MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
Bd. 162 · Nr. 6

DE DANSKE NÛGSSUAQ EKSPEDITIONER 1938 OG 1939
Under Ledelse af Alfred Rosenkrantz

A CRETACEOUS NON-MARINE MOLLUSCAN FAUNA OF WEST GREENLAND

BY

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WITH 3 FIGURES IN THE TEXT

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1958

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Introduction.

During my brief visit to Copenhagen in 1956, Prof. Rosenkrantz of the University Institute of Mineralogy and Geology in Copenhagen showed me a small but very interesting collection of Cretaceous non-marine mollusks from West Greenland. My plan for that trip to Europe was to confine myself to some work in the peri-Alpine areas. I was not able to prolong my stay in Denmark, as I had wished, to examine the contents of this collection. Subsequent to my return to this country, Professor ALFRED ROSENKRANTZ was kind enough to send me the collection for an adequate study, the findings of which have now resulted in the present paper.

The major part of the collection was made by T. SORGENFREI and J. TROELSEN during the Nûgssuaq Expedition in 1938. Besides there are from other localities on the Nûgssuaq peninsula some few incidental lots of Cretaceous freshwater bivalves collected by BRETTING in 1920 and by J. P. J. RAVN in 1909, which are noted at the end of this paper.

In completing the paper, I wish first of all to express my thanks to Professor ALFRED ROSENKRANTZ of the Institute for his generous offer to let me study the collection of mollusks, and also for his kindness in attending to matters relating to the publication of this paper. During my visit to Copenhagen, I had the occasion of meeting Prof. Dr. C. POULSEN, and had the pleasure of enjoying the warm hospitality of Dr. J. C. TROELSEN and Dr. E. NIELSEN, all of the same Institute, to whom I want to offer my heartfelt thanks for their friendly reception.

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Geographic and stratigraphic positions.

Ujaraqtôrssuaq is on the north shore of Nûgssuaq Peninsula, which is located in the northern half of the western coast of Greenland. The fossil-bearing deposit, according to the collectors, is exposed at "cliff 2.5 km east of Ujaraqtôrssuaq, shale, bed I." According to Dr. Sorgenfrei,

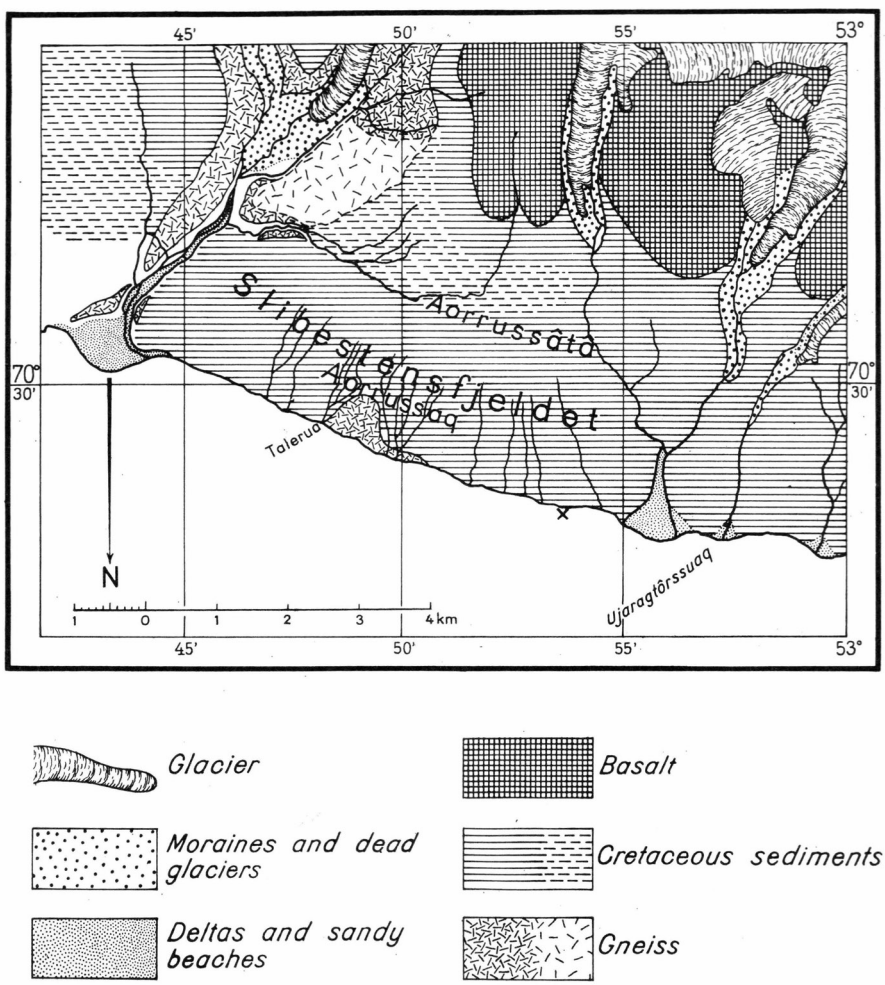

Fig. 1. Geologic map showing part of the north coast of the Nûgssuaq peninsula, compiled by A. Rosenkrantz. Tectonic features omitted.

"about 2.3 km east of Ujaragtôrssuaq two shale beds are visible in the coast section, separated by a 5 m thick conglomeratic sandstone bed. In the lower shale bed which is abt. 15—20 cm thick and overlying sandstone beds, fresh water mollusks were found. In the upper bed which was abt. 1 m thick, imprints of angiosperm-leaves were found together with fresh water mollusks, the latter however less frequent than in the lower shale horizon". The location and exposure are said to be identical with Unit C as that was reported by WHITE and SCHUCHERT (1898, pp. 353—354).

According to WHITE and SCHUCHERT, there occur three units, namely, A, B, C, in the Ujaragtôrssuaq area, each of which yields a distinct flora. Unit A east of a fault is said to be clearly of the Kome age, and Unit B is close to the Atane age. Unit C is considered to be "plainly not older than the Atane age", and it contains well represented dicotyledons along with ferns and gymnosperms of Upper Cretaceous age.

In association with the plant remains in the Unit C, molluscan species of freshwater habitat were found. STANTON (1898), after having examined them, reported: "The new fossils from Ujarartorsuak are entirely different from any of the others (Atane, Patoot or Niakornat) and probably are of more recent age. They appear to be all freshwater forms and include one or possibly two species of *Unio*, an *Anodonta*(?), a

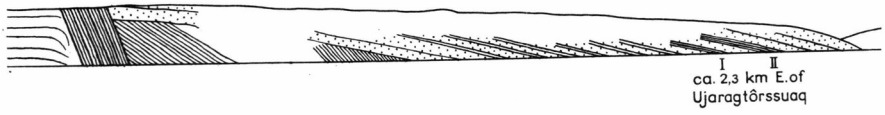

Fig. 2. Sketch of the coast section east of Ujaragtôrssuaq showing shale beds I and II, designed by T. Sorgenfrei.

Sphaerium, and two species of gastropods, each represented by a specimen too imperfect for generic determination. While these forms are such as might occur in the Upper Cretaceous, I think it more probable that they are from Tertiary beds".

The clastic sediments in the general vicinity, according to HEER (1883) on basis of plant remains, are divided into four series: the lowest of them is the Kome bed which may be correlated with the Urgonian in age, if so, they are either the Upper Barremian or the Lower Aptian. The second is the Atane series, which is said to be contemporaneous with the Cenomanian of the Continental Europe. The third is the Patoot group which was considered possibly to be the Senonian, and the fourth is Atanikerdluk series of Tertiary age.

The present mollusca-bearing deposit is said to be identical with the Unit C of WHITE and SCHUCHERT, namely a dark, carbonaceous sandy shale. According to their measured section, this shale bed lies on top of a conglomerate of 20 feet in thickness, by which this shale bed is separated from its underlying sequences of the Kome and the Atane series.

Age of the mollusca-bearing deposit.

On the assumption that the Unit C of WHITE and SCHUCHERT and the "shale, bed I" of SORGENFREI and TROELSEN are identical, the present writer can summarize the previous opinions on the age problem

of the deposit as follows: WHITE and SCHUCHERT considered that it is "plainly not older than the Atane age" and that it contains flora of an Upper Cretaceous age. STANTON thought that while the molluscan forms are such as might occur in the Upper Cretaceous, it is more probable that they are from Tertiary beds.

Because adequate molluscan records in the Atane series are lacking for comparison, it is impossible to say whether this "shale, bed I", on basis of molluscan findings, is older or younger than, or equivalent to that series. However, the evidences of the plant remains indicate sufficiently clear that Unit B and Unit C of White and Schuchert are not of the same age, since each of them contains a distinct flora (p. 353). If the Unit C, which is identical with "shale, bed I", is "plainly not older than the Atane age", then "shale, bed I" must also be "not older than the Atane age". It must be, therefore, younger than the Atane series and most probably a Post-Cenomanian deposition.

STANTON suggested that this mollusca-bearing deposit (Unit C) was more probably of Tertiary age. He did not give any evidence to support his statement, and the two imperfectly preserved specimens of gastropods together with some undeterminable forms of *Unio*, *Anodonta*(?), and *Sphaerium* cannot certainly substantiate the basis of his age-suggestion. Moreover, this age assignment affords a contradiction to the one based on the evidences of fossil plants, for according to WHITE and SCHUCHERT, their Unit C lies stratigraphically much below the well marked Tertiary basalt cap. It seems most unlikely that this mollusca-bearing deposit is of Tertiary age; it is probably a pre-Tertiary sedimentation.

In reviewing the existing data of the non-marine molluscan faunas within the limit of the Upper Cretaceous, we have representatives of several noticeable different levels in North America, each of which yields a distinct molluscan fauna of freshwater or brackish water habitat. The period ranges between the Bear River formation at the bottom through the Judith River and the Fruitland to the Lance formation on the top. Not all the stages within the Upper Cretaceous period are known at present to represent the continental facies in North America. These representations are therefore incomplete, but they may serve the useful purpose of comparison here.

First is the Cenomanian Bear River formation in the southwestern part of Wyoming. It is a well developed sequence of sandstones, shales, mudstones, thin bands of bentonites and other minor units, which indicate changes in conditions of deposition representing a series of alternating freshwater and brackish water deposits. It produces a rich molluscan fauna containing, together with other species, the following common and characteristic species:

Unio belliplicatus MEEK
Unio vestustus MEEK
Corbicula durkeei (MEEK)
Corbula engelmanni MEEK
Corbula pyriformis MEEK
Viviparus couesi WHITE
Campeloma macrospira (MEEK)
Lioplacodes stachei (WHITE)
Pyrgulifera humerosa (MEEK)
Pachychiloides cleburni (WHITE)
Zaptychius haldemani (WHITE)
Physa usitata WHITE

The Judith River formation is possibly a representative of the Campanian stage. It is outcropped both in Montana and Canada. The beds of sandstones and shales are mostly of freshwater origin, but occasionally contain intercalated brackish water layers. Most of the non-marine species were found in the shale beds. The fossil contents contain, in addition to other forms, the following common species of mollusks:

Anodonta propatoris WHITE
Unio subspatulatus MEEK and HAYDEN
Unio danae MEEK and HAYDEN
Sphaerium planum MEEK and HAYDEN
Corbicula occidentalis MEEK and HAYDEN
Corbula subtrigonalis MEEK and HAYDEN
Corbula perundata MEEK and HAYDEN
Viviparus conradi MEEK and HAYDEN
Campeloma vetula MEEK and HAYDEN
Hydrobia subconica MEEK
Goniobasis sublaevis MEEK and HAYDEN
Goniobasis judithensis STANTON

The Fruitland formation in the San Juan Basin of New Mexico and Colorado is possibly within the Maastrichtian stage, and it yields among other forms a number of molluscan species which are common in the deposits:

Unio holmesianus WHITE
Unio amarillensis STANTON
Corbula chacoensis STANTON
Campeloma amarillensis STANTON
Tolotomops laevibasalis YEN
Mesolanites reesidei (STANTON)

The Lance formation in Wyoming and Montana produces a rich fauna, among which the following species of mollusks are common in the deposits, which represent the top of the Upper Cretaceous:

Anodonta parallela WHITE
Unio couesi WHITE
Unio brachyopisthus WHITE
Corbula subtrigonalis MEEK and HAYDEN
Sphaerium planum MEEK and HAYDEN
Viviparus trochiformis (MEEK and HAYDEN)
Campeloma nebrascensis (MEEK and HAYDEN)
Lioplacodes producta (WHITE)
Tulotomops thompsoni (WHITE)
"*Melania*" *insculpta* MEEK
Cassiopella turricula WHITE

An analysis of the existing data together with the molluscan species under consideration seems to demonstrate convincingly that there is a resemblance in species as well as in biotic assemblage between the molluscan species of "shale, bed I" and those of the four Upper Cretaceous formations mentioned above, especially those of the Judith River formation. It is highly possible that this mollusca-bearing shale deposit may be close to the age of the Judith River formation. Because of the small collection of material available at present, I maintain this view only as a working hypothesis leading to further studies. However, it seems to be certain that this mollusca-bearing deposit may be placed in the upper part of the Upper Cretaceous period.

An account of the molluscan species.

The "shale, bed I" of SORGENFREI and TROELSEN contains a molluscan fauna as listed below. This mollusca-bearing dark shale is, as a thin section has shown, carbonaceous, sandy with scattered contents of iron sulfide and plant spores. There are no field data except a geographic locality attached to the collection, and it is assumed that all the specimens were collected within the same bed of the carbonaceous shale.

Anodonta, species undeterminable.
Fig. 3 (1).

This form is represented by two imperfectly preserved specimens of immatured stages in development, however, the expanding wings seem to indicate them well to be specifically undeterminable forms of this genus.

Unio, species undeterminable.

Fig. 3 (2).

Several specimens in compressed, distort or impressed state of preservation can only be identified as species of Unio. The generic assignment is based on its general shape, sculpture and imperfectly preserved lateral teeth of a hinge line for one of the specimens.

Sphaerium troelseni, sp. nov.

Fig. 3 (3).

The shell is of moderately large size for the genus, broadly ovate in outline, subequilateral and having convex valves. The umbo is small, somewhat pointed and projecting higher than the hinge line. The concentric lines of growth are fine in the initial stage and become increasingly coarser later. Such changes are sometimes abrupt as those being indicated at each successive resting stages. The holotype measures 11.5 mm in length and 12.0 mm in height.

This species may be comparable to *Sphaerium planum* Meek and Hayden, originally described from the Judith River formation and considered to be one of the most common species in several localities where the Judith River beds are exposed. However, the species of Ujaragtôrssuaq is larger in size, more rhomboidal in outline and bears stronger concentric ridges. Such external features are generally variable in Sphaerium. The hinge structure of this species is at present unknown, so that the actual relationship between the two species must be traced on basis of more morphological features which can only be gathered from additional collection of specimens.

Sphaerium groenlandensis, sp. nov.

Fig. 3 (4).

The shell is ovately oblong in outline, subequilateral and having strongly convex valves. The umbo appears to be blunt and raising slightly above the hinge line. The sculpture consists of fine and close concentric lines of growth, and a few coarser lines marking the end of the successive resting stages. The holotype measures 9.0 mm in length, 7.8 mm in height and 5.0 mm in convexity of valves.

This species differs from the preceding one by being smaller in size, more oblong in outline, and having more prominent umbo and finer sculpture. These features are clearly critical for differentiation of the specimens from those of the preceding species of the same deposit.

It is a well known fact that species of Sphaerium have remarkable tenacity of life. They occur in ponds and lakes, as well as in rivers, which may be dry during part of the year; and they can withstand drought. Therefore, most of the species have a wide range in geographic distribu-

tion. Such records in distribution have been known not only in the present-day zoo-geography, but also in that of some late Cenozoic period. Because their occurrence is over wide areas within a specific range of time, this group of bivalves is of great value for the purpose of correlating formations of various ages in which their fossil remains are unearthed.

Corbula nûgssuaqensis, sp. nov.

Fig. 3 (5).

The shell is of medium size for the genus, subtriangular oblong in outline, and having moderately convex valves. The umbo is small; both anterior end and ventral margin are gently convex, the posterior end is narrowed and angulated, truncating at the extremity. The surface is marked by sparsely spaced, well developed concentric ridges and fine lines of growth on the interspaces. These ridges are angulated, obtusely at the anterior end and rather sharply at the posterior end. Such angulations produce an appearance of 3 radiating plications on the surface. The holotype measures 12.5 mm in length and 7.0 mm in height.

This species is comparable to *Corbula perundata* MEEK and HAYDEN which was originally described from the type-locality of the Judith River formation in Montana, and it has been also recorded from several other localities in the western States and Alberta. The Greenland species, however, differs from the Judith River form by its more elongated outline, truncating at anterior extremity, and having more strongly developed and fewer concentric ridges.

Mesoneritina groenlandensis, sp. nov.

Fig. 3 (6, 7).

The shell is naticoid in outline, having a small but elevated spire and laterally dilated body whorl. The whorls are gently convex, bearing fine lines of growth, and having moderately impressed suture. The aperture is subovate in outline; outer lip simple and gently produced at the base, inner lip thin and well defined. The holotype measured 12.8 mm in altitude of shell, 10.0 mm in its width; 8.6 mm in height of aperture, 7.0 mm in its width; having 4 whorls.

This species resembles *Mesoneritina naticiformis* (WHITE), which was originally described from the Graham coal mine locality north of Cokeville, Wyoming, but it differs from that species by its much larger size, more elevated spire and much thinner columellar plate. It may also be comparable to *Mesoneritina bannisteri* (WHITE), which was described from a late Cretaceous bed exposed near coalville, Utah, but it is readily different from that by its larger size, higher spire and much thinner shell substance.

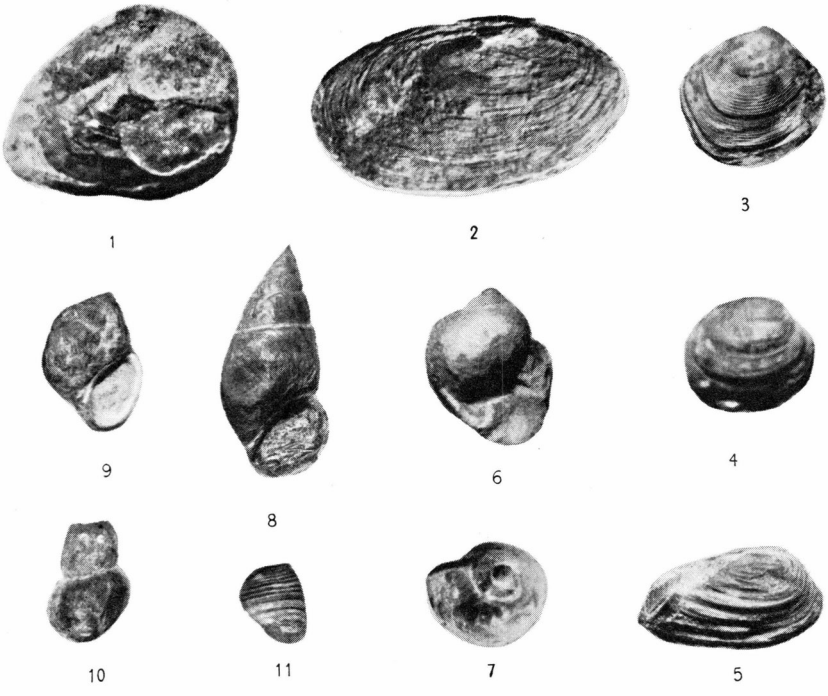

Fig. 3. The collection of specimens contained in this paper, including the holotypes and paratypes, is preserved in the Museum of the Mineralogical and Geological Institute of the University, Copenhagen. The illustrations are enlarged slightly less than $\times 2$. The author is indebted to his colleague, Professor Dr. HERBERT S. WARREN for the provision of the photograph.

1. *Anodonta sp.* undet. — 2. *Unio sp.* undet. — 3. *Sphaerium troelseni, sp. nov.* 4. *Sphaerium groenlandensis, sp. nov.* — 5. *Corbula nûgssuaquensis, sp. nov.* — 6. 7. *Mesoneritina groenlandensis, sp. nov.* — 8., 9. *Lioplacodes sorgenfreii, sp. nov.* — 10. *Lioplacodes sp.* undet. — 11. *Goniobasis*(?) *sp.* undet.

Lioplacodes sorgenfreii, sp. nov.

Fig. 3 (8, 9).

The shell is very narrowly perforate, elongate-ovate in outline, having a highly turreted spire, which is tapering towards the apex, and descending at the body whorl. The whorls increase rapidly in size, moderately convex and slightly shouldered along the suture. The suture is well impressed and rather deep. The sculpture consists of lines of growth, finer on the earlier whorls and coarser on the subsequent ones. The aperture is vertically ovate in outline, having its peristomal margin continuous and gently convex. The parietal wall is arched and the columellar margin nearly straight. The holotype measures 16.0 mm in altitude of shell, 8.0 mm in its width; 8.0 mm in height of aperture, 4.5 mm in its width, and having 7 whorls.

This species may be comparable to *Lioplacodes stachei attenuata* YEN, which was originally described from the Graham coal mine locality north of Cokeville, Wyoming (YEN 1954, p. 46, the age of the enclosing deposit is considered to be younger than the Bear River formation). However, this species can be readily differentiated by its larger size in about same number but more convex whorls, broader outline of the shell and larger aperture. Species of *Lioplacodes* are known in several localities from Lower Cretaceous to Paleocene rocks in the western interior of the United States and Canada.

Lioplacodes, species undeterminable.
Fig. 3 (10).

There are several specimens distinctly of smaller size than the preceding species in the collection. These specimens may represent another species of *Lioplacodes*. None of them, however, has more than two whorls preserved, and cannot, therefore, be identified as to species at present. These specimens remind one of some of the Lioplacodes from the late Cretaceous formation exposed in eastern Utah and western Colorado (Yen, 1954, p. 63).

Goniobasis (?) species undeterminable.
Fig. 3 (11).

An imperfectly preserved specimen shows distinctly well the sculpture of the shell. It is close to the pattern of *Goniobasis Judithensis* STANTON, which is a common species in the freshwater beds of the Judith River formation. The sculpture consists of sharply elevated revolving lines, which are separated by broader, flat bands and crossed by distinct lines of growth.

In addition to the above five species of bivalves and four of gastropods from the "shale, bed I", there are two incidental lots of bivalves in the collection, which were obtained from the general area: one specimen from Unartoq, Disko island, can be identified only as *Unio sp.;* five specimens from Atanikerdluk, Nûgssuaq peninsula, represent another species of *Unio*, and three specimens from the same deposit may be identified as a species of *Anodonta*. Without a knowledge of the hinge structure, it is impossible to identify the species of naiades. Dubious records would merely cause confusion.

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Færdig fra trykkeriet den 29. december 1958.