

NOTES ON THE UPPER CRETACEOUS AND LOWER TERTIARY FISH FAUNAS OF NORTHERN WEST GREENLAND

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Fossil elasmobranchs and actinopterygians collected from Cretaceous and Early Tertiary deposits in northern West Greenland are recorded.

Elasmobranch genera and species from the Kangilia and Agatdal Formations make it evident that these formations are of different age, as demonstrated also by the invertebrate faunas.

The opinion that the West Greenland area and the Dano-Scanian Basin were parts of the same ocean in early Danian time is corroborated by the high degree of similarity between the selachoid faunas of the Greenlandic Lower Danian Kangilia Formation and the Lower and Middle Danian in Dano-Scania.

The Agatdal Formation selachoids and batoids show, as regards genera and species, a high degree of similarity to the Upper Paleocene selachian faunas of Europa and North Africa, and a more remote affinity to that of the Paleocene Aquia Formation of eastern North America. In West Greenland, however, the occurrence of this selachian fauna is manifest already in the Upper Danian, as shown by the associated invertebrate fauna. This affords corroborative evidence for the hypothesis that in Paleocene time the northern Nearctic fauna tended to migrate towards the south-east, but suggests also a migration, although more restricted, to the south-west into the sea covering eastern North America.

The investigations, however, show that the elasmobranchs, at least as far as the Atlantic area is concerned, are of little significance with respect to the drawing of the Cretaceous-Tertiary boundary.

The present notes are based upon material collected during several expeditions to northern West Greenland under the leadership of Professor Alfred Rosenkrantz ("De Danske Nûgssuaq Ekspeditioner 1938-39" and seventeen expeditions under the auspices of the Geological Survey of Greenland).

Fossil fish remains, found in the sedimentary deposits covering large areas of northern West Greenland, were recorded many years ago by Ravn (1918, p. 364) who mentioned a single teleost vertebra and a teleost scale originating from two localities on Nûgssuaq peninsula (Niaqornat and Atâ). The material now available was collected from the following widely distributed localities: Umîvik, Svartenhuk; Kûgssinerssuaq, Disko; Igdors-

suausuaq, Kangilia, Vestre Konglomeratkløft at Angnertuneq, Tuperssuartâ and Danienkløft, all situated at or close to the north coast of Nûgssuaq peninsula; Ilugisq, Oyster-ammonite Conglomerate loc. I, Oyster-ammonite Conglomerate loc. III, Agatkløft, Turritellakløft, and Qaersutjægerdal, all situated in the central part of Nûgssuaq peninsula; and, finally, Tartunaq at the south coast of Nûgssuaq peninsula (see Rosenkrantz *in* Rosenkrantz *et al.*, 1940; 1942, p. 19, fig. 10; Koch, 1959, p. 8, fig. 1; p. 76, fig. 35; pl. 5; Birkelund, 1965, p. 12, fig. 1; p. 13, fig. 2; p. 15, fig. 3; pl. 48).

The fish faunas, ranging in age from the Lower Senonian (Coniacian) to the Paleocene, include elasmobranchs and actinopterygians. The present paper, however, deals mainly with the elasmobranchs in relation to stratigraphy and gives but brief hints about the actinopterygians in the collection. A thorough study and description of the whole material, which is kept in the collection of the Mineralogical and Geological Museum of the University of Copenhagen, will be published later.

Fish from Svartenhuk, Disko and the north coast of Nûgssuaq peninsula

Fish remains are rare in the marine sediments covering these areas. Although many teams have worked intensively during several field seasons since 1938, the fish collection from the area in question amounts to only 27 isolated selachoid teeth, a single selachoid vertebra, and ten actinopterygians or fragments of actinopterygians. The deposits from which these collections were secured are of Senonian and Danian age.

Lower Senonian

A not yet identified teleost specimen originates from marine bituminous shales at Umîvik, Svartenhuk. These deposits have yielded ammonites of Coniacian age (Rosenkrantz *in* Rosenkrantz *et al.*, 1942, pp. 37-39; 1951, p. 156; Birkelund, 1965, pp. 11-14), thus fixing the specimen as the oldest known teleost element of the northern West Greenlandic fish fauna.

Another defective actinopterygian, preserved in a state preventing a closer identification, originates from deposits of Lower Santonian age, as shown by the associated cephalopods (Birkelund, 1965, p. 19), exposed at Tuperssuartâ on the north coast of Nûgssuaq peninsula.

Lower Danian

The fish remains from the north coast of Nûgssuaq peninsula all originate, with the exception of the specimen from Tuperssuartâ mentioned above,

from beds of Danian age, as is possibly also the case with two not identifiable teleost scales from Disko.

The fish from the north coast of Nûgssuaq peninsula, consisting of elasmobranchs and actinopterygians, were collected from the tuff beds I and II as well as from concretions found in the bituminous shales situated below, between and above the tuff beds (for further information on the tuff beds see Floris, *in press*); all these deposits being parts of the Lower Danian Kangilia Formation (Rosenkrantz & Pulvertaft, *in press*).

Elasmobranchii

The elasmobranch remains, comprising isolated teeth and a single vertebra, originate from the tuff beds I and II and from concretions found above the tuff bed II. Invertebrates, indicating the Danian age, are often found associated with the vertebrate remains in these concretions.

The elasmobranch material belongs in all cases to the order Selachoidi; the following families, genera and species are represented:

- Fam. Notidanidae: *Notidanus sp.*
- Squatinidae: (?)*Squatina sp.*
- Squalidae: *Squalus sp. aff. orpiensis* Winkler.
- Lamnidae: *Scapanorhynchus raphiodon* Agassiz.
Lamna appendiculata Agassiz.
Lamna cf. appendiculata Agassiz.
Lamna incurva Davis.
Lamna elegans Agassiz.
Lamna cf. elegans Agassiz.
Lamna cf. venusta Leriche.
Oxyrhina cf. lundgreni Davis.
Oxyrhina sp.

The single selachoid vertebra mentioned above probably belongs to *Lamna appendiculata* Agassiz.

Actinopterygii

The actinopterygian material, preserved in concretions found in the bituminous shales below, between, and above the tuff beds I and II of the Kangilia Formation and comprising seven specimens, includes the oldest hitherto known undoubted gadoid. This important specimen is mentioned in a paper by Rosen & Patterson on morphology and relationships of the paracanthopterygian fishes. This is not the place to deal in any detail with this gadoid specimen, but I think it appropriate to quote the observations mentioned by Rosen & Patterson (1969):

"The earliest undoubted gadoid is a complete fish . . . from the Lower Danian (basal Paleocene) of West Greenland, . . . This fish is about 17 cm in standard length and is of typical gadoid form, slender, with elongate dorsal and anal fins extending almost to the caudal fin, which has very numerous procurrent rays, the first caudal procurrent rays in front of the eighth pre-ural neural and haemal spines. The distal parts of the dorsal and anal fins are not preserved, but the anal appears to be single, the dorsal divided into a short anterior portion and a long posterior portion, as in the Merlucciidae. The caudal skeleton is similar

to those of morids... The skull roof appears to be similar to that of *Rhinocephalus*, the premaxilla and the lacrimal are like those of *Rhinocephalus* and *Sphenocephalus*. The symplectic and preopercular are of gadoid type. The teeth are small, as in morids and macrurids, not enlarged as they are in *Rhinocephalus* and other merlucciids".

Comparisons

The numerically small, but varied selachoid assemblage from the Kangilia Formation shows a conspicuous affinity to that of the Senonian and Lower and Middle Danian deposits in Dano-Scania (Davis, 1890). A comparison with the faunal list given by Davis (pp. 433-434) demonstrates a clear general and specific conformity between these two faunas. Most important is the presence in the West Greenlandic selachoid fauna of a form closely resembling the characteristic Dano-Scanian *Oxyrhina lundgreni* Davis. The crown of the specimen found in West Greenland possesses all the specific traits characterising *Oxyrhina lundgreni*, but differs in being smaller. Unfortunately, the material at hand from West Greenland of this stratigraphically and palaeogeographically very important form is not sufficient to establish its conspecific identity to the well known Dano-Scanian form. On the other hand, I feel rather convinced that the Greenlandic specimens, if found in deposits in Dano-Scania, would be identified as small teeth of *Oxyrhina lundgreni*, but until more material is available for comparison I prefer to refer to the Greenlandic form as *Oxyrhina cf. lundgreni*.

Two of the genera identified in the West Greenlandic material, *Squatina* (identified with doubt) and *Squalus (Acanthias)*, are unknown in the Senonian and Lower and Middle Danian elasmobranch faunas of Dano-Scania, although both genera occur elsewhere in older deposits. The specimen of the West Greenlandic *Squalus (Acanthias)*, however, is interesting because of its resemblance in general shape with teeth of *Squalus (Acanthias) orpiensis* Winkler characteristic of the European marine Upper Paleocene (the marine Landenian incl. Heersian; Leriche, 1902, 1951), but the tooth of the Greenlandic form differs in its bigger size.

Generally speaking, the Kangilia Formation selachoid fauna has Cretaceous affinities, emphasized moreover by the presence of a Lamnid shark resembling the European *Lamna venusta* Leriche of Santonian-Campanian age (Leriche, 1927, pp. 246-247, figs. 9-12). The occurrence, on the other hand, of a species of *Squalus (Acanthias)*, apparently of close affinity to the typical Upper Paleocene species *Squalus (Acanthias) orpiensis* (which is found in its typical form in the Agatdal Formation fish fauna, see below p. 210), gives the Kangilia Formation selachoid fauna that Cenozoic affinity which can be expected in a Danian selachoid fauna definitely transitional between the true Cretaceous and the true Tertiary selachoid assemblages.

Comparing the Kangilia Formation selachoid fauna with the poor elasmobranch fauna of the Montian in Belgium ("Calcaire grossier du Mons") and in France ("Calcaire pisolithique"), it is found that the only common elements, *Lamna appendiculata* Agassiz (found in both Belgium and France) and *Scapanohynchus raphiodon* Agassiz (reported only from Bel-

gium; Woodward, 1889, p. 335; Leriche, 1902, 1923), give no clue to the problem of whether or not these faunas are comparable as to age, since the two species in question are not confined to a sufficiently limited range in geological time that they can be of much use for stratigraphical evaluation.

The West Greenlandic selachoid assemblage is poorer both in genera and species than the Lower and Middle Danian elasmobranch fauna of Danoscandia. Several features shown by the invertebrates indicate marine connection between the West Greenlandic sea and the Danoscandia Basin in Danian time (Rosenkrantz, 1951, p. 156), and the close conformity found between the selachoid faunas of the two regions offers, at least to my mind, corroborative evidence for this palaeogeographical feature. The absence in Greenland, therefore, of such elasmobranch genera as *Ptychodus* and *Corax*, both represented in the Lower and Middle Danian deposits of Danoscandia (Davis, 1890), poses a problem. This difference in the elasmobranch records possibly demands no other explanation than the general scarceness of fish remains in the West Greenlandic deposits investigated, *i.e.* the difference may be only apparent. It cannot be concluded, therefore, that one should ask for other explanations, *e.g.* climatological differences between Greenland and Danoscandia or special ecological features prevailing in the area in question in West Greenland during the deposition of the Kangilia Formation.

Fish from central Nûgssuaq peninsula

Fish remains are known from a number of localities in central Nûgssuaq peninsula, where deposits of both Lower and Upper Danian age are exposed comprising sediments of highly varying lithological character. Although fish fossils, generally speaking, must be considered as rare finds in all these deposits, large numbers of specimens have been secured, due to an extremely thorough washing and sorting in the laboratory of about six tons of sediments from the so-called Sonja Member of the Agatdal Formation, referred formerly to the Lower Paleocene (Rosenkrantz *in Koch*, 1959, pp. 75-79), but now established as Upper Danian (Rosenkrantz & Pulvertaft, *in press*). The fish assemblage thus obtained permits good comparison to be made between this part of the West Greenlandic fish fauna and the European, North African, and North American early Tertiary fish fauna.

Lower Danian

Remains of elasmobranchs and actinopterygians have been collected in central Nûgssuaq peninsula from deposits equivalent to certain parts of the Kangilia Formation as developed on the north coast (Rosenkrantz & Pulvertaft, *in press*). Most of this material, however, was preserved in concretions which originate from eroded older beds, mainly of Maastrichtian

age, and found in a basal conglomerate within the deposits in question (*vide* Birkelund, 1965, p. 18). A tooth of the selachoid *Lamna appendiculata* and a single defective teleost specimen, both belonging to the original fish Fauna of the time of deposition, are at hand. The teleost specimen constitutes a further element of the Lower Danian Kanlilia Formation actinopterygian assemblage.

The fauna found in the reworked concretions of mainly Maastrichtian age comprises:

Elasmobranchii

A fragmentary but very characteristic fin spine, probably representing a new genus.

Actinopterygii

A number of unidentified teleost remains (dermal skull bones, scales, vertebrae), partly preserved in coprolites.

Upper Danian

The marine deposits, referred to the Upper Danian and exposed in the Agatdal valley (Angmårtussut), the Turrítelladal valley, and the Qaersutjægerdal valley, have yielded a huge collection of marine invertebrate fossils; in addition at some levels plant-bearing beds occur (Rosenkrantz, 1951, *in* Koch, 1959; Koch, 1951, 1959, 1963, 1964). All these deposits, constituting the Agatdal Formation, are of coast-near, partially deltaic origin (Rosenkrantz *in* Koch, 1959, p. 7; see also Koch, 1963, pp. 11–13; 1964, p. 545). They overly unconformably Lower Danian shales and conglomerate equivalent to certain parts of the Kangilia Formation (Rosenkrantz & Pulvertaft, *in press*). The Agatdal Formation consists of three members, from bottom to top: the Turrítellakløft Member, the Andreas Member with their lateral equivalent the Sonja Member, and the Abraham Member (Rosenkrantz *in* Koch, 1959, p. 75).

The fish remains at hand were secured from lenticular sandstone bodies include in the black shales of the Turrítellakløft Member, from the shale and tuff deposits of the Abraham Member, and, as mentioned above, from the deltaic Sonja Member. The dominating element in the fish material from the Sonja Member is the selachoid *Odontaspis* (*Synodontaspis*) *macrota* Agassiz, *premut. striata* Winkler. This form is also dominating in the fish material from the Turrítellakløft Member and the Abraham Member. Moreover, with the exception of the presence of teeth, apparently derived from older deposits, of a Lamnid resembling *Lamna venusta* Leriche in the collection from the Turrítellakløft Member, the fish assemblages from the three members differ only quantitatively.

The fish material comprises elasmobranchs (isolated teeth, fragments of one or two unidentifiable fin spines, and some vertebrae) and actinoptery-

gians (isolated, mainly fragmentary dermal skull bones, scales, fin-rays, teeth, and vertebrae).

Elasmobranchii

On the basis of the isolated teeth the following orders, families, genera, and species are recognized in the fauna:

- | | |
|----------------------|---|
| Order Selachoidei: | <i>Heterodontus sp. nov.</i> |
| Fam. Heterodontidae: | <i>Synechodus eocænus</i> Leriche. |
| – Squatinidae: | <i>Squatina prima</i> Winkler. |
| – Squalidae: | <i>Squalus (Acanthias) orpiensis</i> Winkler.
<i>Squalus (Acanthias) minor</i> Daimeries. |
| – Scylliidae: | <i>Scyllium vincenti</i> Daimeries.
<i>Scyllium minutissimum</i> Winkler. |
| – Scyliorhinidae: | <i>Galeus sp.</i> |
| – Scymnorhinidae: | <i>Somniosus crenulatus</i> Arambourg. |
| – Lamnidae: | <i>Lamna vincenti</i> Winkler.
<i>Lamna verticalis</i> Agassiz.
<i>Lamna cf. venustra</i> Leriche.*
<i>Odontaspis (Odontaspis) rutoti</i> Winkler.
<i>Odontaspis (Synodontaspis) macrota</i> Agassiz,
premut. <i>striata</i> Winkler.
<i>Odontaspis (Synodontaspis) hopei</i> Agassiz.
<i>Odontaspis (Synodontaspis) winkleri</i> Leriche.
<i>Odontaspis sp. indet.</i> |
| Order Batoidei: | |
| Fam. Rajidae: | (?) <i>Raja sp.</i> |

* Probably derived from eroded older deposits.

The rather badly preserved elasmobranch vertebrae present in the material are possibly in most cases to be grouped with the Lamnid species *Odontaspis (Synodontaspis) macrota* Agassiz, premut. *striata* Winkler.

Actinopterygii

Fin spines of *Arius sp.* (Fam. Siluridae) and teeth of *Sphyrænodus sp.* (Fam. Scombridae) are easily recognisable in the teleost material.

Comparisons

The Agatdal Formation fish fauna, although its age is fixed as Upper Danian by important members of the associated invertebrate fauna, nevertheless shows a close affinity to fish faunas described from the marine Landenian (including Heersian) deposits in Belgium and Northern France (Leriche, 1901, 1902, 1905, 1906, 1922, 1951; Priem, 1902) as well as to the fauna described from beds ascribed to the Upper Paleocene and the Lower Eocene (Thanetian-Sparnacian) in south-east England (White, 1931; Gurr, 1962). Moreover, it also shares two species, *Odontaspis (Synodontaspis) macrota*, premut. *striata* and *Odontaspis (Odontaspis) rutoti*, with the Danish Mo Clay fish fauna of Lower Eocene age (Bonde, 1966; Casier,

1967, tab. II, erroneously refers the Mo Clay selachoids to the Montian).

Very important, however, is the resemblance between the Agatdal Formation fish fauna and that constituting the major part of the unpublished fish material from the Danish Lower Selandian (Vestre Gasværk; for the stratigraphy, lithology, invertebrate fauna, and faunal affinities, see *i.a.* Rosenkrantz, 1924, 1930, 1960; Ravn, 1939). At present it can be established that the two faunas share the following genera and species: *Heterodontus sp.*, *Synechodus sp.*, *Squatina sp. aff. prima*, *Squalus (Acanthias) orpiensis*, *Squalus (Acanthias) minor*, *Somniosus crenulatus*, *Lamna vincenti*, *Odontaspis (Odontaspis) rutoti*, *Odontaspis (Synodontaspis) macrota*, *premut. striata*, and *Sphyrænodus sp.* The Vestre Gasværk Lower Selandian fish material, on the other hand, contains also elements unknown in the Greenlandic Agatdal Formation fish fauna, but well represented in deposits referred to the marine Landenian elsewhere in Europa (e.g. *Notidanus sp.*, *Ginglymostoma sp.*, *Myliobatis sp.*)

Recently the Vestre Gasværk Lower Selandian was shown to belong to the biozone characterized by *Globorotalia angulata* White, fixing the age of the deposits as Heersian (Hansen, 1968). This corresponds well with the immediate impression one gets on the basis of the fish fauna, quoted above, whose oldest equivalent in Belgium and France occurs in the Early Landenian (*i.e.* the Heersian *Cyprina morrisoni* beds) and which characterizes the entire Upper Paleocene with certain forms reaching even into the Eocene. However, regarding the Vestre Gasværk fish fauna, the picture is complicated by the presence also of forms which are obviously derived from eroded older beds, e.g. *Lamna incurva* Davis known from the Upper Senonian and probably from the entire Danian (Davis, 1890; Rosenkrantz, 1920), and *Cestracion danicus* Rosenkrantz occurring in the youngest part of the Danian (Rosenkrantz, 1920). Because of this it must be borne in mind that even the Vestre Gasværk fish assemblage comparable to the Belgian and French Landenian faunas mentioned might be a reworked fauna originating from the Upper Danian deposits, the fish fauna of which is only partially known at present.

Outside Europe we find in North Africa, in deposits ascribed to the Thanetian and Ypresian, a fish fauna (Arambourg, 1952) sharing a number of forms with that of the Agatdal Formation as well as with that of the Danish Heersian (Vestre Gasværk). Of special interest is the occurrence in the Greenlandic Agatdal Formation fauna as well as in the Danish Heersian fish assemblage of *Somniosus crenulatus* Arambourg, known beforehand only from the Moroccan Thanetian fauna.

A selachoid fauna sharing a few genera and species with the Greenlandic is known from the Aquia Formation of eastern North America (Leriche, 1942). The Aquia Formation, referred to the Eocene by Leriche because he found the batoid *Aetobatis irregularis*, the selachoids *Odontaspis winkleri* and *Lamna vincenti*, and the actinopterygian *Phylloodus toliapicus* in the fish fauna, is now established as Paleocene on strong evidence provided by the foraminifera and the molluscs (Nogan, 1964; Palmer & Brann, 1965). The genera and species shared by the Agatdal Formation selachoid fauna and that from the Aquia Formation are limited to the following:

Synechodus, *Odontaspis* (*Synodontaspis*) *winkleri*, *Odontaspis* (*Synodontaspis*) *macrota*, *premut. striata*, *Lamna vincenti*, demonstrating that the affinity of the West Greenlandic Agatdal Formation fish assemblage to that of the Upper Paleocene of Europe is much closer than to that of the Paleocene Aquia Formation of eastern North America.

Concerning *Aetobatis irregularis*, *Odontaspis winkleri*, *Lamna vincenti*, and *Phyllodus toliapicus*, which in the European Anglo-Franco-Belgian Basin do not appear earlier than the Ypresian and because of this provided the main reason for Leriche (1942, p. 101) to regard the Aquia Formation as being of Eocene age, it should be emphasized that all four forms are now known also from Paleocene deposits. Thus *Aetobatis irregularis*, *Odontaspis winkleri*, and *Phyllodus toliapicus* are recorded by Arambourg (1952) from the Moroccan Thanetian and *Lamna vincenti* is present in the fauna from the Heersian deposits of Denmark, as mentioned above. With regard to their occurrence in the Aquia Formation in eastern North America, they coincide here very well with the age indicated by the invertebrates. Their late occurrence in the European Anglo-Franco-Belgian Basin is probably to be regarded as a purely local feature, the reasons for which at present escape an acceptable explanation.

The Agatdal Formation elasmobranch fauna differs from the European, North African, and North American faunas with which it is compared in the absence of holocephalans. Moreover, the batoids, which are common in the fauna of both Europa, North Africa, and North America, are represented in the Agatdal Formation material only by a single tooth, probably representing the genus *Raja*. These differences, at least that concerning the batoids, might possibly have been caused by climatic differences; the fossil flora recorded from the Agatdal Formation points toward warm temperate climatic conditions (Koch, 1963, 1967). The majority of the recent batoids are tropical or subtropical faunal elements, and only members of the families Rajidae and Trygonidae are widespread in temperate and cold waters; the occurrence of a rajid thus agrees very well with the climatic conditions as indicated by the flora. The biotopes of the Agatdal Formation fish fauna, on the other hand, offered only those very special ecological features where deltaic deposits accumulate. The conditions, therefore, can very well be thought to have sustained a pelagic selachoid fauna, while the bottom-living batoids were excluded, which would explain the scarceness of remains from the batoid group. The absence of holocephalans might likewise depend on the ecological factor.

Fish from the south coast of Nûgssuaq peninsula

Of actinopterygian remains (isolated dermal skull bones, scales, fin remains), preserved in concretions, a small collection has been obtained from beds belonging to the Aussivik Member of the Upper Atanikerdluk Formation at a locality close to Tartunaq (Koch, 1959, p. 14, pl. 5). As is established by its stratigraphical occurrence, this small fish assemblage is the youngest known part of the early Tertiary fish fauna of West Green-

land. It can be inferred from certain geological features (Koch, 1959, p. 85) that the fish in question must be members of a fresh or brackish water fauna.

Concluding remarks

Considered from the viewpoint of vertebrate palaeozoology the most important part of the West Greenlandic Upper Cretaceous and early Tertiary fish collection must, in my opinion, be the few teleost specimens of Coniacian and Danian age, and among them the Lower Danian gadoid originating from the Kangilia Formation inasmuch as it is the oldest known undoubted representative of this teleost group.

From the stratigraphical and palaeogeographical points of view, however, the elasmobranch specimens in the collection play a very prominent role, due to the following facts:

A) The presence in the collection of two definitely different elasmobranch faunas, the first characteristic of the Kangilia Formation, the second characteristic of the Agatdal Formation, demonstrating that the two formations in question are not contemporaneous.

B) The selachoid fauna characteristic of the Lower Danian Kangilia Formation shows a broad conformity with the elasmobranch fauna described from the Lower and Middle Danian type localities in Danoscandia (common genera: *Notidanus*, *Scapanorhynchus*, *Lamna*, *Oxyrhina*; common species: *Lamna appendiculata*, *Lamna elegans*, *Lamna incurva*, *Oxyrhina* cf. *lundgreni*). This feature points toward a close correspondence in age between the two faunas and offers corroborative evidence to the opinion that the marine waters of West Greenland and the Danoscandian Basin were parts of the same sea in early Danian time, as has been maintained by Rosenkrantz (1951, p. 156) on the basis of indications offered by the invertebrate faunas of the two regions.

C) The elasmobranch fauna recorded from the Upper Danian Agatdal Formation and mainly consisting of selachoids is as to genera and species in close accordance with the elasmobranch faunas from the marine Upper Paleocene deposits of Europe (Denmark: "Lower Selandian" = Heersian; Belgium and France: Landénien marin; England: Thanetian + Sparnacian) and North Africa (beds ascribed to the Thanetian), sharing the following forms: *Synechodus eocænus*, *Squatina prima*, *Squalus (Acanthias) orpiensis*, *Squalus (Acanthias) minor*, *Scyllium vincenti*, *Sommiosus crenulatus*, *Lamna vincenti*, *Lamna verticalis*, *Odontaspis (Odontaspis) rutoti*, *Odontaspis (Synodontaspis) macrota*, premut. *striata*; a certain affinity, although of a more remote character, is found also to the fish fauna of the Paleocene Aquia Formation of eastern North America. This suggests an Upper Paleocene age for the West Greenlandic Agatdal Formation fish fauna. However, certain important parts of the invertebrate fauna of the Agatdal Formation establish the age of these deposits as Upper Danian (Rosenkrantz & Pulvertaft, *in press*). The fish fauna of the Agatdal Formation, therefore, apparently represents the earliest hitherto known appearance

of a faunal assemblage occurring in Europe at the beginning of the transgression in Upper Paleocene time. Following this, it is tempting to assume that we are here faced with a further example of that trend in faunal migration from the northern Nearctic toward the south-east, which is indicated by several mollusc genera (Morley Davies, 1934, p. 82; Rosenkrantz, 1960, p. 197). If this is accepted, it can be inferred that the very similar fish fauna constituting the major part of the fish assemblage found in the Danish Lower Selandian (Heersian) Vestre Gasværk deposits represents the proper fish fauna of these deposits. Further investigations, however, of the Upper Danian and Heersian fish fossils from Denmark are needed before any definite conclusions can be drawn concerning this problem. A connection, on the other hand, must also have existed with the sea covering eastern North America in Paleocene time, as suggested earlier by Rosenkrantz (1951, p. 158), allowing some migration also to the south-west into this part of the Nearctic.

D) The Kangilia Formation selachoid fauna is dominated by forms having Cretaceous affinities as is also the case with the very similar contemporaneous elasmobranch fauna of Lower and Middle Danian deposits in Dano-Scania. Corresponding features characterize also the poor Montian selachian fauna of Belgium and France. The disappearance, therefore, of the elasmobranch fauna of late Mesozoic type and the final substitution for this fauna by a proper Cenozoic elasmobranch assemblage took place during Lower Paleocene time; in West Greenland this event took place at the beginning of Upper Danian time, as demonstrated by the elasmobranch fauna found in the Agatdal Formation. That certain features, on the other hand, seem to indicate that this event did not occur simultaneously in all regions is to be expected and is unimportant in the present connection. The important inference, at least to my mind, is that the elasmobranchs, as far as our present knowledge goes, are of no significance with respect to the drawing of the Cretaceous-Tertiary boundary.

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Dansk sammendrag

De fra Vestgrønlands Øvre Kridt og Nedre Tertiær foreliggende vertebrater omfatter elasmobrancher og actinopterygier. Af disse er elasmobrancherne, der alle hidrører fra Danien-lagene på Nûgssuaq halvøen, undersøgt med særligt henblik på deres stratigrafiske, palæogeografiske og faunamigrationsmæssige indikationer.

Elasmobranch-materialet viser særdeles klart, ligesom tidligere foretagne undersøgelser af invertebrat-faunaen (Rosenkrantz, 1951, p. 156; Rosenkrantz &

Pulvertaft, under trykn.), at det vestgrønlandske Daniens stratigrafisk falder i en ældre og en yngre del repræsenteret ved henholdsvis Kangilia Formationen og Agatdal Formationen.

Skønt slægts- og arts-mæssigt fattigere er Kangilia Formationens selachie-fauna dog på slægts- og arts-niveau direkte sammenlignelig med det danoscaniske bassins Nedre og Mellem Daniens selachie-fauna, og har som denne et tydeligt sen-mesozoisk præg. Selachie-faunaen styrker således yderligere de tidligere fremsatte anskuelser om en meget nær tilknytning mellem de vestgrønlandske og dano-scaniske havområder i tidlig daniens tid.

Fra Agatdal Formationen, der på grundlag af invertebrat-faunaen kan henføres til Øvre Daniens (Rosenkrantz & Pulvertaft, under trykn.), foreligger en rig elasmobranch-fauna, som omfatter 13 selachie slægter og mindst 15 arter, men kun en batoid slægt. Denne fauna viser stærk tilknytning til europæiske og nordafrikanske øvre paleocæne elasmobranch-faunaer (Danmark: Heersien (Vestre Gasværk); Belgien – Frankrig – England: marint Landenien (incl. Thanetien); Marocco: lag henregnet til Thanetien), medens tilknytningen til det østlige Nordamerikas Paleocæn (Aquia Formationen) er væsentligt svagere. Med sin øvre daniens alder repræsenterer Agatdal Formationens elasmobranch-fauna imidlertid den hidtil tidligst kendte optræden af denne særlige fauna, hvad der understøtter den tidligere fremsatte hypotese om en generel faunamigration fra det nordlige Nearcticum i overvejende sydøstlig retning gennem Tertiær; dog synes migrationsforbindelse mellem det vestgrønlandske havområde og det hav, der dækkede dele af det østlige Nordamerika i Paleocæn, også at have eksisteret.

Palæoichthyologisk set er det desværre meget begrænsede materiale af actinopterygier fra Vestgrønlands øvre Kridt og Nedre Daniens samlingens værdifuldeste del. Dette materiale omfatter således den ældste kendte repræsentant for torske-gruppen og kan derfor bl. a. bidrage til at kaste lys over den tidligste udviklingshistorie for en af de meget vigtige linier indenfor paracanthopterygierne.

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