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# First record of Acanthuridae (surgeonfish) from the Miocene deposits of the Medvednica Mt.

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## Abstract

Middle Miocene deposits at the Dubravica locality in SW Medvednica Mt. (N Croatia) contain various marine fossils, including one tooth of the surgeonfish (Acanthuridae). This is the first such record in Croatia and the second in the wider region, besides the Vienna Basin. The appearance of surgeonfishes in the Paratethys coincides with the Miocene thermal maximum. Their distribution was probably controlled by available reef habitat and their palaeobiogeography and migration routes are yet to be studied.

## 1. INTRODUCTION

Northern and north-eastern Croatia during the Miocene epoch were covered by the Paratethys Sea (Fig. 1). Abundant and diverse marine fossils can be found in sedimentary rocks of this age. Medvednica Mt. acted as an island near the SW coast of the Paratethys, and Miocene shelf deposits are exposed today in the form of a belt around the mountain core.

Middle Miocene marine environments of Medvednica Mt. were divided into the ''Dolje'' development in the south-western part of Medvednica Mt., the ''Čučerje'' development in the central part of Medvednica Mt., and the ''Zelina'' development in the south-eastern part of Medvednica Mt., each characterized by different fossil assemblages (KOCHANSKY, 1944).

Miocene deposits of the south-western part of Medvednica Mt., considered to be a part of the ''Dolje'' development, have been studied by many authors (e.g. KOCHANSKY, 1944; KOCHANSKY-DEVIDÉ, 1957; ŠIKIĆ et al., 1977, 1979; KOCHANSKY-DEVIDÉ & BAJRAKTAREVIĆ, 1981; VRSALJKO et al., 2006, 2007; BOŠNJAK et al., 2014).

The Dubravica locality (Fig. 1), records the first occurrence of fossil Acanthuridae in Croatia, and is situated on the south-western slopes of Medvednica Mt. The surgeonfish tooth was discovered during recent field work (BOŠNJAK et al., 2014; TRIPALO et al., 2015).

## 2. GEOLOGICAL SETTING

The investigated area is a part of the Miocene deposits belt surrounding Medvednica Mt., and is situated on its south-western slopes (Fig. 1). Geological and palaeontological features of this area were summarized in publications following the Basic Geological Mapping, by ŠIKIĆ et al. (1977, 1979), and later by ŠIKIĆ (Edit.) (1995).

During the Miocene, the whole area palaeogeographically belonged to the south-western margins of the Central Paratethys (Fig. 1), and geotectonically to the Pannonian Basin System (PAVELIĆ, 2002).

An approximately 16 metre high subvertical outcrop, with sedimentary rocks of ca. 11.5 m in thickness, is exposed at the Dubravica locality near the path leading to the Veternica Cave (Fig. 2). Triassic dolomites in the base are transgressively overlain with dolomitic breccias, which gradually pass into breccias-conglomerates, and are later replaced with floatstones containing

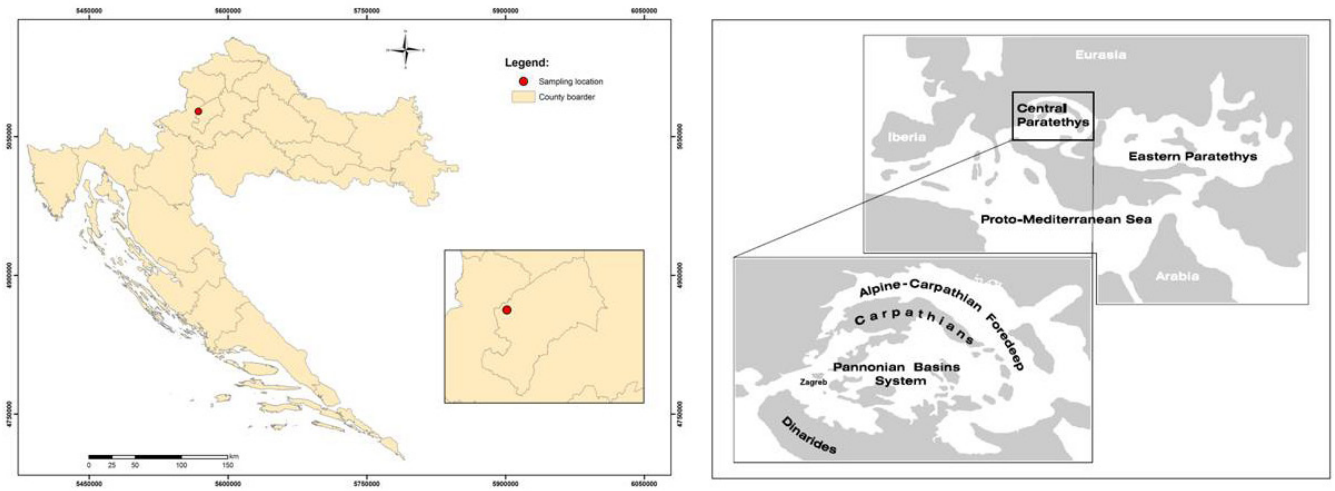


**Figure 1.** Location of the Dubravica locality and palaeogeographic map of Central Paratethys (after VRSALJKO et al., 2006; from BOŠNJAK et al., 2014).

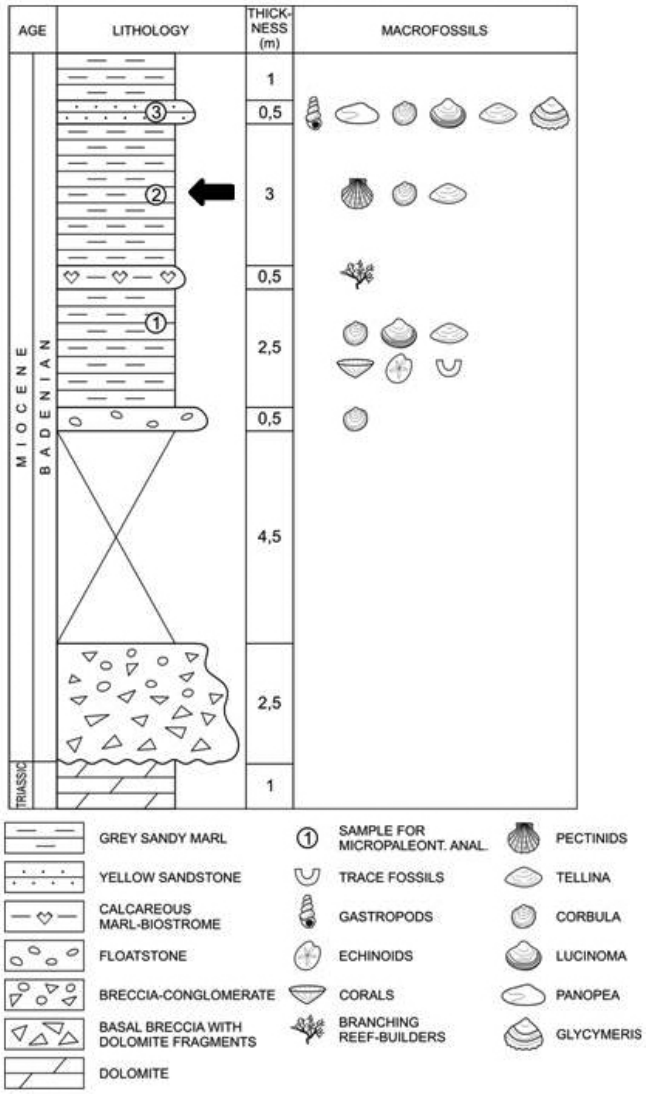


**Figure 2.** Schematic geological column of the Dubravica locality (after BOŠNJAK et al., 2014). Numbers 1, 2, and 3 mark investigated layers; 1: dark grey marl, 2: light grey marl, 3: intercalation of yellow sandstone. Location of the horizon with the surgeonfish tooth is marked with arrow.

bivalve moulds and dispersed dolomitic cobbles. A horizon composed of dark grey marl, ca. 2.5 m thick, overlies this layer. It contains molluscs, solitary corals, bryozoans, echinoids and trace fossils. The upper part of the column is characterized by a light-grey marl, ca. 3 m thick, with molluscs. An intercalation of yellowish sandstone with bivalves and gastropods, ca. 0.5 m thick, occurs within this horizon (Fig. 2).

In the vicinity of the sampled section, ca. 15 m towards the south, marls are laterally replaced with a coralgal reef buildup („*Lithothamnium* limestone", sensu KOCHANSKY, 1944) of contemporary age. The visible part of this buildup is ca. 10 m wide and ca. 5 m high.

Marls and sandstones from the Dubravica locality contain a rich microfossil assemblage present in all of the three analyzed layers (Fig. 2), containing juvenile and fragmented molluscs, foraminifera, ostracods, bryozoans, fish teeth and bones, echinoid spines and sponge spicules. In the light grey marl layer (Fig. 2), a fish tooth from the Acanthuridae family was discovered (BOŠNJAK et al., 2014; TRIPALO et al., 2015). The collected fossil assemblages when compared with the available published data (e.g. KOCHANSKY, 1944; ŠIKIĆ et al., 1977, 1979; ŠIKIĆ, 1995; PIKIJA in VELIĆ & VLAHOVIĆ, 2009; BAJRAKTAREVIĆ & KOCHANSKY-DEVIDÉ, 1981; VRSALJKO et al., 2006, 2007), suggest that the deposits are of Middle Miocene (Upper Badenian) age (BOŠNJAK et al., 2014; BOŠNJAK et al., 2015).

## 3. MATERIAL AND METHODS

Selected samples from the three layers of the Dubravica locality (Fig. 2) were analyzed following wet sieving. Samples were prepared in the Wet laboratory, at the Faculty of Science in Zagreb, Department of Geology, Division of Geology and Palaeontology. Soft marls were crushed, then soaked in the water with hydrogen peroxide. After twenty-four hours, samples were flushed through the 0.5, 0.2 and 0.125 mm sieves. Special attention was given to those with mesh size of 0.2 and 0.125 mm as these were the fractions where fossil fish teeth were discovered. The surgeonfish tooth was found on the 0.2 mm sieve.

## 4. RESULTS

Fish remains are common fossils in the Neogene deposits of Central Paratethys. Fish teeth are particularly common and well preserved reflecting their solid construction. From the Badenian deposits of Medvednica Mt., fossil teeth of *Chrysophrys* sp., *Odontaspis* sp., *Lamna* sp., and *Mylobatis* sp. have been observed to date (KOCHANSKY, 1944; ŠIKIĆ et al., 1979). Among other microfossils from the investigated Dubravica locality, one tooth from the Acanthuridae was also found.

### CLASS: Actinopterygii (KLEIN, 1885)

#### ORDER: Perciformes (BLEEKER, 1859)

#### FAMILY: Acanthuridae BONAPARTE, 1832

The Acanthuridae includes fishes whose common name (surgeonfishes) derives from the presence of a scalpel-like modified scale on the caudal peduncle (WINTERBOTTOM, 1993), which may be used in inter- and intra-specific aggressive behaviour (RANDALL, 2001).

Today, acanthurids all live in tropical and subtropical seas, and are one of the dominant groups of fish on the coral reefs (PURCELL & BELLWOOD, 1993 and references therein; SORENSON et al., 2013; LUDT et al., 2015). Their modern geographic distribution is similar to other reef fish families and largely reflects Neogene biogeographic influences (PELLISSIER et al., 2014).

Surgeonfishes are primarily herbivores, but consume a relatively wide variety of dietary resources, including planktonic animal matter, organic detritus and invertebrates (SORENSON et al., 2013). Dentition can vary dramatically within and across genera, and it is strongly related to diet (TYLER, 1970) (Fig. 3).

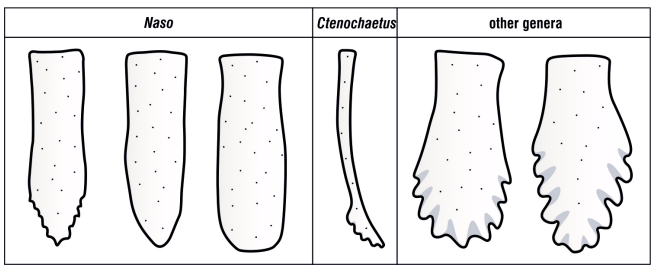


**Figure 3.** Examples of teeth of the Acanthuridae family: *Naso* – fixed teeth, mostly conical but slightly distally compressed, with denticulations variously small, minute or absent; *Ctenochaetus* – numerous, elongated, moveable teeth well denticulated on one side only; other genera (*Paracanthurus, Zebrasoma* and *Acanthurus*) – fixed teeth, compressed with well developed denticulations (after TYLER, 1970).

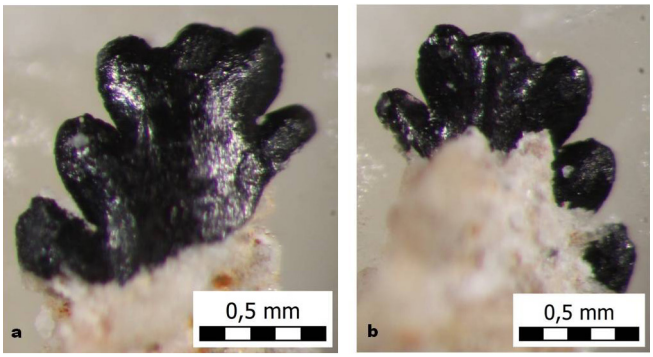


**Figure 4.** Acanthuridae fossil tooth, a) labial side; b) lingual side.

Acanthuridae gen. et sp. indet.

**Material:** one partially preserved tooth with accreted sediment (Fig. 4)

As shown on Fig. 4, the exposed part of the small incisiform tooth is almost black in color. Dimension of the tooth (in mm) are: 1.95 height, 1.13 width.

The tooth has a multidenticulate structure typical of the majority of acanthurids. One apical denticulation, two denticulations on the right and three on the left side of the tooth are visible. Denticulations on both sides increase in size towards the base of the teeth. The investigated tooth is slightly curved inward. Its surface is almost smooth on both the labial and lingual side (Fig. 4). Considering the partial tooth preservation, and range of genera with this configuration, determination at the generic level was not possible.

## 5. DISCUSSION

Fossil Acanthuridae or surgeonfishes are among the best studied fossil percomorph fishes.

The rich fossil record indicates that acanthurids reached a significant diversity by the Middle Eocene (SORENSON et al., 2013). Abundant and diverse surgeonfishes from the Monte Bolca locality, at least 14 extinct genera and 16 species, were studied by several authors (BLOT & TYLER, 1990; SORBINI & TYLER, 1998a, b; TYLER, 1999, 2005a, b; TYLER & BANNIKOV, 2000). The Monte Bolca fish assemblage represents the oldest known fauna that may be defined as a coral reef fish assemblage (BELLWOOD, 1996) and is a key fossil deposit at the birth of modern coral reefs (BELLWOOD et al., 2014). Several genera share the multidenticulate tooth form at this time (BELLWOOD et al., 2014) suggesting that they may have been feeding on short algal turf (PURCELL & BELLWOOD, 1993).

Some fossil taxa of the Acanthuridae are known from the Oligocene deposits (TYLER, 2000; TYLER & SORBINI, 1998; TYLER & MICKLICH, 2011).

Previously Miocene surgeonfishes have only been reported from Sulawesi (TYLER, 1997) and from the Miocene of the Vienna Basin (MEYER, 1842; SCHULTZ, 2003). Austrian acanthurid fish teeth were described as *Acanthurus haueri* (MEYER, 1842). They are of similar size as the specimen from Dubravica, but differ from it in shape. As we are lacking other parts of the skeleton, we can only speculate whether this is a different species, but it is also possible that the tooth belongs to the same species, but had a different position within the jaws (SCHULTZ & BELLWOOD, 2004).

Miocene reefs and reef-like structures in Paratethys which were suitable habitats for acanthurids were predominantly composed of coralline algae: *Lithothamnion valens*, *Phymatoliton calcareum* and *Mesophyllum roveretoi* (BASSO et al., 2008), sometimes in association with bryozoans and, sporadically, corals (VRSALJKO et al., 2006). Interestingly only one other herbivorous reef fish has been recorded from this region, the parrotfish *Calotomus* from the Badenian of Austria (BELLWOOD & SCHULTZ, 1991).

Findings of acanthurid teeth in the Paratethys realm coincide with the Miocene thermal maximum. We can discuss why are these finds so scarce; the small size of acanthurid teeth and their rather bizarre shape may be the reason that palaeontologists do not register or recognize them in the sieved material.

The Croatian surgeonfish record opens discussion of the possible ancestral populations and fish migration routes, but such study requires reexamination of other contemporary rocks along the Paratethys reef formations and the possible discovery of more surgeonfish remains.

## 6. CONCLUSIONS

A small fish tooth from the Dubravica locality in the south-western part of Medvednica Mt. represents the first record of surgeonfishes (Acanthuridae) in Croatia. In the nearby area, similar teeth from Miocene deposits of the Vienna Basin have been referred to the type *Acanthurus haueri* (MEYER, 1842; SCHULTZ, 2003).

The tooth from the Dubravica locality differs from the Austrian samples in shape, but is of similar size. It may belong to another species, or to the same species, but from a different position within the jaw.

The appearance of acanthurids in the Paratethys corresponds with the Miocene thermal maximum, and it opens discussion about the ancestral populations and possible biogeographic extent of the Acanthuridae across Paratethys.

Palaeoecologically it was controlled by distribution of suitable benthic habitats, in this case coralgal or coralgal-bryozoan reef buildups.

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