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specimens are nevertheless important for revealing further the theropod fauna of the Maastrichtian Navesink Formation of New Jersey, as well as for possibly increasing the diversity of tyrannosauroids and further illuminating the presence of ornithomimosaurs on Appalachia.
Theropod specimens from the Navesink Formation and their implications for the Diversity and Biogeography of Ornithomimosaur and Tyrannosauroid on Appalachia

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Abstract.

The sparse dinosaur record of eastern North America has rendered the dinosaurs of the Late Cretaceous landmass of Appalachia obscure. This landmass, isolated from the western landmass Laramidia by a great inland sea known as the Western Interior Seaway, may have been a safe haven for dinosaur species which would be replaced on Appalachia’s western contemporary. An excellent example of these isolated forms are the tyrannosaurs of Appalachia, which have not only been grouped outside Tyrannosauridae proper in phylogenetic analyses, but also bare distinct morphologies, including a gigantic manus in one form, from these ‘western tyrants’. However, Appalachian tyrannosaurs are only represented currently by the two valid taxa *Dryptosaurus aquilunguis* and *Appalachiosaurus montgomeriensis*, both which are only known from partial skeletons with few overlapping elements. Recently, the generic name *Teihivenator* was given to another tyrannosaur named “Laelaps” *macropus* by Cope (1868) by Yun (2017). However, examination of the specimens by the author show morphologies at odds with the morphological descriptions given by Yun (2017). The tyrannosaur named by Yun (2017), known from partial lower hindlimb elements including the portions of two metatarsals and a partial tibia, is shown herein to be a chimaera of ornithomimosaur and tyrannosauroid hindlimb elements. The several different dinosaur specimens which compose the syntypes of
“Teihivenator” include three ornithomimosaur pedal phalanges with affinities to derived ornithomimid taxa, a proximal end of the right metatarsal II and a distal end of the right metatarsal II from either ornithomimosaurs or tyrannosauroids, and a partial tibia of a tyrannosauroid distinct from *Dryptosaurus* or *Appalachiosaurus* but nevertheless considered here to be from an indeterminate taxon based on the lack of observable autopomorphies and issues with the comparability of the specimen to other taxa. The specimens are nevertheless important for revealing further the theropod fauna of the Maastrichtian Navesink Formation of New Jersey, as well as for possibly increasing the diversity of tyrannosauroids and further illuminating the presence of ornithomimosaurs on Appalachia.

Introduction.

The Late Cretaceous saw a major period of change in the geography and ecology of North American ecosystems. During the Cenomanian Stage of the Late Cretaceous, the Western Interior Seaway separated the terrestrial ecosystems of the eastern portion of North America with those of the American west, in turn affecting the faunas of both the east and west of the continent by subjecting each to isolation for millions of years. While in the west, it is known that the ancestors of the iconic *Tyrannosaurus rex* evolved reduced forelimbs and massive, powerful skulls, the tyrannosaurs of the eastern portion of North America, at that time a landmass called Appalachia (e.g., Sampson et al., 2010; Loewen et al., 2013), have remained more obscure, and rarely are associated or partial skeletons ever found. The two most complete tyrannosaurs from Late Cretaceous continent described so far are *Dryptosaurus aquilunguis* and *Appalachiosaurus montgomeriensis*, originally known from the Maastrichtian New Egypt Formation of New Jersey
and from the middle Campanian Demopolis Chalk Formation of Alabama, respectively (e.g.,
Cope, 1866; Marsh, 1877; Weishampel et al., 2004; Carr, Williamson & Schwimmer, 2005;
Weishampel, 2006; Brusatte, Benson & Norell, 2011). Additional remains assigned to
*Dryptosaurus* have been recovered from the Marshalltown Formation-bearing Ellisdale
microfossil site, the Mt. Laurel Formation at upper Hop Brook, and the Navesink Formation at
Big Brook in New Jersey (Krause & Baird, 1979; Baird & Galton, 1981; Gallagher & Parris,
1986; Grandstaff et al., 1992). Possible additional remains of this taxon have been reported from
North Carolina (Baird & Horner, 1979). *Appalachiosaurus* is also known from multiple other
Campanian units in the southeastern United States (e.g., Ebersole & King, 2011). Recently,
Schwimmer et al. (2015) described teeth and bones of *Appalachiosaurus montgomeriensis* from
eastern South Carolina. Remains from the Missouri Chronister Site have also been assigned to an
undetermined genus of tyrannosaur (Fix & Darrough, 2004).

The holotype specimens of *D. aquilunguis* and *A. montgomeriensis* have been found as
“intermediate” tyrannosauriod dinosaurs in multiple phylogenetic analysis, unlike the derived
tyranosaurids of the western portion of North America (e.g., Brusatte, Benson & Norell, 2011;
Loewen et al., 2013; Fiorillo & Tykoski, 2014; Brusatte et al., 2016; Brusatte & Carr, 2016).
Additionally, striking morphologies completely absent in western tyrannosaurs, such as the
gigantic manus with large unguals present in *D. aquilunguis*, are known from Appalachian taxa.
However, the lack of overlap of the skeletal elements of *Dryptosaurus aquilunguis* and
*Appalachiosaurus montgomeriensis* has made their evolutionary relationships ambiguous
(Brusatte, Benson & Norell, 2011).
Very recently, a third tyrannosauroid, “Teihivenator macropus”, was described from the Maastrichtian Formation of New Jersey by Yun (2017). The author, who was also describing and reevaluating the specimens AMNH 2550-2553 at the time of the publication of Yun (2017), though he arrived at different conclusions regarding these specimens. Examination of the specimens by the author reveal that the syntypes of “Teihivenator” actually represent specimens of ornithomimosaurs and indeterminate tyrannosauroids. One of these specimens, a partial eroded tibia, is from a tyrannosauroid that may be distinguished from Dryptosaurus aquilunguis and Appalachiosaurus montgomeriensis, suggesting increased diversity for tyrannosauroids on Appalachia through the Maastrichtian. However, the eroded partial tibia is not diagnostic enough to support the existence of a distinct taxon and not comparable to several tyrannosaur specimens from distinct or likely distinct taxa, and thus “Teihivenator macropus” is considered a nomen dubium. Additionally, several of the specimens included in the syntypes of the aforementioned dubious taxon are assignable to ornithomimosaurs and have morphological affinities to derived ornithomimids.

The reassignment of the syntypes of “Teihivenator” to multiple different species may be seen as another example of the mistaken association of dinosaur specimens leading to the naming of a new genus. Baird & Horner (1979), for example, reevaluated Edward Drinker Cope’s holotype specimen of Hypsibema crassicauda, finding it to include elements assignable to cf. Dryptosaurus aquilunguis and indeterminate hadrosaurids in addition to the lectotype specimen of H. crassicauda.

Methods.
Permits.

No permits were required for the described study, which complied with all relevant regulations.

Access to the collections at the American Museum of Natural History was given by Carl Mehling.

Institutional Abbreviations.

The term “AMNH FARB” is used to refer to the fossil amphibian, reptile and bird collections of the American Museum of Natural History.

The specimens described herein were photographed using a Canon Powershot G12 camera and cropped using Apple Preview.

Results.

Geologic Setting. AMNH 2550-2553 have been thought as coming from the Maastrichtian Mt. Laurel, Navesink, or New Egypt Formations of New Jersey (e.g., Horner, 1979; Gallagher, 1993). Several clues are of help when determining exactly from which of these formations these coelurosaurian elements were recovered. In his original description of the fossils, Leidy (1865) cites the location of the discovery of these fossils as in Monmouth County, New Jersey. Cope (1870) gives a brief description of the stratigraphy of the unit from which the specimens which constitute the holotype of this new tyrannosaur species were recovered, stating it was from the “Upper Cretaceous, upper green sand bed Monmouth Co., N. J.” Gallagher (1997) gives a more detailed location of discovery and discoverer of AMNH 2550-2553, the former being a marl pit
in Marlboro, New Jersey, and the later being the notable geologist George Cook. Most recently, Gallagher et al. (2014) identified the location of the discovery of AMNH 2550-2553 as the Big Brook site in Marlboro, New Jersey, noting the Navesink and Mt. Laurel Formations to both be present there. Yun (2017) also suggested a Navesink Formation origin for the specimens, which fits with the coloration of the syntypes. Indeed, AMNH 2550-2553 have coloration that resembles fossils found from the Navesink (e.g., Anné, Hedrick & Schein, 2016). Finally, Brusatte et al. (2012) agree that the origin of these specimens was the Navesink Formation. Notably, the Navesink Formation is a marine deposit.

Systematic Paleontology.

Dinosauria Owen 1842 sensu Padian and May 1993
Theropoda Marsh 1881 sensu Gauthier 1986
Coelurosauria Huene 1914 sensu Sereno et al. 2005
Tyrannosauroidea Walker 1964 sensu Holtz 2004
Tyrannosauroidea indet.

Specimen: AMNH 2550, proximal and distal ends of a right tibia.

The proximal end of the right tibia of a tyrannosauroid dinosaur (figure 1.A-F) is eroded, likely from water wear. The specimen measures 95 mm proximodistally and 94 mm dorsoventrally as measured on the lateral surface, 72 mm mediolaterally and 93 mm proximodistally as measured dorsally, 93 mm dorsoventrally and 89 mm proximodistally as measured on the medial surface, and 35 mm mediolaterally and 45 mm proximodistally on the ventral surface. The proximal surface is 95 mm mediolaterally and 60 mm dorsoventrally. The cnemial crest has been partially destroyed by erosion, and thus the autopomorphy of the cnemial crest being visible in ventral
view of proximal tibia given by Yun (2017) for “Teihivenator” cannot be supported. The lateral portion of the proximal articular surface and lateral portion of the shaft are also not preserved. The incisura tibialis is subtle as in Dryptosaurus aquilunguis (Brusatte et al., 2011), and the presence of an anterior process cannot be determined. The medial posterior condyle is well-preserved and triangular. The side of the medial posterior condyle facing the lateral posterior condyle is eroded, and the lateral posterior condyle is also too poorly preserved for morphological description, thus undermining one other autopomorphy listed by Yun (2017) for “Teihivenator”. This is the position of the medial condyle being higher than that of the lateral condyle. The lateral surface of the tibia is much more strongly curved towards the proximal surface than in Dryptosaurus aquilunguis. The preserved portion of the lateral posterior condyle and the medial posterior condyle are separated by a deep, I-shaped notch, noted as an autopomorphy of “Teihivenator” by Yun (2017). This notch is deeper than in Dryptosaurus or Appalachiosaurus (Carr, Williamson & Schwimmer, 2005; Brusatte, Benson and Norell, 2011), though is very similar in shape to that of the tibia of Appalachiosaurus (Carr, Williamson & Schwimmer, 2005). Considering the eroded nature of the specimen, the understanding of this notch as a distinguishing feature of the tyrannosaur to which this tibia corresponds is considered ambiguous. The protuberance within this notch suggested as an autopomorphy of “Teihivenator” by Yun (2017) is considered herein to be a taphonomic relic from erosion that simply represents a non-eroded portion of the surface of the posterior lateral condyle. The rounded medial edge of the medial posterior condyle resembles the condition in other tyrannosauroids (Holtz, 2004). As in Dryptosaurus aquilunguis, there is a notable depression in the center of the proximal articular surface of the tibia (Brusatte et al., 2011). The medial posterior condyle is strongly offset from
where the cnemial crest is indicated to have been located. The proximal and distal ends of the shaft of the tibia indicate an elongate tibia was present in this tyrannosaur, a feature that is indicative of placement in Tyrannosauridae (Holtz, 2004).

The distal end of the right tibia (figure 1.A-F) is well-preserved. The distal end is dorsoventrally flattened. The lateral malleolus reaches its end very slightly distal to the medial malleolus, though the lateral malleolus shows slight signs of wear. Nevertheless, the position of the lateral malleolus relative to the medial malleolus distinguishes this tibia from *Dryptosaurus aquilunguis* or *Appalachiosaurus montgomeriensis* (Carr, Williamson & Schwimmer, 2005; Brusatte, Benson & Norell, 2011). Nevertheless, the identification of this feature as an autopomorphous trait of the tibia by Yun (2017) is considered nebulous, as Yun (2017) even noted that other derived tyrannosaurs display this feature. The lateral malleolus extends 20 mm outward laterally (=33% of the adjacent shaft). Though the medial malleolus does not protrude as strongly outward in this tyrannosaur as in *Dryptosaurus*, in the case of *Dryptosaurus* this morphology of the distal end of the tibia was because of erosional damage (Brusatte, Benson & Norell, 2011). Muscle scars may also be preserved on the distal end of the tibia. As in *Dryptosaurus*, the specimen shows the distal margin of the tibia was concave (Brusatte, Benson & Norell, 2011). The articular facet faces anteriorly as in other tyrannosaurs (Holtz, 2004). The dorsal surface 143 mm proximodistally, 90 mm mediolaterally at the malleoli (55 mm at the shaft), 140 mm proximodistally and 95 mm mediolaterally (55 mm at the shaft) at the ventral surface, 140 mm dorsoventrally and 32 mm proximodistally at the lateral surface, and finally 95 mm mediolaterally, and 37 mm and 23 mm dorsoventrally at the lateral and medial malleoli, respectively, as measured on the distal surface. This tibia belongs to a small tyrannosaurid of
around 5 to 6 meters in length (based on comparisons with *Appalachiosaurus*) (Carr, Williamson & Schwimmer, 2005).

Dinosauria Owen 1842 sensu Padian and May 1993

Theropoda Marsh 1881 sensu Gauthier 1986

Coelurosauria Huene 1914 sensu Sereno et al. 2005

Tyrannosauroidea (Walker 1964 sensu Holtz 2004) or Ornithomimosauria (Barsbold 1976 sensu Choiniere, Forster & de Klerk 2012)

Tyrannosauroidea indet. or Ornithomimosauria indet.

Specimens: AMNH 2553, proximal end of right metatarsal II or IV.

Description: The proximal end of metatarsal IV or II (figure 2.A-E) is notably different in coloration and preservation from the partial tibia, suggesting the specimens were not associated. The coloration of the bone shaft not destroyed by pyrite disease is a dark black, whereas the tibia ranges in color from brownish-grey to dark grey in color. Though Yun (2017) identified this element as the proximal end of metatarsal II, the specimen may also be half of the proximal end of metatarsal IV of a tyrannosaurid dinosaur. This is due to the fact that, as Yun (2017) noted, a portion of the specimen is missing. Though the specimen (though more gracile) indeed resembles the metatarsal II of *Appalachiosaurus montgomeriensis*, an unnamed specimen of tyrannosaurid from the Merchantville Formation, and other tyrannosaurids (e.g., Holtz, 2004; Carr, Williamson & Schwimmer, 2005, pers. obs.), the morphology of the proximal surface may also represent half of the characteristic v-shaped notch for the articulation of metatarsal III restricted to the plantar half of the foot that is found in derived tyrannosaurids (e.g., Holtz, 2004). In either case, the specimen represents a metatarsal more gracile than either metatarsals II and IV of
Appalachiosaurus and tyrannosaurids (e.g., Holtz, 2004). As Yun (2017) noted, Dryptosaurus aquilunguis has a relatively gracile metatarsal IV, and so an affinity with Dryptosaurus is certainly worth considering for this specimen. However, the incomplete nature of this metatarsal IV does not allow for the identification of the possible autopomorphy on this specimen that was identified on the metatarsal IV of D. aquilunguis found by Brusatte, Benson & Norell, (2011). Brusatte et al. (2012) assigned this specimen to a derived taxon of ornithomimid from the Navesink Formation based on what they interpreted as a weakly-developed articular surface for metatarsal III.

The lateral face of the proximal end of AMNH 2553 measures 139 mm proximodistally and 34 mm dorsoventrally at its proximal end, whilst the same measurements of the medial side are 139 mm and 43 mm, respectively. The dorsal face is also 139 mm proximodistally and is 5 mm mediolaterally at its proximal end. The same two measurements for the ventral surface are 139 mm and 23 mm.

Dinosauria Owen 1842 sensu Padian and May 1993
Theropoda Marsh 1881 sensu Gauthier 1986
Coelurosauria Huene 1914 sensu Sereno et al. 2005
Tyrannosauroidea (Walker 1964 sensu Holtz 2004) or Ornithomimosauria (Barsbold 1976 sensu Choiniere, Forster & De Klerk 2012)
Tyrannosauroidea or Ornithomimosauria indet.
Specimen: AMNH 2552, distal end of metatarsal II.
Description: This gracile distal end of the metatarsal II of a coelurosaurian dinosaur (figure 3.A-E) may be assignable either to Tyrannosauroidea or Ornithomimosauria. This assignment is
based on the size of the specimen in conjunction with the articular surface for metatarsal III on
the medial face of AMNH 2552 suggesting an arctometatarsalian or sub-arctometatarsalian
condition where the metatarsals are closely appressed. The size of the specimen and the unfused
nature of the metatarsus suggests against assignment of AMNH 2552 to an avalian. Additionally,
the specimen is more robust than the metatarsals of troodontids (e.g., Makovicky & Norell,
2004). Like AMNH 2553, the erosional patterns and color of AMNH 2552 suggest against
association with AMNH 2550. Notably, the coloration and wear patterns on AMNH 2552 closely
resemble those of AMNH 2553, suggesting possible association between the two specimens.
The lateral face of this metatarsal II measures 100 mm proximodistally and 22 mm
dorsoventrally at the condyles, whereas the medial face is 101 mm proximodistally and 35 mm
dorsoventrally at the condyles. The dorsal surface also measures 101 mm proximodistally, while
mediolaterally it measures 31 mm at the distal end. The ventral surface is 100 mm
proximodistally and 40 mm mediolaterally at the distal end. The distal surface is 38 mm wide
dorsoventrally and 37.8 mm wide mediolaterally.

Dinosauria Owen 1842 sensu Padian and May 1993
Theropoda Marsh 1881 sensu Gauthier 1986
Coelurosauria Huene 1914 sensu Sereno et al. 2005
Ornithomimosauria Barsbold 1976 sensu Choiniere, Forster & de Klerk 2012
Ornithomimosauria indet.

Specimen: AMNH 2551, three pedal phalanges.

Description: The three pedal phalanges included in the syntypes of “Teihivenator” macropus are
identified herein as the left and right pedal phalanges III-1 and the right pedal phalanx II-1 of an
indeterminate ornithomimosaur or possibly ornithomimid dinosaur. Yun (2017) noted the
distinguishability of these phalanges from those of other tyrannosaurs based on the presence of
proximally oriented process extending from the proximal ends of each specimen, also noting that
these specimens (along with the rest of the syntypes of “Teihivenator macropus”) were referred
to ornithomimosaur in multiple studies. However, no comparison of these phalanges with those
of ornithomimosaur was made in Yun (2017). The dorsoventrally straightened nature of the
left and right pedal phalanges III-1 is clearly more congruent with that of the corresponding
phalanges of ornithomimosaur than the robust, curved pedal phalanges of derived
tyranosauroid (e.g., Holtz, 2004; Makovicky, Kobayashi & Currie, 2004). Examination of
these phalanges reveals that the processes are rather the ventral lateral and medial edges of the
proximal articular facets of each phalanx, forming tips proximally but also appearing on the
ventral surface towards the diaphysis of the phalanges as ridges that intersect to form a triangular
shape in ventral view. In fact, the specimens are almost identical to the corresponding elements
in the pes of Struthiomimus altus (Osborn, 1921), where these process-like tips of bone at the
ventrolateral and ventromedial ends of the rim surrounding the proximal articular facet of the
phalanges are clearly visible. This morphology of phalanx appears in many different genera of
ornithomimosaur, including possibly in the basalmost ornithomimosaur taxon Nqwebasaurus
thwazi (figure 14.B in Choiniere, Forster & de Klerk, 2012). Additional figures of
ornithomimosaur pedal specimens showing this morphology may be found in Cullen et al.
(2013). Yun (2017) also noted the presence of this morphology in other clades of theropod
dinosaur. As such, these specimens cannot in good faith be used to justify the presence of a
distinct taxon of tyrannosauroid or even assigned to Tyrannosauroidea. These phalanges are grey
in color and almost match the color of the tyrannosauroid tibia described above, though they are clearly more well-preserved. Thus, these phalanges likely hail from the Navesink Formation, where a distinct taxon of ornithomimid of possibly similar phylogenetic derivation to ornithomimid taxa like *Gallimimus* and *Ornithomimus* known for now as “*Ornithomimus*” *antiquus* is also found (Brusatte et al., 2012). The morphological similarity of these phalanges with *Struthiomimus altus* especially supports their origin from a derived ornithomimosaur. The presence of such an animal in Appalachia would be intriguing, considering the basal position of the tyrannosauroids, hadrosaurids, and hadrosauroids of Appalachia when compared to related genera from other parts of the globe (e.g., Schwimmer, 1997; Carr, Williamson & Schwimmer, 2005; Brusatte, Benson & Norell, 2011; Prieto-Marquez, Erickson & Ebersole, 2016).

The left pedal phalanx III-1 measures 80 mm proximodistally, 50 mm mediolaterally at the proximal articular facet, and 29 mm mediolaterally at the distal end. The medial surface measures 82 mm proximodistally, 40 mm dorsoventrally at the proximal end and 22 mm at the condyles. The ventral surface measures 80 mm proximodistally, 35 mm mediolaterally at the proximal end, and 26 mm at the condyles. The lateral surface is 83 mm long proximodistally, and dorsoventrally measures 35 mm at the proximal end and 22 mm at the condyles. The distal end is 20 mm dorsoventrally between the condyles and 35 mm mediolaterally. The proximal end is 35 mm dorsoventrally and 5 mm mediolaterally.

The dorsal face of the right pedal phalanx II-1 is 90 mm proximodistally, 40 mm mediolaterally at the proximal end and 30 mm at the distal, whereas the ventral face in the same dimensions is 89 mm, 29 mm, and 26 mm. The medial surface is 93 mm proximodistally, 47 mm dorsoventrally at the proximal end and 31 mm at the distal end. The lateral face is 91 mm
proximodistally, 50 mm mediolaterally at the proximal end, and 25 mm at the distal end. The proximal surface is 39 mm dorsoventrally and 36 mm mediolaterally, whereas the distal surface is 25 mm in both the same two dimensions.

Discussion.

The syntypes of “Teihivenator macropus” are herein shown to be the bones of both indeterminate tyrannosaurids and ornithomimosaurs. Additionally, the autopomorphies on the tibia of “Teihivenator macropus” listed by Yun (2017) are unable to be found on the specimen AMNH 2550 or are found in other tyrannosaurids. Thus, the syntypes of “Teihivenator macropus” are a chimaera and the tibia lacks any non-dubious autopomorphies. As such, “Teihivenator macropus” must be regarded as a nomen dubium. Nevertheless, the proximal and distal ends of the Navesink tibia assignable to a tyrannosaurid are distinct enough from *Appalachiosaurus* and *Dryptosaurus* to suggest the presence of another morphotype and possibly distinct taxon of tyrannosaurid in New Jersey during the Maastrichtian. Notably, the small size of the tibia when compared to those of the aforementioned Appalachian tyrannosaurid taxa (suggesting an animal ~5-6 meters in length) may indicate that the tibia was from an immature specimen of tyrannosaur. Additionally, the tibia is unfortunately not comparable to the tyrannosaurid morphotype represented by a partial metatarsus from the Merchantville Formation of New Jersey (pers. obs.). As such, AMNH 2550 is likely best thought of as the tibia of an indeterminate tyrannosaurid that may represent a distinct but indeterminate taxon of tyrannosaur on Appalachia. In addition to this possibly distinct taxon of tyrannosaurid, the Navesink Formation has also been documented as including *Dryptosaurus aquilunguis*,
Hadrosaurus “cavatus”, “Ornithomimus” antiquus, and an indeterminate theropod based on a tooth known as “Diplotomodon horrificus” (e.g., Gallagher, 1993; Gallagher, 1997; Weishampel & Young, 1996; Weishampel, 2006). The presence of two genera of tyrannosauroids in this unit allies it in faunal composition with the Merchantville Formation of New Jersey (fauna includes Dryptosaurus sp. and an indeterminate but distinct Merchantville tyrannosauroid)(Gallagher, 1993; pers. obs.) and the the temporally equivalent and geographically adjacent faunas of the Tar Heel and Coachman Formations (fauna includes Dryptosaurus aquilunguis and Appalachiosaurus montgomeriensis)(e.g., Baird & Horner, 1979; Weishampel & Young, 1996; Schwimmer et al., 2015). The presence of two tyrannosauroids in the same ecosystem is also known in a few units from Laramidia (e.g., Weishampel et al., 2004).

The ornithomimosaur or tyrannosauroid metatarsals described herein may be assignable to either group. Further study of these elements and comparison with the metatarsals of both ornithomimosaurs and tyrannosauroids is needed before more definite assignments may be made.

Finally, the phalanges included in AMNH 2551 suggest the presence of a derived taxon of ornithomimosaur in the Navesink Formation, supporting the hypothesis of Brusatte et al. (2012). Whether these pedal elements are assignable to “Ornithomimus” antiquus will require the collection of further ornithomimosaur specimens from the Maastrichtian of the Atlantic Coastal Plain.

The assignment of the remains of several clades of dinosaur to a single taxon is not an occurrence unique to the case of “Teihivenator macropus” in eastern dinosaur paleontology. As noted, Baird & Horner (1979) revised the assignment by Cope (1869) of tyrannosauroid and indeterminate hadrosaurid material to the holotype of the gigantic hadrosaurid Hypsibema
crassicauda based on the close location of the specimens. Thus, the cases of both Hypsibema crassicauda and “Teihivenator macropus” represent cautionary tales of mis-assignment from appeared association of specimens.

Conclusions.

The syntypes of “Teihivenator macropus” represent a chimaera composed of the tibia of an indeterminate though possibly distinct tyrannosaurid, metatarsals possibly assignable to either tyrannosaurs or ornithomimosaurids, and pedal phalanges likely assignable to a derived ornithomimosaur. The specimens increase the current understanding of theropod dinosaurs from the Navesink Formation, and have implications for the biogeography and diversity of ornithomimosaurids and tyrannosaurids on the landmass of Appalachia.

Additionally, the case of “Teihivenator macropus” should be considered a cautionary tale of dinosaur paleontology, showing that possible association of partial disarticulated specimens (especially from marine deposits) should be rigorously scrutinized before the specimens are remarked to have come from a single animal.

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Figure 1. Tibia of an indeterminate taxon of tyrannosauroid, AMNH 2550. Tibia in lateral (A), medial (B), dorsal (C), ventral (D), proximal (E), and distal (D) views. Scale bar = 50 mm.
Figure 2. Metatarsal II or IV of an ornithomimosaur or tyrannosauroid dinosaur, AMNH 2553. Metatarsal in lateral (A), medial (B), dorsal (C), ventral (D), and proximal (E) views. Scale bar = 50 mm.
Figure 3. Distal metatarsal II of a tyrannosauroid or ornithomimosaur, AMNH 2552. Metatarsal in lateral (A), medial (B), dorsal (C), ventral (D), and distal (E) views. Scale bar = 50 mm.
Figure 4. Phalanges of a derived ornithomimosaur, AMNH 2551. Phalanges in medial (A) dorsal (B), and ventral (C) views. Scale bar = 50 mm.