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SELACHIAN FAUNA FROM THE UPPER CRETACEOUS DALTON SANDSTONE, MIDDLE RIO PUERCO VALLEY, NEW MEXICO

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Abstract.—Three localities in the Coniacian Dalton Sandstone along the Rio Puerco in Bernalillo County, New Mexico, yield numerous teeth of selachians in addition to other vertebrate fossils. The selachian fauna is composed of *Scapanorhynchus raphiodon, Squalicorax kaupi, Pseudohypolophus mcnultyi, Ptychotrygon triangularis, Ischyriza mira, Cantioscyllium decipiens, Squatina* sp., *Hybodus* cf. *H. butleri* and *Ptychodus mortoni*. *Pseudohypolophus* and *Scapanorhynchus* are the dominant selachian taxa from these localities. Taxonomic composition does not vary between the Dalton selachian localities, but the percentages of taxa present do vary. These differences are most likely due to hydraulic sorting by currents and by storm action.

INTRODUCTION

Little study has been undertaken of the selachian fauna from the Dalton Sandstone. Lucas et al. (1988) and Williamson et al. (1989) made passing reference to a single locality in the Dalton Sandstone. In this paper, we document selachian fossils from three localities in the Dalton Sandstone, in sec. 9, T11N, R2W, on the Herrera quadrangle in west-central New Mexico (Fig. 1).

These localities were collected through surface picking and screen washing of 200+ kg of sediment from each of the sites. The majority of the sediments collected were unconsolidated, but some had to be disaggregated by soaking in water. The sediments were washed through window screen (30 mesh) sieves, and then picked for fossils under a stereoscopic microscope. In sum, more than 3000+ teeth have been recovered from the Dalton localities. These teeth represent a large selachian fauna that includes *Scapanorhynchus raphiodon, Squalicorax kaupi, Pseudohypolophus mcnultyi, Ptychotrygon triangularis, Ischyriza mira, Cantioscyllium decipiens, Squatina* sp., *Hybodus* cf. *H. butleri* and *Ptychodus mortoni*. Associated with this selachian fauna are the teeth of mosasaurs and freshwater crocodiles, shell material and bones of turtles, scales of gars (probably *Atractosteus*), teleost teeth and centra, calcified selachian centra, selachian coprolites and steinkerns of large ammonites (*Placenticeras* sp.).

GEOLOGY

The Coniacian Dalton Sandstone is a regressive shoreline sandstone that is the lower member of the Crevasse Canyon Formation (e.g., Molenaar, 1983). At the selachian localities, the Dalton overlies the Mulatto Member of the Mancos Shale, and is overlain by the Gibson Coal Member of the Crevasse Canyon Formation (Fig. 1). In this area, the Dalton Sandstone is 40 m thick and mostly yellowish orange and pale orange sandstone. The sandstones range from massive with some bioturbation to cross-bedded to ripple laminated and thinly bedded (Fig 1). One of the localities, 5310, probably represents a storm deposit. It is in an approximately 20-cm thick, coarser grained sandstone than the layers both above and below it. In this coarser-grained deposit, there is an abundance of shark teeth. The other two localities, 342 and 4830, are stratigraphically higher, superposed (Fig. 1) and separated on strike by about 0.5 km.

PALEONTOLOGY

Scapanorhynchus raphiodon (Agassiz)

The teeth of *S. raphiodon* (Fig. 2A-B) numerically dominate all three Dalton localities. These teeth are very tall and narrow. The root is bilobate, with a distinctive nutrient groove that bisects the large, circular, lingual boss. The anterior teeth have a single, tall cusp. The medial and posterior teeth have three cusps--a primary cusp and two small, accessory cusplets. On these teeth the root is broader to accommodate the additional cusps. The lingual side of the cusp is convex and heavily striated, less so in the posterior teeth. The labial side of the tooth is smooth and slightly convex. The teeth of *S. raphiodon* have a good deal of sigmoidal flexure, though this is diminished in the posterior teeth.

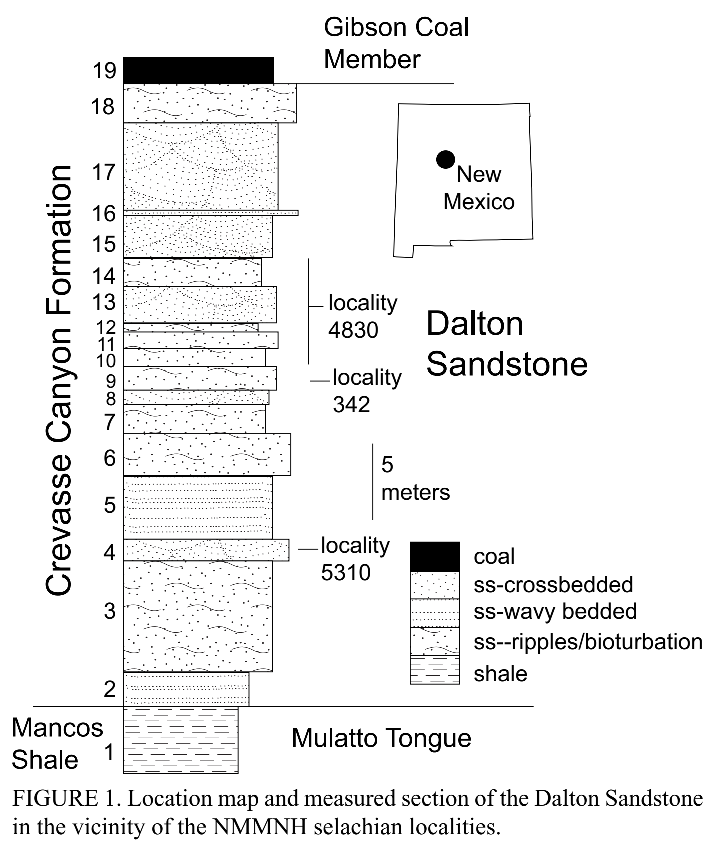

FIGURE 1. Location map and measured section of the Dalton Sandstone in the vicinity of the NMMNH selachian localities.

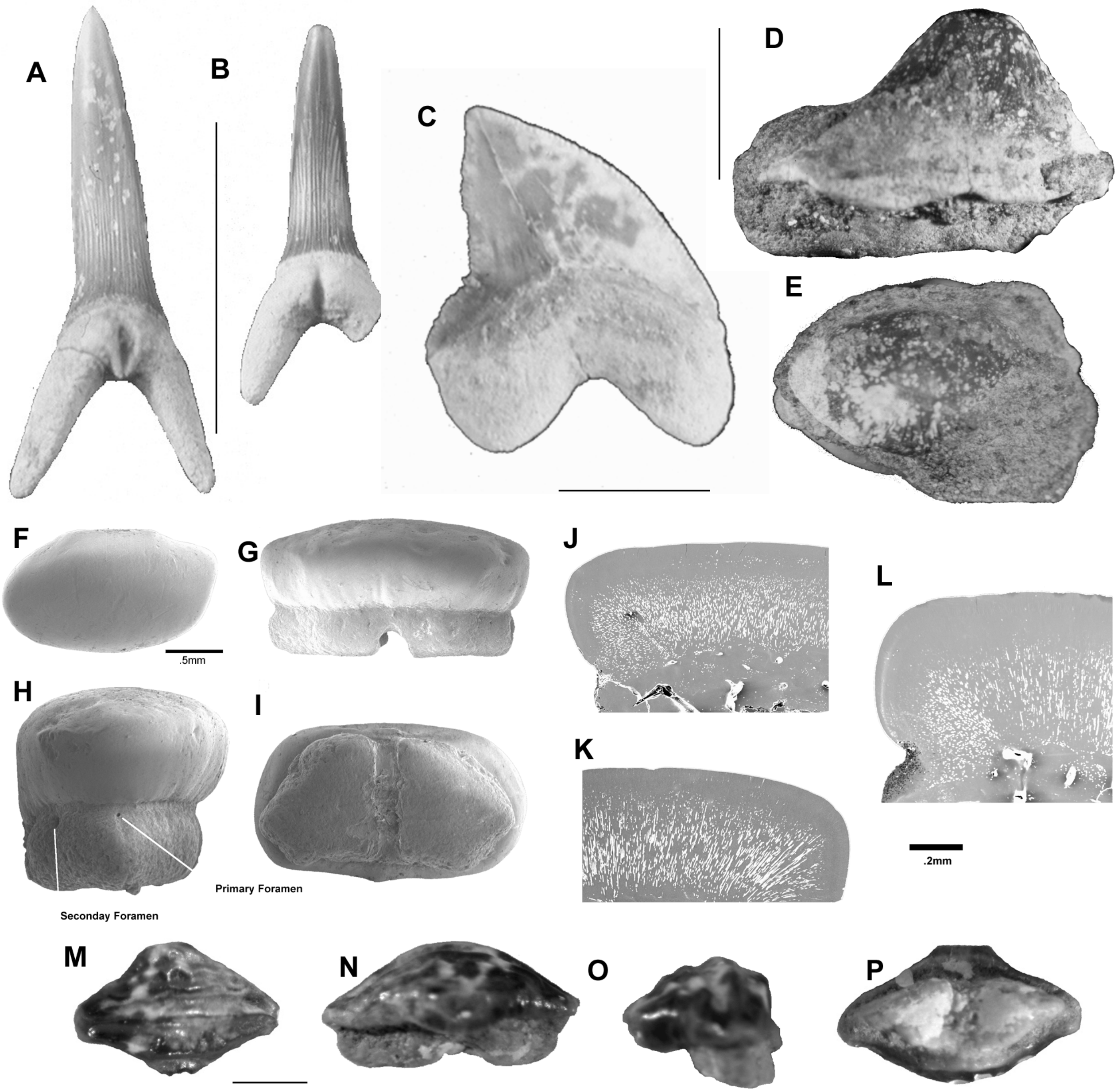

FIGURE 2. Selected selachian teeth from the Dalton Sandstone. A-B, NMMNH P-37728, *Scapanorhynchus raphiodon,* (A) labial view and (B) lingual view, scale = 5 cm. C, NMMNH P-29087, *Squalicorax kaupi,* labial view, scale = 2 cm. D-E, NMMNH P-37721, *Ptychodus mortoni,* (D) lateral view, (E) occlusal view, scale = 3 cm. F-I, NMMNH P-35367, *Pseudohypolophus mcnultyi*, (F) occlusal view, (G) labial-lingual view, (H) anterior-posterior view, (I) root view, scale = 0.5 mm. J-L, NMMNH P-35368, *Pseudohypolophus mcnultyi,* thin section views, scale = 0.2 mm. M-P, NMMNH P-37718, *Ptychotrygon triangularis,* (M) occlusal view of tooth, (N) occlusal view of tooth (O) root view, (P) root view, scale = 1 cm.

Scapanorhynchus raphiodon has a very large spatial and a long temporal distribution. It is found in Aptian through Maastrichian rocks worldwide (Cappetta, 1987; Welton and Farish, 1993). In New Mexico, *S. raphiodon* is also very common in the Santonian Hosta Tongue of the Point Lookout Sandstone (Williamson et al., 1989).

Squalicorax kaupi (Agassiz)

Squalicorax kaupi has moderate-sized, slicing teeth, ranging in length from 1 to 5 cm (Fig. 2C). These teeth have a large triangular cusp, and the crown margins are convexo-concave with a sharp apex. The mesial edge is convex and weakly serrated. The distal edge of the tooth is nearly vertical to concave, and a strong notch forms a heel at the back of the tooth. On some specimens, this heel has a small cusplet. The apex of the tooth has a high angle of acuity that is approximately 65°. Both the labial and lingual faces of the tooth are smooth. The root is bilobate with rounded lobes. The crown does not overhang the root at any point, and the crown-root boundary parallels the base of the root.

Meyer (1974) reports a Santonian-Campanian range of *Squalicorax kaupi* in Texas, and Cicimurri (1998) reports a Santonian to early Campanian range in South Dakota and Wyoming. However, Bilelo (1969), in her study of the stratigraphic ranges of the different *Squalicorax* species in Texas, only reports an Albian and

Cenomanian range for *S. kaupi*. As noted previously, the teeth present at the Dalton localities have a high angle of acuity that falls in the range of what Bilelo calls *S. kaupi*. Williamson et al. (1989) use the same justification to classify the *Squalicorax* teeth found in the Hosta Tongue of the Point Lookout Formation as *S. kaupi*, and the Dalton teeth are identical to those reported by Williamson et al. (1989). There is thus disagreement between Bilelo (1969) and Meyer (1974) about the range of these sharks in Texas. The Dalton teeth are in the range reported by Meyer (1974) and Cicimurri (1998), but not the range reported by Bilelo (1969).

Pseudohypolophus mcnultyi **(Thurmond)**

Ray teeth are some of the most abundant teeth found at all three Dalton localities. The external morphology of these teeth is oval to hexagonal in occlusal view (Fig. 2F). The long axis of the tooth runs labial-lingually in the mouth of the ray, and these teeth fit together to form a dental pavement used for crushing. The crown of these teeth overhangs the root, and the root and the crown are about equal in height (Fig. 2G-H). These teeth have a bifurcated root (Fig. 2I). Each end of these teeth has two blood vessel foramina (Fig. 2H). The primary foramen is very near the edge of the enamel crown, and is slightly off center from the axis of the tooth. The secondary foramen is also slightly off of the center axis of the tooth. This foramen is more distant from the crown than is the primary foramen. Each lobe of the root is triangular in shape. The nutrient groove runs anteriorly-posteriorly between the two lobes of the root, and there are no foramina in the nutrient groove. The teeth were thin sectioned, and the crown of the tooth is composed of orthodentine that is covered with three layers of enamel, and the root of the tooth is composed of osteodentine (Fig. 2J-L).

In general, the teeth of *Pseudohypolophus* are minute and difficult to identify without the aid of thin section (Fig. 2J-L). Indeed, the only distinction between the teeth of *Pseudohypolophus* and other genera of rays is in the internal structure of the teeth. Johnson and Lucas (2002) undertook detailed histological work on the ray teeth from the Dalton localities, as well as those from the overlying Hosta Tongue. They have positively identified these teeth as those of *P. mcnultyi*. These rays have a long temporal range, Aptian-Campanian (Cappetta, 1987).

Ptychotrygon triangularis **(Reuss)**

At the Dalton localities, *Ptychotrygon triangularis* is represented by small teeth up to about 4 mm long along the longitudinal axis of the tooth (Fig. 2M-P). These rhombohedral teeth are thought to have formed a dental pavement in the mouth. The occlusal surface is covered with transverse ridges. The primary ridge bisects the tooth, and on each side of it are smaller, less prominent ridges. The crown overhangs the root, and the root is bilobate, with two triangular lobes. The nutrient groove is deep and narrow, with a central foramen. The lingual face of each root has three foramina.

Ptychotrygon triangularis is found in Cenomanian-Maastrichtian rocks throughout the Cretaceous Interior Seaway (Evetts, 1979; Welton and Farish, 1993). In New Mexico, teeth of this ray are found in Turonian-Santonian rocks. Wolberg (1985) reported *P. triangularis* from the Turonian Tres Hermanos Formation, and it is also found in the Point Lookout Sandstone (Williamson et al., 1989). In both the Dalton and the Point Lookout Sandstone, the teeth of this ray are not common.

Ischyriza mira **Leidy**

The rostral teeth of *Ischyriza mira* are conical and dorso-ventrally flattened (Fig. 3D). The base is much wider in diameter than the crown and is crenulated on its dorsal and ventral sides. The anterior and posterior portions of these teeth have a notch in the base, and a large pulp cavity in the base extends up into the crown of the tooth.

The oral teeth of *Ischyriza mira* are small, with the cusp canted lingually (Fig. 3C). These teeth have a single sharp cusp, and the labial face of the tooth is canted in the same direction as is the cusp. This forms a ridge running from the cusp to the edge of the tooth. Both faces of the tooth are smooth. The root is bilobate with triangular lobes, and there is little to no overhang of the crown over the root.

Ischyriza mira has a Turonian-Paleocene temporal range with a very broad geographic distribution, and has been found in the Cretaceous Interior Seaway as well as in the then newly opened Cretaceous Atlantic Ocean (Meyer, 1974; Cappetta and Case, 1975). The Paleocene records are questionable, as they are probably re-worked from older sediments. In New Mexico, teeth of these sharks have been reported from Turonian (Wolberg, 1985) and Santonian (Williamson et al., 1989) rocks.

Cantioscyllium decipiens **Woodward**

The small to microscopic teeth of *Cantioscyllium decipiens* (Fig. 3E) range in size from 1 to 3 mm. The three cusps on these teeth are inclined lingually. The central cusp is taller and comes to a sharp point, whereas the accessory cusps are poorly developed, with rounded edges. The labial face of these teeth is striated. The crown overhangs the bilobate root, and each lobe of the root is short and round. The nutrient grove is wide and terminates with a large, central foramen in the lingual bulge of the root. The teeth of this species are very similar in shape to the oral teeth of *Ischyriza mira*. The main differences between the teeth are the presence of striations and the number of cusps. *Ischyriza* has a single cusp, and the surface is smooth. The roots on the teeth of *Ischyriza* are also much larger than those of *Cantioscyllium*.

C. decipiens is reported from middle Cenomanian-Santonian rocks in North America. In the northern part of the Cretaceous Interior Seaway (South Dakota and Wyoming), these sharks teeth are only found in Cenomanian and Turonian rocks (Evetts, 1979; Cicimurri, 1998). In the southern part of the seaway, they are found in Cenomanian through Santonian rocks (Meyer, 1974; Williamson et al., 1989; Welton and Farish, 1993).

Ptychodus mortoni **Mantell**

The teeth of *Ptychodus mortoni* are square with a conical cusp (Fig. 2D-E). The cusp slopes evenly from the apex to the margin of the tooth, is not differentiated from the margin and is moderate to

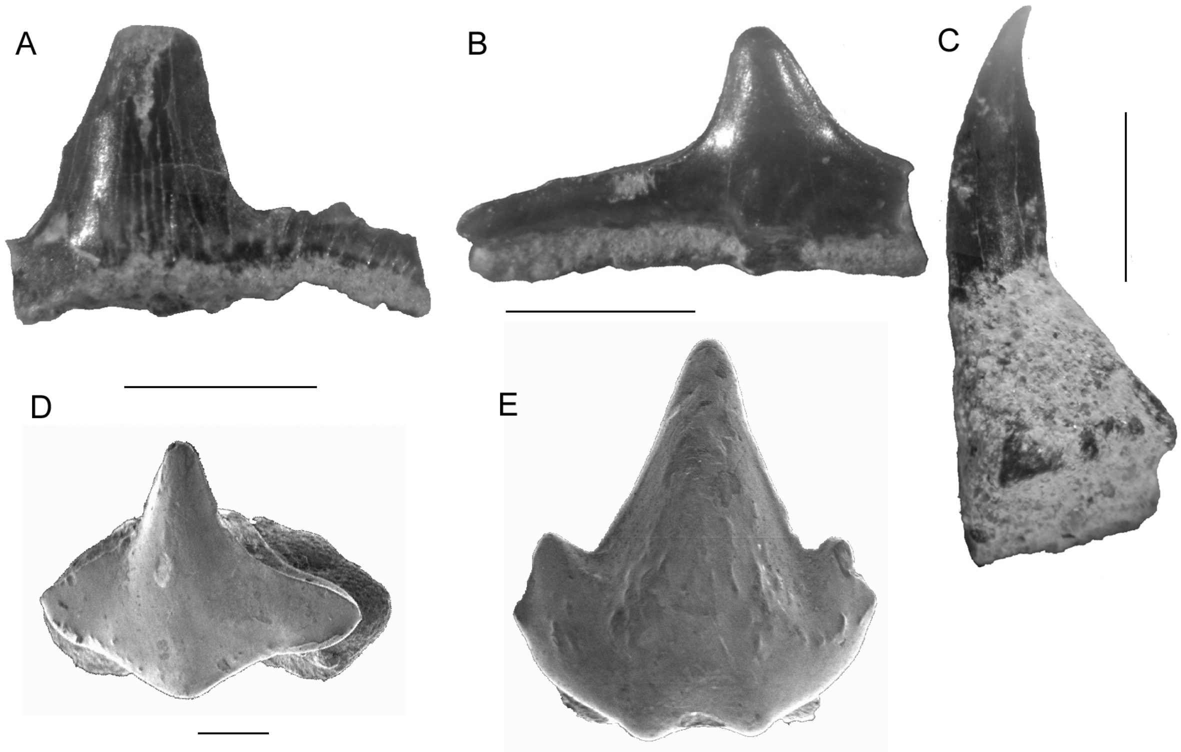

FIGURE 3. Selected selachian teeth from the Dalton Sandstone. A, NMMNH P-37710, lateral view *Hybodus* cf. *H. butleri*. B, NMMNH P-37708, lateral view of *Squatina* sp. C, NMMNH P-37705, oral tooth of *Ischyriza mira*. D, NMMNH P-37705, rostral tooth of *I. mira*. E, NMMNH P-37706, *Cantioscyllium descipiens*. Scale bars = 1 cm for A-B and 5 mm for C-E.

high crowned. The ridges on these teeth radiate from the center of the tooth to the margins.

Ptychodus mortoni is the Coniacian-Campanian species of high-crowned *Ptychodus*. *P. mortoni* arose in the middle Coniacian to replace *P. whipplei* as the high crowned species of *Ptychodus*. *P. mortoni* has a broad distribution, being found throughout the Cretaceous Interior Seaway, and in the then newly opened Atlantic Ocean. It has a middle Coniacian-Santonian distribution in New Mexico (Williamson et al., 1989; Williamson and Lucas, 1990), which is similar to what Meyer (1974) reported for Texas. Cicimurri (1998) reported *P. mortoni* from Coniacian-early Campanian sediments in South Dakota and Wyoming. Herman (1975) documented a middle to late Coniacian distribution for *P. mortoni* in Belgium.

Squatina sp.

The teeth of *Squatina* that are found at the Dalton localities are laterally elongate (Fig. 3B). The central cusp projects posteriorly, and a lobe projects from the labial side of the tooth. The root is flat and lacks a basal medial groove. The genus *Squatina* has a very long stratigraphic range (Jurassic to Recent), and the teeth of individual species of this genus are difficult to distinguish due to the high degree of interspecific variability (Meyer, 1974; Williamson et al., 1989).

Hybodus cf. *H. butleri* Thurmond

The three teeth of *Hybodus* recovered from the Dalton localities (Fig. 3A) are broken yet closely resemble those of *H. butleri* Thurmond. These teeth are laterally elongate with a strong central cusp. The teeth of *H. butleri* differ from other *Hybodus* in the lack of lateral cusps. There is a rudimentary process that forms a trenchant ridge that runs from the margin of the cusp to the tooth margin on both the anterior and posterior portion of the tooth. The crown is striated, and these striations go nearly to the tip of the cusp, which suggests that they are lateral teeth.

Thurmond (1971) and Welton and Farish (1993) both report an Aptian-Albian range for *H. butleri*. Broken teeth that resemble *H. butleri* are also found in the Point Lookout Sandstone. If these teeth are correctly assigned to *H. butleri*, the Dalton and Point Lookout occurrences significantly extend this taxon's stratigraphic range.

PALEOECOLOGY

Reconstructing the paleoecology of the Dalton selachian sites is a challenging task. Localities 342 and 4830 are both at essentially the same stratigraphic level (Fig. 1) and are within 0.5 km of each other geographically. While the faunal lists are identical at the two sites, the abundances of the constituents of the faunas are different (Fig. 4). At locality 342, the fauna is dominated by the teeth of the pelagic shark *Scapanorhynchus*, and the teeth of *Pseudohypolophus* are only a minor constituent of the teeth found. At locality 4830, the teeth of *Pseudohypolophus* dominate those collected, though there is still a high abundance of *Scapanorhynchus* teeth. The difference between these two sites may be due to water currents winnowing the smaller, lighter material at locality 4830. This locality has a smaller number of elements such as tele-

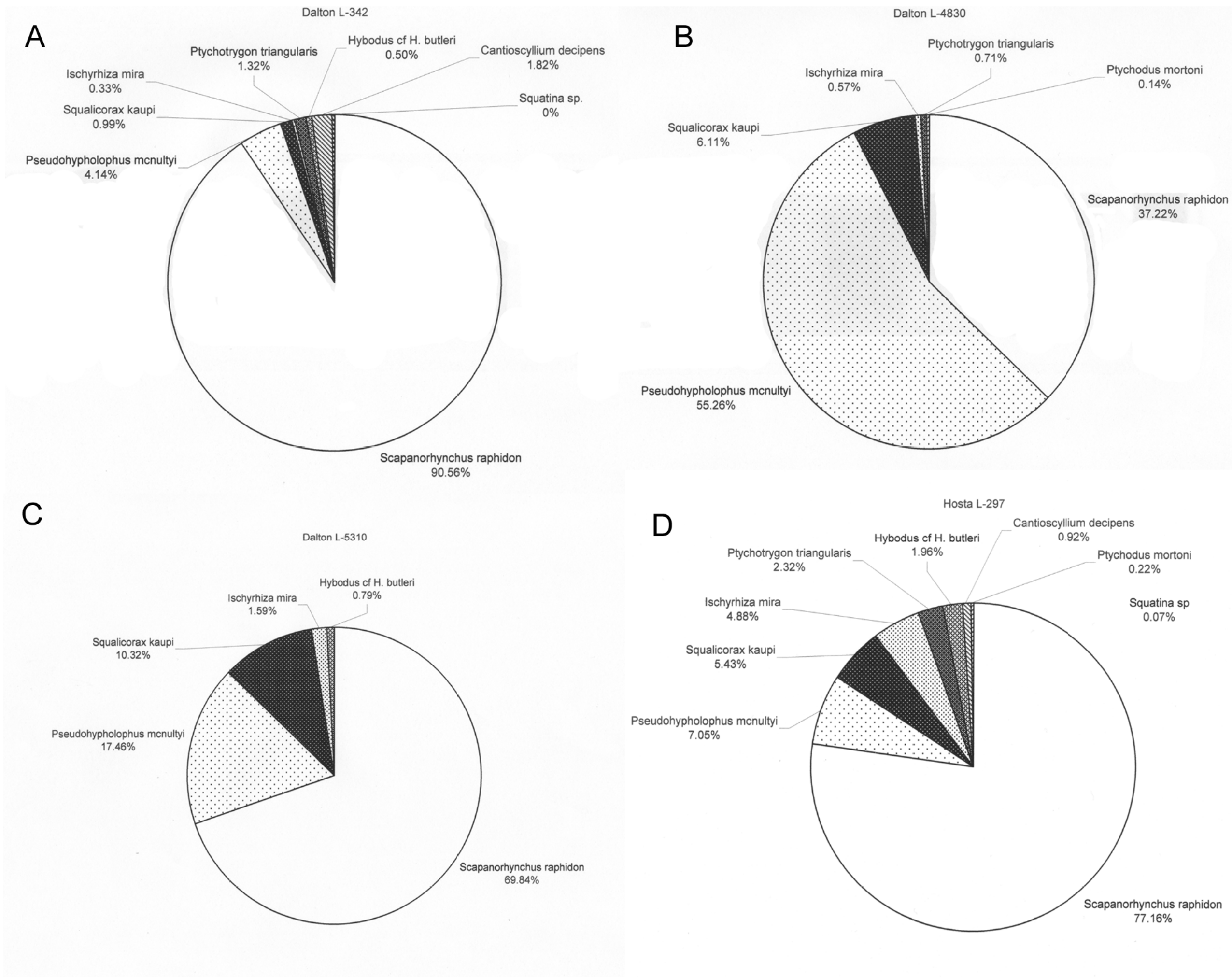

FIGURE 4. Pie diagrams representing the relative abundances of different shark species at each locality. (A) 342, (B) 4830, (C) 5310 and (D) 297.

ost vertebrae, which are small and light, and easily carried away by the water currents. There is also a slight sedimentological difference between the two localities, inasmuch as the matrix at locality 4830 has coarser grains mixed in. At locality 4830 there are substantially more freshwater elements (e.g., reptiles) than at locality 342. This suggests that 4830 is closer to a freshwater source, which could have provided a current to winnow parts of the fauna from the site.

In terms of relative abundances, there are very similar selachian faunas in the Hosta Tongue of the Point Lookout Formation and the Dalton Sandstone (Fig. 4). The only differences are the presence of some rare elements of the Hosta Fauna such as cf. *Onchosaurus* and the vast quantities of calcified centra. This suggests little if any evolutionary turnover of the selachian fauna in New Mexico from Coniacian to Santonian time.

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APPENDIX-DESCRIPTION OF MEASURED SECTION

Measured at NMMNH locality 4830. Base of section at UTM zone 13, 313366E, 3897009N. Strata dip 5° to N70°E.

Crevasse Canyon Formation:
Gibson Coal Member:

19.	Coal/lignite; dark yellowish brown (10 YR 4/2) with pale yellowish orange (10 YR 8/6) sulfurous streaks.	**2.0**
	Dalton Sandstone Member:	
18.	Sandstone; very pale orange (10 YR 8/2) with moderate yellowish brown (10 YR 5/4) lignitic streaks; fine grained; quartzose; subangular; slightly calcareous; ripple laminated and bioturbated.	**1.7**
17.	Sandstone; same colors and lithology as unit 15 but consists of thick, multistoried beds with lenses of coal.	**6.0**
16.	Sandstone; dark yellowish orange (10 YR 6/6), dark yellowish brown (10 YR 4/2) and moderate brown (5 YR 3/4); hematitic; very indurated crust.	**0.1**
15.	Sandstone; yellowish gray (5 Y 8/1); quartzose; fine to coarse grained; subrounded; poorly sorted; not calcareous; kaolinitic?; trough cross bedded; local lenses of pebbles and some petrified wood.	**2.3**
14.	Sandstone; grayish orange (10 YR 7/4) and dark yellowish brown (10 YR 4/2); quartzose; hematitic; fine grained; slightly calcareous; ripple laminated and bioturbated; stratigraphically highest selachian teeth.	**1.6**
13.	Sandstone; pale yellowish brown (10 YR 6/2) and very pale orange (10 YR 8/2); litharenite; fine to medium grained; calcareous; trough crossbedded.	**1.2**
12.	Sandstone; same color and lithology as unit 10; selachian teeth.	**1.1**
11.	Sandstone; very pale orange (10 YR 8/2); fine grained; subarkose; not calcareous; bioturbated; bench.	**0.8**
10.	Sandstone; grayish orange (10 YR 7/4); quartzose; fine to medium grained; very calcareous; bioturbated; main selachian-teeth horizon.	**1.1**
9.	Sandstone; same color and lithology as unit 7.	**1.4**
8.	Sandstone; dark yellowish orange (10 YR 6/6) and grayish orange (10 YR 7/4); hematitic; very fine grained; very calcareous; contains shell debris and some cannonball concretions.	**0.6**
7.	Sandstone; very pale orange (10 YR 8/2) and grayish orange (10 YR 7/4); subarkose; very fine grained; subrounded; calcareous; thick bedded and extensively bioturbated.	**2.5**
6.	Sandstone; very pale orange (10 YR 8/2); subarkose; very fine grained; not calcareous; ripple laminated with pebbly rip-ups at sharp base.	**1.8**
5.	Sandstone; same color and lithology as unit 3.	**4.3**
4.	Sandstone; very pale orange (10 YR 8/2) unweathered, weathers moderate yellowish brown (10 YR 5/4); subarkose; very fine grained; not calcareous; trough crossbedded and ripple laminated; many concretions.	**2.1**
3.	Sandstone; very pale orange (10 YR 8/2); subarkose; very fine grained; not calcareous; trough crossbbeded and hummocky; numerous ironstone concretions.	**6.5**
2.	Sandy siltstone; pale yellowish brown (10 YR 6/2); not calcareous; laminar; carbonaceous.	**2.2**
	Mancos Shale:	
	Mulatto Member:	
1.	Shale; medium gray (N5); not calcareous.	**not measured**