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First shark record (Chondrichthyes, Elasmobranchii) from the Paleogene of Spitsbergen, Svalbard

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Abstract: This is a short report about the first Cenozoic shark fossil from Svalbard. The specimen derives from the late Paleocene greenish sandstone of the Grumantbyen Formation, which is exposed in Fossildalen on the western side of Colesbukta on Spitsbergen. The single tooth is assigned to the Paleogene sand tiger shark genus *Striatolamia* that also is known from other polar regions. The Fossildalen specimen represents the northernmost Paleogene shark record, and is the second reported body fossil of a vertebrate from the Cenozoic of Spitsbergen.

Key words: Arctic, Paleocene, Grumantbyen Formation, sand tiger shark, tooth morphology.

Introduction

Svalbard has a rich record of fossil fishes, especially from the Devonian (*e.g.*, Blieck *et al*. 1987; Harland 1997; Janvier 1998) and Triassic strata, where sharks are well-represented (Stensiö 1918, 1921; Birkenmajer and Jerzmańska 1979; Błażejowski 2004). Therefore, it is the more surprising that there is not a single Cenozoic record of sharks from Svalbard and, with the exception of a single actinopterygian fish described as a fossil bowfin (Lehman 1951), no Cenozoic fishes at all. The goal of our paper is to communicate the first evidence of a Paleogene shark from Spitsbergen.

Material and methods

The shark tooth was discovered by JH in an allochthonous rock specimen from the riverbed of Fossildalen during 2015 fieldwork in Fossildalen, Colesbukta area, Spitsbergen (Fig. 1) aimed at an investigation of hydrocarbon seep deposits (Hryniewicz *et al*. 2016, 2019). The tooth is embedded in an indurated, fine-grained greenish sandstone with a horizontal, unbranched and smooth-walled tracefossil of *Planolites*/*Palaeophycus* type, preserved on the reverse side. Reconnaissance fieldwork in 2017 identified the massive, glauconite-rich and highly bioturbated sandstones of the less than 200 m thick Paleocene Grumantbyen Formation, higher up in the Fossildalen section, as the source of the shark tooth.

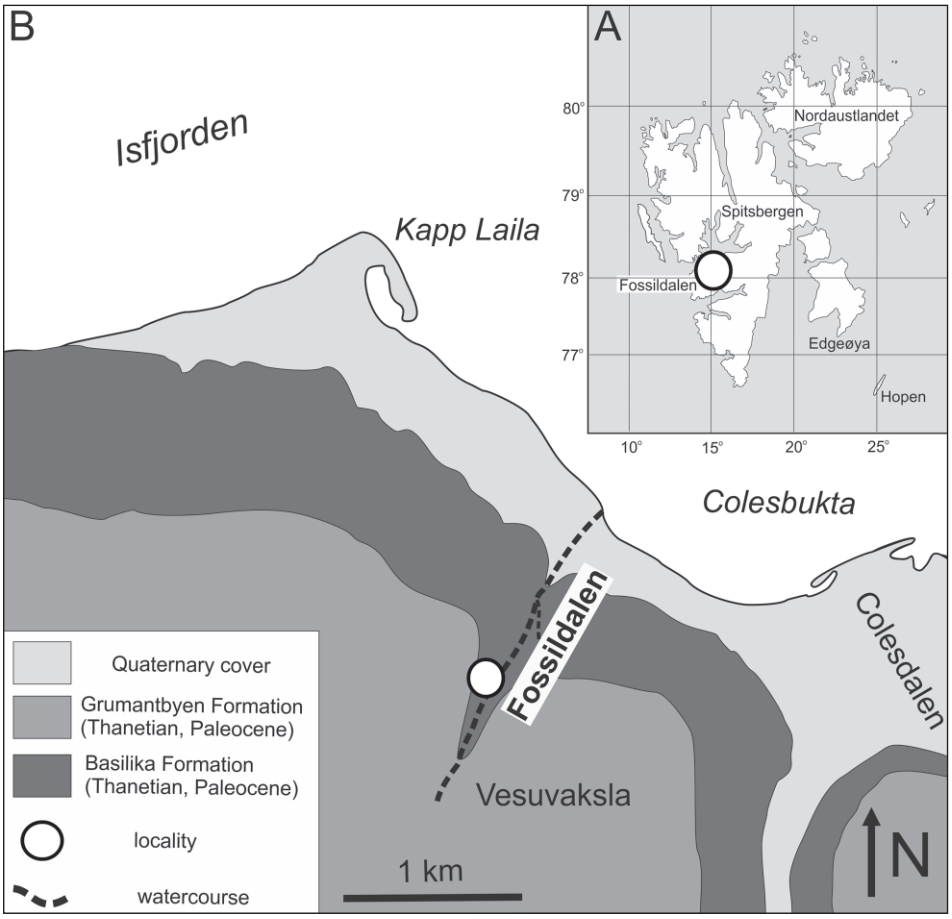

Fig. 1. The position of the study area on Svalbard (**A**) and the map of the western part of the Colesbukta area (**B**), with the approximate locality of the fossil specimen indicated.

The fieldwork included collection of identical green sandstone samples containing *Planolites*/*Palaeophycus* from the stratigraphic level of Grumantbyen Formation. Dating is based on molluscs, foraminifera and palynomorphs (Harland 1997). Dallmann (2015) assigned a Thanetian (late Paleocene) age for the formation. In the Fossildalen area this formation is overlain by dark shales of the Eocene Frysjaodden Formation. Together with the intercalated Hollendardalen Formation with its sandstones typically containing plant fragments, rootlets and ripple lamination, this combined unit has a thickness of about 200 m. The youngest rocks in the area are the whitish sandstones of the Eocene Battfjellet Formation (Dallmann 1999, 2015). Thus, no other than the Grumantbyen Formation can be regarded as the source of the shark specimen described here. The Grumantbyen Formation represents a prograding sand bar complex deposited at inner to middle shelf depths (Nagy *et al*. 2013). The green colouration has been attributed to the higher detrital chlorite content, formed in a terrestrial setting due to mechanical weathering in colder and less humid climate, and transported to the marine sedimentary basin (Dypvik *et al*. 2011).

The specimen is housed in the palaeozoological collections of the Department of Palaeobiology, Swedish Museum of Natural History, Stockholm, under the inventory number NRM-PZ P16468.

Systematic paleontology

Class Chondrichthyes Huxley, 1880
Subclass Elasmobranchii Bonaparte, 1838
Order Lamniformes Berg, 1958
Family Odontaspidae Müller and Henle, 1839
Genus *Striatolamia* Glikman, 1964

Type Species: *Otodus macrotus* Agassiz, 1843.

Stratigraphic Range: Danian (early Paleocene) to Priabonian (late Eocene) (Cappetta 2012; Kriwet *et al*. 2016).

Fossil Occurrences: Africa, Antarctica, Central Asia, Europe, North America (Cappetta 2012; Kriwet *et al*. 2016).

Striatolamia sp.

Material. — One fragmented anterior tooth, NRM-PZ P16468.

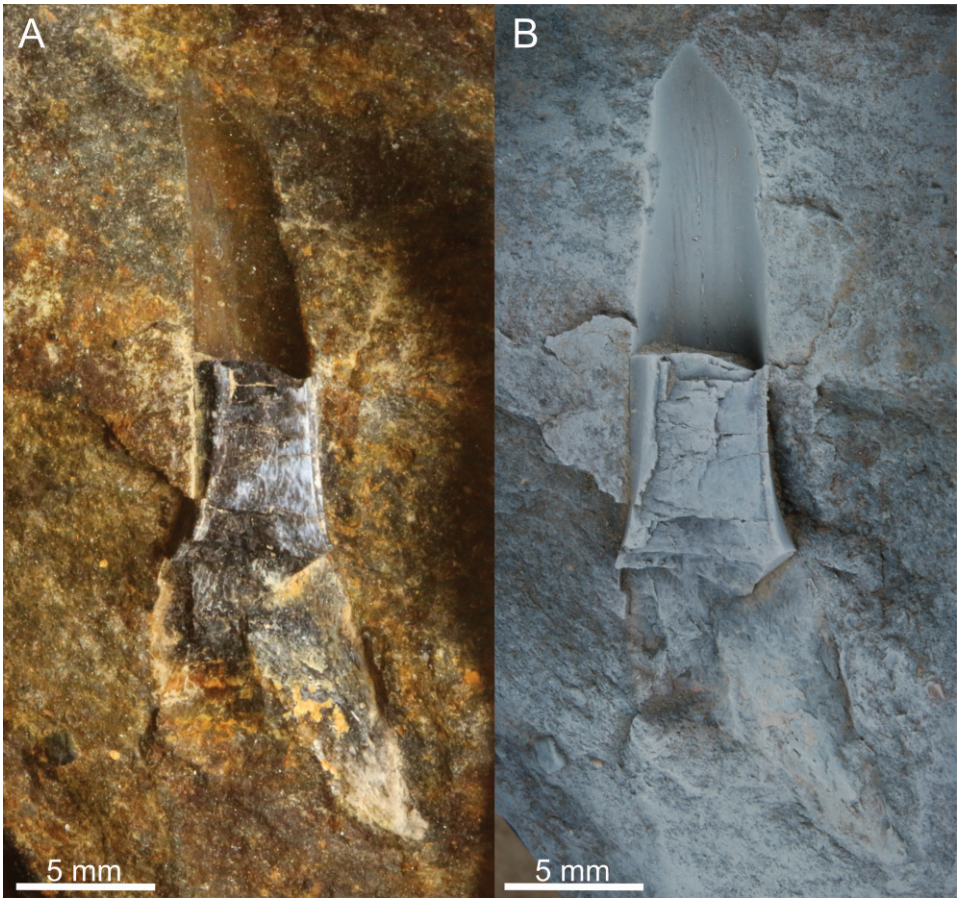

Fig. 2. Anterior tooth of *Striatolamia* sp. from the late Paleocene Grumantbyen Formation of Fossildalen, Spitsbergen (NRM-PZ P16468). **A**. Uncoated view. **B**. Coated view.

Horizon and Locality. — Basal Grumantbyen Formation (Dallmann 2015), Fossildalen, western Colesbukta area ~78°5'52.68" N, 14°31'51.59" E (Fig. 1).

Age. — Thanetian, late Paleocene (Dallmann 2015).

Description. — The specimen is embedded in sandstone on its lingual side and exposing its labial side. It lacks portions of the root and the apex of the central cusp. Most of the missing part of the latter is finely casted as an imprint, showing the lingual crown face. The labial side of the central cusp is abraded and lacks most of the enameloid. The preserved part, including the imprint, of the central cusp measures 24 mm, and the diameter at the cusp base is 9 mm. The preserved part of the root measures 11 mm in height. The tooth is long

and slender with a slightly sigmoidal profile, it seemingly does not have lateral cusplets. It is of typical odontaspidid, sand tiger shark anterior tooth appearance. The preserved cutting edge is not serrated and reaches seemingly the base of the crown. The lingual crown face of the central cusp is convex and displays weak and irregular striations. The small enameloid portion on the labial side is devoid of striation.

Remarks. — The genus *Striatolamia* is characterized by stronger irregular striations on the lingual face of the central cusp in comparison to *Carcharias*. Anterior teeth of *Striatolamia* are characterized by greatly reduced or even absent cusplets, a less pronounced sigmoidal profile than *Carcharias*, and more massive roots that form an acute diverging angle (see Ferrusquia-Villafranca *et al*. 1999; Cunningham 2000). The taxonomy and systematic position of *Striatolamia* is still under debate due to similar dental morphology of the sand tiger shark *Carcharias* (for a more elaborate discussion, see Kriwet *et al*. 2016). *Striatolamia* is known from the early Paleocene up to the late Eocene (Cappetta 2012). The genus includes at least four species, *S. cederstroemi*, *S. macrota*, *S. sibirica*, and *S. striata*. A specific assignment of the single tooth is not possible due to the fragmentary preservation (for species differentiation, see Kriwet *et al*. 2016).

Discussion

The tooth reported here is not the first Arctic record of *Striatolamia*. Padilla *et al*. (2014) described, together with two species of *Carcharias*, *S. macrota* as the most common shark from Eocene strata of the Eureka Sound Formation on northern Banks Island in the Canadian High Arctic (76° N paleolatitude; 74°10' N recent latitude). Oxygen isotope analysis ($\delta^{18}O$) of *S. macrota* tooth enameloid from Banks Island indicates that these sand tiger sharks lived in a brackish Arctic Ocean (Kim *et al*. 2014). Collected at 78°5' N latitude, the Fossildalen tooth represents the northernmost occurrence of *Striatolamia*. *Striatolamia* is also the most common shark genus in the Eocene of Antarctica (Kriwet *et al*. 2016). The shark tooth described here is the first chondrichthyan, and the second body fossil of a vertebrate from the Paleogene of Spitsbergen. In the latter case, the first is the bowfin *Pseudamia heintzi* mentioned before. According to Thomsen (2013), the specimen was discovered at Kapp Dresselhuys, which would imply that it, like the *Striatolamia* tooth, also derives from the late Paleocene (Thanetian) Grumantbyen Formation (Dallmann 2015).

Conclusion

The discovery of a *Striatolamia* tooth in the Paleocene of Spitsbergen indicates that sand tiger sharks (*Striatolamia* and *Carcharias*) occurred abundantly in Arctic coastal waters during the Paleogene, with their Arctic distribution covering the coast at least from the present day Banks Island in Canadian western Arctic to Svalbard. Such a broad Paleogene distribution could likely have been supported by the warmer regional climate during the Paleocene–Eocene (Kim *et al*. 2014).

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