## EDGEMONT JR./SR. HIGH SCHOOL

## IMPLICATIONS OF AN ANALYSIS OF DEEP PES TRACES AND MANUS IMPRESSIONS FOR THE SUPPOSED ATREIPUS-GRALLATOR ICHNOGENERIC PLEXUS: AN APOMORPHY-BASED APPROACH

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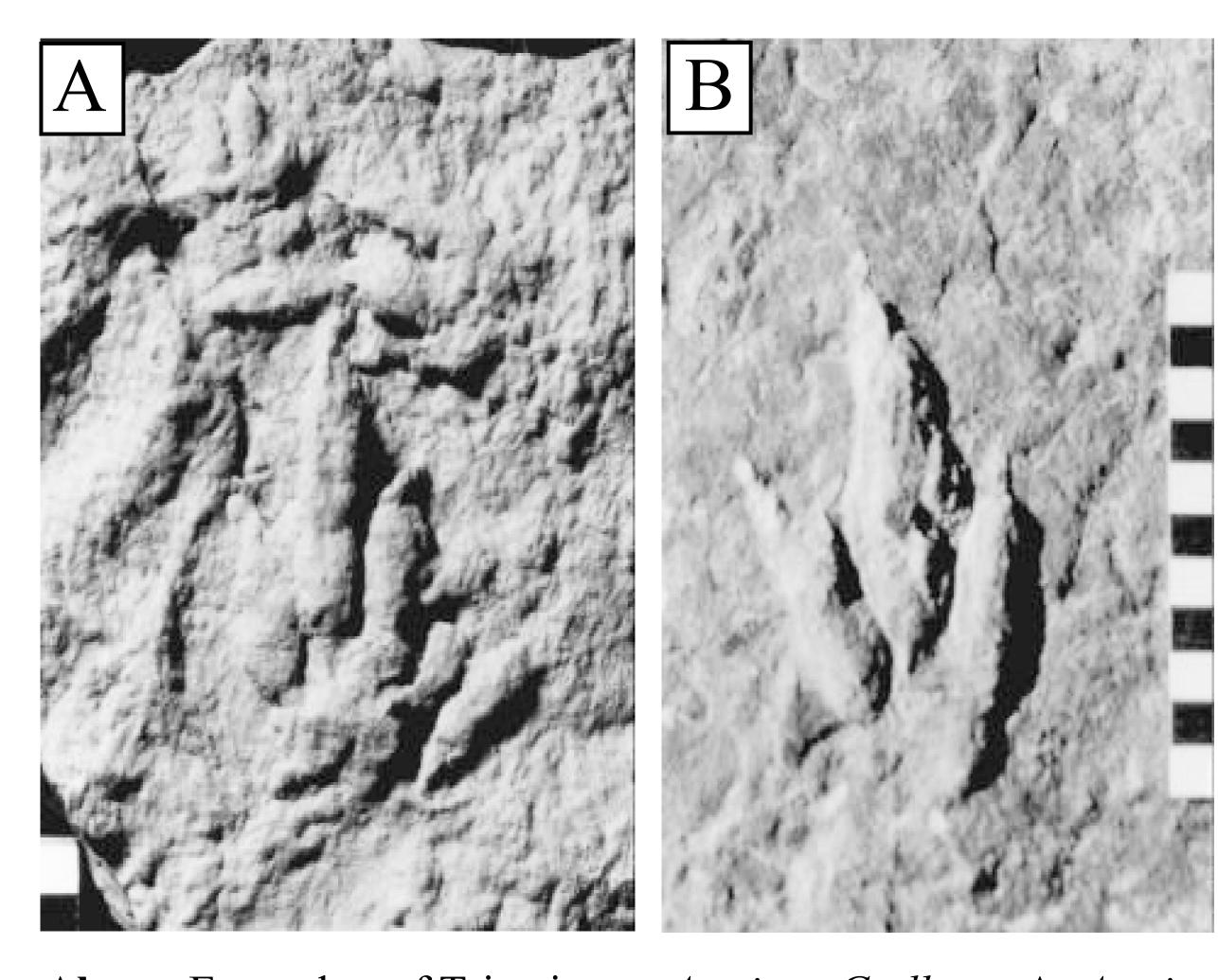
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## **ABSTRACT**

Grallator has been used as a basis for hypothesizing an evolutionar between their track makers. We use an apomorphycladistics-based methodology of track maker identification to test the Atreipus-Grallator complex that we argue does not reflect a biological entity. Eastern North American Atreipus (A. milfordessis, A. and A. acadianus) morphology, in well-preserved examples, is ly of knuckle impressions of digits II and III. Atreipus with small claws primarily used for locomotion the up to phylogenetic analysis. Therefore the so-called Atreipus-Grallator plexus reflects a non-biological concept for

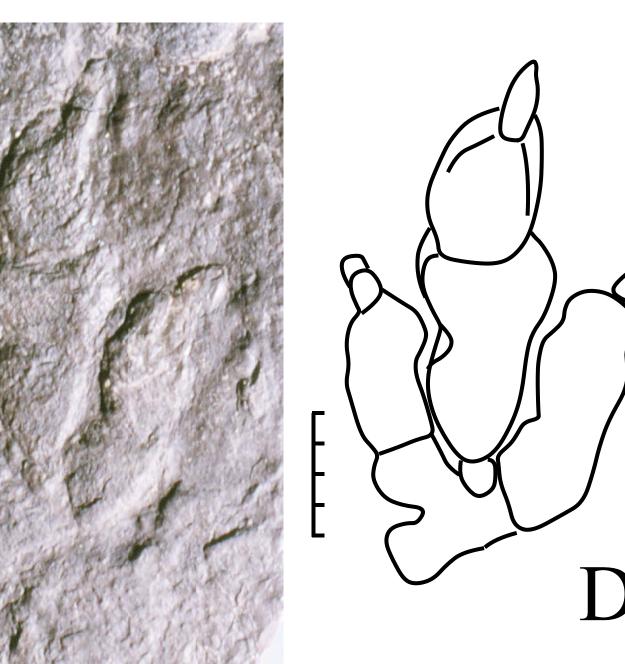


Above: Examples of Triassic age A treipus-Grallator: A: A treipus metzneri, Ansbacher Sandstein, Altselings-bach bei Fürth; B: Grallator sp., natural cast of left pes impression, Coburger Sandstein Hassberge. NHMS VT 99/100. (both from ref. 2)

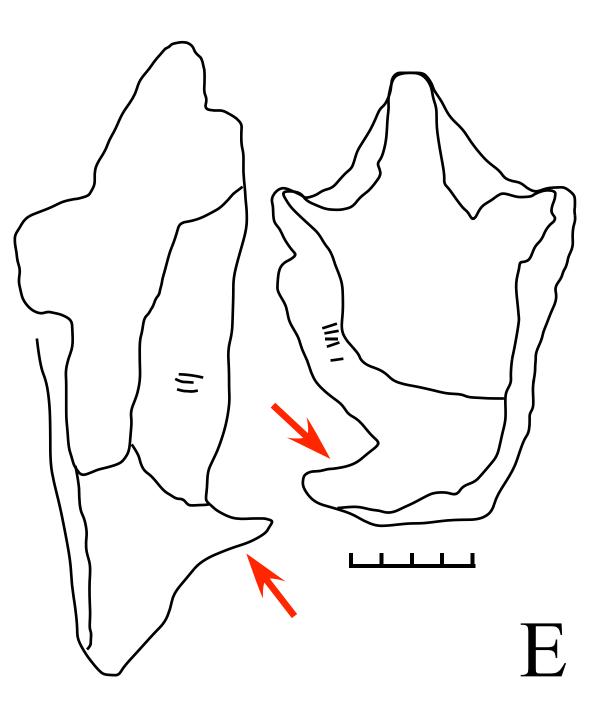
ever since has puzzled researchers. The tridactyl imprints often appear nearly identical to those of Grallator often leading them to be grouped together in the so called Atreipus-Grallator complex. However, we show that these two footprints are made by very different creatures with Atreipus being limited to the Triassic with confusion stemming from extra-morphological causes and not an "ichnologic-evolutionary sequence".

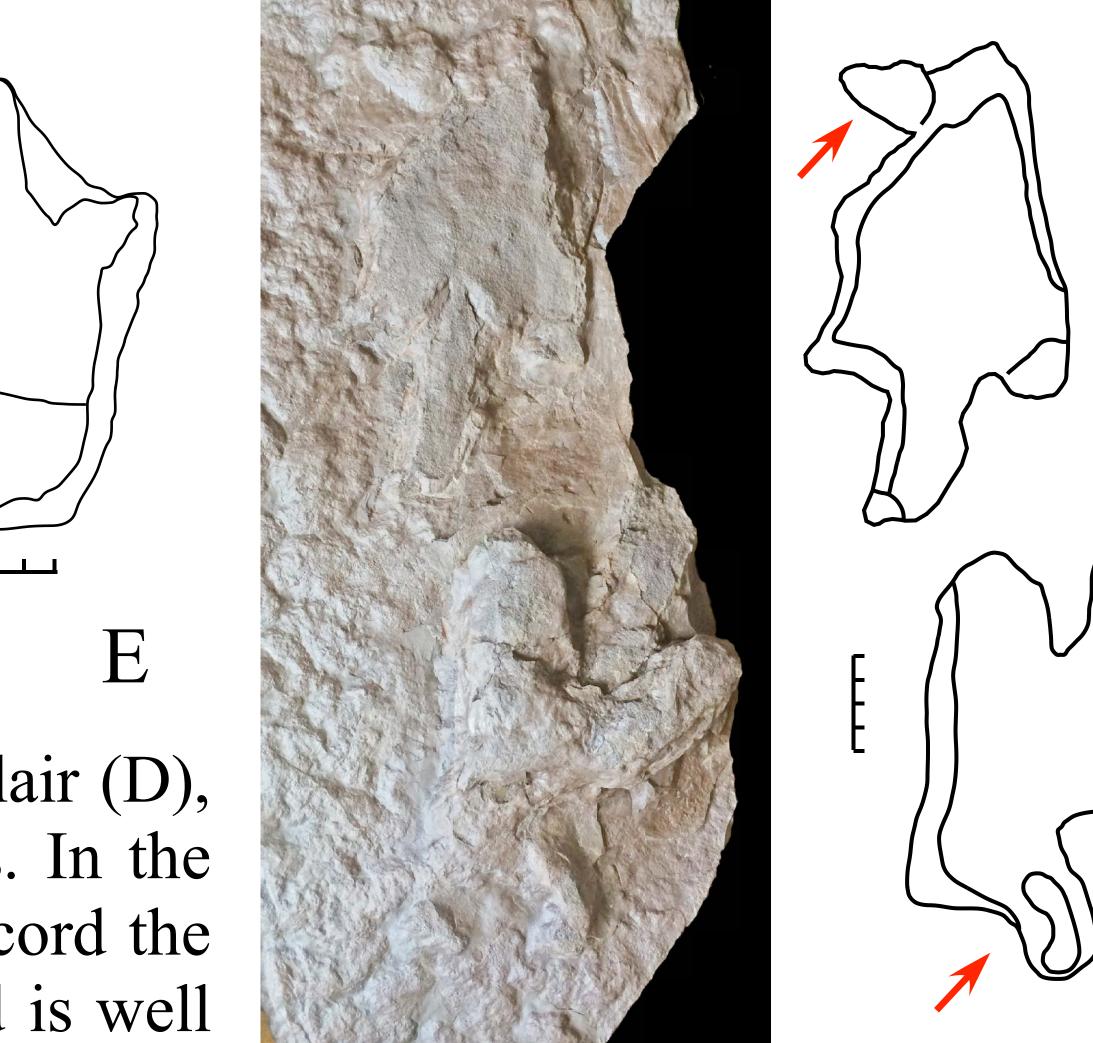
**2** APOMOPHY-BASED APPROACH: It has been commonplace to identify tetrapod ichnotaxa by general resemblances often dominated by extra-morphological information. However, if the goal is to recognize entities that have phylogenetic or evolutionary significance, then an apomorphy-based approach is better suited to meaningful identifications as well as permitting parsimonious hypotheses of trackmaker assignment.

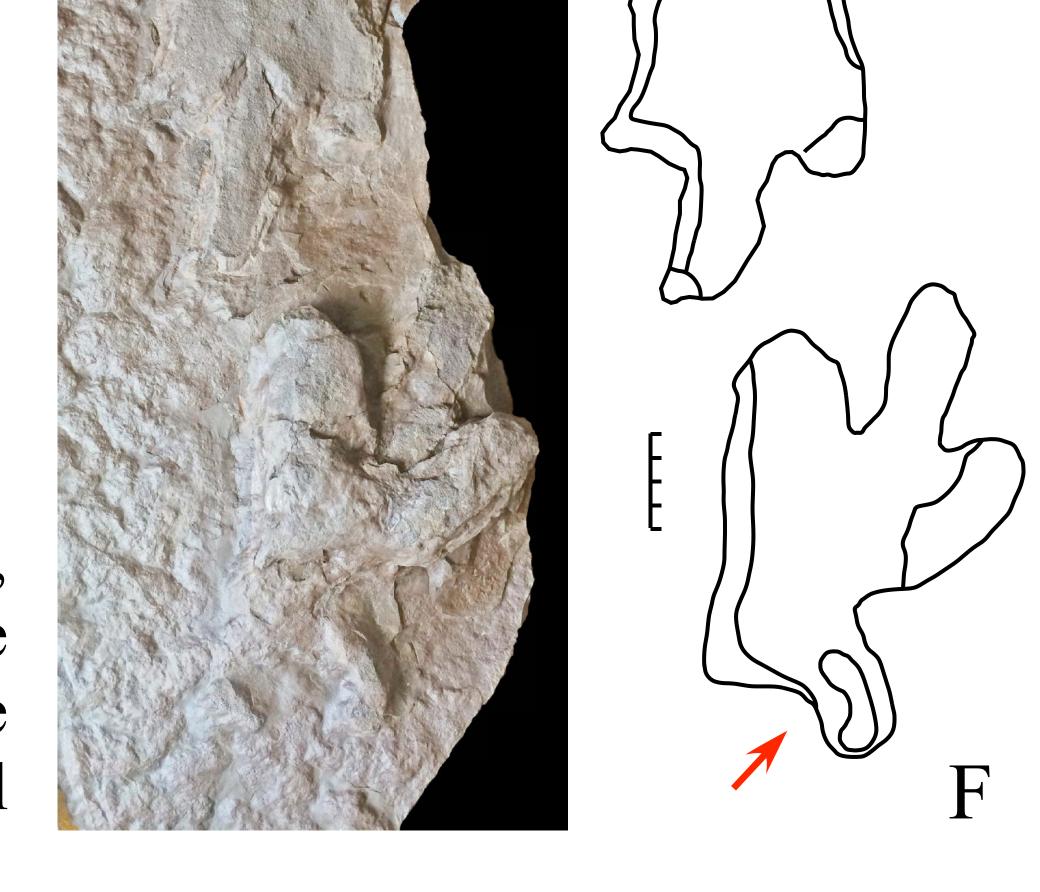


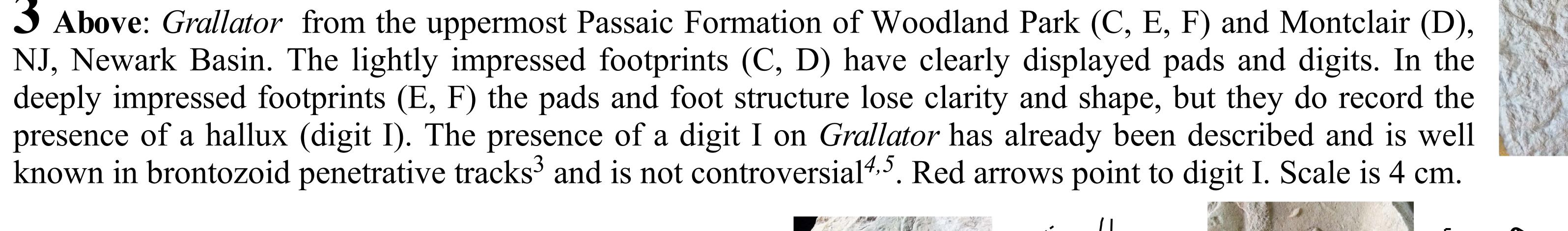


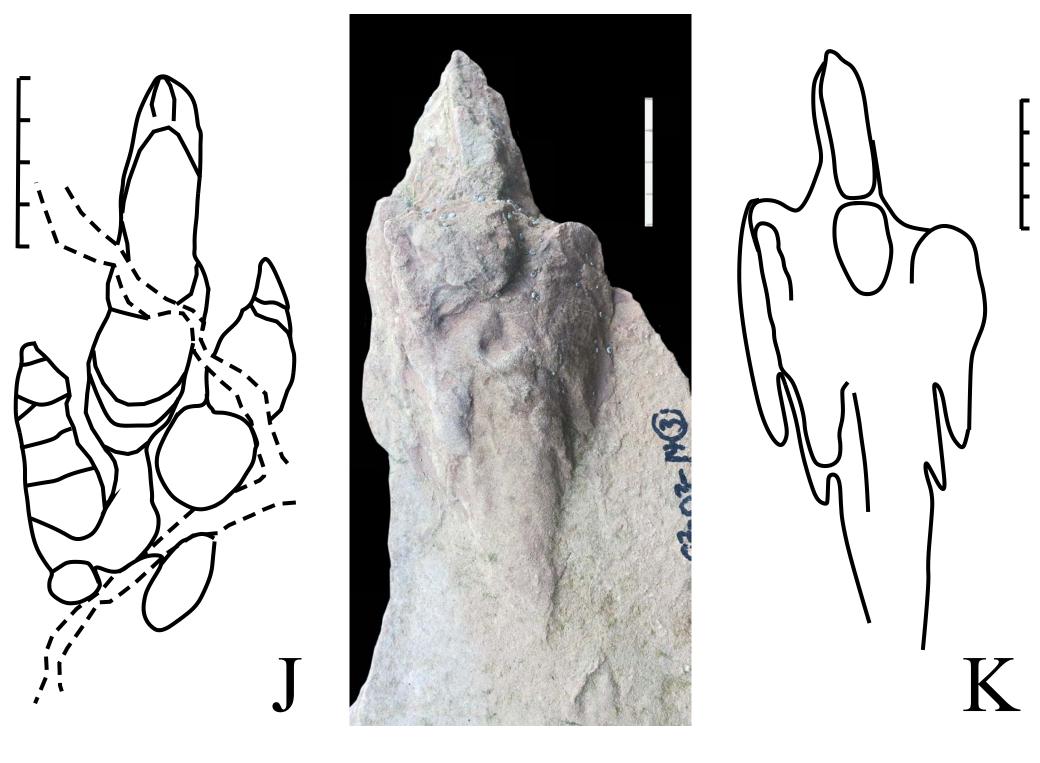


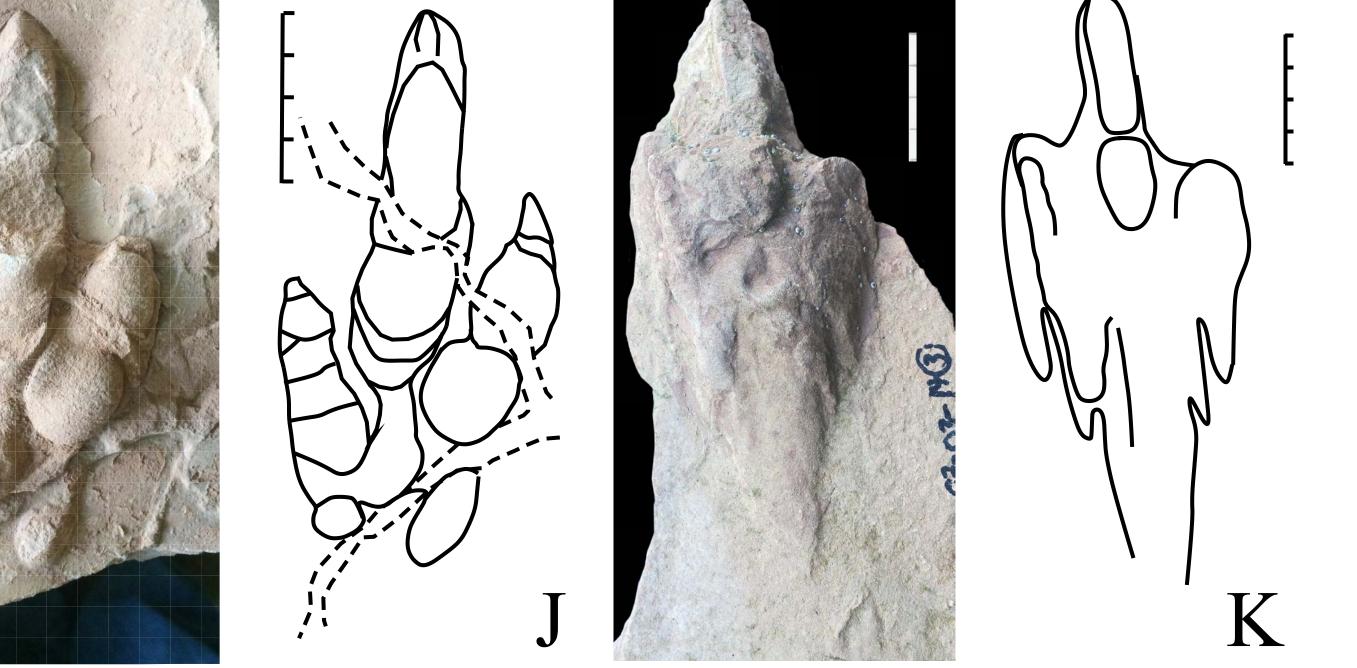




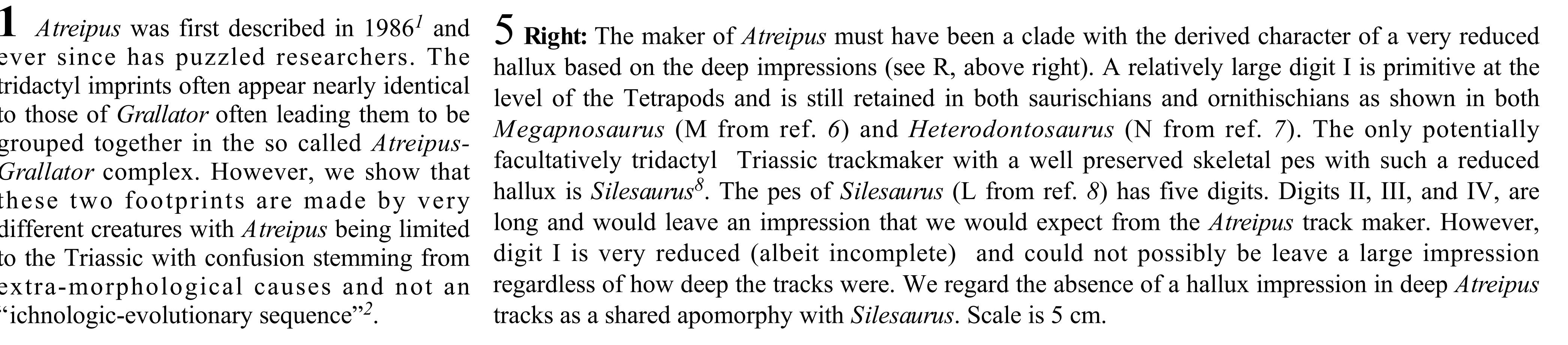


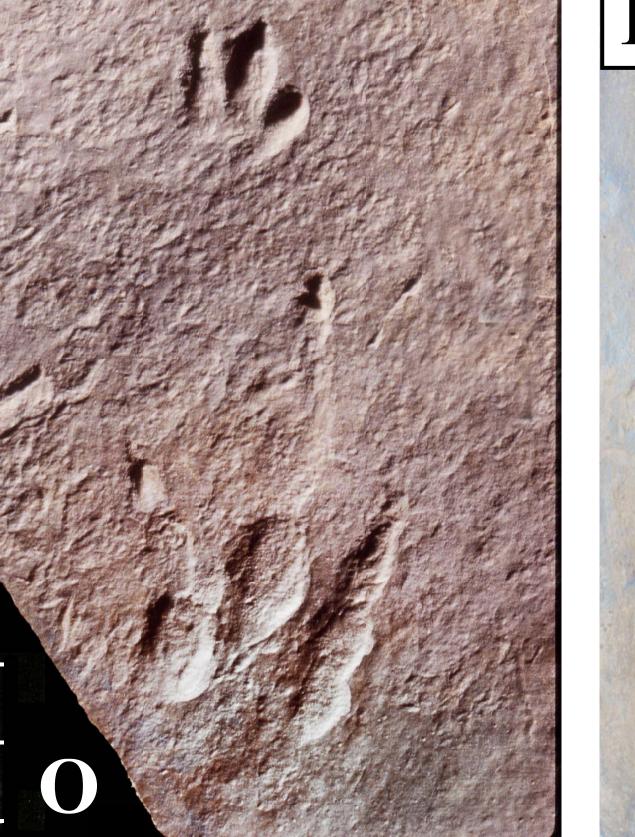


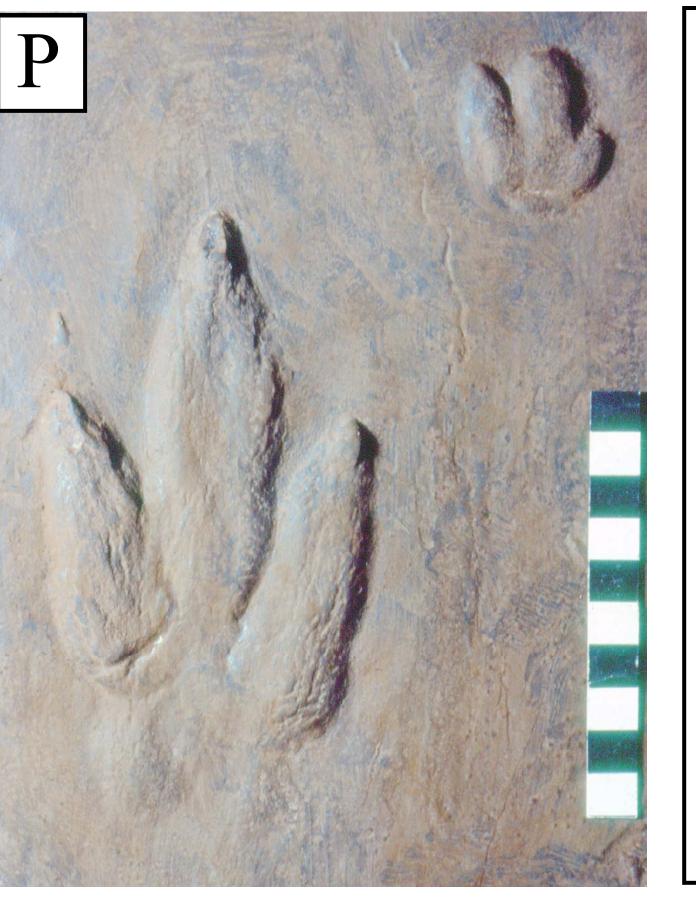


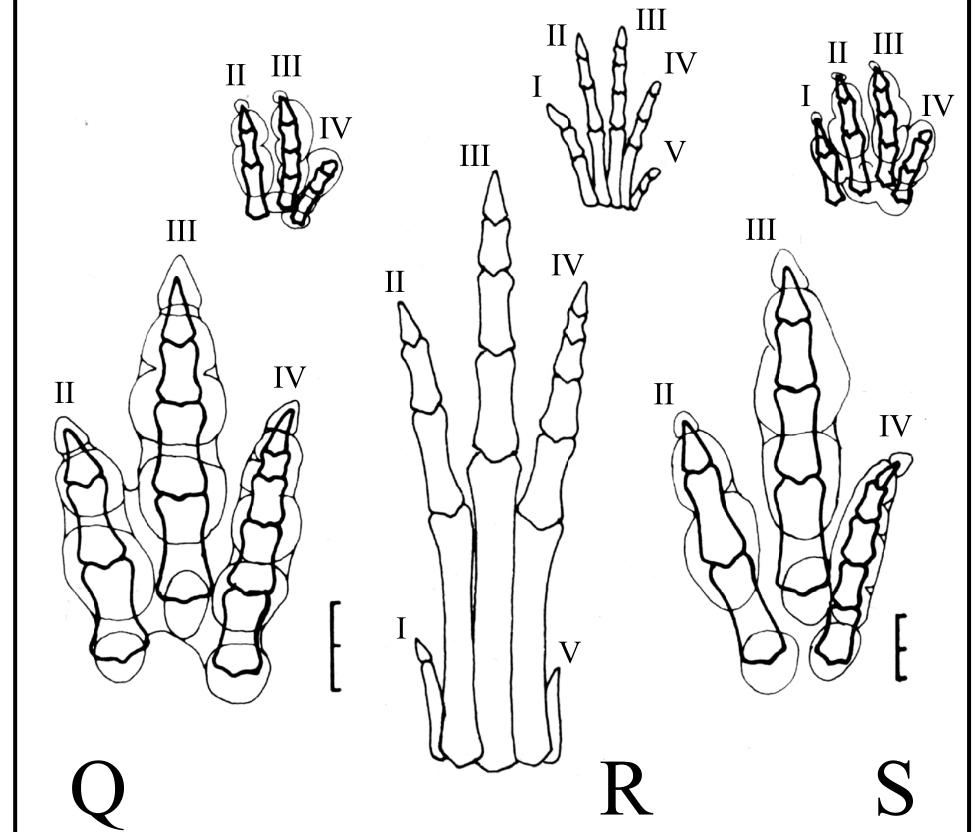


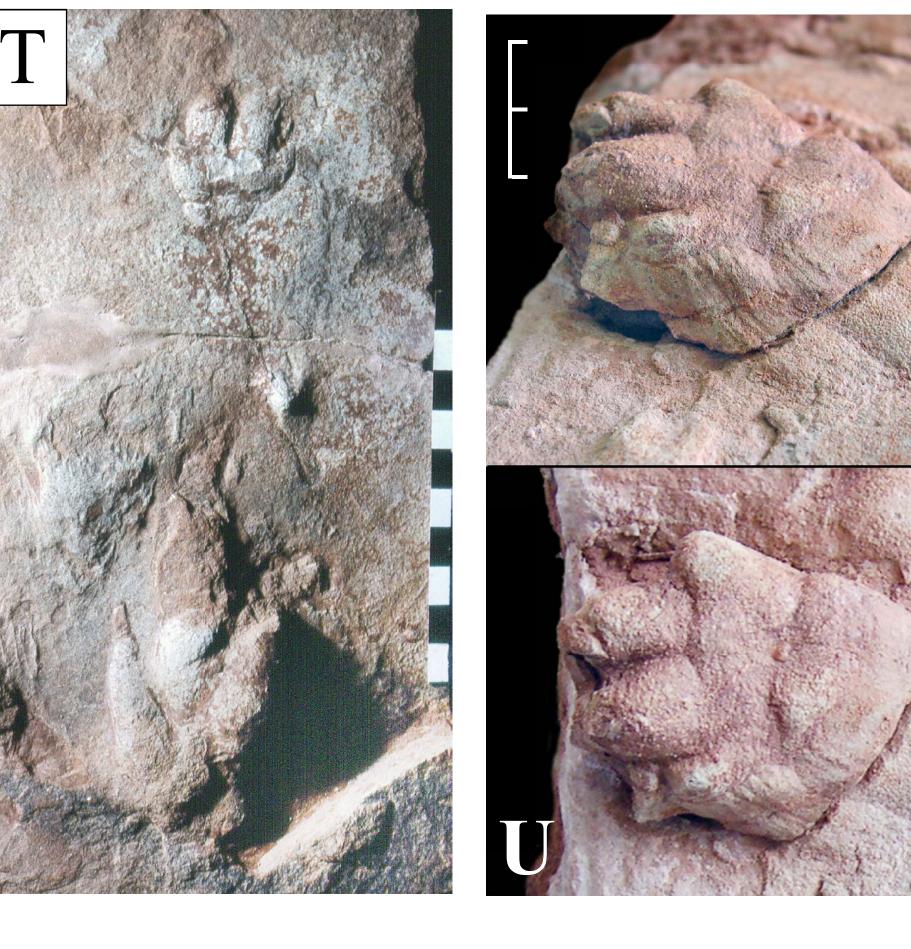
4 Above & Left: These Atreipus tracks come are from the Passaic Formation of the Newark Basin (G-I) and the Fundy Basin (J-K). The lightly impressed footprints (G,H) appear to be very similar to Grallator (3C, D). However, deeply impressed Atreipus footprints reveal no digit I (I-K). The Atreipus track maker has the highly derived condition of a reduced hallux that differs from the primitive condition of a long hallux as seen in deep *Grallator* footprints, and this is true for any reasonable phylogenetic hypothesis. No matter how deep Atreipus footprints are (e.g., K), there is never a hint of digit I. Scale is 4 cm.





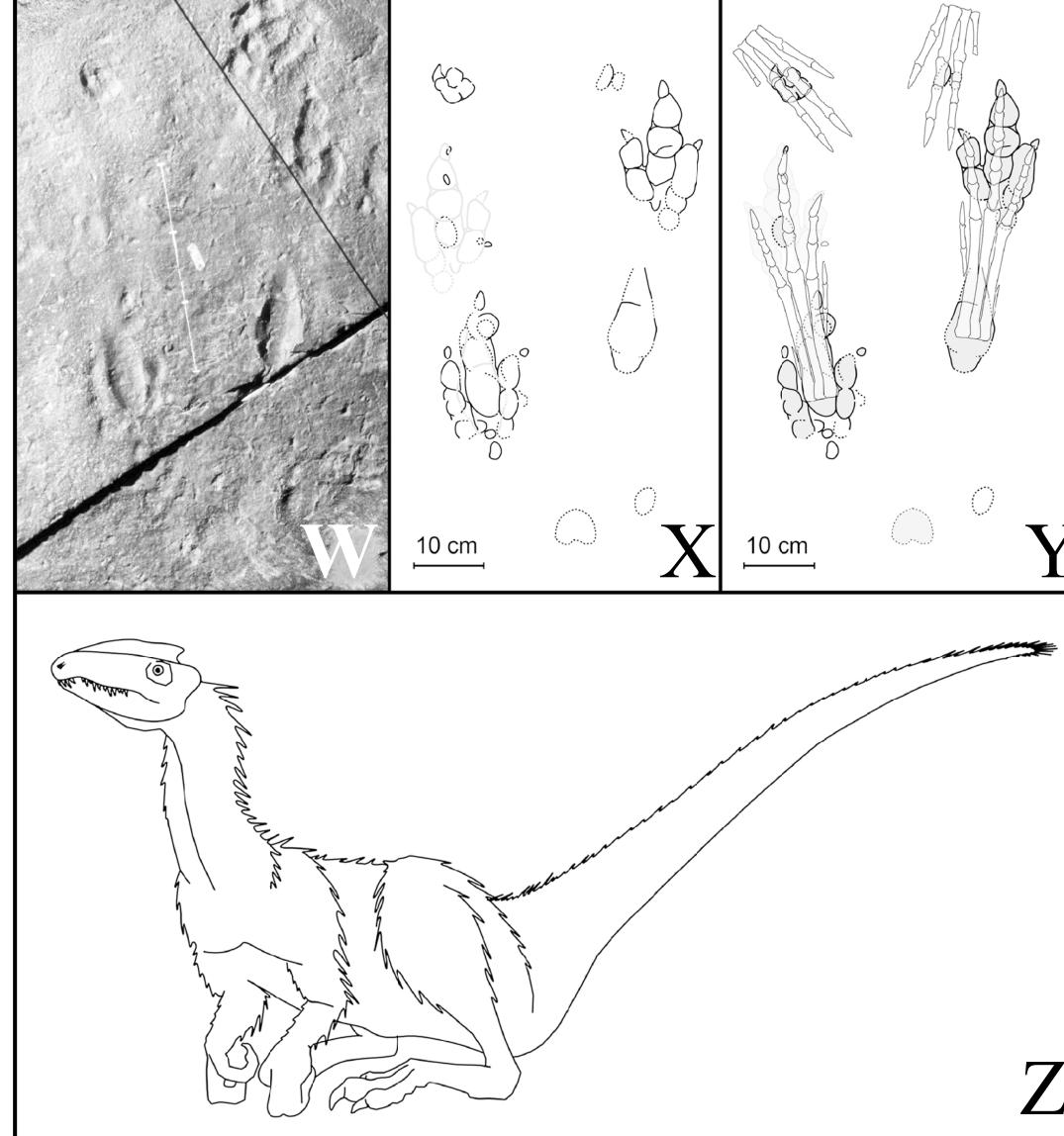


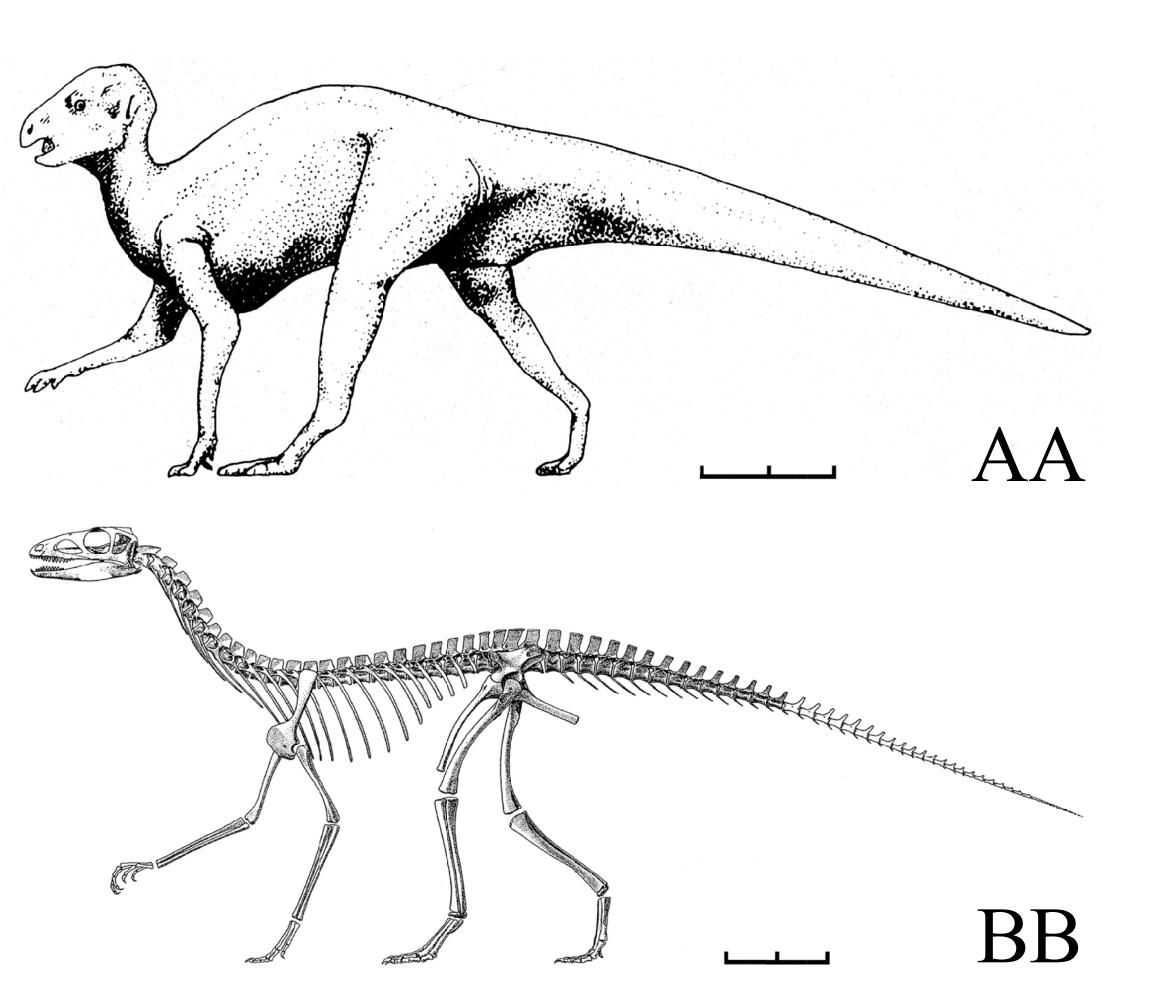




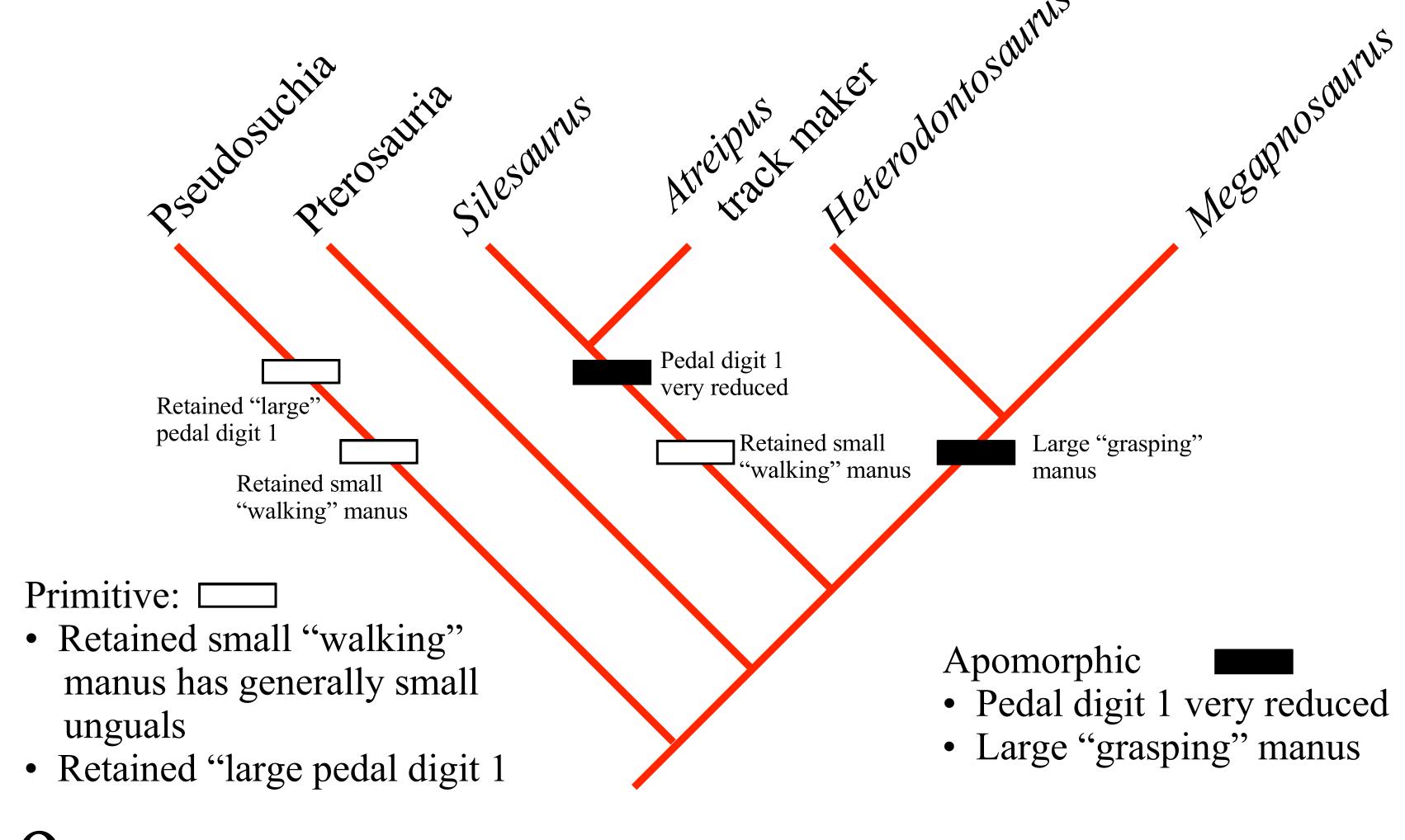
O Above: Further distinctions with phylogenetic import are apparent between Grallator and Atreipus through an analysis of the manus. Examples here are from the Passaic Formation of the Newark Basin (A. milfordensis; O, Q), the Gettysburg Formation of the Gettysburg Basin (A. milfordensis; P), and the basal Blomidon Formation of the Fundy Basin (A. acadianus; T-V). The manus of Atreipus has between three and five short digits, depending on the species, with minute claws on I, II, and III, consistant with expectations for the primitive condition in non-dinosaurian archosaurs but inconsistant with the expectations for the common ancestor of *Heterodontosaurus* and *Megapnosaurus* (See below). Skeletal reconstructions of Atreipus (Q-S) are modified from ref. 1. Scale is in cm.

Right: Grallator manus 1mpressions are incredibly rare with the best specimens indicating knuckle resting<sup>9,10</sup> W-Z (from ref 9) are from Beneski Museum ACM ICH 1/1 from the Turners Falls Ss. of the Deerfield Basin,





8 Left: Atreipus trackmaker recontracks compared to Silesaurus (BB). described in 2003<sup>7</sup>. integument. Scale is



9 Above: Very simplified cladogram consistent with ref. 11 showing basic application of apomorphy-based identification of trackmaker. Because the primitive manus configuration is retained by the Atreipus track maker and Silesaurus, in combination with the synapomorphy of the very reduced pedal digit I, there cannot be an "ichnologic-evolutionary sequence", in any sense, between Atreipus and Grallator.

**References:**1 Olsen, P.E. & Baird, D., 1986, in K. Padian (ed.), The Beginning of the Age of Dinosaurs, Faunal Change Across the Triassic-Jurassic Boundary, Cambridge Univ. Press, NY:61-87; 2 Haubold, H. & Klein, H., 2000, Hallesches Jahrb. Geowiss. 59-85; 3 Gatesy, S.M., et al., 1999, Nature 399(6732):141; 4 Olsen, P.E., Smith, J.B., McDonald, N.G., 1998, JVP 18(3):586-601; 5 Rainforth, E.C., 2004, March. Geol. Soc. Amer. Abstracts with Programs 36(2):96; 6 Raath, M.A., Arnoldia 4(28):1-25; 7 Santa Luca, A.P., 1980, Annals South African Museum 79:159-211; 8 Dzik, J., 2003, JVP 23(3): 556-574; 9 Olsen P.E., Winitch, M.L., 2017, in Getty, P.R. et al., Exploring a Real Jurassic Park from the Dawn of the Age of Dinosaurs in the Connecticut Valley, Geol. Soc. CT and State Geol. Nat. Hist. Sur. CT:35-37; 10 Milner, A.R., et al., 2009, PloS one 4(3):e459; 11 Nesbitt, S.J. et al., 2017, Nature 544(7651):484-487.