin (17 mm. broad) forms a flattened curve, the middle part as well as the side parts are slightly bent inwards. The posterior margin carries throughout its length a row of quite small regular tubercles.

The furrows which border the different regions of the carapace are shallow, but yet rather distinct. In the casts they are seen most distinctly; on weathered shells it is sometimes somewhat difficult to follow their course.

From the incurvation between the two middle of the four front spines, runs a small flat furrow which divides the front into two symmetrical parts. Farther back, where it separates the two epigastric lobes, it gets deeper and broader, and then it divides itself into two branches which between them enclose the long forward extension of the mesogastric lobe. The epigastric lobes are seen as a small, crooked, square prominence on either side of the furrow; by another furrow they are separated from the elevated part of the supraorbital margin.

Between the epigastric and protogastric lobes a broad, flat furrow is found. The last mentioned lobe is large, and rather flat, its highest part is near the furrow which separates it from the long mesogastric lobe.

The metagastric lobe has grown together with the mesogastric lobe, and forms with the latter a hexagonal, slightly

elevated part, which as already mentioned sends forward a long projection.

The furrows which separate the urogastric lobe in front from the metagastric lobe, and at the back from the cardiac region, are curved, (with the concavity towards the front) broad and flat, but yet distinct. The urogastric lobe is formed like a flat, curved, rather narrow elevation.

The epicardiac lobe is rather large, slightly heart-shaped. In the casts indistinct traces of a few nodes are sometimes seen on its front part.

The metacardiac lobe is narrower than the epicardiac lobe, and there is no distinct partition between the two. In the casts traces of a small node on its front part are often seen. In specimens with shell preserved I have not seen this node, nor have I seen the two nodes on the epicardiac lobe.

The orbital region is narrow, and rather long; the inner part of its outer margin (the supraorbital margin) is thickened. It is separated from the protogastric region, and the hepatic region by flat, but distinct furrows.

The hepatic region is rather large and bordered at the back by the cervical furrow. Its highest part is about at the middle, and somewhat behind that.

The epibranchial lobe is — especially in the casts — distinctly separated from the hepatic region; its border towards the mesobranchial lobe is less distinct. The fourth node of the anterio-lateral margin belongs as above mentioned to the epibranchial lobe.

The mesobranchial lobe is well developed. It forms a long fairly arched wall which, towards the middle of the carapace, bends strongly backwards; at the back it slopes more steeply than in front, where it is bordered by a very flat furrow. At the back it is not bordered by any furrow, but here gradually unites itself with the metabranchial lobe. The strong fifth

spine on the anterio-lateral margin belongs to the mesobranchial lobe.

The metabranchial lobe is very large. About at its middle is a sharply marked, somewhat rounded keel, which runs nearly parallel with the longitudinal axis, as the two keels from their respective sides only converge slightly forwards. This keel, which is very conspicuous in the casts as well as in the specimens with shells, forms something like an extension of the elevated part of the mesobranchial lobe, from which it is however separated by a furrow. Frequently a couple of points on the keel, especially in the casts, give indications of little nodes. The part of the lobe situated outside the keel is rather strongly excavated, and the same is the case, in a somewhat less degree, with the part inside the keel.

The orbits are, as usual in the genus *Coeloma*, very large and deep; they reach from the anterio-lateral margin right to the front. Their top border, the supraorbital border, is mentioned above. Downwards they are bordered by the infra-orbital margin, which from the front spine of the anterior margin curves strongly downwards, and at the same time somewhat forwards, and rather near to the front forms a strong, flat spine which is placed a little lower than the spines of the front, and reaches about as far to the front as the latter ones. Beside this spine is a somewhat smaller, flattened spine or tooth, which forms the end of the infra-orbital margin. This margin also, like the supraorbital margin, is ornamented by a regular row of little nodes. The orbit is indistinctly divided into two parts, separated by the slit between the two infra-orbital teeth; the latter is continued as a very indistinct furrow into the orbit. The inner part of the orbit is much smaller and flatter than the outer part, and served to hold the stalk of the eye, while the outer part held the eye itself. The stalk of the eye is short and rather thick.

The flanks form towards the front (near the anterior-side-

spine) a very acute angle with the surface of the carapace; this angle becomes larger farther back until at the last side-spines it is about 90°, and near the posterior margin it gets still larger. The pterygostomial furrow, which is very distinct, starts from the innermost infra-orbital spine, and runs from thence in a slightly S-shaped line towards the posterio-lateral margin which it almost reaches at a point situated a little behind the hindmost spines of the posterio-lateral margin, then it runs parallel with the latter at a short distance from it, down to the posterior margin. The inner margin of the branchiostegites is thickened, and during its whole length accompanied by a furrow.

I have only an imperfect knowledge of the epistoma. It seems to consist of a long cross-beam the ends of which are bent somewhat upwards, and enclose the basal-segments of the inner antennae. From the middle of the epistoma a narrow projection runs at right angles up towards the front; it separates the basal-segments of the two inner antennae.

Nor have I seen the endostoma in a good state of preservation. As far as can be seen it greatly resembles the endostoma of *Coeloma holsaticum* Stolley. Its highest parts are found on each side of the bottom of the deep incision.

The basal-segments of the inner antennae are situated just below the front, they are very large, and are separated by the cross-lamella which unites the front with the epistoma.

The basal-segments of the outer antennae lie close to the inner ones, and are much smaller than these.

Of the oral appendages I have seen the last pair of maxillipeds. They greatly resemble the corresponding pair in the *C. holsaticum* Stolley; only in the Greenland species the furrow on the head-segment generally seems to be somewhat deeper, and the following segment gets somewhat broader towards the outside.

Of the other oral appendages I have seen here and there indistinct remains only.

The *sternal plastron* is broadly elliptical, almost circular; in front it is somewhat pointed; its height only slightly surpasses its breadth. The anterior sternite is the smallest, it has the shape of a low isosceles triangle, its point is bent somewhat upwards. The following sternite is the largest of all. The two together occupy almost half the length of the whole plastron. The whole middle part of this sternite is concave, but especially is this the case with the back part — its object being to contain the end of the abdomen. The two furrows which run in a slanting direction towards the middle are more or less distinct; they are deepest towards the outside of the margin of the plastron; towards the middle of the latter they disappear. The outer margin is somewhat swollen.

The next sternite is much smaller and wedge-shaped; it does not reach the middle of the plastron. Its posterior edge, which is at right angles with the longitudinal axis of the carapace, bends strongly forwards at the point where the sternite lowers itself to help to form the cavity which contains the abdomen. — The next two sternites also get narrower farther in, but both reach the middle line. On the posterior one, a deep furrow is seen which begins right at the outer margin, and runs parallel with the posterior margin of the sternite, and at short distance from the latter, the furrow suddenly disappears before reaching the middle line.

The episternites are generally seen very distinctly. They have a pointed projection at the back which projects in between the basal-segments of the walking feet and the sternites, and sometimes reaches the middle of the next sternite, sometimes still farther.

The front pair of walking feet are strongly developed, and end in large chelæ of which the right one is stronger than the left. The first segment is, like the two next, of small size; on the border turning inwards towards the sternal plastron, there is a small spine which corresponds with an

incision in the second sternite. At the back it reaches right up to the third segment, whereby the second segment which is quite small becomes wedge-shaped. The third segment has a furrow which runs parallel with its posterior margin, and at a short distance from the latter. — The upper part of the arm is short, but very strong, and has the shape of a three-sided pyramid with the point turned downwards; in height it reaches the surface of the anterio-lateral margin. The plane which turns inwards towards the flanks is slightly arched, while the two other sides are arched more strongly, the one which turns upwards more so than the one turning downwards. Farthest to the front on the lowest margin a strong round spine is seen, the base of which is bordered by a deep furrow. On the front border of the innerside are two spines, one above the other. — The forearm is short, strong and square. On its two upper front corners two spines are seen whereof the innermost one is long and pointed, while the outer one is rounded, and fits into a cavity in the hand. The upper side is strongly arched, the two back corners rounded. Further details of the structure of the forearm cannot be made out.

The hand is short, strongly built; its shape is longish-triangular. Its outer side is fairly strongly arched, the inner side is arched in the middle, but excavated near the under and upper margin. At the end of the hand there is, on the upper side, a small tubercle with a cavity with which a small projection on the forearm corresponds, and hereby a sort of joint is formed. The hand is separated from the immoveable finger by a cavity.

The fingers are narrow. On their innerside they have a row of large and small oblong teeth, which decrease in size towards the front. Inside the teeth a row of small irregular cavities is seen. In a number of specimens, which all seem to be males, the fingers (especially the immoveable finger) have a distinct furrow on both sides, while in the females there is

no furrow at all. In one female however I have seen an indistinct furrow in the immoveable finger.

The other four pairs of walking feet are only partly preserved, having almost always projected beyond the concretions wherein the crabs are found, and have therefore disappeared. They seem to have been comparatively strong, and rather flat.

The abdomen consists of seven segments. It is of a longish-triangular form in the males, more oval in the females. In the males the second segment is the broadest, while the greatest breadth in the females is not reached till the third or fourth segment; whether this rule may be considered universal I am not able to determine with perfect certainty, however it is valid with regard to the specimens whose abdomens are completely preserved. The length of the two last segments is greater than their breadth. In the middle of the abdomen an indistinct, broad, longitudinal keel is seen in most specimens.

Only in rare cases can the nature of the surface be examined, as the shell generally adheres to the stone by its surface, and where this is not the case it is much decayed. Still one sees that it is finely granulated. The granules are generally stronger on the more elevated parts of the shell.

It has already been mentioned that a row of regular little nodes are found here and there on the border of the carapace. In the Greenland species we also find (in casts or decayed shells) marks similar to those which Noetling has declared to be the places where the muscles were joined to the shell. Such marks are found in the shape of short flat curves at the border between the meso- and metagastric lobes, and in the side furrows somewhat behind the latter two, and moreover in the flat furrow between the mesobranchial lobes and the keels on the metabranchial lobes.

Noetling [1]) has divided the species of *Coeloma* into two groups: *Laeves* and *Tuberculati*. To the first group are referred the forms whose carapace is almost perfectly smooth with the exception of a few rather large nodes. To the second group belong those whose carapace is more uneven, and provided with rather large nodes and tubercles. To the *Laeves* he refers *Coeloma vigil* Milne Edwards from the Vicention Eocene, *C. balticum* Schlüter from the Lower Oligocene formation in Samland, *C. granulosum* Milne Edwards from the Upper Nummulitic beds near Biarritz, and *C. Reidemeisteri* Noetling from the Phosphate-beds near Büddenstedt and Helmstedt. Of the second group, *Tuberculati*, he knows only two species, viz. *C. tauni-cum* v. Meyer *sp.* from the Middle Oligocene Septarian clay near Breckenheim, and *C. Credneri* v. Schloth. *sp.* from the Upper Oligocene in the neighbourhood of Hildesheim. To these Stolley [2]) adds two more species, viz. *C. rupeliense* Stainier from the Middle Oligocene Rupel clay near Rupelmonde in Belgium, and *C. holsaticum* Stolley from the Middle Oligocene Septarian clay near Itzehoe in Holstein.

According to Noetling the group *Laeves* contains chiefly earlier species, while the group *Tuberculati* is characteristic of the younger Eogene.

Coeloma bicarinatum n. sp. is quite in agreement with the group *Laeves*, and if, as Noetling thinks, in the development from the older to the younger species there is an inclination towards a sharper definition of the furrows, and a richer ornamentation of the surface, it must certainly be one of the oldest species. Especially characteristic of this species, and very

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[1]) F. Noetling: Die Fauna des samländischen Tertiärs. I Theil. — Abhandl. zur geol. Specialkarte von Preussen und den Thüringsch. Staaten. Bd. 6, Heft. 3. Berlin 1885. S. 415—17.

[2]) E. Stolley: Ueber zwei Brachyuren aus dem mitteloligocänen Septarienthon Norddeutschlands. — Mitth. aus. dem mineralog. Institut der Univ. Kiel. Bd. I, Heft. 3. Kiel 1890. S. 165.

conspicuous, are the two strong keels or ridges on the carapace. Indications of such keels are also seen in other species, but they are far from reaching the development which they do in the Greenland species. In the following I shall only state the most evident differences between *C. bicarinatum* and the other species of the genus *Coeloma* with which I am acquainted.

C. vigil Milne Edwards. In the museum of Göttingen I saw a specimen of this species from Laverda. It was in a rather bad state of preservation. According to this specimen *C. vigil* seems to differ in the following particulars: Its form is higher, less narrowing towards the posterior region, a little less inflated. The front is narrower in proportion. The anterio-lateral margins are placed somewhat more steeply; they only carry four spines on each side. The two keels on the carapace are much less pronounced, and carry two nodes which are indistinct and placed rather near each other. The surface carries rather coarse tubercles which are placed close together.

C. balticum Schlüter. In addition to Noetling's very detailed description I know this species from a specimen in the museum of Göttingen. The anterio-lateral margins are here comparatively longer, and only carry four spines on each side. The two keels on the metabranchial lobes are missing, or are at any rate only very indistinctly indicated. The granulations on the carapace are considerably coarser than in *C. bicarinatum sp.*

C. granulosum Milne Edwards has a narrower front, and a much longer anterior margin. The anterio-lateral margins run in almost the same direction as the posterio-lateral ones. Only four spines are found on each of the anterio-lateral margins. No keels on the metabranchial lobes.

C. Reidemeisteri Noetling. I only know this species from Noetling's description. It is said to belong to his group *Laeves*, and is different from *C. balticum* Schlüter with which species it was formerly identified. This circumstance presumably permits

he conclusion that it is closely related to SCHLÜTER's species, and therefore differs not a little from the Greenland one.

To the group *Laeves*, or perhaps to a new independent group, *C. vareolata* LÖRENTHEY [1]) from the Eocene of Kressenberg must be referred. The carapace of this species is much broader comparatively, and very narrowing towards the posterior region; the anterio-lateral margins carry only three little spines on each side. The surface is punctate, not granulated.

From the *Tuberculati* group *Coeloma bicarinatum n. sp.* differs by its almost perfectly smooth carapace. I have also seen in the few species belonging to this group the following differences.

C. taunicum v. MEYER *sp.* In the museum of Göttingen I have seen a specimen of this species from Breckenheim. The anterio-lateral margin has only four spines. No keels are found on the metabranchial lobes, but two strong nodes on each side. The posterior margin is comparatively broad. The chelæ seem to be more slender than in the Greenland species.

C. rupeliense STAINIER. I have seen no specimen of this species, and as I have not been able to procure STAINIER's description of it, I only know it from STOLLEY's [2]) description and the figure which he has copied from STAINIER. This figure is however drawn from a cast. *C. rupeliense* STAINIER seems to closely resemble the Greenland species in form, but differs from it in the following particulars: The two middle spines of the front margin are longer than the two outer ones, the front is broader, the carapace broader towards the posterior region. The furrows between the different regions and lobes are much

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[1]) E. LÖRENTHEY: Ueber die Brachyuren der palaeontologischen Sammlung des bayerischen Staates. Termiszetrajzi Fürzetek. Bd. 21. Budapest 1898. p. 149; pl. 11. fig. 5.

[2]) E. STOLLEY: l. c. p. 166; pl. 5. fig. 2.

more distinct. On each side of the metabranchial lobes there are two strong nodes, but no keels.

C. holsaticum Stolley. Three specimens of this species are preserved in the Mineralogical Museum of Copenhagen. They have broader, less prominent fronts; the anterio-lateral margins are placed more slantingly; their spines are formed differently to those in *C. bicarinatum n. sp.* No distinct keels are found.

C. bicarinatum n. sp. was found at Kap Dalton in great numbers in the numerous concretions in the shale. In almost every concretion a specimen of this crab was found. On account of this frequent occurrence I have called the bed the Coeloma-bed. The sizes of the specimens are, as a rule, almost the same as the size of the one to which the measurements in the above description refer. There are however specimens the size of which is much less, thus the carapace of the smallest of the specimens present only measures 10,5 mm. in length, and 14 mm. in breadth. A few other specimens are unusually large, the carapace of one being about 41 mm. long, and 50 mm. broad.

The Coeloma-bed: Very common.

D. Insecta.

In one of the concretions of the Coeloma-bed which is quite filled with imprints of fragments of leaves, and other remains of plants, I found a fragment of the wing of a Beetle. On the surface of the wing are seen longitudinal rows of little cavities. A closer determination is impossible.

The fossils from the Coeloma-bed and the Cyrena-bed have here been treated collectively. What the mutual relation in age is between the two beds is not known; the only thing known about the conditions of deposition is what has been stated on pp. 99—100. But I must remark that the bits of shale, which are found in the sandstone of the Cyrena-bed, have some

resemblance to the shale of the Coeloma-bed, and that there is therefore some probability of the latter bed being older than the former. Against this the objection cannot be raised, that in addition to the bits of shale, the concretions of the shale ought also be found in the sandstone, because these may have been formed in the shale at a much later period.

Neither would I dare to draw a positive conclusion from the fossils found, regarding the respective ages of the two beds, but as may be seen from the accompanying list of fossils, the two beds seem to have two species in common viz. the species which I have above assigned as *Cryptodon cfr. unicarinatus* Nyst, and *Aporrhais speciosa* v. Schloth. *sp.* We may therefore presumably be right in supposing that the two deposits do not differ much with regard to age. To the question of the age of the Tertiary deposits at Kap Dalton I shall return later on.

	The Coeloma-bed	The Cyrena-bed	Eocene	Oligocene	Miocene
1. *Nucula similis* J. Sow.	+	−	+	−	−
2. *Mytilus affinis* J. Sow.	−	+	+	+	−
3. *Modiola cfr. simplex* J. Sow.	+	−	(+)	−	−
4. *Cyprina sp.*	−	+	−	−	−
5. *Cyprina sp.*	+	−	−	−	−
6. *Astarte cfr. tenera* Morris	−	+	(+)	−	−
7. *Cyrena Gravesii* Desh.	−	+	+	−	−
8. *Cryptodon cfr. unicarinatus* Nyst.	+	+	−	(+)	−
9. *Erycina sp.*	−	+	−	−	−
10. *Tellina sp.*	−	+	−	−	−
11. *Psammobia sp.?*	−	+	−	−	−
12. *Donax sp.*	−	+	−	−	−
13. *Teredo sp.*	+	−	−	−	−
14. *Natica sp.*	−	+	−	−	−
15. *Aporrhais speciosa* v. Schloth. *sp.*	+	+	+	+	+
16. *Fusus sp.*	−	+	−	−	−
17. *Bulimulus sp.?*	−	+	−	−	−
18. *Hoploparia groenlandica n. sp.*	+	−	−	−	−
19. *Coeloma bicarinatum n. sp.*	+	−	−	−	−
20. *Coleopter*	+	−	−	−	−

If we now look at the fossils which have been found in the Coeloma-bed, we see that with the exception of the single beetle-wing we have here a purely marine fauna. The nature of the rock indicates that the deposition took place in comparatively deep water. However, we also sometimes find in the concretions innumerable well preserved imprints of fragments of leaves and other remains of plants, which presumably together with the beetle-wing were carried by a river into the sea. The number of the land-organisms in the concretions moreover permits the conclusion, that the deposition took place near the mouth of the river.

If we now consider the fauna of the Cyrena-bed it is at once evident that it is of a quite different composition from that of the Coeloma-bed. Beside typical salt-water species, such as those belonging to the genera *Cyprina*, *Astarte*, *Cryptodon*, *Erycina*, *Tellina*, *Natica*, *Fusus*, *Aporrhais* a. s. o. we here find a brackish-water species, namely *Cyrena Gravesii* Desh., and presumably a land-species *Bulimulus sp.* That we have to do with a marine deposit here also is plainly proved by the above named salt-water species, but the deposition here took place in less deep water, and nearer the coast. A material as coarse as that which forms the sandstone, in which the fossils mentioned have been found, could hardly be washed very far out into the sea, but would subside near the coast. That this was the case, the bits of shale which are found deposited in the sandstone, are also signs of. Another argument for the Cyrena-bed being a shallow-water formation is from the fossils, among which is found such a strongly marked littoral form as a species of the genus *Donax.* Species of the genus *Mytilus*, and probably also of the genus *Psammobia*, which are both generally found in shallow water, also occur here. Even if some of the other species belong to genera which are found in somewhat deeper water, there are presumably none of these exclusively found at such great depths,

that a transport of them to the shore would be inconceivable. — It is probable that the coast during the formation of the Cyrena-bed consisted of deposits of clay in layers; whether or not this clay belonged to the Coeloma-bed or a like formation is uncertain. The coast was subjected to abrasion, whereby loosened bits of the clay were washed into the sea. The clay must probably already have attained a certain firmness, as the bits would otherwise soon have become macerated in the water, and would then have been deposited as clay again in deeper water. In the sandstone itself none or only very slight traces of clay are found. At the same time as the sea by the denudation of older deposits provided material for the formation of new ones, the rivers washed a lot of material from the mainland. This material consisted in a great part of sand which in a few places was formed of volcanic products, but generally consisted of grains of quartz, produced by the weathering of the Archæan rocks inland. This sand was deposited in the sea near the mouths of the rivers. In the rivers or in the brackish swamps connected with them, near the coast, lived mollusca, and other animals (e. g. *Cyrena Gravesii* Desh.); after the death of the animals a part of their remains were washed into the sea, and were deposited there together with the other material which the rivers brought with them. The negative change of position of the coast-line which probably took place between the formation of the Coeloma-bed and the Cyrena-bed was continued, with the result that the Cyrena-bed was at last raised above the level of the sea. Then volcanic eruptions occurred whereby the Tertiary deposits, at any rate in some places, were covered by thick basalt-deposits.

That the tertiary deposits at Kap Dalton are connected with the ones farther north on the east coast of Greenland may presumably be supposed. Marine-fossils are here, as above mentioned, only known from Hochstetters Vorland. Of the five

genera which Lenz and Fuchs mention from this locality (see p. 96) only one, viz. *Astarte*, has been found at Kap Dalton. However too much significance must not be attached to this, as the material from Hochstetters Vorland is very imperfect. Tertiary fossils are said to be very frequent here, and it is therefore to be hoped that we shall some day succeed in getting both more abundant and better preserved material from this part of Greenland, which is unfortunately so difficult of access.

As has been already mentioned by Nathorst [1]) we shall hardly be wrong in supposing that the marine Tertiary of Spitzbergen and Greenland was deposited in the same sea, and yet Fuchs' list of the fauna from Kolbay at Spitzbergen (see p. 97) has very little in common with the one from Kap Dalton, as the only resemblance is that the genus *Psammobia* possibly is common to both localities. As for Spitzbergen the same is the case there as in Hochstetters Vorland, the material of the marine Tertiary fossils is both scarce and in a bad state of preservation.

From the west coast of Greenland marine Tertiary has certainly not been mentioned in literature until now. Whether the very coarse-grained sandstone found by K. J. V. Steenstrup [2]) at Alianaitsunguak is from the Tertiary beds I dare not decide as the only fossils I have seen are a very large and thick-shelled *Dentalium* and some imperfect remains of a snail. But the sandstone however contains concretions derived from older formations; these concretions resemble those which have been found near Niakornat, and in other localities, and, according to V. Madsen [3]), they contain a number of spe-

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[1]) A. G. Nathorst: Marine Conchylien im Tertiär Spitzbergens und Ostgrönlands. — Zeitschr. d. deutsch. geol. Gesellschaft. Bd. 48. Berlin 1896. S. 986.

[2]) K. J. V. Steenstrup: Om Forekomsten af Forsteninger i de kulførende Dannelser i Nord-Grønland. — Medd. om Grønland. Kjøbenhavn 1883. S. 63.

[3]) V. Madsen: The genus *Scaphites* in West-Greenland. — Medd. fra Dansk geolog. Foren. Nr. 4. Kjøbenhavn 1897. S. 45.

cimens of *Scaphites Römeri* D.'ORB, though their fauna according to DE LORIOL [1]) ordinarily consists partly of new species, and partly of such as have been described by MEEK and HAYDEN from the North-American «Fox hills' group». As this group is reckoned to belong to the Upper Senonian of which *Scaphites Römeri* D'ORB. is also characteristic, it does not seem improbable to me that the above mentioned sandstone from Alianaitsunguak might belong to the older Tertiary. If this is the case it would be highly interesting to have this sandstone more closely examined, as there is a possibility that the West-Greenland marine Tertiary may be more closely connected with the American, than with the European Tertiary, a thing which cannot at all be said to be the case with the marine Tertiary from Kap Dalton.

Also marine Tertiary formations are said to be known from Iceland, viz. from the well known locality Halbjarnarstadir, and a few other places. The fauna found here is however quite different from the one from Kap Dalton, and must, according to the opinion of various naturalists, be considered as being much younger [2]).

If we now consider the West-European Tertiary, we find deposits there which have much in common with those at Kap Dalton. This resemblance is so great, that I believe we may draw a parallel between the East-Greenland Tertiary, and

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[1]) P. DE LORIOL: Om fossile Saltvandsdyr fra Nord-Grønland. Genf 1882. (Meddelt i et Brev til Prof. O. HEER). — Medd. om Grønland. Hefte 5. Kjøbenhavn 1883. S. 205.

[2]) In the archives of the Museum of Mineralogy are found four plates, showing figures of mollusca from this locality; these four plates were composed by O. MØRCH, but were not published before his death. Later (1884), C. M. POULSEN undertook the revision of the plates and the composition of a text; this text, however, was never published, but the MS is deposited in the archives of the Museum; it shows that according to POULSEN's opinion the fauna from Halbjarnarstadir may be considered to be still younger than the youngest of the English Crag-faunas.

the Eocene in England and the Paris basin. With a single exception all the species which form the fauna of Kap Dalton seem to be either identical, or at any rate closely connected with species which occur in the English or North-French Eocene. An exception to this is perhaps formed by the species which I have mentioned under the designation of *Cryptodon cfr. unicarinatus* Nyst.; but as will be seen from this designation the specimens in question do not quite agree with the *Cr. unicarinatus* Nyst. However I have not seen any other species described to which they have so great a resemblance as to this Middle Oligocene species. Besides this one all the other determinable species which I have mentioned from Kap Dalton are represented in the West-European Eocene; from this must perhaps be excepted one of the crustaceans viz. *Coeloma bicarinatum n. sp.*

There seems to be some reason for drawing a parallel between the Coeloma-bed, and the *London Clay*, not only on account of these two deposits having a petrographic resemblance (brown or greyish brown clay with calcareous concretions), but also because there seems to be a certain resemblance in their fauna, as far as the material from Kap Dalton, which is so poor with regard to species, will permit of comparison. I do not attach any importance to the fact that wood perforated by Teredos is common in both formations, as this phenomenon is of very frequent occurrence also in other Tertiary deposits. The occurrence of *Hoploparia groenlandica n. sp.* seems to me to be of importance; this species is very closely related to, if not identical with, the *H. gammaroides* Bell from the *London Clay* of Sheppey. Something the same is the case with the *Modiola* found at Kap Dalton, which is certainly closely related to *M. simplex* J. Sow. found in the *Bognor Beds*, that is, in a deposit of the same period as the *London Clay*. To the other crustacean from Kap Dalton, *Coeloma bicarinatum n. sp.*, I have not found any corresponding

species in the *London Clay*; yet I must draw the attention to the resemblance it has to the *Portunites incerta* Bell [1]); according to Bell's description the two species cannot be identical, but in the first place the *Portunites incerta* (judging from Bell's figures), seems to vary not a little, and secondly Bell's description is somewhat brief. In spite of all my exertions I have unfortunately not succeeded in procuring any specimen of this species for purposes of comparison with the Greenland one.

If a closer comparison could be drawn between the Cyrena-bed and the West-European Tertiary, it would presumably be between the *Sables de Cuise* or the *Bagshot beds*, which deposits are said to be partly contemporaneous. This supposition is especially supported by the frequent occurrence of *Cyrena Gravesii* Desh. at Kap Dalton. This species is also very common at Cuise-la-Motte, where a like mixed fauna is found as in the Cyrena-bed at Kap Dalton. Of other species which I have found in the latter bed, I have already mentioned *Cryptodon cfr. unicarinatus* Nyst. Like this species *Mytilus affinis* J. Sow. also seems to indicate a higher horizon, while the opposite is the case with *Astarte cfr. tenera* Morris; but the occurrence of these species is not quite certain, and it is not impossible that some species, in such a distant locality, may have a somewhat different vertical extension than usual.

As will be seen by the above description, the East-Greenland Tertiary seems to be closely related to the West-European. The resemblance is so great that we may certainly suppose, that at the time when the above mentioned formations were deposited, there must have been a connection between the two oceans. However this connection presumably need not exclude the possibility of a «land-bridge» between Western-Europe and

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[1]) Bell: A monograph of the fossil malacostracous Crustacea of Great Britain. Part I. Crustacea of the London clay. London 1857. p. 21; pl. 3, figs. 1—5. — The Palaeontogr. Society.

North-America via Iceland and Greenland. But if this bridge was in existence at that period, it must certainly have been broken through by the sea in one or more places, so that it formed no hindrance to the propagation of the same fauna in both oceans. But there is no reason to think, that the strait or straits constituted a hindrance to the propagation of terrestrial animals and plants.

Although by the finding of the marine Tertiary fossils the Danish expedition to East-Greenland in 1900, has greatly advanced the knowledge of the Tertiary formations of the Arctic regions, still much is left of which we have no knowledge, and further new discoveries will be received with the greatest interest.

Plate III.

Figs. 1 a-c. *Nucula similis* J. Sow. 1 c. Posterior view.
- 2, 3 a-b. *Mytilus affinis* J. Sow. Internal moulds. 2. × 2.
- 4 a-b. *Modiola cfr. simplex* J. Sow. Wax mould.
- 5 a-b. *Astarte cfr. tenera* Morris.
- 6 a-b. *Cyrena Gravesii* Desh. Cast.
- 7 a-b. - - - . Wax mould of interior of a specimen from Cuise-la-Motte, France.
- 8-9. *Cyrena Gravesii* Desh.
- 10. *Tellina sp.*
- 11. *Psammobia sp.*?
- 12. *Erycina sp.* Internal mould. × 2.
- 13. *Donax sp.* Internal mould.
- 14 a-b. *Cryptodon cfr. unicarinatus* Nyst *sp.* × 2.

The figures are of the natural size, except where otherwise stated.

All the specimens figured are preserved in the Mineralogical Museum of the University, Copenhagen.

1 a

1 c

1 b

2

3 a

3 b

4 a

4 b

5 a

5 b

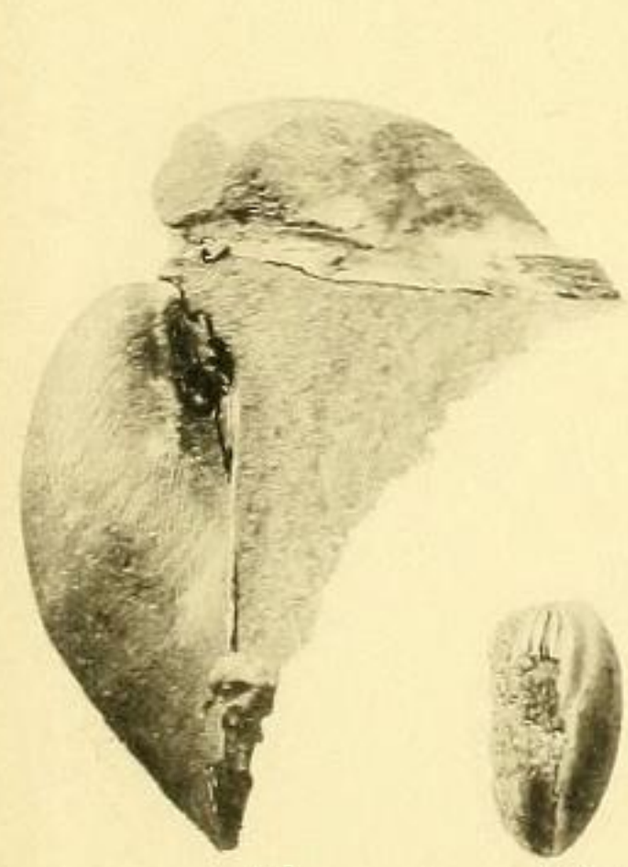
7 a

8

6 a

10

9



6 b

14 a

7 b

11

12

13

14 b

Th. Bloch phot. et del.

Pacht & Crone phototyp.

Plate IV.

Figs. 1 a-c. *Hoploparia groenlandica n. sp.* 1 c. Portion of the carapace; ×2.
- 2. — — — Chela of an other specimen.
- 3. *Natica sp.* Cast.
- 4-5. *Aporrhais speciosa* v. SCHLOTH. *sp.*
- 6. *Coeloma bicarinatum n. sp.*

The figures are of the natural size, except where otherwise stated.

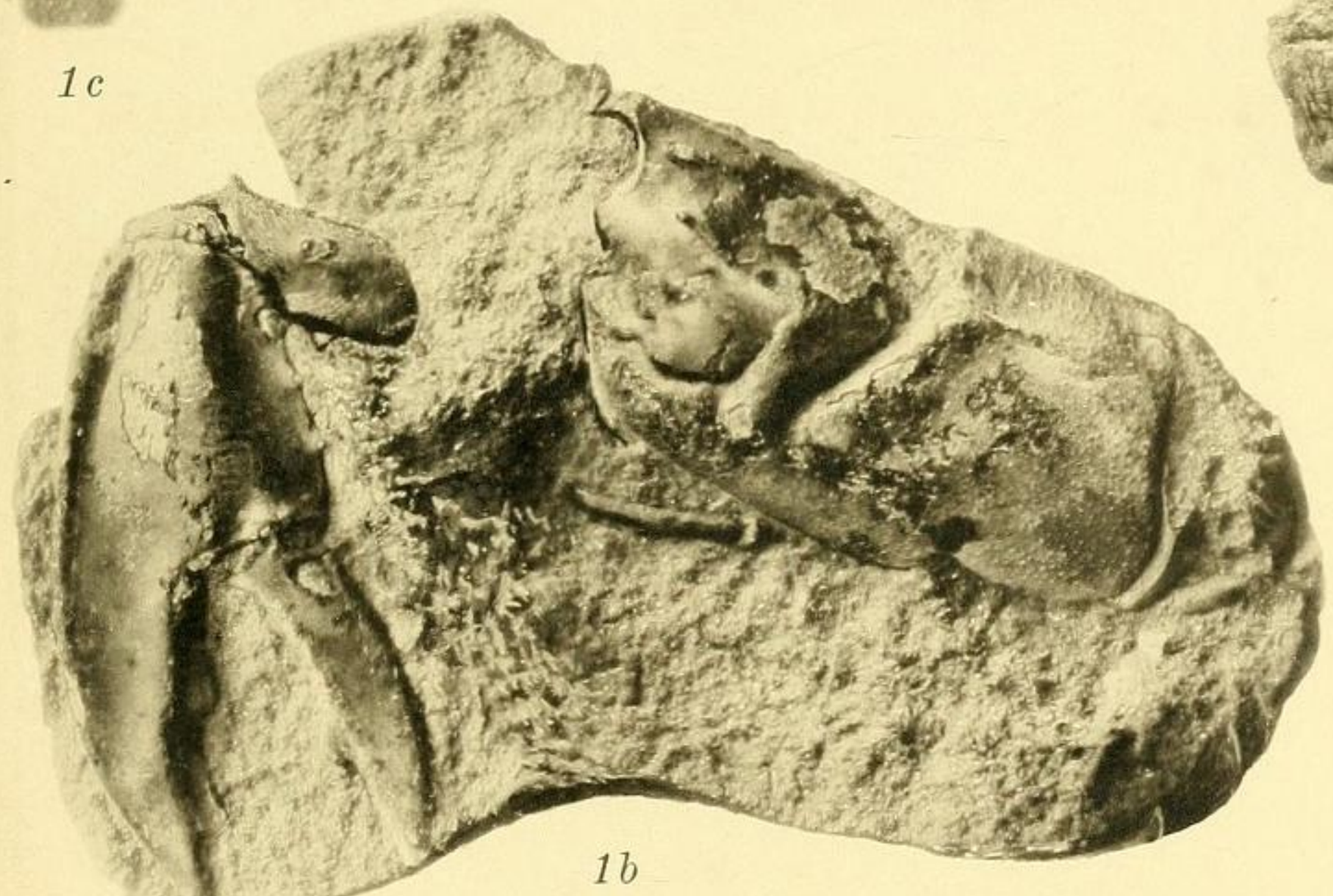
All the specimens figured are preserved in the Mineralogical Museum of the University, Copenhagen.

1a

3

1c

4



1b

5

2

6

Th. Bloch phot. et del.

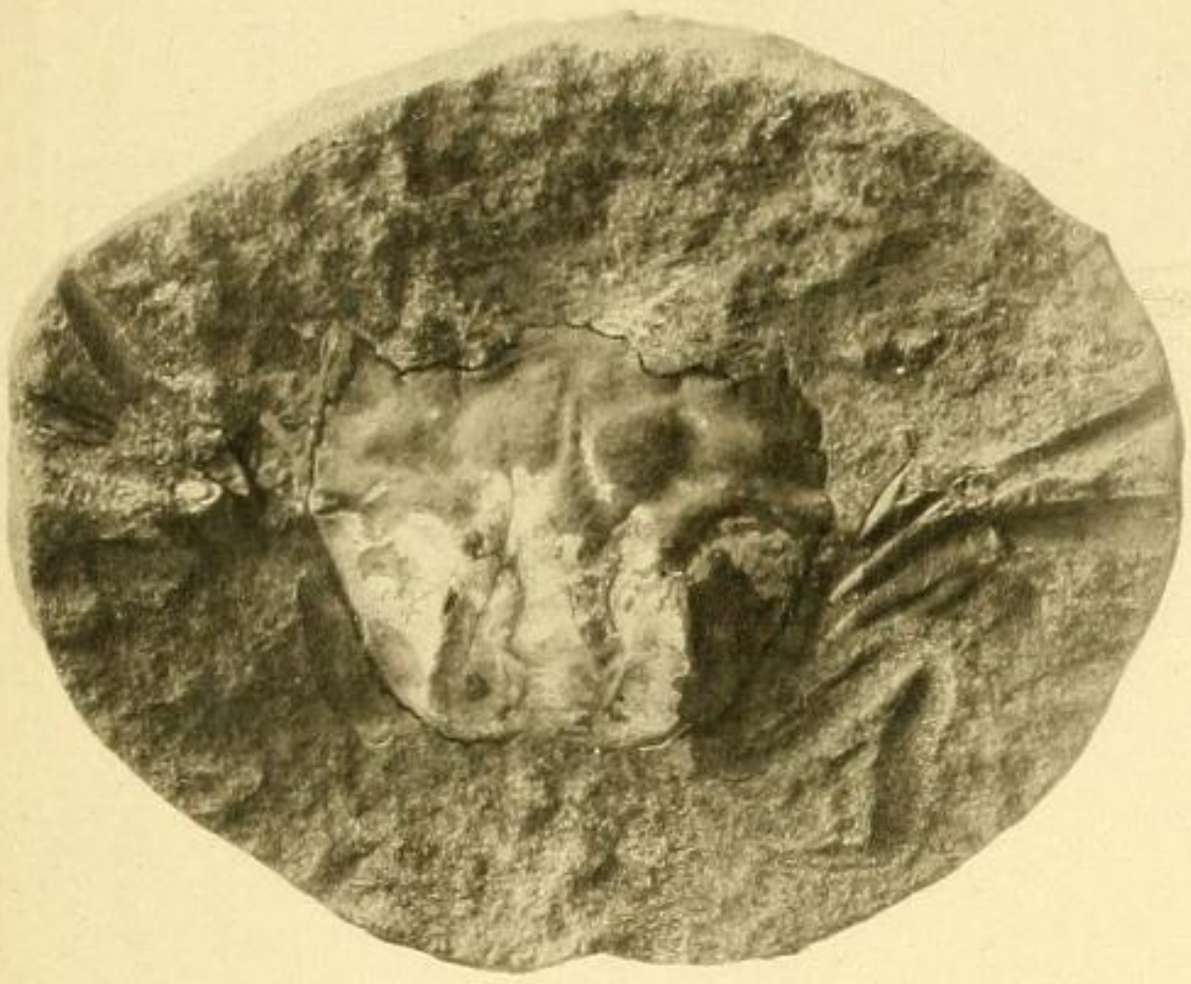
Pacht & Crone phototyp.

Plate V.

Figs. 1-6. *Coeloma bicarinatum n. sp.* 1 & 3. Females. 4. Male. 6. A young specimen; × 2.

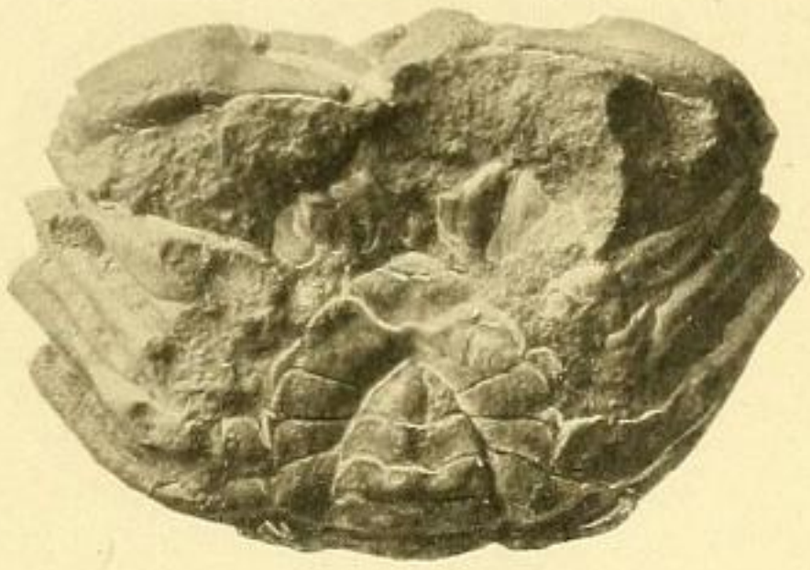
The figures are of the natural size, except where otherwise stated.

All the specimens figured are preserved in the Mineralogical Museum of the University, Copenhagen.

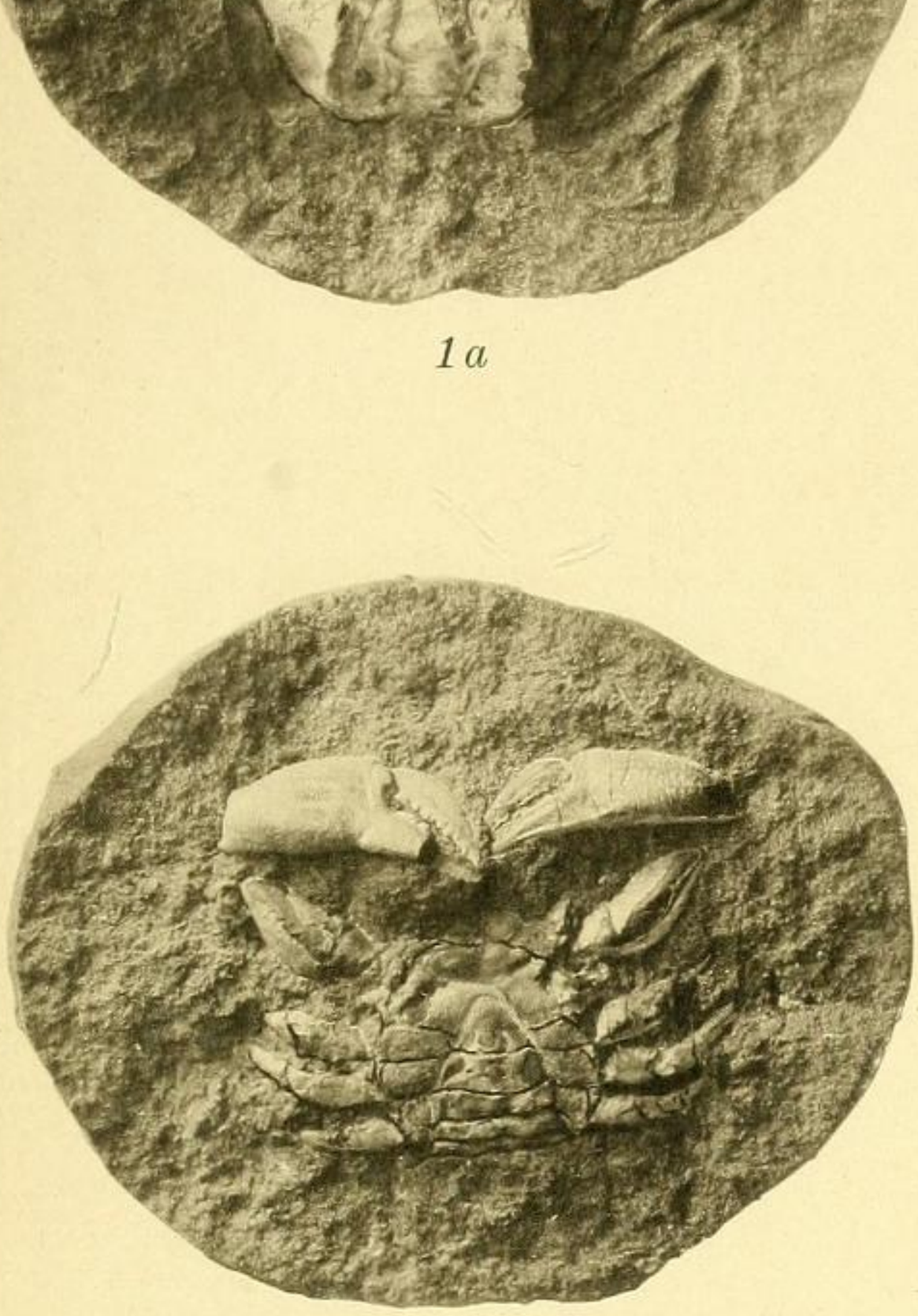


1a

2



3



1b

4

5

6

Th. Bloch phot. et del.

Pacht & Crone phototyp.