

An unusual archosauriform tooth increases known tetrapod diversity in the lower portion of the Chinle Formation (Late Triassic) of southeastern Utah, USA

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Abstract:

An unusual tetrapod tooth was discovered in the Upper Triassic Chinle Formation of southeastern Utah. In this paper, we compare MNA V10668 to other known fossil tooth crowns from the Chinle Formation and assign the tooth to the least inclusive clade currently available, Archosauriformes, based on the presence of mesial and distal serrations, a distal keel, and a conical mesiodistal profile. Using data found in other publications and pictures of other teeth, we compare this specimen to other Triassic dental taxa. MNA V10668 shares some similarities with *Crosbysaurus*, *Tecovasaurus*, and several other named taxa, including a teardrop-shaped labiolingual profile, but possesses a unique combination of characteristics not found in other archosauromorph teeth thus observed. This increases the known diversity of archosauromorphs from the Chinle Formation and represents the first tooth of this morphotype to be found from Utah in the Late Triassic.

1 **Introduction:**

2 The recovery of vertebrate life from the Permian-Triassic transition resulted in a diverse
3 array of new body forms as life filled ecological voids (MacLeod et al., 2000; Benton et al.,
4 2004; Retallack et al, 2007). This is especially noticeable in the archosauromorphs. Many
5 archosauromorph, archosauriform, and archosaurian reptile-groups radiated across the globe,
6 filling numerous niches with novel body forms (Nesbitt et al., 2010) and dietary specializations
7 (Heckert, 2004; Parker et al., 2005; Barrett et al., 2011). The ecological revolution of the Triassic
8 Period laid the groundwork for dinosaurs (including modern birds), crocodiles, and mammals to
9 dominate terrestrial vertebrate assemblages for the next 200 million years.

10 It is perhaps somewhat surprising then that the terrestrial record of the Upper Triassic
11 Period from Utah, USA has not reflected the global disparity of tetrapod clades. While
12 paleontologists were making collections in Utah since at least the late 1800s (e.g., Cope, 1875)
13 most of the collection effort has gone towards finding vertebrate fossils in younger rocks. In
14 addition, greater attention that Late Triassic deposits in neighboring Arizona and New Mexico
15 have received (e.g., Long and Murry, 1995; Heckert et al., 2005; Parker, 2005; Parker et al.,
16 2006). Until recently (Fraser et al., 2005; Heckert et al., 2006; Gibson, 2013; Martz et al., 2014)
17 the Triassic vertebrate record published from Utah has mainly consisted of the ubiquitous
18 phytosaurs (Morales and Ash, 1993). This has especially been the case when looking only at
19 body fossils. Even with this recent work, Utah's Triassic tetrapod record is lower in diversity
20 compared to adjoining states, with the majority of specimens being identified as either
21 phytosaurs or aetosaurs (Martz et al., 2014).

22 In May of 2014 a paleontological expedition to Comb Ridge in southeastern Utah was
23 conducted by Mission Heights Preparatory High School (Figure 1). During the expedition a new,
24 very rich (>300 specimens collected representing 15 taxa in two field seasons) microsite they
25 dubbed “The Hills Have Teeth” (Museum of Northern Arizona Locality 1724), approximately
26 five meters south of a locality that was previously discovered (MNA Loc. 1721). Both at “The
27 Hills Have Teeth” and area immediately adjacent to the west of the hill a dozen partial and
28 complete tetrapod teeth were collected. Most of these teeth belonged to phytosaurs (e.g. MNA
29 V10658, MNA V10659, etc.) and temnospondyls (e.g. MNA V10655, MNA V10656). Two
30 teeth were notably different from these two taxa that dominate the locality in number of
31 specimens. One, referred to *Crosbysaurus sp.*, is described elsewhere (Gay and St. Aude, 2015).
32 The other collected is the subject of this contribution. That specimen, MNA V10668, is
33 compared here to many Triassic diapsids in order to assign it to a taxon. We compare it to the
34 non-archosauriform archosauromorphs *Azendohsaurus madagaskarensis* (Flynn et al., 2010),
35 *Mesosuchus browni* (Dilkes, 1998), and *Teraterpeton hrynewichorum* (Sues, 2003), several non-
36 archosaurian archosauriforms including *Crosbysaurus harrisae* (Heckert, 2004),
37 *Krzyzanowskisaurus hunti* (Heckert, 2005), *Lucianosaurus wildi* (Hunt and Lucas, 1995),
38 *Protecovasaurus lucasi* (Heckert, 2004), *Revueltosaurus callenderi* (Hunt, 1989), *Tecovasaurus*
39 *murryi* (Hunt and Lucas, 1994), unnamed archosauriform teeth (Heckert, 2004), and various
40 other archosaurs (e.g., Colbert, 1989; Dalla Vecchia, 2009; Heckert, 2004).

41 **Materials and Methods:**

42 Standard paleontological field materials and methods were used to collect all specimens
43 from MNA locality 1725, including brushes, dental tools, and other small hand tools. Specimens
44 were wrapped in toilet paper and placed in plastic zip-seal bags for transport back to the

45 museum. Locality data for MNA Locality 1725 was recorded using Backcountry Navigator Pro
46 running on an Android OS smartphone with a spatial error of +/- 2 meters. Measurements of
47 MNA V10668 were obtained using a set of Craftsman metal calipers (model 40257) with
48 0.05mm precision. Figures were created using GIMP 2.8.4. Photos were taken with an Olympus
49 E-500 DSLR and PC USB digital microscope. MNA V10668 was collected under Bureau of
50 Land Management permit UT14-001S and is permanently housed at the Museum of Northern
51 Arizona (MNA) along with the exact locality information. Quantitative and qualitative
52 comparisons of MNA V10668 to published photographs, drawings, and descriptions, along with
53 direct comparison to material from the Chinle Formation are housed at the MNA were used to
54 assign MNA V10668 to its least-inclusive clade.

55 **Geologic Setting:**

56 MNA V10668 was found at MNA Locality 1725 as float on the surface of the Chinle
57 Formation at Comb Ridge, Utah (Figure 1), roughly 6 meters from the base of the unit along
58 with teeth of phytosaurs (e.g., MNA V10670, MNA V10672), temnospondyls (e.g., MNA
59 V10669, MNA V10678), and *Crosbysaurus* sp. (MNA V10666). The fossil material found at
60 locality 1725 originated at MNA Locality 1724 and was washed down slope. The horizon is a
61 fossiliferous light grey mudstone with interspersed carbonaceous clasts and abundant carbonized
62 plant fragments (Figure 2). This mudstone sits below a 13 cm thick dark grey mudstone, which
63 itself is below a red brown mudstone-grading-to-shale. The fossiliferous horizon is 8.75 meters
64 above the base of the Chinle Formation (Gay and St. Aude, 2015; figure 4). The fossil-bearing
65 layer, informally referred to as, “the Hills Have Teeth bed,” is exposed locally for about half a
66 kilometer in the Rainbow Garden (MNA Locality 1721) area. Preliminary stratigraphic work
67 done in the summer of 2015 shows that this bed lenses out. It is present where the base of the

68 Chinle Formation is exposed along the western face of Comb Ridge between the Hills Have
69 Teeth and the San Juan River. At the northern end of Comb Ridge the lower member of the
70 Chinle Formation is dominated by at least two thick (>10 m) channel sandstones and
71 conglomerates. At this time it is unknown if these channel deposits are laterally equivalent to the
72 Hills Have Teeth fossil-bearing bed or whether they are incised into the lowest portions of the
73 Chinle Formation, though further work is currently ongoing to solve this problem.

74 Although the stratigraphy of the Chinle Formation has generally been well studied across
75 the Colorado Plateau (e.g. Stewart et al., 1972), no detailed work has been published on the
76 exposures at Comb Ridge. Superficial work conducted by Bennett (1955), Lucas et al. (1997),
77 and Molina-Garza et al. (2003) suggested various correlations for the uppermost reddish member
78 of the Chinle Formation at Comb Ridge (see Gay and St. Aude for a discussion of this history).
79 Most recently, Martz et al. (2014) have suggested that the uppermost Chinle Formation at Comb
80 Ridge correlates to the Church Rock Member, as in Lisbon Valley to the northeast. We have
81 elsewhere agreed with this correlation (Gay and St. Aude, 2015).

82 The grey bed is more difficult to correlate with other members of the Chinle Formation
83 exposed in southwestern Utah. The studies mentioned above looked primarily at the upper units
84 of the Chinle Formation. Current work is being conducted to assess the stratigraphic correlations
85 of this lower unit. We can state that the fossil producing beds at The Hills Have Teeth are 15
86 meters below the base of the Church Rock Member at Comb Ridge.

87 Lithologically the lower part of the Chinle Formation at Comb Ridge is dominated by
88 grey to light grey bentonitic muds and shales with rare localized conglomerates and coarse-
89 grained sandstones. These conglomerates tend to be calcium-cemented and are dominated by
90 sandstone clasts, though chert clasts can occur. These resistant beds tend to be clastically

91 homogeneous and are rarely over 2 meters in thickness. At The Hills Have Teeth beds
92 carbonized plant remains are common but have not been noted at other localities within the
93 lower member where trenching has been conducted and stratigraphic sections measured whereas
94 both the Kane Springs Member to the northeast and Monitor Butte Member to the south and west
95 preserve abundant carbonized plant fragments and occasional well-preserved plant material
96 (Stewart et al., 1972; Martz et al., 2014).

97

98 **Description:**

99 MNA V10668 is a single tooth crown that is labiolingually flattened and conical in
100 profile. It measures 5 mm apicobasally and 3mm mesiodistally. The distal side of the tooth
101 crown has a continuous serrated edge from the base to the apex. Based on other
102 archosauromorph teeth examined, we interpret this to be the distal edge as it presents a more
103 vertical profile when viewed in labial or lingual view. The distal serrations are 0.1 mm
104 apicobasally with a density of eight serrations per millimeter. We estimate there are thirty
105 serrations along the entirety of the distal keel, though a precise count is difficult due to wear at
106 the apex. The serrations show increasing wear apically with the apex itself completely worn
107 away prior to fossilization. We interpret this structure as a wear facet (Figures 3, 4). The distal
108 serrations are stacked apicobasally and are not labiolingually staggered as they progress to the
109 apex of the specimen. The mesial side of the crown is missing most of its enamel so
110 identification of features is difficult. Nonetheless the dentine does preserve traces of several
111 apical serrations. It is possible that a pronounced mesial keel existed in this region but there is no
112 evidence of this in the preserved dentine (though this does not rule out the possibility of an
113 enameled keel). The wear on the apex is well rounded with no jagged edges. Coupled with the

114 fact that no root is preserved and a small resorption pit is present on the base we suggest that
115 MNA V10668 is a shed tooth crown. The loss of enamel from the majority of the tooth surface
116 does not appear recent, as all the enamel edges are smooth. It is possible that this tooth was
117 digested. Although there is no pitting observed on the preserved enamel surface the dentine
118 shows occasional pitting. We have interpreted these pits as transport damage but the presence of
119 both coprolites and a theropod or rauisuchian tooth (MNA V10689) showing evidence of
120 ingestion collected in the 2015 field season do not allow us to rule out this second option. The
121 tooth has a small chip on its base, likely a result of recent weathering and transport due to the
122 freshness of the break, distal to the midline (Figure 3, 4).

123

124 **Systematic Paleontology:**

125 Diapsida Osborn, 1903

126 Archosauromorpha Von Huene, 1946

127 ?Archosauriformes Gauthier, 1986

128

129 **Diagnosis:**

130 We can diagnose MNA V10668 as being an archosauriform based on the following
131 characters from Godefroit and Cuny (1997): tooth conical in mesiodistal profile with a single
132 cusp and possesses serrations on both the mesial and distal edges. The tooth (at least on the distal
133 edge) possesses an enamel keel basally and is labiolingually compressed. Since MNA V10668 is
134 a shed tooth crown we cannot assess the character of deep thecodont implantation, though
135 Godefroit and Cuny (1997) regard this as a dubious character in any case.

136

137 **Comparisons:**

138 MNA V10668 differs from most described Triassic teeth with serrations only along one
139 edge. Because this morphology is due to taphonomic processes discussed above, we compare
140 MNA V10668 to other archosauromorphs with thecodont or sub-theodont dentition with both
141 mesial and distal serrations as well as those only possessing distal serrations.

142 *Azendohsaurus madagaskarensis* is an archosauromorph from Madagascar known from
143 reasonably complete remains (Flynn et al., 2010). Its dentition is well documented and
144 illustrated, allowing comparisons to be made (Flynn et al., 2010). *Azendohsaurus* teeth are
145 slightly recurved with a basal constriction whereas MNA V10668 appears to be conical with no
146 mesiodistal constriction apical to the base. The teeth of *Azendohsaurus* do not possess significant
147 wear facets or worn denticles, as MNA V10668 does. The denticles that exist on the teeth of
148 *Azendohsaurus* are apically directed. In MNA V10668 the preserved distal denticles appear
149 perpendicular to the long axis of the tooth. The denticles of *Azendohsaurus* are also much larger
150 (>0.5 mm) and fewer in number than those of MNA V10668, having between four to 18 on the
151 carinae, depending on tooth position. MNA V10668 cannot be assigned to *Azendohsaurus*. Flynn
152 et al. (2010) also report that the teeth of *Azendohsaurus* do not possess wear facets, a feature that
153 is seen in MNA V10668, though this is a behavioral trace and not directly tied to evolutionary
154 trends.

155 *Mesosuchus browni* is a basal rhynchosaur, deeply nested within Archosauromorpha,
156 (Dilkes, 1998), and is known from at least four specimens. The dentition of *Mesosuchus* is
157 rounded in cross-section and conical in profile. The tooth-jaw junction is not well preserved
158 enough to say whether the teeth had thecodont implantation. Dilkes (1998) noted an unusual
159 wear facet on the teeth of *Mesosuchus*, which is why it is included here. Despite MNA V10668

160 and *Mesosuchus* both having erosional surfaces, those on *Mesosuchus* are mesiolabially directed
161 whereas in MNA V10668 the wear is mesiobasal. *Mesosuchus* dentition also lacks serrations or
162 denticles. Indeed the mesial and distal faces, as illustrated and described by Dilkes (1998) show
163 teeth round to square in cross section and conical in labial or lingual view. Taken all together the
164 teeth of *Mesosuchus* are not a good match for MNA V10668 and as such does not represent a
165 specimen of *Mesosuchus* or any rhynchosaur by extension.

166 The archosauromorph *Teraterpeton hrynewichorum* from the Triassic of Nova Scotia was
167 first described by Sues (2003). The teeth are round to oval in cross-section, with the posterior-
168 most teeth being much broader labiolingually than mesiodistally. The teeth have a distal
169 triangular cusp and a flattened area mesially on each occlusal surface. The narrow, conical
170 profile and labiolingually compressed cross-section of MNA V10668 strongly differs from the
171 teeth of *Teraterpeton* in all these aspects.

172 *Crosbysaurus harrisae* (Heckert, 2004) is an archosauriform that has serrations on both
173 mesial and distal sides of the tooth, with the distal serrations being much larger than those on the
174 mesial keel. These denticles are subdivided and on the distal keel they point apically. Both MNA
175 V10668 and *Crosbysaurus* teeth are similar in size apicobasally and have the same triangular
176 shape in labial and lingual views. *Crosbysaurus* teeth are distally curved at the apicomerial keel,
177 a condition not present in MNA V10668.

178 MNA V10668 and MNA V10666, referred to *Crosbysaurus sp.* by Gay and St. Aude
179 (2015), were both found at the same locality. MNA V10666 lacks serrations on the mesiobasal
180 keel, as MNA V10668 appears to as well. The tooth referred to as *Crosbysaurus sp.* by Gay and
181 St. Aude (2015) has clear mesial denticles towards the apex. The distal denticles are much larger
182 and subdivided, as in all other *Crosbysaurus* teeth (Heckert, 2004). Whereas MNA V10668 is

183 labiolingually compressed like MNA V10666 and other known *Crosbysaurus* teeth, it is not as
184 mesiodistally narrow. Considering that *Crosbysaurus* serrations are larger, present on the mesial
185 side, apically directed, and the teeth tend to be mesiodistally narrower it is certain that MNA
186 V10668 is a *Crosbysaurus* tooth.

187 *Krzyzanowskisaurus hunti* (Heckert 2005) is a small (presumably) herbivorous
188 archosauromorph known only from dental remains. It resembles *Revueltasaurus callenderi* but
189 can be diagnosed by the presence of a cingulum on the base of the tooth (Heckert 2002). Since
190 MNA V10668 does not have a cingulum it cannot presently be referred to *Krzyzanowskisaurus*.

191 *Lucianosaurus wildi* (Hunt and Lucas, 1995) is similar to other isolated Triassic teeth
192 described in the literature by having enlarged denticles and a squat shape with convex mesial and
193 distal edges, being mesiodistally broad while apicobasally short. MNA V10668 is taller than it is
194 long and has relatively small denticles. MNA V10668 does not represent *Lucianosaurus*.

195 *Protecovasaurus lucasi* (Heckert, 2004) is diagnosed by having a recurved mesial surface
196 where the apex is even with or overhangs the distal margin. The denticles on both the mesial and
197 distal keels are apically directed. In all these features the teeth of *Protecovasaurus* do not match
198 the features seen in MNA V10668.

199 *Revueltasaurus callenderi* (Hunt, 1989; Heckert, 2002; Parker et al., 2005) has serrations
200 on both the mesial and labial sides. Its serrations are proportionally larger and closer together.
201 The teeth of *Revueltasaurus* are broader mesiodistally compared to their apicobasal height. In
202 general, *Revueltasaurus* teeth have more serrations on the distal keel of the tooth than at the
203 mesial side of the tooth. MNA V10668 is labiolingually narrower than the teeth of
204 *Revueltasaurus*. These differences rule out the possibility that MNA V10668 is *Revueltasaurus*.

205 Heckert (2004) described some tetrapod teeth found from other localities across the
206 Chinle Formation. Some of these teeth are from phytosaurs (Heckert, 2004, figure 43). NMMNH
207 P-30806 for example is roughly conical in outline and somewhat labiolingually compressed. The
208 serrations are perpendicular to the long axis of the tooth. In these regards young phytosaur teeth
209 are similar to MNA V10668. Unlike MNA V10668, however, these teeth are moderately curved
210 lingually and have serrations on their mesial surface. In addition the serrations on phytosaur
211 teeth, like those figured in Heckert (2004), are denser (>14 per millimeter) compared to MNA
212 V10668. Phytosaur teeth in general, especially the teeth from segments of the jaw posterior to
213 the premaxillary rosette, tend to be more robust than MNA V10668. Although phytosaurs are the
214 most common taxa represented at MNA V1724 it not likely MNA V106668 is a phytosaur tooth.

215 Heckert described another specimen, NMMNH P-34013 (Heckert, 2004, figure 20 A-C),
216 that is roughly the same size as MNA V10668. Both have a resorption pit at the base and,
217 seemingly unusual for predatory Triassic archosauriformes, a wear facet on the tip. This is a
218 feature shared with MNA V10668. However the serrations on NMMNH P-34013 are smaller
219 (<0.1 mm) than MNA V10668, and has a slight curve unlike MNA V10668. Heckert described
220 this tooth as belonging to an indeterminate archosauriform. Despite their differences, this tooth,
221 NMMNH P-34013, is the closest in morphology to the tooth MNA V10668 yet identified.

222 They differ from *Coelophysis* teeth being naturally recurved, at least slightly, whereas
223 MNA V10668 does not have a noticeable curve to it. *Coelophysis* teeth (Cleveland Museum
224 31374; Colbert, 1989) have small serrations along the mesial and distal sides. *Coelophysis* teeth
225 tend to be even more mesiodistally compressed and the serrations at the distal side are
226 completely different. *Coelophysis* tooth serrations are smaller and are closer together to each
227 other. We can conclude that MNA V10668 cannot be a *Coelophysis* tooth and indeed is unlikely

228 to be a theropod dinosaur at all. Although the enamel of MNA V10668 is not well preserved, it
229 does not preserve any surface features such as longitudinal grooves, ridges, fluting, or
230 undulations that are characteristic of theropod dinosaur teeth (Hendrickx et al., 2015). In
231 addition, whereas MNA V10668 is moderately laterally compressed, Triassic theropod dinosaur
232 teeth are compressed even more so (Colbert, 1989).

233 Pterosaurs are rare from the Triassic of North America and several good examples are
234 known from Europe. Perhaps the best illustrated in terms of dentition is *Austriadactylus* (Dalla
235 Veccia, 2009). MNA V10668 differs from *Austriadactylus* in shape and size. *Austriadactylus*
236 teeth are smaller and sharper; also they have serrations at the mesial and labial sides of the tooth.
237 The serrations are completely different because they are larger and possess more distinct tips.
238 *Austriadactylus* has a few different types of teeth. Most teeth are small, have three cusps, and a
239 slight curve to them. Other teeth have only one distinct cusp and have a slight curve to them.
240 They have very few and large serrations. MNA V10668 differs from all of the *Austriadactylus*
241 teeth as it has no visible curve, and serrations along the mesial side. Seeing this, MNA V10668
242 does not represent *Austriadactylus*.

243 Reported Chinle early sauropodomorph teeth, such as those figured in Heckert (2004,
244 figures 45, 83, 84) are extremely mesiolaterally compressed. They also exhibit serrations on the
245 mesial and labial sides of the tooth. Its serrations are relatively larger, closer together, and are
246 apically directed. Also early sauropodomorph teeth have a distinctly tapered apex with no wear
247 facets. Its shape is completely different; MNA V10668 is relatively wider labiolingually and
248 apicobasally smaller than the reported early sauropodomorph specimens. There is no reason to
249 classify this specimen is an early sauropodomorph. It should also be noted that the extreme

250 convergence seen in *Azendohsaurus* (Flynn et al., 2010) makes the identification of early
251 sauropodomorphs from the Chinle Formation tentative at best (Nesbitt et al., 2007).

252 The most common vertebrate remains from the Chinle Formation are phytosaur teeth
253 (Heckert, 2004; Martz et al., 2014; pers. obs.). Despite the small size of MNA V10668 it is
254 possible that this specimen pertains to a juvenile phytosaur. To test this hypothesis two phytosaur
255 snouts, identified as juveniles in the collections at the Museum of Northern Arizona, were
256 examined. It should be noted that although both specimens are identified in collections data as
257 juvenile phytosaurs no histological examinations have been conducted to assess their ontogenetic
258 stage. One of these, PEFO 13890/MNA V1789 was collected by George Billingsley in 1979
259 from the Upper Petrified Forest Member of the Chinle Formation in Petrified Forest National
260 Park (PEFO). It represents articulated paired premaxillae with 15 preserved alveoli on the right
261 and 14 on the left, all of which save one are empty. The total preserved length of this specimen is
262 9.3 cm. While identified in collections as "*Machaeroprotopus*" *zunii* there are no preserved
263 autapomorphies to support this assignment, so we assign it instead to Phytosauria indet.

264 The second specimen, MNA V3601, is a partial right dentary from the Blue Mesa
265 Member of the Chinle Formation (Parker and Martz, 2011; Ramezani et al., 2014) *Placerias*
266 Quarry, near St. Johns, Arizona identified in collections as *Leptosuchus* sp. (Long and Murry,
267 1995, though see also Stocker, 2010). MNA V3601 is 4.95 cm in length, preserving the anterior
268 tip and eight alveoli. In this specimen several of the tooth crowns are present and show wear
269 whereas others are broken off at the oral margin or inside the alveolus.

270 In PEFO 13890/MNA V1789 the tooth row exhibits homodonty in the alveolar cross
271 sections (Figure 5). This tooth is lingually curved and symmetrical in mesiodistal profile. The
272 tooth lacks any visible serrations (Figure 6).

273 In MNA V3601 the erupted crown heights vary but their labiolingual and mesiodistal
274 profiles are remarkably similar (Figure 5). This is notable considering the heterodonty present in
275 larger phytosaurs (Heckert, 2004). We do acknowledge that not having complete juvenile skulls
276 available limits the inferences we can make about overall tooth form, but feel that the
277 comparisons to smaller individuals is none-the-less informative in that it allows us to directly
278 compare similar size teeth from the Chinle Formation that are firmly associated with non-dental
279 remains. Whereas MNA V10668 is roughly the right size of tooth to have come from a phytosaur
280 similar in size to PEFO13890/MNA V1789 or MNA V3601, the basal structure, especially in
281 cross section, of the tooth is unlike any of the preserved small phytosaur tooth crowns or alveoli.
282 Both undisputed phytosaur specimens have round alveoli with serrated or unserrated conical
283 teeth preserved (Figure 7, 8). In addition, all preserved teeth in MNA V3601 do not show any
284 lingual curvature as seen in MNA V10668. While larger phytosaurs, presumed to be
285 ontogenetically more mature, have triangular, lingually curved teeth in their dentition, especially
286 as one moves posteriorly (Long and Murry, 1995; Hungerbühler, 2000; Heckert, 2004), these
287 seem to be absent in juveniles from the preserved portions specimens observed at the MNA,
288 though additional smaller phytosaur jaws and histological sampling would help refine our
289 comparison. The lingually curved teeth of large phytosaurs are also much more robust, with
290 labiolingually wide basal and mid-crown section, unlike the laterally compressed and teardrop-
291 shaped base of MNA V10668. Considering this we do not think that MNA V10668 can be
292 assigned to the Phytosauria because of the marked differences between it and all other known
293 phytosaur teeth.

294

295 **Conclusions:**

296 MNA V10668 cannot be identified as any previously described Triassic taxon as it does
297 not have any distinguishing autapomorphies and preserves a unique combination of characters.
298 However, this tooth can be identified at least as Archosauriformes. MNA V10668 has many
299 character states that match up with other archosauriforms, including labiolingual compression
300 and the presence of serrations on distinct carinae. Another taxonomically indeterminate tooth,
301 NMMNH P-34013, is the closest tooth morphologically to MNA V10668 and likely belongs to
302 Morphotype T (Sensu Heckert, 2004). Despite their similarities it is obvious that MNA V10668
303 is morphologically distinct from NMMNH P-34013, primarily due to the smaller serrations and
304 slight lingual curvature found in NMMNH P-34013. Although isolated teeth have been described
305 before from Utah (Heckert et al., 2006; Gay and St. Aude, 2015) this is the first occurrence of
306 tooth Morphotype T described from Utah. It is likely that other teeth now in collections may also
307 represent unique morphotypes or previously described morphotypes not previously identified
308 from Utah. It may also represent a previous identified taxon for which little or nothing is known
309 of its dentition (e.g., *Spinosuchus*, Spielmann et al., 2009).

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319

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