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DINOSAUR FOOTPRINTS FROM GARDEN PARK, COLORADO

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Dinosaur footprints have been reported in the Morrison Formation in many areas. The Garden Park exposures of the Morrison Formation have long been well-known for their vertebrate body fossil assemblages, but until recently had a virtually nonexistent footprint record. New discoveries of five footprints help fill in this gap. The earliest discovered print is probably the manus print of a camptosaurid. Two other isolated tracks demonstrate a morphology more consistent with ornithopods than theropods. A fourth print is an unusual but poorly preserved track possibly made by a large "coelurosaur." A fifth, poorly preserved footprint is possibly attributable to a "carnosaur."

Keywords: Ichnofossils; Ornithopods; Camptosaurid; Coelurosaur; Carnosaur

INTRODUCTION

The Morrison Formation is perhaps the most famous formation in the American West for its remarkable body fossil assemblages. The vast geographical space the formation occupies has allowed paleontologists to collect enormous quantities of bones from sites in widely spaced outcrops, dating back well over 100 years. During most of this colorful history, dinosaur footprints were not reported in the Morrison of Colorado, either ignored in favor of the body fossils that generated great public interest or unrecognized by eyes searching for bone.

Dinosaur footprints were first recognized in the Morrison of Colorado by Hatcher (1903), who made a very brief mention of a small purported

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dinosaur print in a paper describing the sauropod *Haplocanthosaurus*. The paper includes a photograph of the footprint, but the only information provided is that the print was retrieved from the Canyon (sic) City area of Colorado. Probably it came from Garden Park, where virtually all Jurassic dinosaur fossils in the region were exhumed. Investigations of field notes failed to turn up specific site information for the print; likely it was donated by one of the Cañon City locals, so no site information was ever recorded (K. Carpenter, personal communication).

A few poorly preserved coelurosaur tracks were excavated from the vicinity of the town of Higbee in 1937 (DMNH 1498, Lockley, 1986), but better preserved and more abundant tracks were found in the now-famous Purgatoire River valley (MacClary, 1938; 1939; Bird, 1939). This site contains a plethora of sauropod, ornithopod, and theropod tracks, although the site was largely ignored until quite recently (Lockley, 1986; Lockley and others, 1986). Subsequently, the majority of dinosaur footprint discoveries in the Morrison were made after 1980, including some apparent coelurosaurian tracks from the vicinity of Fruita, Colorado (Lockley, 1986).

In 1991, the Denver Museum of Natural History began a series of reconnaissance expeditions into the Morrison exposures in Garden Park, just north of Cañon City, Colorado. This region, although relatively small in area, has produced an abundance of important and historic dinosaur body fossil finds. However, with the exception of a single footprint (Hatcher, 1903), no footprints from this area had been reported, until four new specimens were discovered by the Denver Museum expeditions (Fig. 1). The Morrison of the region consists of sandstones, claystones, and freshwater limestones of both lacustrine and fluvial origins (Brady, 1968; Dodson and others, 1980), any of which could have supported a wet substrate, allowing for the formation of footprints. This is particularly true of lacustrine carbonate facies, in which many of the more renowned Morrison footprints have been found (Marsh, 1899; MacClary, 1938; Lockley and others, 1986; Conrad and others, 1987). Future discoveries will undoubtedly be made in these facies.

METHODS

Footprint length was measured from the tip of the mesaxial digit along its axis to the farthest point on the opposing edge of the heel impression (method "b" of Thulborn, 1990, p. 82). Footprint width was measured perpendicular to footprint length (per Thulborn, 1990, p. 82). The outermost

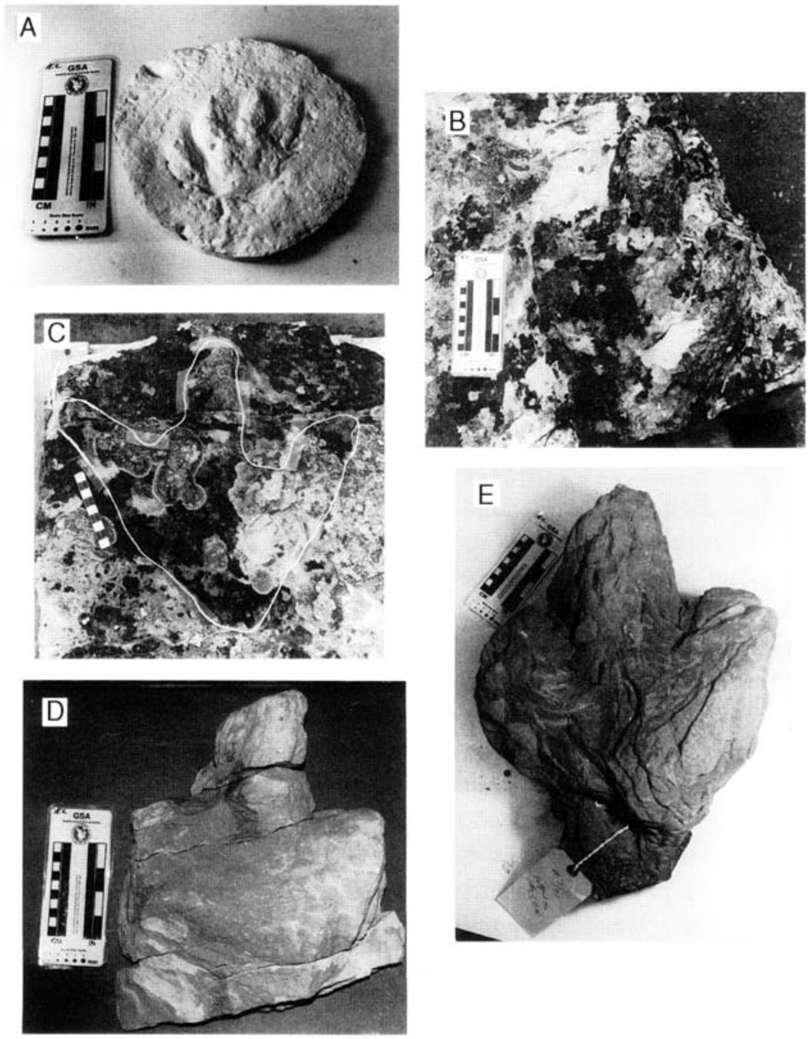

FIGURE 1 Dinosaurian footprints from the Morrison of Garden Park, Colorado. (A) Plaster cast of CM 924, a probable camptosaurid manus print. (B) Isolated "round-toed" natural cast, attributed to a camptosaurid. (C) Isolated natural cast, attributed to a large ornithopod, possibly a camptosaurid. Outlined with white string for emphasis of shape. (D) Isolated natural cast, attributed to a "coelurosaurian" theropod. (E) Isolated natural cast, attributed to a "carnosaurian" theropod. All photos with centimeter scales.

digits were measured along their axes from the anterior tip of each digit to the intersection of the axis and a line drawn both perpendicular to the axis and tangent to the most recessed point of the adjoining hypex (method "c" of Thulborn, 1990, p. 83). The middle (mesaxial) digit was measured along its axis to the intersection of the axis and a line connecting the tangents of both adjoining hypeces (method "b" of Thulborn, 1990, p. 83). Measurements were taken directly from the footprints when possible, from computer scans of scale photographs, and from tracings of photographs.

Abbreviations. CM = Carnegie Museum of Natural History, Pittsburgh, PA; DMNH = Denver Museum of Natural History, Denver, CO; UCM = University of Colorado Museum, Boulder, CO.

TRACKS AND TRACKMAKERS

There has been no formal description or analysis of CM 924 (the small footprint initially mentioned by Hatcher [1903]), (a plaster replica, UCM 49167, was used for this study [Fig. 1(A)]). The print has four short, broad digits which terminate in blunt points. No claws are apparent. All the digits are subequal in length. The heel is broad and roughly semicircular in shape. The print is a natural cast of low relief, implying that the original track was either shallow or is an "infilling" (a natural cast formed by new sediments being deposited over other sediments that have already partially filled in the footprint). Measurements are given in Table I. This footprint is considered herein to be the manus track of an ornithopod dinosaur.

The following discussion examines the possibility that the track was made by some other taxon. *Stegosaurus* possesses a functionally tetradactyl manus, with the digits arranged in a semicircular pattern (Thulborn, 1990). The phalanges and unguals of the *Stegosaurus* manus are extremely short; the entire hand was most likely encased in an elephant-like pad, from which the unguals protruded only slightly (Galton, 1990), unlike the clearly defined and separate digits of the small Garden Park print. Hypothetical manus prints of a stegosaur (Thulborn, 1990, p. 203) do not closely resemble the track. A newly discovered track attributed to a stegosaur (Lockley and Hunt, this volume) is much larger and has a different morphology as well.

Nodosaurs, which have only recently been recognized in the Morrison (Kirkland and Carpenter, 1994), possess a tetradactyl pes and a pentadactyl manus. Unlike the manus of *Stegosaurus*, the digits of nodosaurs are not as tightly encased in a "pad." The ichnogenus *Tetrapodosaurus* is usually attributed to an ankylosaur (Carpenter, 1984; Thulborn, 1990). In this ichnogenus, the manus print is clearly pentadactyl with digits radiating in a stellate pattern, while the tetradactyl pes print displays widely divergent digits and a large heel region. Neither the morphology of the manus or pes of a nodosaur coincides with that of the Garden Park print.

TABLE I Measurements of Garden Park dinosaur footprints

	Camptosaurid hand print	*Blunt-toed footprint*	*Iguanodon-like ornithopod footprint*	*Zhengichnus-like theropod footprint*	*"?Carnosaur" print*
Footprint length	9.3 cm	42.5 cm	34.2 cm	13 cm	29.5 cm
Footprint width	9.9 cm	32 cm	35.8 cm	25 cm	32.3 cm
Length of Digit I	3.9 cm	n/a	n/a	n/a	n/a
Length of Digit II	3.6 cm	21 cm	?11.5 cm	?10 cm†	5.3 cm
Length of Digit III	4.8 cm	30 cm	13.3 cm	13.6 cm†	13 cm†
Length of Digit IV	4.8 cm	15 cm	?9.6 cm	?5.5 cm†	12.1 cm
Divarication, Digits I–II	−17°*	n/a	n/a	n/a	n/a
Divarication, Digits II–III	34°	22°	46°	?86°	32°
Divarication, Digits III–IV	10°	14°	28°	?42°	40°
Divarication, Digits II–IV	44°	36°	74°	128°	72°
Divarication, Digits I–IV	27°	n/a	n/a	n/a	n/a

* Angle of divarication measured anterior to proximal ends of digits, rather than posterior, because the axis of digit I has a positive rotation with respect to the other digits.
? Assignment of digit number uncertain; assignments as for left pes (digit II is to the left of center).
† Digital impression incomplete; measurement given is for length preserved.

Conrad and others (1987) and Lockley and Prince (1988) suggest that the Garden Park print might be that of a crocodilian. Crocodilians possess a pentadactyl manus and a tetradactyl pes. Tracks attributed to Morrison crocodilians (e.g., Conrad and others, 1987) are almost exclusively pes prints, which do not closely resemble the Garden Park print (Fig. 2). While these pes prints do possess four digits, they also have elongate, parabolic or pointed heel impressions. The pedal digits are also very long and narrow, unlike the shorter, broader digits of the Cañon City print, and it is therefore unlikely that the print is a crocodilian pes print. The manus print of a modern crocodilian, *Caiman*, is pentadactyl, with the digits arranged in a stellate pattern (Fig. 2(D)), unlike the subparallel configuration displayed by the Garden Park print.

The ichnogenus *Pteraichnus* has been attributed to a crocodilian by Padian and Olsen (1984). The reported pentadactyl nature of these prints, with a high degree of negative rotation and extremely elongate digit V are quite unlike the Garden Park print, or the manus of any known crocodilian. I agree with Lockley and others (this volume) and Lockley and Hunt (1995) that these prints are more likely pterosaurian in origin.

Lockley and others (this volume) report the discovery of possible crocodilian prints from the Morrison Formation of southeastern Utah. The

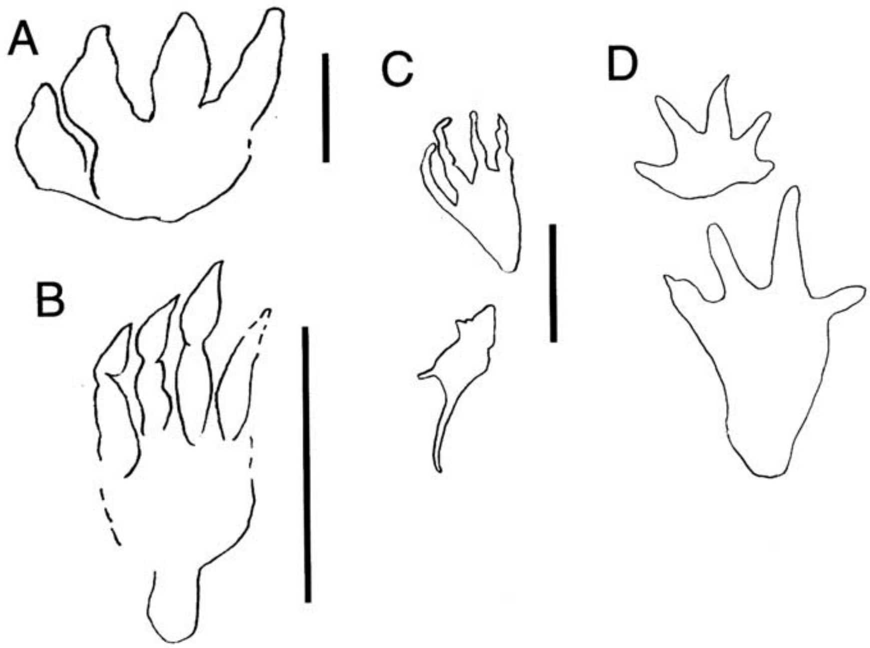

FIGURE 2 Comparison of Cañon City camptosaurid manus print with fossil and modern crocodilian tracks. Scale = 5 cm. (A) Schematic of the isolated Garden Park track attributed to a camptosaur manus. (B) Unnamed pes print assigned to a crocodilian from the Morrison of Oklahoma (redrawn from Conrad and others, 1987). Scale = 5 cm. (C) *Pteraichnus* manus (bottom) and pes (top) prints, previously believed to be pterosaur tracks but reassigned to a crocodilian, from the Morrison of Arizona (redrawn from Padian and Olsen, 1984). Scale = 5 cm. (D) Manus (top) and pes (bottom) prints of a modern crocodilian, *Caiman*. No scale given.

clearest of these prints, attributed to the manus, is tetradactyl, not pentadactyl as in modern crocodilians. The track displays a negative rotation with respect to an axis drawn between it and the following, tridactyl print, and would thus appear to be the impression of a manus or pes of the right side. However, the "swish marks" in association with the prints are to the right of and behind the trackway, an obvious discrepancy if the marks are from the tail. More likely, the "swish marks" are sedimentary features unrelated to the tracks. In general, the Utah tetradactyl print bears some slight resemblance to the Morrison track; however, it differs in significant details. The digits of the Utah print are longer and more slender than those of the Garden Park print, and they bear distinct claw marks. The digital impressions are not subparallel, as are those of the Garden Park print. The Garden Park print is thus probably not crocodilian in origin. The origin of the Utah prints is uncertain.

A relatively common Morrison faunal component is the primitive iguanodontid dinosaur *Camptosaurus*. While iguanodontids are often portrayed as bipedal, structural evidence indicates that these animals often moved quadrupedally (Norman and Weishampel, 1990). Ichnites attributed to iguanodontids indicate that at least some forms did indeed do so (e.g., *Amblydactylus* [Lockley, 1991]; *Caririchnium* [Lockley, 1987]; *Iguanodon* [Lockley, 1991]). As a primitive iguanodontid, it is likely that *Camptosaurus* may have also occasionally progressed quadrupedally; Norman and Weishampel (1990) point out that the manus, with its spread digits, was quite capable of supporting weight.

The manus of *Camptosaurus* is pentadactyl, but digit V is reduced and elevated, possessing no large terminal ungual, and did not ordinarily touch the ground in quadrupedal pose. The manus is probably functionally tridactyl, with digit III as the main weight-bearer, but it is likely that digits I–IV were in contact with the ground (Gilmore, 1909). The manus skeleton of *Camptosaurus* matches the morphology of the isolated Garden Park print very closely; the simplest explanation is that the print is that of a camptosaurid manus (Fig. 3). The manus of later iguanodontids has been described as having been encased in a single, fleshy pad (e.g., Lockley, 1987; Hallett, 1987); the Garden Park print argues that such a configuration for the manus of these ornithopods evolved after *Camptosaurus*.

A large track-bearing slab of sandstone was recovered in 1991 from the Morrison near the proposed site of the Garden Park National Visitor Center. It is currently uncatalogued and stored at the Cañon City office of the Bureau of Land Management. This slab includes two natural footprint casts, both of tridactyl morphology. The clearer of these prints (Fig. 1(B)) is a large, tridactyl print in fairly high relief. All three digits are subparallel. Footprint length is greater than footprint width, a characteristic usually attributed to theropod tracks, but the print does not display any other "theropod" hallmarks. All three digits terminate in round, U-shaped toes, with no traces of claws. Digit III broadens slightly anteriorly, and, despite the high relief of the digit, bears no claw impression. The heel is likewise broad and U-shaped. All of these features, save the subparallel nature of the digits, are characteristic of ornithopods. Measurements are given in Table I.

Other purported ornithopod footprints have been reported from elsewhere in the Morrison (Marsh, 1899; MacClary, 1938; 1939; Bird, 1939; Lockley, 1986; Lockley and others, 1986; Lockley and Hunt, 1995; Lockley and others, this volume). Many of these prints have been reidentified as being of theropod origin, based largely on various footprint measurements,

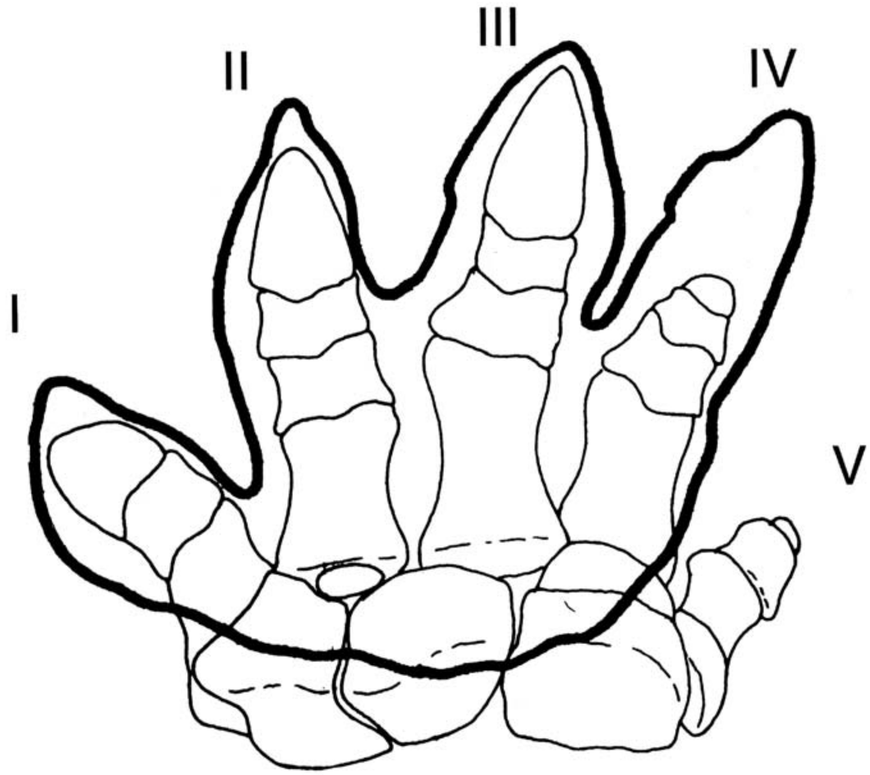

FIGURE 3 Right manus skeleton of *Camptosaurus* drawn over schematic of the print from Cañon City (courtesy of Kenneth Carpenter).

rather than morphology (e.g., Lockley and Prince, 1988; Lockley and Hunt, 1995; Lockley and others, this volume), resulting in the conclusion that there are virtually no ornithopod prints in the Morrison. However, a very few (Lockley and Hunt, 1994; 1995; Lockley and others, this volume) have been identified.

Of the purported ornithopod tracks in the Morrison, some closely resemble the Garden Park track, and others do so less approximately (Fig. 4). The plaster cast pictured in MacClary (1938) and sketches in Lockley (1986) and Lockley and others (1986), all from the Purgatory River site, share with the Garden Park footprint subparallel digits which terminate in broad, U-shaped toes, contrary to the slender, narrowing, claw-bearing digits expected for a theropod track. The lateral digits of the Garden Park specimen are somewhat more distinctly separated from the central digit than any of the Purgatory River prints. Lockley (1986) compares the

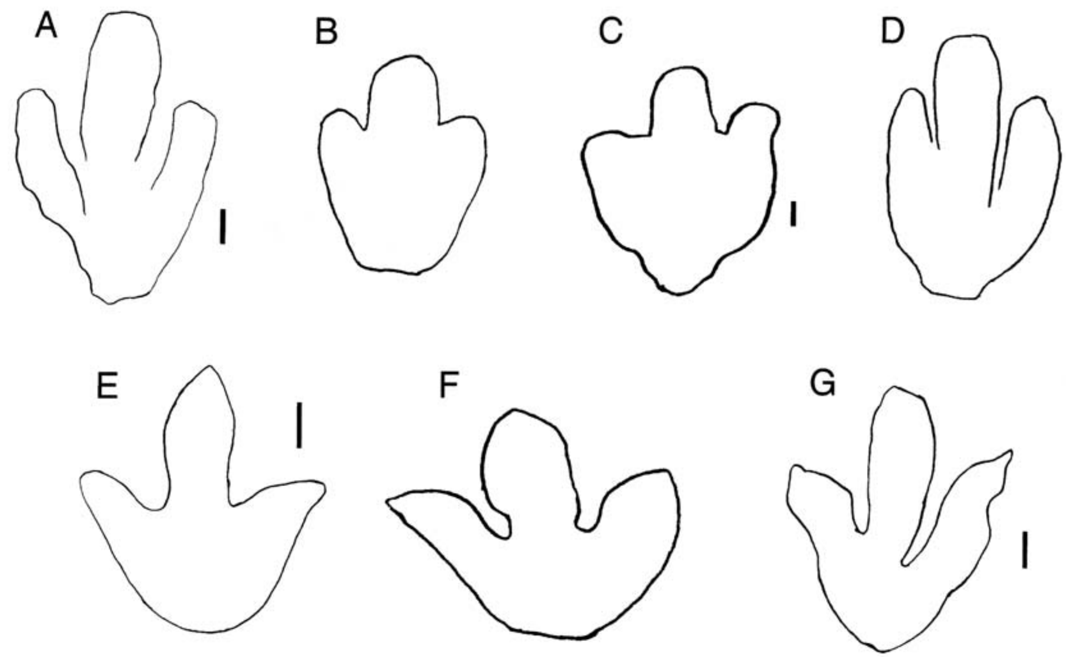

FIGURE 4 Pes prints attributed to ornithopods. (A) Isolated, possible camptosaurid print from Garden Park. Scale = 5 cm. (B) Unnamed print, also possibly of a camptosaurid (traced from MacClary, 1938). No scale given. (C) "Camptosaur print" from the Purgatory River site in the Morrison of Colorado (redrawn from Lockley and others, 1986). Scale = 5 cm. (D) *Yangtzepus* pes print, attributed to an indeterminate ornithopod (redrawn from Zhen and others, 1989). No scale given. (E) *Gypsichnites* print, attributed to a *Camptosaurus*-like form, from the Lower Cretaceous Gething Member of the Bullhead Mountain Formation, Canada (redrawn from Sternberg, 1932). Scale = 5 cm. (F) Unnamed print from the Purgatory River site in the Morrison of Colorado (traced from MacClary, 1939). No scale given. (G) Unnamed "camptosaurid" print from the Morrison of South Dakota (traced from Marsh, 1899). Scale = 5 cm.

Purgatory River tracks and the track from Marsh (1899) to the ichnogenus *Gypsichnites*, described by Sternberg (1932) based on tracks from the Lower Cretaceous of Canada. The *Gypsichnites* tracks have a much greater angle of total divarication than the Purgatory River tracks pictured by Lockley (1986), Lockley and others (1986), and the Garden Park print. Furthermore, *Gypsichnites* tracks terminate in dull points, unlike the U-shaped toes of the Purgatory River and Garden Park prints.

It is possible that the "round-toed" Morrison footprints (Fig. 4(A)–(C)) are a distinct ichnospecies from the more *Gypsichnites*-like tracks (Fig. 4(E)–(G)). J. Pittman (personal communication) notes that the foot of primitive ornithopods, including *Camptosaurus*, probably made "grallatorid" prints (see below). Differences in footprint morphology may be the result of differences in the substrate or the walking habit of the animal. A further study of the occurrences of both footprint morphologies and the substrates in which the tracks were made would help clear up the issue.

Young (1960) and Zhen and others (1989) describe the ichnogenus *Yangtzepus* from the Upper Jurassic of China, roughly contemporaneous with the Morrison tracks, and which is morphologically quite closely resemble the Garden Park and other "round-toed" Morrison tracks (Fig. 4(A)–(D)). A noteworthy difference displayed by the Chinese prints is at least one manus print is reported associated with *Yangtzepus* pes prints, indicating an animal in a quadrupedal progression. While it is probable that *Camptosaurus* and similar ornithopods did progress quadrupedally, at least occasionally (see above), no definite quadrupedal ornithopod trackways have yet been reported from the Morrison.

It must be acknowledged that, due to gross similarities in morphology and the varying natures of potential track-preserving substrates, ornithopod and theropod prints can be and often are mistaken for one another. The question is: what is of greater importance in determining the trackmaker, measurements or morphology? Moratalla and others (1988) and Thulborn (1990) cite useful characteristics. Many of the purported Morrison ornithopod tracks are longer than wide and have low total divarication angles, both traditional theropod track characteristics (Thulborn, 1990; Lockley and others, this volume). Moratalla and others (1988), however, note that while length/width ratios are useful, divarication angles are highly variable and statistically impracticable. J. Pittman (personal communication) has noted that primitive ornithopods, as well as theropods, can leave "grallatorid" tracks, in which digits II and IV curve inwards towards digit III, a trait displayed by the Garden Park print. Footprints attributed to hypsilophodontid dinosaurs, however, seem to display an *outward* curve of digit IV (Lockley and others, this volume). Thus, the morphology of many of these prints suggests that these traits are not limited to theropods, and are, in fact, blurred at the boundary between theropod and ornithopod (J. Pittman, personal communication). *Yangtzepus* prints from China display "theropodous" traits (i.e., footprint length greater than width, low divarication angles), and yet are reportedly of a quadrupedal animal (Zhen and others, 1989); no one has yet proposed quadrupedal progression for any Late Jurassic theropod. The Garden Park print is a well-preserved natural cast, with a high degree of relief, and has a third digital impression that broadens distally. No digit bears any trace of a claw. Despite the greater length than width of the print and the low divarication angles (Table I), its morphology is more ornithopodan than theropodous. It is more parsimonious to assume that the track maker was an ornithopod with the digits arranged, for whatever reason, in a theropod-like configuration, than to assign them to a theropod but have to explain away the differences in morphology.

A second track occurs on the same slab as the "round toed" ornithopod track described above, although the block has now broken and the track is separate. The track (Figs. 1(C) and 5(A)) is less distinct than the first print, but is significantly different. Measurements are given in Table I. The total divarication is much greater – more in the traditional ornithopod range (Thulborn, 1990; Table I) – and the impressions of each digit, the clearest parts of the natural cast, are shorter. All three digits terminate bluntly, with no traces of claws. The hypeces are not well preserved, but seem to be very relatively broad, web-like extensions between the toes. The heel print appears to be generally parabolic in shape, a feature more typical of theropods than ornithopods, although it is not unknown in the latter (Delair and Sarjeant, 1985; Lockley, 1987). However, the entire heel impression is very poorly preserved, and made all the more indistinguishable by lichen on the slab, and the parabolic shape may be a preservational artifact rather than the true nature of the heel.

In morphology, the track bears some resemblance to the fossil footprints attributed to iguanodontids, particularly *Iguanodon* (Fig. 5(B)) from the Lower Cretaceous of England (Delair and Sarjeant, 1985) and unnamed tracks (Fig. 5(C)) from the Lower Cretaceous Dakota Group of Colorado (Lockley, 1987, Figure 51). These tracks, along with the Garden Park specimen, are similar in that they all possess blunt and narrow digital impressions, as opposed to many other footprints attributed to iguanodontids or hadrosaurids (e.g., *Amblydactylus* [Sternberg, 1932; Currie and Sarjeant, 1979] and *Caririchnium* [Lockley, 1986], as well as other specimens of

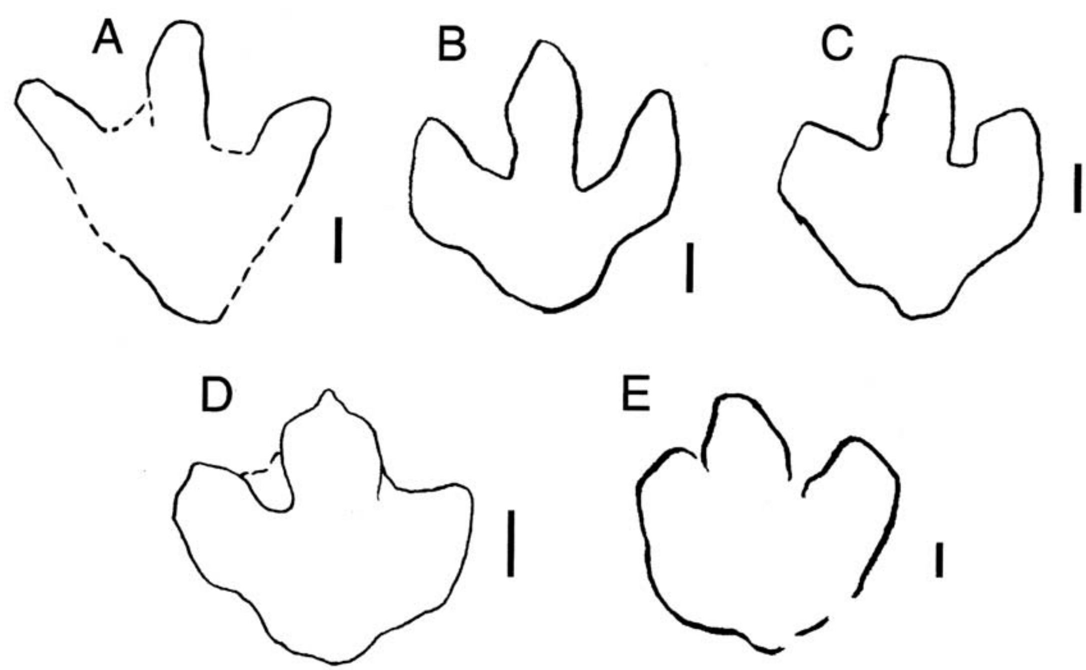

FIGURE 5 Pes prints attributed to ornithopods, especially iguanodontids and hadrosaurs. (A) Isolated print from Garden Park. (B) Unnamed footprint attributed to an iguanodontid from the Lower Cretaceous Wealden of Sussex, England (redrawn from Lockley, 1987). Scale = 10 cm. (C) Unnamed footprint attributed to an iguanodontid from the Lower Cretaceous Dakota Formation, Colorado (redrawn from Lockley, 1987). (D) *Amblydactylus*, a footprint attributed to an iguanodontid or a hadrosaurid, from the Lower Cretaceous Gething Member of the Bullhead Mountain Formation, Canada (redrawn from Currie and Sarjeant, 1979). Scale = 10 cm. (E) *Caririchnium*, a footprint attributed to an iguanodontid, from the Lower Cretaceous Dakota Formation of Colorado (redrawn from Lockley, 1986). Scale = 5 cm.

Iguanodon [Delair and Sarjeant, 1985]). Except for having narrower digital impressions, the track also resembles undescribed tracks attributed to ornithopods, possibly from the Morrison, in the vicinity of the Cleveland-Lloyd Quarry (Lockley and Hunt, 1994; 1995; Lockley and others, this volume).

The lack of known Late Jurassic iguanodontid or hadrosaurid material forces the attribution of this Garden Park track to the Camptosauridae, although this is negative evidence and by no means conclusive. The track is notably different from either of the two "camptosaurid" footprint morphologies outlined above. The fact that the print is of comparatively low relief may indicate that it is a shallow infilling of a more detailed footprint, long since eroded away.

Another uncatalogued footprint, also in possession of the Cañon City Bureau of Land Management office, displays a poorly preserved footprint of apparent theropod origin (Fig. 1(D)). This print was found farther north than the other tracks described herein. Measurements are given in Table I. This isolated and relatively poorly preserved print displays a highly unusual morphology. Although incompletely preserved, digit III is extremely long and narrow, a traditionally theropodous characteristic (Thulborn, 1990). The digit to the left of digit III is likewise incompletely preserved, and diverges at a high angle from the mesaxial digit (measurements are given in Table I). The digit to the right of digit III seems to be completely preserved, is short in relation to digit III, and also diverges at a high angle from the central toe. It is a broad digit that terminates in a blunt point; no claw impressions are preserved. The heel is broad and parabolic in shape. The length and narrowness of digit III indicates that the track maker was probably a theropod.

A track attributed to a reptile of indeterminate origin (Zhen and others, 1986; Zhen and others, 1989), assigned to the ichnogenus *Zhengichnus*, shares some characteristics with the track from Garden Park. Both tracks possess an extremely long digit III and short, highly divergent digits II and IV (Fig. 6(A) and (B)). The Morrison track possesses a deeper, rounder heel than the Chinese specimen, and has broader, more blunt lateral digits. A somewhat similar purported theropod track from the Upper Jurassic of England, *Taupezia* (Fig. 6(D)), also demonstrates a long digit III and widely divergent outer digits, even more so than either the Garden Park track or *Zhengichnus*, but has virtually no heel impression at all (Delair, 1963, as cited in Thulborn, 1990). Several tridactyl prints of an "unidentified biped" from the Aztec Sandstone (Fig. 6(C)) of California possess a wide divarication and a rounded heel (Reynolds, 1989), and are thus similar to the more poorly preserved Cañon City track. However, the

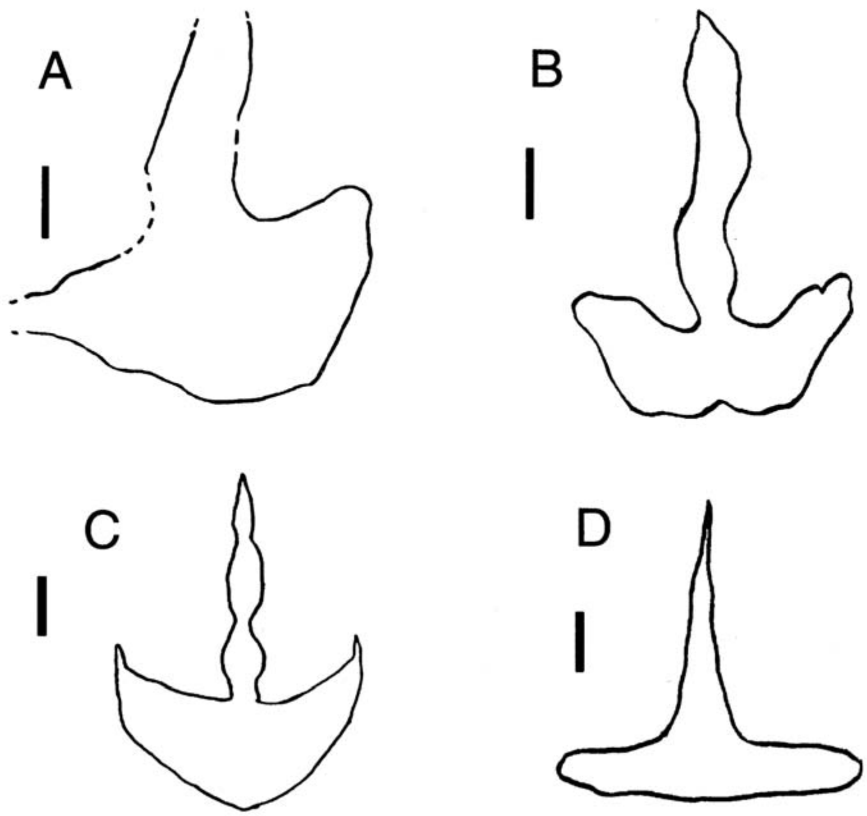

FIGURE 6 Theropod footprints with large angles of total divarication. (A) Unnamed footprint from Garden Park. (B) *Zhengichnus*, a footprint attributed to an indeterminate theropod, from the Lower Jurassic Lower Fengjiahe Formation of Yunnan, China (redrawn from Zhen and others, 1989). Scale = 2 cm. (C) Unnamed footprint of an "unidentified biped" from the Lower Jurassic Aztec Sandstone of California (redrawn from Reynolds, 1989). Scale = 2.5 cm. (D) *Taupezia*, a footprint attributed to a coelurosaurian dinosaur, from the Upper Jurassic Purbeck Beds of Dorset, England (redrawn from Haubold, 1971). Scale = 3 cm.

Chinese *Zhengichnus* and the Aztec prints occur in Lower Jurassic sediments (Reynolds, 1989; Zhen and others, 1989). The Garden Park track almost certainly does not represent the same animal. More likely it represents a normal theropod under unusual track-making circumstances.

A fifth track, DMNH 23523, was collected in 1991 in the "Valley of Death," located northeast of and below the "Cope's Nipple" quarry. This natural cast (Fig. 1(E)) is very poorly preserved, and its morphology is difficult to discern. Measurements are given in Table I. It is a tridactyl print, with digit III longer than either lateral digit, though the leftmost digit

(digit II) is incomplete. Digit III is long and narrow, a characteristic feature of theropod prints, but terminates bluntly, with no trace of a claw. The rightmost digit is deemed digit IV because it extends from a distal protrusion probably made by the metatarsus. The position of this extension behind digit IV is characteristic of many footprints, especially those of "carnosaurian" (inclusive of large ceratosaurians and carnosaurians [Gauthier, 1986]) and theropods in general (Thulborn, 1990). Digit IV is very broad at its base, an ornithopod footprint trait, but tapers sharply to a blunt point, a theropod characteristic. Digit II is not at all clear, and the anterior end has been lost to erosion. The digit appears to be broad, but some of the features of the cast may be strictly sedimentological, and the digit may in reality be narrower than it appears in the cast (Fig. 7). The track bears some superficial resemblance to "carnosaur" tracks from the Purgatory River site (Lockley and others, 1986), but is too poorly preserved for a decent comparison.

It is interesting to note that the dinosaur footprints from Garden Park are all natural casts, and virtually all occur in the sandstone and claystone facies of the Morrison Formation. This is in contrast to many other Morrison footprint-producing sites, including the Purgatoire River site, in

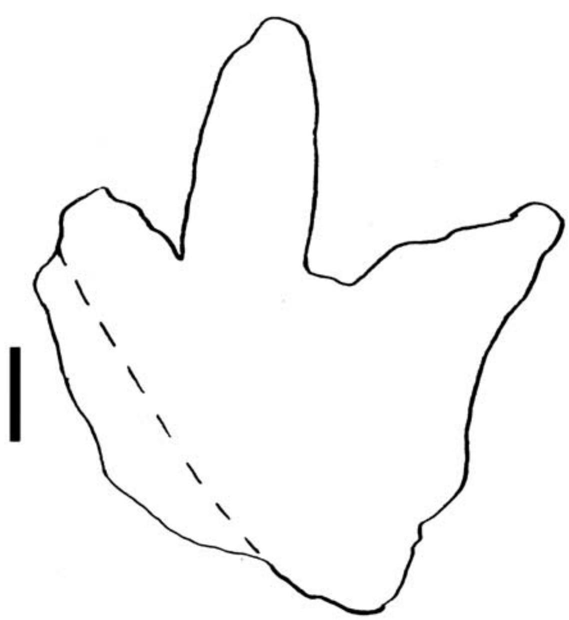

FIGURE 7 Schematic of a possible "carnosaur" footprint from Garden Park. Scale = 5 cm.

which the footprints are natural molds and occur in freshwater limestone facies (MacClary, 1938; Lockley and others, 1986; Conrad and others, 1987), although recent discoveries have produced other natural casts (e.g., Lockley and Hunt, this volume). While the lacustrine facies have a tendency to preserve long trackways, rather than isolated prints, this perhaps represents a bias in the ichnological record of the Morrison, favoring those animals that frequented the lake shores (q.v. Lockley and others, 1986). The broad surface exposures at the Purgatoire River site have exposed greater numbers of footprints than at any other Morrison locality, further biasing this record. Nevertheless, it is evident that the other facies can provide additional data towards a more complete understanding of the fauna the Morrison paleoecology supported.

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