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ADDENDUM: A NEW SPECIES OF GIANT THRESHER SHARK (FAMILY ALOPIIDAE) WITH SERRATED TEETH

Bretton W. Kent and David J. Ward¹

The Neogene has a remarkably complex array of large macropredatory sharks (BWK, this chapter) that is well represented along the eastern United States. Despite extensive research on fossil elasmobranchs in this area, one species of large thresher shark (family Alopidae) with distinctively serrated teeth has not been previously named.

SYSTEMATIC PALEONTOLOGY

SUBCLASS ELASMOBRANCHII BONAPARTE, 1838

SUPERORDER SELACHIMORPHA NELSON, 1984

ORDER LAMNIFORMES BERG, 1958

FAMILY ALOPIIDAE BONAPARTE, 1838

Genus *Alopias* Rafinesque, 1810

Alopias palatasi, new species

FIGURE 2.A1

HOLOTYPE. An anterior tooth at the Calvert Marine Museum (CMM-V-385).

TYPE LOCALITY. Parkers Creek, Maryland.

HORIZON. Calvert Formation (bed 12).

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PARATYPES. Calvert Marine Museum: CMM-V-3876 (beach-collected tooth, Flag Ponds, Maryland), CMM-V-3981 (beach-collected tooth, Parkers Creek, Maryland), CMM-V-4242 (beach-collected tooth, Calvert County, Maryland), and CMM-V-5823 (river-collected tooth, south end of Buck Island, Calibogue Sound downstream of the mouth of the May River, South Carolina). U.S. National Museum of Natural History: USNM 411148 (bed 12, Calvert Formation, Parkers Creek, Maryland) and USNM 639783 (beach-collected tooth, Parkers Creek, Maryland).

ADDITIONAL MATERIAL. Kent's reference collection, University of Maryland, College Park: UMCP 12147 (beach-collected tooth, Chesapeake Beach, Maryland), UMCP 12155 (river-collected tooth, Morgan River, South Carolina), UMCP 12158 (river-collected tooth, Westmoreland/Stratford Hall, Virginia), and UMCP 12166 (beach-collected tooth, northern Calvert Cliffs, Maryland). Mike Elwood collection: two teeth (bed 12, Calvert Formation, north of Scientists Cliffs, Maryland). Harriet Ertman collection: one river-collected tooth (Stratford Hall, Virginia). Walt Johns collection: one beach-collected tooth (Governor Run, Maryland), one beach-collected tooth (Plum Point, Maryland), and three beach-collected teeth (one whole tooth and two tooth fragments; Stratford Hall, Virginia). Jason Osborne collection: scuba-collected tooth (Newport News unit, Calvert Formation, New Kent County, Virginia).

ETYMOLOGY. Named for Mark Palatas, who provided one of the original specimens (CMM-V-5823; Figure 2.A1G,H) for study.

DIAGNOSIS. The holotype (CMM-V-385; Figure 2.A1A,B) is an upper anterior (A3?) tooth. The crown is broad and compressed, with cutting edges that are coarsely serrated. The serrations are irregular in size on the basal portions of the crown, becoming somewhat finer and more regular apically. The mesial cutting edge is convex, whereas the distal edge is markedly concave. The lingual coronal face is relatively flat, whereas the labial face is weakly convex. The root is compressed with substantially shortened and relatively deep root lobes that do not extend beyond the lateral shoulders of the crown. The basal root margin is strongly arched.

Anterior teeth closer to the jaw symphysis (Figure 2.A1C,D) are less strongly arched distally than the holotype and have somewhat broader crowns. The root lobes on these teeth may extend slightly beyond the lateral margins of the crown.

Upper lateral teeth (Figure 2.A1E,F) are more triangular, with the height and width being nearly identical. The mesial cutting edge is less convex than in anterior teeth and may become weakly sigmoidal in some specimens. The distal edge is only weakly concave. The root is compressed, with a broadly arched to slightly obtuse basal margin. The root is typically slightly broader than the base of the crown.

Lower lateral teeth (Figure 2.A1G,H) have crowns weakly inclined distally and a strongly arched basal root margin. The root is slightly thicker than in upper lateral teeth, although this character is somewhat variable.

Lateral teeth located nearer the commissure have crowns that become lower and more distally arched. In some cases the coronal apex is positioned distal to the distal margin of the root. The distal cutting edge becomes progressively more strongly concave, and the basal root margin becomes more weakly arched.

REMARKS. *Alopias palatasi* resembles the more widely known *A. grandis* but has coarsely serrated cutting edges. These serrations are substantially larger and more distinctive than those of the weakly crenulated specimens of *A. grandis* (Kent, this chapter). The teeth of *A. palatasi* can also be quite large, with the largest specimens more than 40 mm in height (P. Picard, Germany, personal communication, 2015).

The teeth of *A. grandis* and *A. palatasi* are similar in a number of respects, including large teeth with tall, broad, compressed crowns and shortened root lobes. In addition to coarsely serrate cutting edges *A. palatasi* also differs from the unserrated species in having more extensive monognathic heterodonty; the broadly triangular lateral teeth of *A. palatasi* are only occasionally present in *A. grandis*.

A number of embayments occur along the Neogene paleo-coastline of the eastern United States (Ward and Powars, 2004: fig. 1), and teeth of *A. palatasi* have been found in three of these, the Salisbury Embayment (Maryland and Virginia), the Albemarle Embayment (North Carolina), and the Charleston Embayment (South Carolina). From north to south localities where *A. palatasi* teeth have been found include the following.

MARYLAND. The distribution of *A. palatasi* along Calvert Cliffs is restricted to the northern portion of the cliffs (Flag Ponds to Chesapeake Beach), a region of the cliffs associated with the Calvert and Choptank Formations (Ward and Andrews, 2008: fig. 5; Visaggi and Godfrey, 2010: fig. 3). The Calvert Formation within this region of the cliffs includes a small exposure of the Fairhaven Member (bed 3B, middle Burdigalian) and a much more extensive exposure of the Plum Point Member (beds 4–16A, late Burdigalian to late Langhian). The entire sequence of Choptank Formation sediments (beds 17–20, Serravallian) is present in this region.

VIRGINIA. *Alopias palatasi* teeth have been found as beach specimens along the Potomac River at Wakefield, Horseshoe Cliffs, Stratford Cliffs, and Nomini Cliffs. The stratigraphy along this portion of the Potomac River is moderately complex (Ward and Andrews, 2008: fig. 7); the principal horizons in these localities are extensive exposures of the Calvert Formation (Plum Point Member, beds 14, 15; late Langhian) and the Eastover Formation (Claremont Manor Member [late Tortonian] and Cobham Bay Member [Messinian]). Between the Calvert and Eastover sediments are smaller, more variable exposures of the Choptank Formation (Boston Cliffs Member, bed 19; middle Serravallian) and the St. Marys Formation (late Serravallian). The St. Marys sediments have been reliably assigned to a specific horizon (Ward and Andrews, 2008:49, fig. 7); possible assignments include the Little Cove Point Member (beds 21–23, Tortonian) and the Windmill Point Member (bed 24). The cliffs in this area are capped with a layer of sediments questionably assigned to

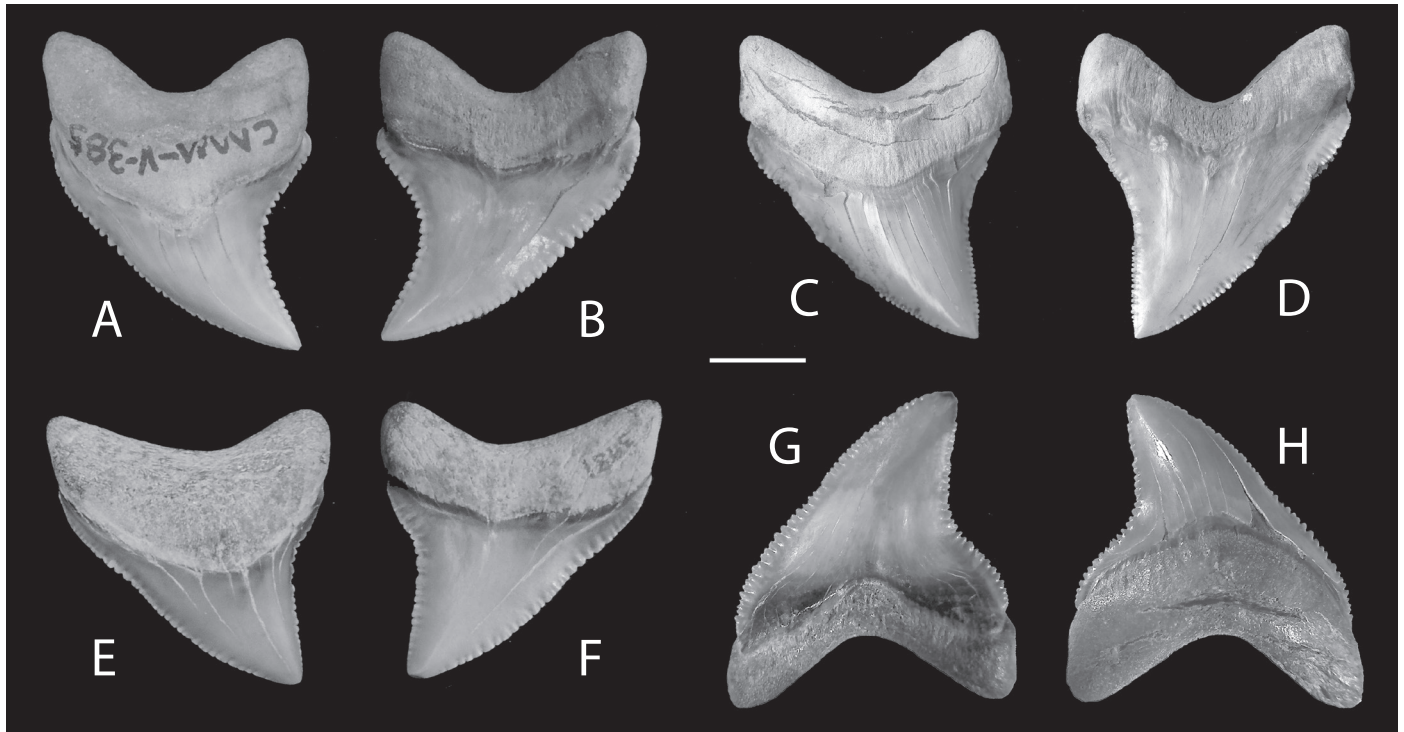


FIGURE 2.A1. *Alopias palatasi* (new species) teeth. Scale bar = 1 cm. (A) Right upper anterior tooth (holotype; CMM-V-385; lingual view). (B) Right upper anterior tooth (holotype; CMM-V-385; labial view). (C) Right upper anterior tooth (CMM-V-7735; lingual view). (D) Right upper anterior tooth (CMM-V-7735; labial view). (E) Right upper lateral tooth (paratype; CMM-V-3981; lingual view). (F) Right upper lateral tooth (paratype; CMM-V-3981; labial view). (G) Left lower lateral tooth (paratype; CMM-V-5823; labial view). (H) Left lower lateral tooth (paratype; CMM-V-5823; lingual view).

the middle Pliocene Yorktown Formation (late Zanclean to early Piacenzian). A single specimen has also been collected in situ from the Pamunkey River, New Kent County (J. Osborne, Paleo Quest, pers. comm., 2015), in the Newport News unit (basal Calvert Formation, early Burdigalian; Edwards et al., 2005).

NORTH CAROLINA. *Alopias palatasi* is poorly documented from North Carolina. This species is not listed in the extensive review of sharks and rays from Lee Creek Mine, North Carolina (Purdy et al., 2001). Teeth have been collected as river specimens from the Meherrin River, Hertford County, North Carolina (M. Palatas, Sharks Underground, pers. comm., 2014; S. Alter, pers. comm., 2015). The fossil beds in this area represent the early to middle Miocene Pungo River Formation (Burdigalian to Langhian), late Miocene Eastover Formation (Cobham Bay Member, Messinian), and the Middle Pliocene Yorktown Formation (Sunken Meadow, Rushmere and Morgarts Beach Members, late Zanclean to early Piacenzian; Miller, 1982; Gibson, 1983; Geisler et al., 2012). Although the Pungo River Formation is generally accepted as being of Burdigalian to Langhian

in age (Gibson, 1987; Purdy et al., 2001), the beds in this area may extend into the early Serravallian (Gibson, 1983).

SOUTH CAROLINA. Teeth of *A. palatasi* are occasionally collected as river or scuba specimens from the coastal area of southwestern South Carolina in southern Beaufort County, including the Broad and May River areas (M. Palatas, pers. comm., 2014; S. Alter, pers. comm., 2015). The stratigraphy of Beaufort County consists largely of undifferentiated early Miocene (Aquitanian and Burdigalian) sediments typically overlain with Quaternary marine terraces (Doar and Clendenin, 2002). *Alopias palatasi* specimens from this area are almost certainly derived from these early Miocene sediments. Seaward a thin stratum of the younger Coosawhatchie Formation intrudes between the undifferentiated Miocene formations and the cap of marine terraces (Doar and Clendenin, 2002). The Coosawhatchie Formation is middle Miocene in age (Langhian to Serravallian; Popenoe, 1990), and *A. palatasi* teeth collected in tidal portions of the South Carolina coastline (such as the Mark Palatas specimen; CMM-V-5823) could be from this formation rather than the underlying early Miocene beds.

Outside of the eastern United States, partially and fully serrated teeth of *A. palatasi* are occasionally found in the Upper Globigerina Limestone above the C2 phosphorite on the Mediterranean island of Malta (middle Miocene, Langhian; Ward and Bonavia, 2001), indicating that it had a wider distribution than the western Atlantic (D. Ward, personal observation). As yet there is no evidence of *A. palatasi* in mainland Europe. Recent monographs on the elasmobranchs of Germany (Reinecke et al., 2011) and the Netherlands (Bor et al., 2012) include no teeth attributable to *A. palatasi*. The sister species, *A. grandis*, is known from Belgium, but no *A. palatasi* have been found to date (Pieter De Schutter, pers. comm., 2012; Everaert, 2014).

The rarity of *A. palatasi* precludes a definitive assessment of its stratigraphic range, although across all three Neogene embayments *A. palatasi* is, with one possible exception, always found in localities with Burdigalian or Langhian fossil beds. Certainly, both older and younger sedimentary horizons occur in all of the localities, so a broader stratigraphic range is possible, but the Burdigalian-Langhian interval appears to be the primary distribution. Further, in all three embayments *A. palatasi* teeth are typically found comingled with the teeth of the giant otodontid *Carcharocles chubutensis*, a species well represented in the Burdigalian to Langhian and possibly into the Serravallian (BWK, this chapter). The distribution of *A. palatasi* teeth in the Langhian of Malta is consistent with Burdigalian-Langhian distribution observed in the western North Atlantic.

The one exception to this general Burdigalian-Langhian pattern of distribution is a single *A. palatasi* tooth from Flag Ponds (CMM-V-3876). This is a heavily worn beach specimen, so it is unclear whether it was derived from the Choptank Formation (Serravallian) or the upper Plum Point Member (late Langhian) located slightly more than 2 km upstream of Flag Ponds at Calvert Beach. This distance is likely too far for water transport of the tooth given the weak alongshore currents in this area, but it could have been rafted downstream attached to beach ice during the spring thaw.

The three known in situ specimens of *A. palatasi* provide a somewhat clearer estimate of stratigraphic range. The oldest specimen was collected from the Newport News beds, an informal basal unit of the Calvert Formation on the Pamunkey River, Virginia. There is some controversy about the exact age of this bed, ranging from late Aquitanian (on the basis of the age of bed 1; Vogt et al., this volume) to earliest Burdigalian (Edwards et al., 2005). The other two *A. palatasi* specimens were both collected from bed 12 of the Plum Point Member (Calvert Formation, middle Langhian).

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