

Short Note



A megachasmid shark tooth (Chondrichthyes, Lamniformes) from the Zanclean (early Pliocene) of San Quirico d'Orcia, central Italy

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Megachasmids are unusual, large, epipelagic, filter-feeding sharks belonging to a mid-Cenozoic lamniform lineage (Taylor et al., 1983; Compagno, 1990; Berra, 1997). The only Recent species, *Megachasma pelagios* Taylor, Compagno & Struhsaker, 1983, lives in the tropical sector of all oceans (Compagno et al., 2005; Nelson, 2006). Only 63 specimens of this uncommon species are known to date (Florida Museum of Natural History website: <http://www.flmnh.ufl.edu/fish/sharks/megamouth/tablemega.htm>; last access 2.10.2014).

Fossil record is scarce and ranges from the middle Cenozoic (Chattian) to the Recent (Cappetta, 2012). An allegedly older member of the family, *Megachasma comanchensis* Shimada, 2007, has been described from the Cenomanian of Colorado (Shimada, 2007) but its systematic position has been questioned by Cappetta (2012). Indeed it belongs to a still undescribed odontaspidae lineage, sister group to *Johnlongia* Siverson, 1996 (Lamniformes, Odontaspidae) (Shimada et al., 2014a). Certain reports of megachasmids are from the Cenozoic and seem to belong to two distinct groups: the former, from the late Oligocene or early Miocene of western North America and perhaps from the early Miocene (?) to the early Pliocene (?) of western Europe, corresponds to *Megachasma applegatei* Shimada, Welton & Long, 2014, and is characterized by a large percentage of teeth with accessory cusplets. The latter, from the early Miocene of Mexico, the late Miocene of Crete and Chile and the early Pliocene of eastern North America, probably corresponds to the Recent species and is characterized by a small percentage of teeth bearing cusplets (Shimada et al., 2014b, with reference to geographical and stratigraphical distribution).

We report a new record based on a large, almost complete tooth from the Pliocene of San Quirico d'Orcia, Tuscany, central Italy. The tooth was collected in the 1970s by Franco Rossi (Montepulciano, Siena) at Poggio delle Bandite near Vitaleta (municipality of San Quirico d'Orcia, province of Siena; WGS84 [World Geodetic System 1984] UTM reference 32TQN1471) (Fig. 1) in an outcrop which provided an abundance of fossil shark teeth. Many shark teeth in the San Quirico d'Orcia area were previously collected from Selva Piana and Strozzevolpe by Vittorio Simonelli and Giovanni Capellini, respectively (De Stefano, 1910), and even earlier in the late eighteenth

century by Ambrogio Soldani in many sites around the village (Soldani, 1780). Unfortunately, the site where the tooth was found, a badland area with many *biancane* and *calanchi*, no longer exists because it was levelled in the 1980s.

San Quirico is located in the midwestern part of the Neogene Siena-Radicofani Basin. In this area, marine sedimentation started at the beginning of the Pliocene with offshore deposition of clays. It was interrupted by uplifting and emersion, after which the marine setting was restored and offshore deposition of marine clays resumed. All these sedimentary successions are assigned to the Zanclean (early Pliocene) (Bossio et al., 1992; Aldinucci & Sandrelli, 2004).

SYSTEMATIC PALEONTOLOGY

Class CHONDRICHTHYES Huxley, 1880

Subclass ELASMOBRANCHII Bonaparte, 1838

Order LAMNIFORMES Berg, 1958

Family MEGACHASMIDAE Taylor, Compagno & Struhsaker, 1983

Genus MEGACHASMA Taylor, Compagno & Struhsaker, 1983

Type species - *Megachasma pelagios* Taylor, Compagno & Struhsaker, 1983

Megachasma cf. *M. pelagios* Taylor, Compagno & Struhsaker, 1983
(Fig. 2)

Material examined - One tooth (Museo di Storia Naturale dell'Accademia dei Fisiocritici, geopaleontological collections, MUSNAF/GEO 7075).

Description - Tooth apically incomplete due to pre-burial damage, having pointed, lingually directed, crown and large root. Crown long, robust, acute, slightly sigmoidal in profile, inclined lingually at about 45° and laterally at about 5°, more extended basally on labial side, with semicircular section, wide at base and progressively narrower toward apex, and short, poorly discernible apical cutting edges (probably one-third to one-half of crown

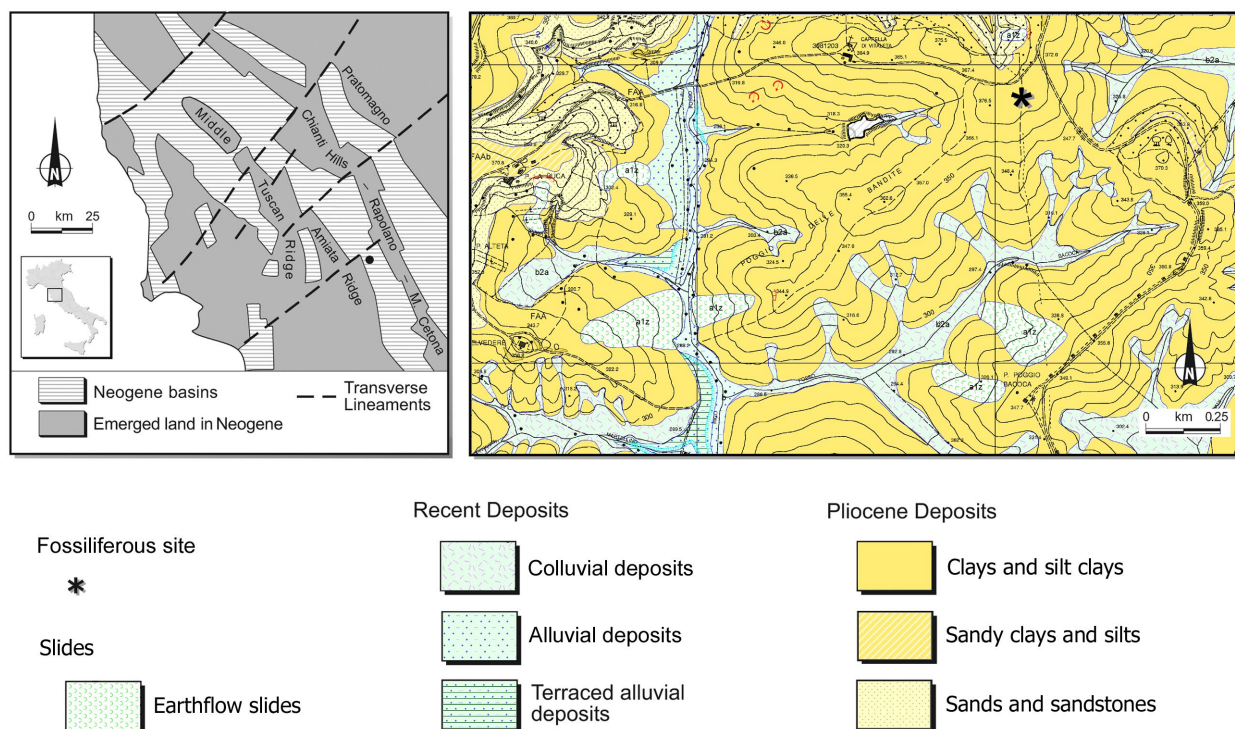


Fig. 1 - Location of the outcrop where the tooth was found. Left: structural setting of Tuscany (dot: San Quirico d'Orcia area). Right: geological sketch of the area west of San Quirico d'Orcia from the Carta Tecnica Regionale 308120 (downloaded from <http://www502.regione.toscana.it/geoscopio/cartoteca.html>).

length). Labial side smooth, flat basally and convex apically; lingual side convex in section with poorly discernible short vertical ridges along crown base. Dental band (neck) quite evident on lingual side. Accessory lateral cusplets absent. Root subtrapezoidal (longer linguolabially than mesiodistally) in basal view, massive, slightly porous, with base slightly concave on labial side, flat or slightly convex on lingual side, long bulky lingual protuberance, short blunt mesial and distal lobes (mesial lobe more prominent than distal lobe), transverse nutrient groove extending for one-third of base length from lingual side, small foramina scattered on lingual and labial sides.

Remarks - The two Cenozoic *Megachasma* species, *M. applegatei* and *M. pelagios*, overlap widely in morphology

and stratigraphic distribution so that they cannot be readily identified from scarce series of teeth or a single isolated tooth (Shimada et al., 2014b). MUSNAF/GEO 7075 is larger than, but very similar to, the lower fifth tooth of a Recent adult female of *M. pelagios* from Hakata Bay, Japan (Yabumoto et al., 1997, fig. 5B). It is also similar to a lower mid-lateral tooth of the holotype from the Hawaii, USA (Taylor et al., 1983, fig. 8), a lower anterior tooth from Santa Catalina Island, Mexico (Herman et al., 1993, pl. 46, fig. a; pl. 47, fig. a; pl. 48, fig. a) and an unspecified tooth of a specimen (Megamouth #2) from California, USA (De Schutter, 2009, pl. 11, figs M-R). It is very similar, also in size, to a paratype of *M. applegatei* from the early Miocene of California, USA (Shimada et al., 2014b, fig. 4BI "LACM 122197") and to a tooth of *M.*



Fig. 2 - Tooth of *Megachasma* cf. *M. pelagios* from the Zanclean (early Pliocene) of Poggio delle Bandite, San Quirico d'Orcia, province of Siena, central Italy. From left to right: specimen MUSNAF/GEO 7075 in labial, basal, lingual, distal, occlusal and mesial views. Scale bar corresponds to 5 mm.



<i>M. cf. M. pelagios</i> (MUSNAF/GEO 7075)	9.8	10.0	14.8	11.7	8.2	12.5	3.5
<i>M. applegatei</i> (Shimada et al., 2014b: 67 teeth)	2.5-(8.3)	3.3-10.2	3.4-14.7	2.1-9.2	3.1-8.2	2.5-12.9	0.9-3.4
<i>M. pelagios</i> (Taylor et al., 1983: one tooth)	6.6	5.8			4.0	9.0	
<i>M. pelagios</i> (Hermann et al., 1993: six teeth)	5.6-9.1	5.5-9.4			4.5-7.0	(7.0)-(12.0)	
<i>M. pelagios</i> (Yabumoto et al., 1997: 12 teeth)	2.3-6.5	2.5-6.8			1.8-5.0	3.1-9.4	

Tab. 1 - Measurements (in millimeters, estimated values in parentheses) of *Megachasma* teeth, according to the variables used by Shimada et al. (2014b). Measurements of *M. applegatei* (67 teeth, Shimada et al., 2014b) and *M. pelagios* (one tooth, Taylor et al., 1983; six teeth, Herman et al., 1993; 12 teeth, Yabumoto et al., 1997) from Shimada et al. (2014b). Abbreviations: CH: crown height; CT: crown thickness; CW: crown width; RL: root length; TH: total tooth height; TT: total tooth thickness; TW: total tooth width (equivalent to root width [RW]).

cf. *M. pelagios* from the early Pliocene of North Carolina, USA (De Schutter, 2009, pl. 10, figs R-V) (Tab. 1).

MUSNAF/GEO 7075 matches *M. pelagios* in terms of RL/RW and CH/CW ratios (Shimada et al., 2014b, fig. 6B), albeit near the overlap of the two species and it is therefore tentatively assigned to the Recent species. It is probably an anterior or one of the mesial most lateral teeth. It is much larger than those of extant specimens and is at the upper limit of the size range known for *Megachasma* teeth, although De Schutter (2009) and Cappetta (2012) reported even larger material from the Miocene of Chile.

This is the first report of a species of *Megachasma* from the Mediterranean Pliocene (see De Schutter, 2009; Cappetta, 2012; Shimada et al., 2014b). Megachasmid sharks inhabited the Mediterranean Basin in the Middle Cenozoic before the Messinian Crisis: a tooth of *M. cf. M. pelagios* is reported from the Tortonian of Crete, Greece (Keupp & Bellas, 2002, as *Hexanchus* sp.; De Schutter, 2009). This report from San Quirico shows that these sharks colonized the Mediterranean again when the basin refilled after the Messinian desiccation.

ACKNOWLEDGEMENTS

Franco Rossi collected the fossil tooth and donated it to the Museo di Storia Naturale dell'Accademia dei Fisiocritici. Helen Ampt revised the English. Giovanni Cappelli took the photos. Mikaela Bernardoni and Florence Conti (Biblioteca di Area Scientifica-Tecnologica, Università di Siena, Italy) helped with bibliographic research. Ivan Martini (Università di Siena, Italy) provided information on the stratigraphic setting of the San Quirico area. Henry Cappetta (Université de Montpellier, France) and Kenshu Shimada (DePaul University, Chicago, USA) made useful comments on an earlier draft of the paper.

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Manuscript received 16 October 2014
 Revised manuscript accepted 21 March 2015
 Published online 21 May 2015
 Editor Annalisa Ferretti