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HADROSAUR TRACKWAYS FROM THE LOWER CRETACEOUS OF CANADA

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The most common ichnogenus in the Peace River Canyon is *Amblydactylus*, a large bipedal herbivore. The morphology of the hand and footprints suggest that the tracks and trackways were made by hadrosaurs, and the ichnites might represent the earliest record of these dinosaurs. *Amblydactylus* tracks were made in a wide variety of depositional environments, including the mud beneath several metres of water. Juveniles were gregarious and stayed together after hatching until they were large enough to join herds of more mature animals. Hadrosaur herds appear to have walked side by side, seldom crossing paths, although there was little structure to the herds when they were in the water and/or feeding. Calculation of the walking speeds indicate that the herbivores were generally slower than the carnivores.

Key words: footprints, dinosaur, hadrosaur, herding, activity levels.

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Dinosaur footprints were first discovered in the Peace River Canyon of British Columbia in 1922 (McLearn 1923). Expeditions by the National Museum of Canada in 1930 (Sternberg 1932), the Royal Ontario Museum (1965) and the Provincial Museum of Alberta (1976, 1977, 1978, 1979) have recovered dinosaur footprints throughout the 500 metres of strata of the Gething Formation (Aptian-Albian, Lower Cretaceous; Stott 1975). More than 1,700 footprints were documented, 90 specimens were collected, casts were made of 200, almost 1,000 footprints in more than 100 trackways were measured, and more than 1,000 tracks were mapped.

Sternberg (1932) described six genera and eight species of dinosaur footprints from the canyon. A new species of *Amblydactylus* (Currie and Sarjeant 1979) and the earliest known record of bird footprints (Currie 1981) have increased the diversity of the fauna. It should be pointed out that foot structure is usually conservative, and that one ichnospecies could represent many species of closely related animals.

The fauna of the ancient Gething Delta is much different from that of contemporary faunas in other part of the world. At Glen Rose and Davenport in Texas, the Early Cretaceous footprint fauna is dominated by sauropod dinosaurs (Bird 1954), as is the Demnat locality of Morocco (Dutuit and Ouazzou 1980). Footprints of ornithopods are rare at these two sites, whereas they dominate the Peace River fauna. The Wealden beds of England and Europe are dominated by large ornithopods, probably *Iguanodon*. The purpose of this paper is to discuss the identification and behaviour of the large herbivores of the Peace River Canyon.

The species *Amblydactylus gethingi* was established on the basis of a single footprint (NMC 8555). The original specimen had to be left in the canyon because of the difficulty in excavating the actual specimen. Efforts to relocate the specimen failed until 1979 when it was spotted underwater from a helicopter. Three attempts were made to produce a new and better cast of the holotype when the levels of the Peace River were extremely low, but failed because the river level never stayed low enough for more than a few hours. Although it is an extremely important and well preserved specimen (comparison with Sternberg's photograph shows that there has been no significant erosion of the specimen after 50 years), the water levels and hardness of the rock prevented any attempt to excavate it. This specimen and most others in the canyon are now inundated by a reservoir behind the Peace Canyon Dam.

A second species of *Amblydactylus*, *A. kortmeyeri*, was established on the basis of a well preserved natural mould of a footprint (Currie and Sarjeant 1979). It differs from *A. gethingi* in its length to width ratio, and in the outline of the footprint itself.

Although it was possible to distinguish the species in well preserved specimens, specific indentification was not possible for the majority of *Amblydactylus* tracks. As both species of footprint seem to represent the same general type of animal (a large, planteating biped), they will be treated together in this paper.

As the hooves of the type specimens were sharper than expected for a hadrosaur, Sternberg (1932) suggested that *Amblydactylus* more closely resembled the footprints of *Iguanodon*. The majority of *Amblydactylus* tracks appear to have blunt hooves (fig. 1) and are relatively shorter and broader than *Iguanodon* tracks from England (Beckles 1856). The type specimen of *Amblydactylus kortmeyeri* is almost identical to hadrosaur footprints from the Upper Cretaceous of Alberta (Langston 1960).

A trackway worked on by the Royal Ontario Museum and numerous trackways found by the Provincial Museum of Alberta had handprints associated with the footprints of *Amblydactylus*. There is no evidence of the specialized "spike" on the hand, which is characteristic of *Iguanodon*. The handprints are roughly crescent shaped, and are remarkable for the lack of details indicating separation of fingers, no matter how well

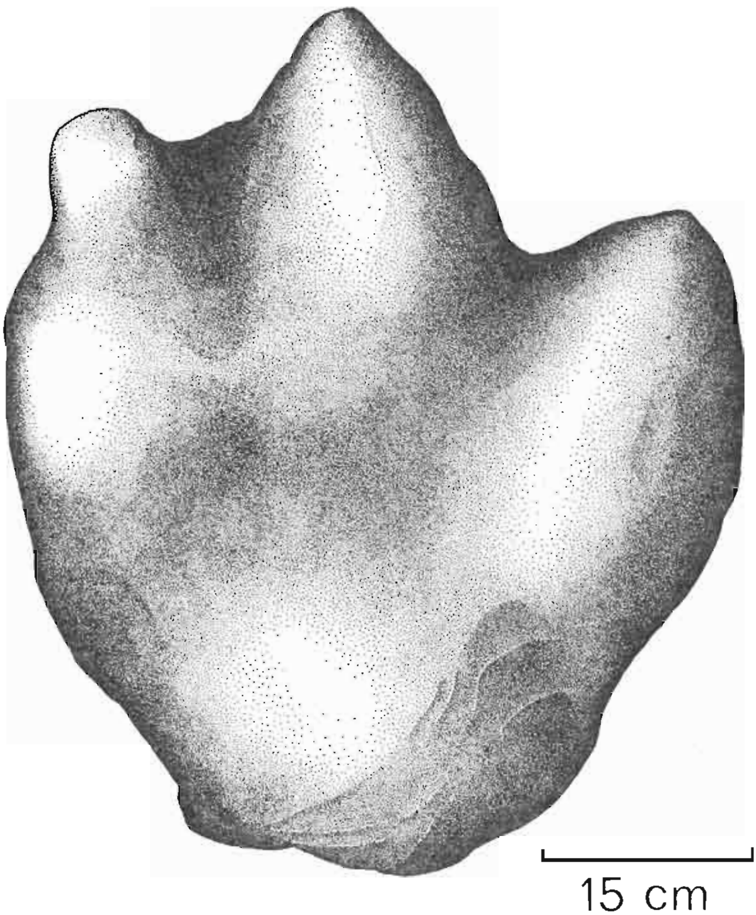

Fig. 1. *Amblydactylus gethingi*, PMA P78.11. Natural mould of a footprint (or a natural cast of the foot) of a hadrosaurian dinosaur.

the associated footprints are preserved. The handprints, however, are exactly the impression one would expect to find for a hadrosaur. It is known from "mummified" specimens (Osborn 1912; PMA P80.23.2) that the fingers of hadrosaurs were encased in a sheath of hide and were capable of only limited independent motion. It appears highly likely that the footprints of *Amblydactylus* represent hadrosaurian dinosaurs. This is significant because the earliest records of duckbilled dinosaurs from North America are Santonian in age (Kaye and Russell 1973), whereas the beds in the Peace River Canyon are considerably older.

Sternberg collected a trackway of four footprints that he described as *Irenesauripus occidentalis*. The impressions are very shallow and the outlines are poorly defined. The relative width of the tracks, the width of the trackway and the shortness of stride are very different from *Irenesauripus mclearni* and *I. acutus*. Sternberg felt the different characters of the trackway may be partly due to the slow movement of the animal when making the tracks. However, it is more likely that these four prints are synonymous with *Amblydactylus*. The divarication of digits II and IV is 73°, much higher than that of *I. mclearni* and *I. acutus*, but within the range for *Amblydactylus*. As in *Amblydactylus*, the width of the foot is almost as great as the length. The average width to length ratio for the four tracks is .95. The stride length and width of the trackway are well within the range expected for *Amblydactylus*. Finally, it is worth pointing out that no other tracks were found that fit the description of *Irenesauripus occidentalis* whereas *Amblydactylus* footprints are very common.

Sternberg (1932) described only a single specimen of *Amblydactylus*, and did not refer to any trackways. This leaves the reader with the impression that it must be a rare genus. However, 50% of the trackways discovered and 90% of the isolated footprints observed are attributable to *Amblydactylus*.

Amblydactylus footprints of the Peace River Canyon were preserved in several types of depositional environments. At Site 1 (Currie 1980) the tracks are found in a grey, fine-grained sandstone. Rootlets and biological turbulence are evident in overlaying layers, and the variety of footprint types and sizes suggest that the dinosaurs were walking on the muddy margin of a quiet body of fresh water. The major footprint bearing level at Site 3 is a grey, ripple-marked sandstone with rootlets and bioturbation. There are many footprints of small animals, and it seems probable that the site was a soft, flat expanse of mud at the edge of a body of quiet water, or was possibly even covered with a couple of centimetres of water. At Site 4, a trackway of *Amblydactylus* is found in a ripple-marked, ferruginous sandstone. The pattern of the tracks at this site suggests that the animal was partially floating when the trackway was made, and that the tracks were made in the muddy bottom of a quiet body of water that was at least two metres in depth. Numerous other sites in the canyon appear to have been underwater when the footprints were made. A large block was found on the talus slope near Site 5 with three large negative footprints of a single *Amblydactylus*. On the other side of the slab were worm burrows of a type known as *Rhizocoralia*, indicating that shortly after the dinosaur walked over the mud, additional sediments accumulated in a body of brackish water. The seashore must have been very close at that time. The hadrosaurs that left their footprints at the main level of Site 8 (fig. 2) were walking across a splay crevace. A single footprint was recovered from Site 10 from a coarse-grained, cross-bedded channel sandstone, showing that *Amblydactylus* was not restricted to quiet waters. Footprints at Site 15, including the type specimen of *Amblydactylus gethingi*, were made in the water covered mud on the edge of a sandbar. Another footprint recovered from the talus slope above Site 15 appears to have been made in a very organic layer of mud. In summary, the hadrosaurs of the ancient Gething Delta appeared to live in proximity to almost all of the available depositional environments.

Amblydactylus trackways are well represented. In most cases, neither handprints nor tail drag marks are preserved with footprints of *Amblydactylus*. This is expected if the animal is floating or swimming in the water. Handprints are associated with the footprints in at least six of the *Amblydactylus* trackways, indicating that the animals were facultative and not obligatory bipeds. The juveniles do not show any signs of having used their hands in supporting their bodies even though they were found at Site 3 where there appears to have been little or no water to support them. The tail was used as a counterbalance as the animal walked, and was never dragged as it was in many of the dinosaurs of the Lower Jurassic of the Connecticut River valley (Hitchcock 1858).

The trackway at Site 4 appears to indicate that hadrosaurs were efficient swimmers. Here an animal was walking on the muddy bottom of a quiet body of water. As the water became deeper, its stride decreased, and it appears to have been pushing off the bottom with its toes because the mark for the heel pad is very shallow and poorly defined. At one point, the midline of the trackway shifts more than a metre to the right, and several steps later, it shifts to the left again. It would difficult to explain these shifts unless the three or four tonne weight of the body was buoyed up by water. Furthermore, there are other isolated but clearly defined tracks at Site 4 which suggest that animals were swimming over the muddy bottom, but were occasionaly putting a foot down to push off the bottom. There are many other sites in the canyon where clearly defined *Amblydactylus* footprints are not associated in trackways, even though individual tracks cover the entire bedding plane. The best explanation for the lack of continuous trackways is that the animals were in water deep enough to swim. Finally, it should be pointed out that at many of the sites, only the footprints of large animals were found, suggesting that the water was too deep for small animals, or that the smaller dinosaurs were floating at the surface.

Juvenile *Amblydactylus kortmeyeri* footprints were found at Site 7 (Currie and Sarjeant 1979) and Site 3. In both cases, two animals of approximately the same size were moving in the same direction, suggesting that juveniles were gregarious and stayed together after hatching until they were large enough to join herds of more mature animals.

Trackway series of numerous animals of the same type proceeding in one direction have been reported for numerous sites in the world and have been cited as evidence that dinosaurs were gregarious (Ostrom 1972). Site 8 (fig. 2) in the Peace River Canyon could be one of the best sites anywhere to demonstrate that hadrosaurs were herding animals because the animals are showing the same trends in changing direction.

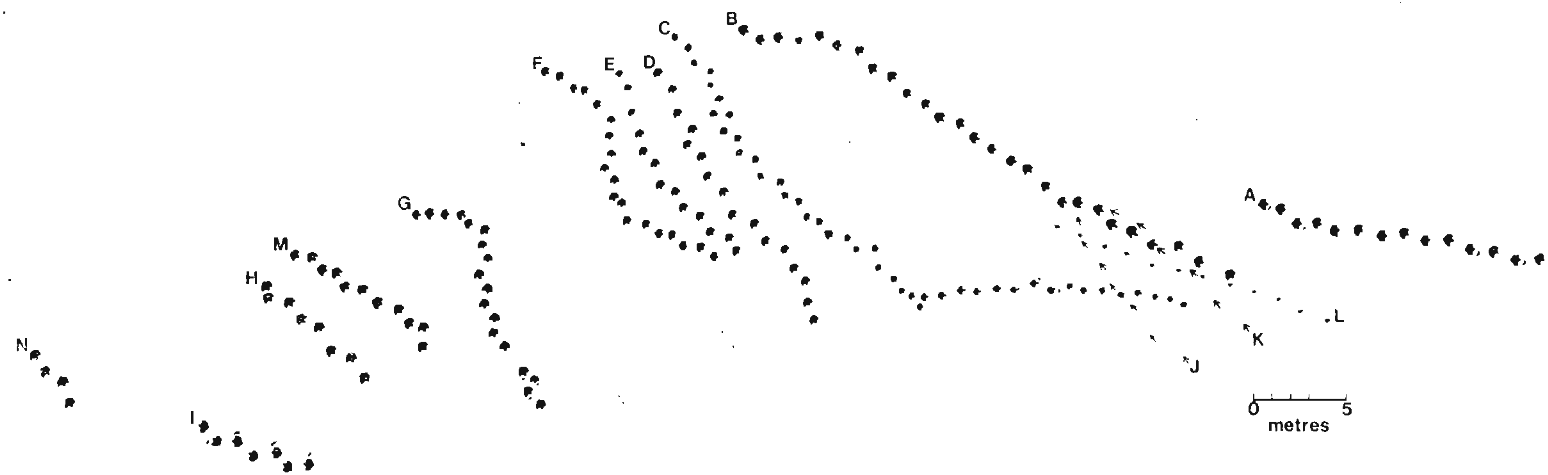

Fig. 2. Map of a portion of Provincial Museum of Alberta Site 8 in the Peace River Canyon, showing trackways of *Amblydactylus gethingi* (*A, B, C, D, E, F, G, H, I, M, N*) and *Irenesauripus acutus* (*J, K, L*). All footprints were mapped in the field. Because of the reduced scale and the complexity of the drawing, a standard outline has been used for the *Amblydactylus* footprints (except for trackway *C*). The only place where this practice may have had a significant effect is Trackway M, where none of the footprints are well enough preserved to indicate with certainty the direction the animal was going.

Nine or ten animals were walking across a splay crevace. The more northerly footprints must have been made in very soft mud because they are deeply impressed and there was considerable fluid mud flow after the dinosaurs walked on. The footprints are shallower and better defined towards the end of the series, suggesting that the mud was firmer in this area. Ripple marks on the bottoms of these shallow footprints could indicate that the whole series was made underwater.

Trackways C, D, E and F were made by animals that must have been walking side by side. The four trackways follow the same sinuous curves although the curvature of the path is stronger in F. The trackways are close together at points, but do not intersect. One possible interpretation is that the four animals were walking so close together that when F changed course suddenly, the courses of the remaining three animals were affected to avoid collision.

The evidence at Site 8 and an unmapped series of nine trackways at Site 5 indicate that hadrosaur herds were spread out on a wide front, and that the animals might have been walking side by side, seldom crossing paths. An *Amblydactylus* trackway at Site 3c is overlain by a second trackway made by an animal of the same species and of a smaller size. This shows that they did not always walk side by side when proceeding in the same direction. Other sites in the canyon with a deep-water depositional environment show a random distribution and orientation of the *Amblydactylus* tracks, suggesting that there was little structure to the herd when they were in the water and/or feeding.

There is an interesting association between the trackways of *Amblydactylus* and the large carnivore *Irenesauripus acutus*. At Site 8, three trackways (J, K and L) of the theropod appear toward the end of series of hadrosaur footprints (fig. 2). Trackways of *I. acutus* are also found in some (Sites 3d and 8a) of the deep water environments in association with the hadrosaur tracks. The large carnivores of the Gething Delta were apparently not adverse to walking in relatively deep water, although no evidence has been found to suggest that they swam as one of the Early Jurassic theropods did (Coombs 1980).

Alexander (1976) developed a formula from which the speed of a dinosaur could be calculated from a dinosaur trackway. The speeds of movement of the Peace River dinosaurs have been calculated using this formula (Kool 1981; Table 1). The hadrosaurs appear to be relatively slow animals in comparison with the carnivores (*Irenesauripus, Irenichnites, Columbosauripus*), and attained a top speed of 8.5 km/hr. This figure was calculated on the basis of the total length of the hadrosaur foot, which includes a substantial "heel" pad. Alexander's formula is based on the distance between the distal end of the third metatarsal and the distal end of the third toe. As the pad obscures the distal end of the third metatarsal, it is not known precisely what percentage of the length of the

Table 1

Speeds of dinosaurs calculated from trackways in the Peace River Canyon
L = average length of foot (in m).

Trackway Number	Identification	L	Speed (m/sec)			Speed (km/hr)		
			Aver.	Min.	Max.	Aver.	Min.	Max.
III-B	cf. *Columbosauripus ungulatus*	.307	2.26	2.12	2.34	8.15	7.64	8.42
III-C	Theropod	.343	2.90	2.84	2.96	10.44	10.21	10.66
III-D	cf. *Columbosauripus ungulatus*	.259	2.33	—	—	8.38	—	—
III-E	Therepod?	.285	2.28	—	—	8.21	—	—
III-F	Therepod?	.292	2.58	2.43	2.68	9.30	8.76	9.64
III-H	Therepod?	.293	2.13	—	—	7.66	—	—
III-I	*Irenesauripus mclearni*	.318	1.86	1.56	2.08	6.71	5.62	7.48
III-J	*Amblydactylus* sp.	.140	.84	.63	1.00	3.04	2.27	3.59
III-K	cf. *Gypsichnites pacensis*	.283	1.70	1.36	1.99	6.12	4.90	7.18
III-L	*Irenesauripus acutus*	.419	1.83	1.52	2.09	6.60	5.48	7.54
III-M	*Irenesauripus mclearni*	.365	1.67	1.45	1.85	6.01	5.23	6.64
III-N	*Irenesauripus mclearni*	.326	2.94	2.86	3.06	10.57	10.31	11.01
III-O	cf. *Gypsichnites pacensis*	.295	2.74	2.59	2.86	9.86	9.32	10.29
III-P	cf. *Gypsichnites pacensis*	.246	1.98	.91	2.59	7.12	3.26	9.32
III-Q	*Irenesauripus mclearni*	.288	4.56	4.10	4.89	16.43	14.78	17.61
III-R	*Irenesauripus mclearni*	.334	3.21	2.34	4.19	11.55	8.42	15.07
III-S	cf. *Gypsichnites pacensis*	.292	2.04	1.82	2.20	7.34	6.56	7.91
III-T	cf. *Gypsichnites pacensis*	.294	2.15	2.08	2.23	7.75	7.47	8.04
III-V	*Irenesauripus mclearni*	.339	2.36	1.98	2.63	8.51	7.13	9.47
III-W	*Irenesauripus mclearni*	.334	7.69	1.50	1.85	6.10	5.40	6.65
III-X	Theropod?	.268	1.59	1.50	1.73	5.73	5.40	6.23
III-Z	*Irenichnites gracilis*	.147	1.89	1.77	2.03	6.80	6.38	7.30
III-AA	cf. *Irenesauripus mclearni*	.274	2.12	1.87	2.40	7.62	6.75	8.65
III-BB	*Irenesauripus mclearni*	.365	2.30	—	—	8.30	—	—
III-CC	*Irebichites gracilis*	.157	1.97	1.88	2.06	7.09	6.76	7.42
III-DD	*Irenesauripus acutus*	.370	.83	.75	.99	2.97	2.69	3.58
III-EE	*Irenesauripus mclearni*	.275	3.02	—	—	10.87	—	—
IIIa-A	*Amblydactylus* sp.	.542	1.63	1.38	1.75	5.85	4.98	6.32
IIIa-B	*Amblydactylus* sp.	.382	1.63	1.24	1.94	5.88	4.45	6.99
IIIa-C	*Amblydactylus* sp.	.513	1.38	—	—	4.95	—	—
IIIa-E	*Amblydactylus* sp.	.560	1.12	—	—	4.03	—	—
IIIc	*Irenesauripus mclearni*	.300	2.45	1.61	3.42	8.81	5.79	12.32
IIIc-A	*Irenesauripus mclearni*	.291	2.37	2.26	2.56	8.55	8.14	9.20
IIIc-B	*Irenesauripus mclearni*	.333	1.49	1.36	1.91	5.37	4.88	6.87
IIIc-C	*Irenesauripus mclearni*	.256	2.63	2.48	2.84	9.47	8.93	10.22
IIIc-D	*Amblydactylus* sp.	.275	2.05	1.24	2.38	7.36	4.47	8.56
IIIc-E	*Irenichnites gracilis*	.160	2.31	2.23	2.37	8.31	8.03	8.52
IIIc-F	*Irenesauripus mclearni*	.266	1.97	1.81	2.16	7.10	6.51	7.78
IIIc-G	*Irenesauripus mclearni*	.197	3.08	2.73	3.23	11.08	9.84	11.64
IIId-A	*Irenesauripus acutus*	.578	1.78	1.58	1.99	6.41	5.68	7.18
IIId-B	*Amblydactylus* sp.	.466	1.77	1.58	2.04	6.38	5.70	7.36
IIId-C	*Amblydactylus* sp.	.505	1.33	—	—	4.79	—	—
IIIe-A	*Amblydactylus* sp.	.430	1.88	1.59	2.11	6.76	5.74	7.60
IIIe-C	*Amblydactylus* sp.	.265	1.34	1.30	1.37	4.82	4.70	4.95
IIIe-D	*Amblydactylus* sp.	.371	1.32	1.14	1.81	4.75	4.09	6.52
IV-A	*Amblydactylus* sp.	.543	.94	.44	2.18	3.39	1.59	7.84
IV-F	*Amblydactylus* sp.	.510	1.39	1.02	1.79	5.00	3.68	6.46
V-A	*Amblydactylus* sp.	.550	1.35	1.32	1.38	4.87	4.76	4.98
V-B	*Amblydactylus* sp.	.580	1.19	—	—	4.29	—	—
V-C	*Amblydactylus* sp.	.547	1.53	1.29	1.80	5.50	4.66	6.47
V-D	*Irenesauripus acutus*	.416	2.35	2.29	2.41	8.45	8.25	8.66
V-E	*Amblydactylus* sp.	.420	2.16	—	—	7.79	—	—
VI-A	*Amblydactylus* sp.	.530	1.80	—	—	6.48	—	—
VI-B	*Amblydactylus* sp.	.466	.94	.82	1.13	3.38	2.95	4.07
VIa-A	*Amblydactylus* sp.	.410	1.47	—	—	5.28	—	—

c.d. table 1

Trackway Number	Identification	L	Speed (m/sec)			Speed (km/hr)		
			Aver.	Min.	Max.	Aver.	Min.	Max.
VIa-B	*Amblydactylus* sp.	.577	.51	.48	.57	1.85	1.73	2.04
VIII-A	*Amblydactylus* sp.	.529	1.05	.90	1.24	3.78	3.24	4.45
VIII-B	*Amblydactylus* sp.	.628	1.02	.82	1.25	3.67	2.95	4.52
VIII-C	*Amblydactylus* sp.	.458	.83	.24	1.25	3.00	.87	4.50
VIII-D	*Amblydactylus* sp.	.430	1.48	.92	1.80	5.33	3.33	6.46
VIII-F	*Amblydactylus* sp.	.413	1.02	.60	1.30	3.68	2.15	4.69
VIII-G	*Amblydactylus* sp.	.492	.68	.30	1.10	2.44	1.07	3.96
VIII-I	*Amblydactylus* sp.	.594	.97	.80	1.14	3.49	2.88	4.11
VIII-J	*Irenesauripus acutus*	.508	1.83	1.72	1.91	6.60	6.19	6.88
VIII-K	*Irenesauripus acutus*	.551	2.37	1.60	3.38	8.53	5.76	12.17
VIII-L	*Irenesauripus* cf. *acutus*	.394	2.19	1.14	2.61	7.87	4.09	9.39
VIII-N	*Amblydactylus* sp.	.500	1.10	1.04	1.16	3.96	3.75	4.18
VIII-O	*Irenesauripus acutus*	.542	1.72	1.45	2.06	6.18	5.21	7.41
VIII-P	*Irenesauripus acutus*	.560	2.28	2.21	2.35	8.21	7.97	8.46
VIIIa-T	*Amblydactylus* sp.	.617	1.35	1.33	1.37	4.87	4.79	4.95
VIIIa-U	Theropod? n. gen, n.sp.	.332	1.80	1.65	1.89	6.49	5.95	6.81
VIIIa-V	Theropod? n. gen, n.np.	.194	1.47	1.21	1.72	5.29	4.37	6.17
VIIIa-W	Theropod? n. gen, n.sp.	.247	1.78	1.72	1.85	6.42	6.19	6.66
VIIIa-X	Theropod? n. gen, n.sp.	.267	1.76	1.70	1.88	6.34	6.14	6.76
VIIIa-Y	Theropod? n. gen, n.sp.	.310	1.16	1.08	1.23	4.17	3.89	4.43
VIIIa-Z	Theropod? n. gen, n.sp.	.300	2.07	1.85	2.32	4.44	6.64	8.36
IX-A	Theropod? n. gen, n.sp.	.315	2.09	—	—	7.53	—	—
IX-B	*Irenesauripus mclearni*	.237	1.26	1.19	1.32	4.53	4.29	4.76
IX-C	*Irenesauripus mclearni*	.310	2.19	1.97	2.32	7.90	7.08	8.35
IX-D	*Amblydactylus* sp.	.425	1.44	—	—	5.18	—	—
XII-A	*Amblydactylus* sp.	.640	1.15	.98	1.41	4.14	3.51	5.08
XIII-A	*Amblydactylus* sp.	.355	2.15	—	—	7.73	—	—
XIII-B	*Amblydactylus* sp.	.434	1.46	1.40	1.52	5.26	5.06	5.47
XIV-A	*Amblydactylus* sp.	.594	1.62	1.61	1.64	5.82	5.79	5.91
XIV-B	*Amblydactylus* sp.	.730	1.77	—	—	6.39	—	—
NMC 8548	*Irenesauripus mclearni*	.323	.88	—	—	3.15	—	—
NMC 8550	*Irenesauripus occidentalis*	.464	1.22	1.21	1.24	4.40	4.35	4.45
NMC 8552	*Irenichnites gracilis*	.156	2.47	2.24	2.75	8.90	8.07	9.89
NMC 8556	"*Tetropodosaurus borealis*"	.280	1.11	1.10	1.12	3.98	3.94	4.02
NMC 8558	*Irenichnites gracilis*	.158	1.47	—	—	5.31	—	—
NMC 8561	*Irenesauripus mclearni*	.281	2.06	1.95	2.13	7.40	7.01	7.68
NMC 8562	*Irenesauripus mclearni*	.297	2.21	2.16	2.28	7.96	7.79	8.20
NMC 8563	*Irenesauripus mclearni*	.257	1.82	—	—	6.55	—	—

foot is made up by the "heel" pad. The increased length of the foot by inclusion of the pad is a significant error in the calculation of the speed. For example, the average calculated speed of trackway IIIa-A is 5.85 km/hr for the full length of the footprint. However, if we reduce the length of the track by 15% to compensate for the additional length of the heel pad, then the average speed for the same animal increases to 7.08 km/hr. The average speed for all of the carnivore trackways is 7.56 km/hr, whereas that for the herbivores is 5.18 km/hr. If we add a 20% compensation to the speed of the herbivores in response to the "heel" pad, then the average speed of the herbivores can be raised to about 6.25 km/hr, which is still significantly less than the average speed of the carnivores. Alexander's formula was used by Russell and Béland

(1976) to calculate the speed of an eleven tonne hadrosaur from Colorado at 27 km/hr. This calculated speed has been questioned because a third footprint may exist in series between the tracks that were previously considered to have been consecutive right and left footprints. If this is the case, the hadrosaur would have been moving at only 7 km/hr.

In summary, the footprints of the large herbivorous dinosaurs that are found in Lower Cretaceous strata of the Peace River Canyon may have been left by hadrosaurs. The trackway evidence strongly suggests that these animals were gregarious. They would not have been safe from the attacks of carnivores in the water. The walking speed of the herbivores was calculated and found to be significantly less than the carnivores of that region.

The abbreviations used in this paper are:
NMC National Museum of Canada, Ottawa;
PMA Provincial Museum of Alberta, Edmonton.

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