

**CHECKLIST OF THE FOSSIL SHARK AND BONY FISH TEETH
(ELASMOBRANCHII AND ACTINOPTERYGII) HOUSED AT THE
NATIONAL MUSEUM OF NATURAL HISTORY, SOFIA**

PLAMEN ANDREEV¹, NEDA MOTCHUROVA-DEKOVA²

¹Department of Earth Sciences, University of Birmingham, Birmingham B15 2TT, UK
e-mail: pxa012@bham.ac.uk

²Department of Geology and Palaeontology University of Mining
and Geology, Studentski grad, 1756 Sofia, Bulgaria;
ex-curator - National Museum of Natural History,
1 Tsar Osvoboditel blvd., 1000, Sofia,
e-mail: neda_dekova@yahoo.com

This paper provides a taxonomic list of the fossil Mesozoic and Cenozoic shark and bony fish teeth from the collections of the National Museum of Natural History, Bulgarian Academy of Sciences (NMNHS). The material was collected mostly from Bulgaria, but specimens from Angola and France are also available. Elasmobranch taxa prevail in the collection (47 specimens), with the rest of the material consisting of actinopterygian teeth (8 specimens). The largest portion of specimens (35) is of Turonian age. Of particular systematic interest is a dental plate composed of seven associated teeth belonging to a yet undetermined member of the batoid family Myliobatidae, collected from the Lower Eocene of Bulgaria.

Key words: museum collection, Elasmobranchii, Actinopterygii, Mesozoic, Cenozoic teeth, dental plate.

INTRODUCTION

The present work gives a taxonomic account of the fossil shark and bony fish teeth deposited in the National Museum of Natural History - Sofia, Bulgarian Academy of Sciences (NMNHS). The material has been collected for the past 35 years from localities in Bulgaria, France, and Angola, and was donated to the NMNHS by the geologists E. Belmustakov, Ts. Tsankov, St. Breskovski, D. Datchev, G. Cuny and the leading author (P. A.). The data concerning the age of the fossils are taken from the labels accompanying the specimens and reflect the state of knowledge at the time of their registration at the museum. Thus, in some cases the quoted stratigraphic horizons may not correspond to the actual ones. Redetermination of horizons was not possible since no associated fossils or embedding rock was available for study. Only in the case of NMNHS F-12115 did the presence of sediment encasing the fossil allow for reevaluation of its geological age and its assignment to a particular lithological formation.

The total number of specimens equals 55 and, with the single exception of NMNHS F-12115, which is an articulated myliobatid dental plate, they are exclusively represented by isolated teeth in different states of preservation. More than half of the elasmobranch teeth (27 specimens) are over a centimeter in size. This reflects a collecting bias towards bigger specimens rather than the use of techniques such as bulk sampling and subsequent disaggregation of the sediments which do not exclude smaller teeth from the analysis of a particular horizon.

Until recently, a large part of the material was either misidentified or given names which are no longer valid by museum curators. Given that there are only two publications, one by Jagt *et al.* (2006) and another by Andreev (2010), concerning the material under consideration here, during the compilation of the present checklist most of the collection was re-examined and determined by the leading author (P. A.). A full dataset about this collection, including the names of collectors, the state of preservation, old numbers, and the specific treatment of the specimens, will be available on the website of the museum at <http://www.nmnhs.com/>.

This study aims to facilitate further investigation of the elasmobranch and actinopterygian teeth housed at the NMNHS collection. Future research could give important information about the dental histology and systematic position of certain problematic specimens.

The elasmobranch systematic scheme adopted here follows Cappetta (1987), with modifications from Klug (2009) regarding the position of Synechodontiformes and that of *Protolamna* inside Lamniformes (Kriwet *et al.* 2008). The placement of *Sargodon* within Semionotiformes is left undetermined according to the suggestion by Tintori & Lombardo (2007), and the classification of Pycnodontiformes complies with the scheme proposed by Poyato-Ariza & Wenz (2002). Due to the fragmentary nature of most teeth, some specimens are identified up to a genus level and designated with informal specific names (sp., sp. 1, sp. 2).

When a single taxon is represented by material from different sites, the information relevant to the teeth from each particular locality is separated by a semicolon in the Referred material, Locality, and Horizon sections. Specimens that were not mentioned in a published work thus far are marked in parentheses as undescribed material; otherwise, the name of the author and year of publication are specified. In some cases, previous reports mentioning the occurrence of the specific taxa in Bulgaria are provided under the heading Notes.

SYSTEMATIC PALAEOLOGY

Class **C h o n d r i c h t h y e s** Huxley, 1880

Subclass **Elasmobranchii** Bonaparte, 1838

Cohort **Euselachii** Hay, 1902

Subcohort **Neoselachii** Compagno, 1977

Order **Synechodontiformes** Duffin & Ward, 1993

Family **ORTHACODONTIDAE** Beaumont, 1960

Genus ***Sphenodus*** Agassiz, 1843

Sphenodus sp.

Referred material: NMNHS F-31692, a single tooth consisting only of partially preserved crown. The specimen's enameloid ultrastructure was examined in an unpublished master's thesis by Andreev (2009, fig. 9 a-d; fig. 10; fig. 11 a-f.).

Locality: 1 km S from the village of Bilka, Burgas province (Bulgaria).

Horizon: Lower Jurassic, undetermined lenses of sandstones.

Notes: Previous reports mentioning the occurrence of the genus *Sphenodus* in Bulgaria come from Datchev (1972), who described two incomplete teeth of *Sphenodus longidens* from the Callovian (Middle Jurassic).

Superorder **Galeomorphii** Compagno, 1973

Order **Lamniformes** Berg, 1958

Family **EOPTOLAMNIDAE** Kriwet *et al.*, 2008

Genus ***Protolamna*** Cappetta, 1980

Protolamna sp.

Referred material: NMNHS F-976, 977, two isolated teeth belonging to Cretaceous *Protolamna* species (undescribed material).

Locality: Strashimirovo, Varna province, Bulgaria

Horizon: Ypresian (Lower Eocene), Aladan Fm (Aladjova-Khrischeva 1984). NMNHS F-976 and 977 probably belong to Cretaceous *Protolamna* species, although the specimens were probably redeposited in Eocene sediments (H. Cappetta *pers. comm.*).

Family **ODONTASPIDIDAE** Müller & Henle, 1839

Genus and species uncertain

Referred material: NMNHS F-937-939, three teeth in different states of preservation, all with a large part of their root intact (undescribed material).

Locality: Somovit, Pleven province, Bulgaria.

Horizon: Maastrichtian (Upper Cretaceous).

Family **MITSUKURINIDAE** Jordan, 1898

Genus ***Anomotodon*** Arambourg, 1952

Anomotodon sp.

Referred material: NMNHS F-31693 and NMNHS F-978, two partial teeth investigated for their enameloid microstructure by Andreev (2009, fig. 3a-d); NMNHS F-31363, single, incomplete tooth described by H. Cappetta in Jagt *et al.* (2006, fig. 5 c-e).

Locality: Dragoman, Sofia province, Bulgaria (NMNHS F-31693); Strashimirovo, Varna province, Bulgaria (NMNHS F-978); Labirinta cave situated 10 km SW of Cherven Bryag, Vratsa province, Bulgaria (NMNHS F-31363).

Horizon: Turonian (Upper Cretaceous), coal-bearing unit (Kostadinov 1995) (NMNHS F-31693); NMNHS F-978 probably belongs to Cretaceous *Anomotodon* species (H. Cappetta *pers. comm.*), although the specimen was collected from Eocene sediments; Uppermost Maastrichtian (Upper Cretaceous), Kajlaka Fm (Jolkičev 1986) (NMNHS F-31363).

Genus ***Scapanorhynchus*** Woodward, 1889

Scapanorhynchus sp. 1 (Fig. 1 a-d)

Referred material: NMNHS F-940, one anterior tooth represented only by a crown, and a lateral tooth (NMNHS F-943) with partially preserved root (undescribed material).



Fig. 1. - *Scapanorhynchus* sp. 1 anterior (NMNHS F-940) and lateral (NMNHS F-943) tooth and *Scapanorhynchus* sp. 2 anterior (NMNHS F-944) tooth from the Maastrichtian (Upper Cretaceous) of Bulgaria. NMNHS F-940 in labial (a) and lingual (b) view; NMNHS F-943 in labial (c) and lingual (d) view; NMNHS F-944 in labial (e) and lingual (f) view. Scale bars = 5 mm. All specimens coated with ammonium chloride before photographing.

Locality: Somovit, Pleven province, Bulgaria.

Horizon: Maastrichtian (Upper Cretaceous).

Scapanorhynchus sp. 2 (Fig. 1 e, f)

Referred material: NMNHS F-944, single anterior tooth lacking a root (undescribed material).

Locality: Somovit, Pleven province, Bulgaria.

Horizon: Maastrichtian (Upper Cretaceous).

Family LAMNIDAE Müller & Henle, 1838

Genus *Carcharodon* Müller & Henle, 1838

Carcharodon carcharias Linnaeus, 1758 (Fig. 2 a, b)

Referred material: NMNHS F-11893, almost complete upper anterior tooth (undescribed material).

Locality: Angola.

Horizon: Age of the specimen unknown. The museum label specifies Turonian, but the species is known only from the Miocene onward (Gottfried & Fordyce 2001; Ehert *et al.* 2009). The material is probably of Early Pliocene age; comparable to the *Carcharodon carcharias* teeth figured by Antunes (1963) from the Farol das Lagostas locality in Angola.

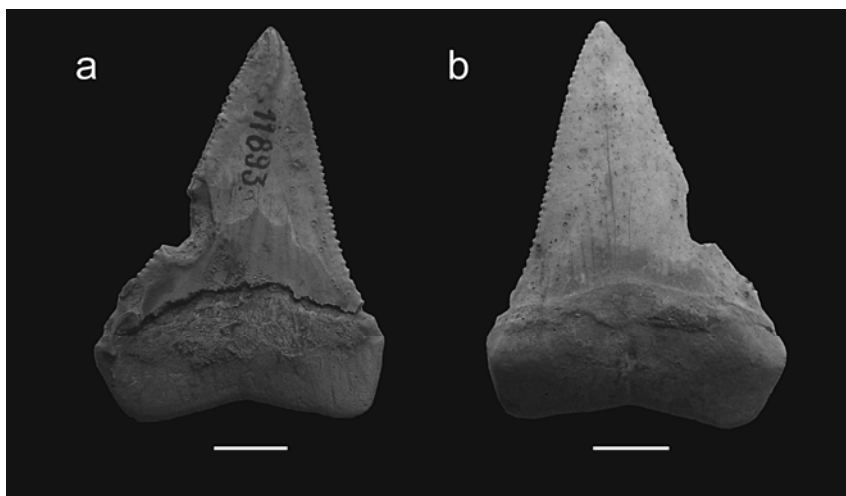


Fig. 2. - Upper anterior tooth of *Carcharodon carcharias* from Angola (NMNHS F-11893) in labial (a) and lingual (b) view. Scale bar = 10 mm. The specimen was coated with ammonium chloride before photographing.

Genus *Isurus* Rafinesque, 1810

Isurus sp. (Fig. 3 a, b)

Referred material: NMNHS F-971, partially preserved anterior tooth missing large part of the root (undescribed material).

Locality: Strashimirovo, Varna province, Bulgaria.

Horizon: Lutetian (Eocene).

Family CRETOXYRHINIDAE Glikman, 1958

Genus *Cretalamna* Glikman, 1958

Cretalamna aff. *appendiculata* (Agassiz, 1843) (Fig. 4 a, b)

Referred material: NMNHS F-974, fragmentary tooth (undescribed material).

Locality: Strashimirovo, Varna province, Bulgaria.

Horizon: Lutetian (Eocene).

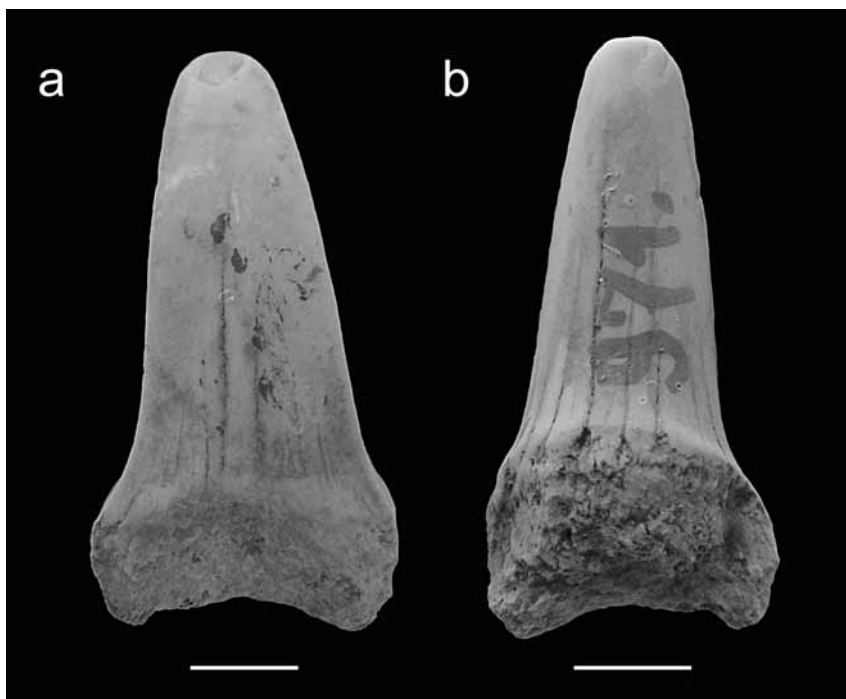


Fig. 3. - Fragmentary lateral tooth (NMNHS F-971) of *Isurus* sp. from the Lutetian (Eocene) of Bulgaria in labial (a) and lingual (b) view. Scale bar = 5 mm. The specimen was coated with ammonium chloride before photographing.

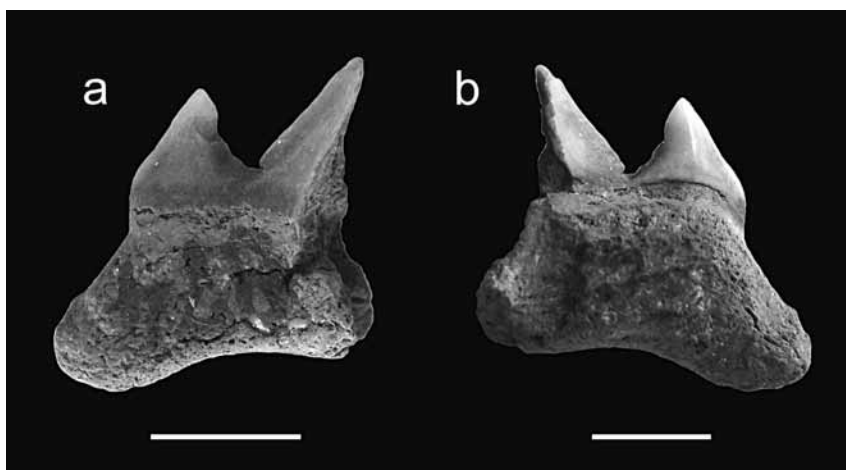


Fig. 4. - Fragment of *Cretalamna* aff. *appendiculata* tooth (NMNHS F-974) from the Lutetian (Eocene) of Bulgaria in labial (a) and lingual (b) view. Scale bar = 5 mm. The specimen was coated with ammonium chloride before photographing.

Notes: According to Cappetta (1987), *Cretalamna* ranges from Albian (Lower Cretaceous) to the Ypresian (Lower Eocene), which would make NMNHS F-974 the stratigraphically youngest reported representative of the genus. This information should be taken with caution, as there is no independent way to verify the geological age of the tooth beyond the label accompanying the specimen.

Family OTODONTIDAE Glikman, 1964

Genus *Carcharocles* Jordan & Hannibal, 1923

Carcharocles megalodon (Agassiz, 1843)

Referred material: NMNHS F-11894, completely preserved tooth (undescribed material).

Locality: Angola.

Horizon: Age of the specimen unknown. The museum label specifies Turonian, but the species is known from the Miocene to the Pliocene (Cappetta 1987). As in the case of *Carcharodon carcharias*, this tooth is considered to come from the Early Pliocene Farol das Lagostas locality, Angola (Antunes 1963).

Carcharocles auriculatus (Blainville, 1818)

Referred material: NMNHS F-979, single tooth consisting of partially preserved crown (undescribed material).

Locality: Strashimirovo, Varna province, Bulgaria.

Horizon: Lutetian (Eocene).

Genus *Otodus* Agassiz, 1843

Otodus sp.

Referred material: NMNHS F-946–947, two partially preserved teeth (undescribed material).

Locality: Somovit, Pleven province, Bulgaria.

Horizon: Unknown.

Notes: In the museum registry book, the geological age of the material is reported to be Maastrichtian, but as the genus *Otodus* is known only from the Thanetian to the Ypresian (Cappetta 1987) its exact stratigraphic position could not be determined.

Family ANACORACIDAE Casier, 1947

Genus *Squalicorax* Whitley, 1939

Squalicorax pristodontus (Agassiz, 1843)

Referred material: NMNHS F-31362, single, incomplete tooth described in Jagt *et al.* (2006, fig. 5 a, b).

Locality: Labirinta cave situated 10 km SW of Cherven Bryag, Vratsa province, Bulgaria.

Horizon: Uppermost Maastrichtian (Upper Cretaceous), Kajlâka Fm (Jolkičev 1986).

Note: Based on the general design of this tooth, a late Maastrichtian age was assigned to this specimen by comparison with Maastrichtian material collected from the phosphate series of Benguerir, Morocco (H. Cappetta in Jagt *et al.* 2006).

Squalicorax sp. 1

Referred material: NMNHS F-31672-31687, sixteen fragmentary teeth. (NMNHS F-31672, 31673 are illustrated in Andreev (2010, fig. 1 a, b; fig. 3 a-g)).

Locality: Dragoman, Sofia province, Bulgaria.

Horizon: Turonian (Upper Cretaceous), coal-bearing unit (Kostadinov 1995).

Notes: The lack of roots on all teeth makes their identification at specific level uncertain. Nevertheless, the crown morphology resembles closely that of *Squalicorax pawpawensis* (Siverson *et al.* 2007), although this species is currently restricted to the Albanian.

Squalicorax sp. 2

Referred material: NMNHS F-31688, one incomplete tooth (Andreev 2010, fig. 2 a, b).

Locality: Dragoman, Sofia province, Bulgaria.

Horizon: Turonian (Upper Cretaceous), coal-bearing unit (Kostadinov 1995).

Notes: Crown morphology shows affinities to *Squalicorax baharijensis* (Werner 1989).

Lamniformes undetermined

Referred material: NMNHS F-941, 942, 945, three badly preserved cusps (undescribed material); NMNHS F-972, 973, 975, three damaged teeth with different states of preservation (undescribed material).

Locality: Somovit, Pleven province, Bulgaria (NMNHS F-941, 942, 945); Strashimirovo, Varna province, Bulgaria (NMNHS F-972, 973, 975).

Horizon: Maastrichtian (Upper Cretaceous), (NMNHS F-941, 942, 945); Lutetian (Eocene), (NMNHS F-972, 973, 975).

Order *Carcharhiniformes* Compagno, 1973

Family *HEMIGALEIDAE* Hasse, 1879

Genus *Hemipristis* Agassiz, 1843

Hemipristis serra Agassiz, 1843 (Fig. 5 a, b)

Referred material: NMNHS F-31689, one completely preserved upper lateral tooth (Andreev 2010, fig. 4 a-c).

Locality: Angola.

Horizon: Upper Miocene.

Family CARCHARHINIDAE Jordan & Evermann, 1896

Genus *Carcharhinus* Blainville, 1816

Carcharhinus sp. (Fig. 5 c, d)

Referred material: NMNHS F-31691, a single complete, lateral tooth (Andreev 2010, fig. 7 a-c).

Locality: Angola.

Horizon: Upper Miocene.

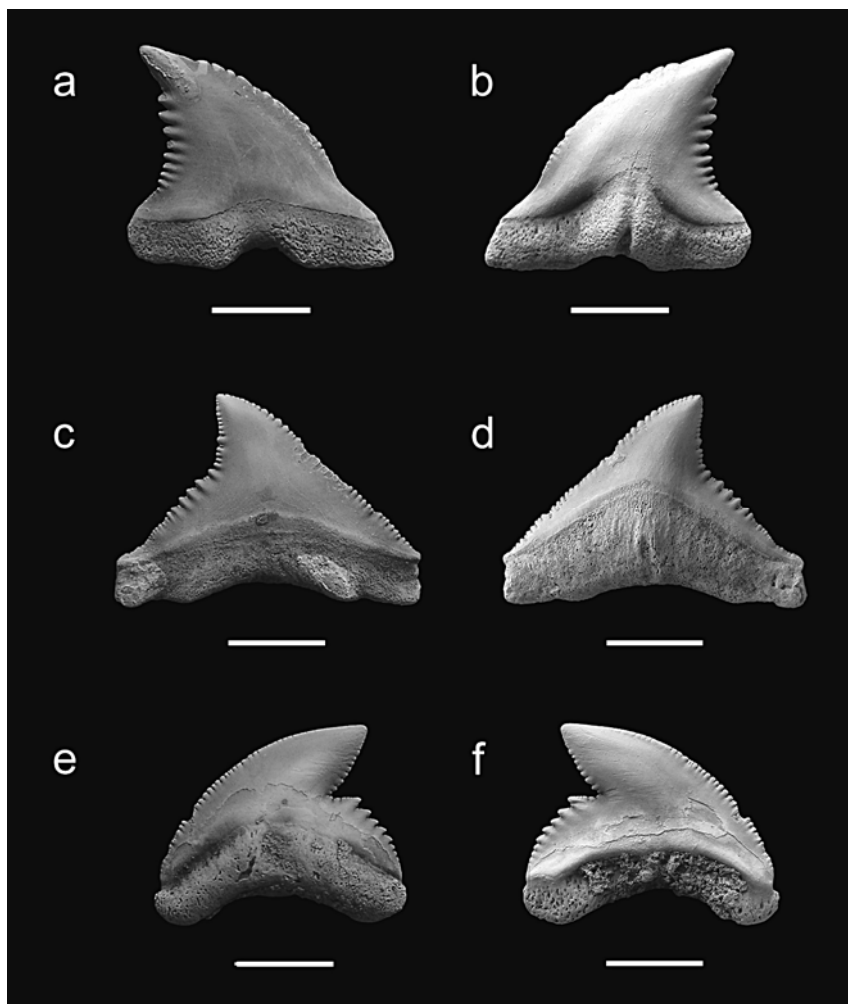


Fig. 5. - Carcharhiniforms from the Upper Miocene of Angola: upper lateral tooth of *Hemipristis serra* (NMNHS F-31689) in labial (a) and lingual (b) view; lateral tooth of *Carcharhinus* sp. (NMNHS F-31691), labial (c) and lingual (d) view; tooth of *Galeocerdo* sp. (NMNHS F-31690) in lingual (e) and labial (f) view. All scale bars = 5 mm. The specimens were coated with ammonium chloride before photographing.

Genus *Galeocerdo* Müller & Henle, 1838

Galeocerdo sp. (Fig. 5 e, f)

Referred material: NMNHS F-31690, one complete tooth (Andreev 2010, fig. 5 a-c; fig. 6).

Locality: Angola.

Horizon: Upper Miocene.

Superorder **Batomorphii** Cappetta, 1980

Order **Myliobatiformes** Compagno, 1973

Superfamily **MYLIOBATOIDEA** Compagno, 1973

Family **MYLIOBATIDAE** Bonaparte, 1838

Genus and species uncertain (Fig. 6)

Referred material: NMNHS F-12115, upper dental plate consisting of seven associated teeth (undescribed material).

Locality: Beloslav, Varna province, Bulgaria.

Horizon: Ypresian (Lower Eocene), Aladan Fm (Aladjova-Khrischeva 1984). The label accompanying the specimen assigned it to the Lutetian, but the presence of nummulite-rich grainstone encasing the fossil allowed for redetermination of its geological age and affiliation to specific lithological formation.

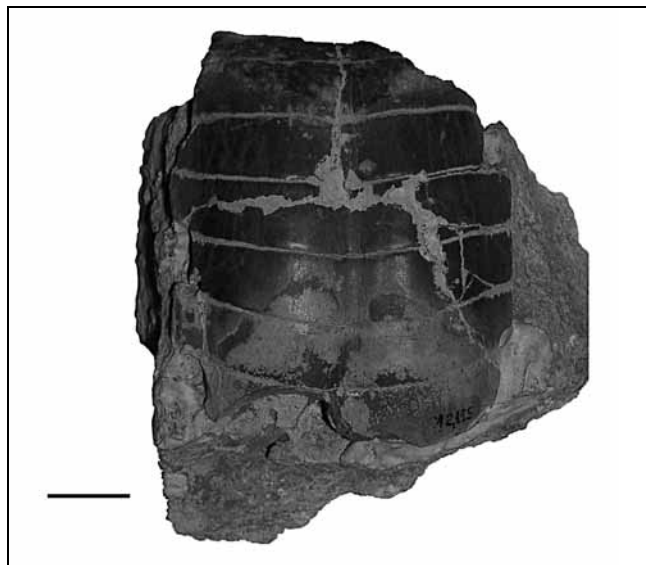


Fig. 6. - Dental plate of *Myliobatidae inc. sed.* (NMNHS F-12115) from the Ypresian (Lower Eocene) of Bulgaria, in occlusal view. Scale bar = 30 mm.

Notes: The same taxon, also coming from the Lutetian of Bulgaria, was figured by Tzankov & Datchev (1966, Table IV, fig. 2, 3) and assigned to *Aetobatis* (junior synonym of *Aetobatus*). NMNHS F-12115 resembles *Aetobatus* in the possession of only a single medial dental file

in which the teeth do not display a hexagonal outline, but their proportions are more akin to these of the genus *Myliobatis*. Further investigation and preparation of the specimen are needed in order to determine its systematic position within Myliobatidae.

Class **Osteichthyes** Huxley, 1880

Subclass **Actinopterygii** Cope, 1887

Infraclass **Neopterygii** Regan, 1923

Order **Semionotiformes** Arambourg & Bertin, 1958

Family INCERTAE SEDIS

Genus *Sargodon* Plieninger, 1847

Sargodon tomicus Plieninger, 1847

Referred material: NMNHS F-31698-31699, two incisiform teeth investigated histologically in Andreev (2009, fig. 12 a-f; fig. 13 a-d).

Locality: Near Dijon, Northeastern France.

Horizon: Rhaetian (Upper Triassic), Grès et Schistes à *Rhaetavicula contorta*.

Order **Pycnodontiformes** Berg, 1937

Suborder **Pycnodontoidei** Nursall, 1996

Family **PYCNODONTIDAE** Agassiz, 1833 sensu Poyato-Ariza & Wenz 2002

Genus and species uncertain (Fig. 7 a, b)

Referred material: Six isolated teeth with missing shafts, one grinding (NMNHS F-31697) and five incisiform (NMNHS F-31694-31696, 31702, 31703), were studied for their microstructure in Andreev (2009, fig. 14 a, b; fig. 15 a-f; fig. 16; fig. 17 a, b).

Locality: Dragoman, Sofia province, Bulgaria.

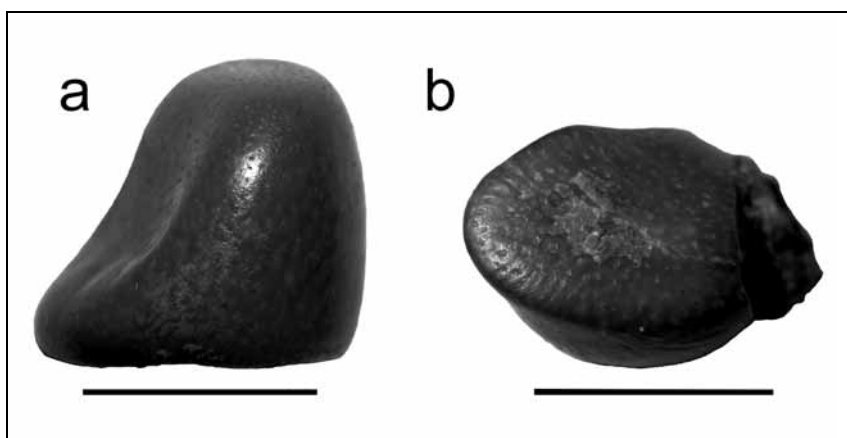


Fig. 7. - Pycnodontid incisiform teeth from the Turonian (Upper Cretaceous) of Bulgaria, (a) NMNHS F-31696 in lateral view and (b) NMNHS F-31703 in latero-occlusal view. Scale bar = 5 mm.

Horizon: Turonian (Upper Cretaceous), coal-bearing unit (Kostadinov 1995).

Notes: Datchev (1973) identified six isolated teeth from the same locality and horizon as *Pycnodus scrobiculatus*, which subsequently were allied with the genus *Coelodus* by Schultz & Paunović (1997). At present, the genus *Coelodus* is considered to be monotypic, restricted only to the species *Coelodus saturnus* (Poyato-Ariza & Wenz 2002, Poyato-Ariza 2005). The incisiform teeth referred here show characters identical to those figured by Datchev (1973), but despite that, the leading author (P. A.) refrains from designating them to a particular genus and species without the presence of associated dentition.

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**ЛИСТА ПРИМЕРАКА ЗУБА ФОСИЛНИХ АЈКУЛА И КОШЉОРИБА
(ELASMOBRANCHII И АСТИНОПТЕРЫГИИ) ДЕПОНОВАНИХ У
ПРИРОДЊАЧКОМ МУЗЕЈУ У СОФИЈИ**

ПЛАМЕН АНДРЕЕВ, НЕДА МОЧУРОВА-ДЕКОВА

РЕЗИМЕ

У раду је представљена таксономска листа фосилизованих мезозојских и кенозојских зуба ајкула и кошљориба из збирке Природњачког музеја Бугарске академије наука (NMNHS). Материјал је углавном сакупљан на територији Бугарске, док мањи број примерака потиче са локалитета у Анголи и Француској. У збирци доминирају таксони из групе елазмобранхија (47 врста) док остали материјал обухвата зубе актиноптеригија (8 врста). Од укупног броја, за 35 примерака утврђена је туронска старост. Посебан значај са аспекта систематике има налазак зубне плоче, састављене од седам повезаних зуба, која је откривена у шљунковима доњег еоцена Аладан формације (провинција Варда, Бугарска) и припада још неидентификованом представнику породице Myliobatidae.