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Cretaceous terrestrial biotas of East Asia, with special reference to dinosaur-dominated ichnofaunas: towards a synthesis

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Abstract

This paper represents an ''editorial'' introduction to this issue, which is one of two special issues of Cretaceous Research on the geology and paleontology of East Asia. This paper makes special reference to the results of joint Japanese, Chinese, and North American expeditions that investigated more than 70 fossil footprint sites and other fossiliferous localities in China, Japan, Korea, Laos, Mongolia, and Thailand. More than 50 of the track sites are considered Cretaceous in age, though in some cases dating is uncertain. We herein present summaries of selected important sites not previously described in detail based on new maps, tracings, and replicas of representative type specimens and related materials that have been assembled in accessible reference collections. Other sites are described in detail elsewhere in this issue and are placed in broader paleoenvironmental context in conjunction with papers that deal with floras, invertebrate and vertebrate body fossils, paleoecosystem reconstruction, and their stratigraphic, sedimentological, and tectonic settings in the second of the two special issues.

Preliminary syntheses suggest that Cretaceous vertebrate ichnofaunas of East Asia contain various distinctive elements that are neither typical nor common in other regions. These include an abundance and significant diversity of bird tracks, some with web impressions, various small theropod tracks including diminutive examples (*Grallator* and *Minisauripus*) with foot lengths of 2.0–3.0 cm, probable small dromeosaurid tracks (*Velociraptorichnus*), probable coelurosaurid tracks with bilobed heel impressions (*Siampodus*), and various small ornithopod tracks that resemble *Anomoepus*. Giant pterosaur tracks (*Haenamichnus*) are also unique to this area. A review of the ichnotaxonomy generously accepts about eleven valid ichnogenera of dinosaurs, two of pterosaurs, and nine of birds. At least ten other ichnogenera are dubious and among these several have already been rejected.

A preliminary overview of these ichnotaxa in broader context suggests that the dominance of bird and theropod ichnotaxa is a valid reflection of a corresponding dominance of birds and theropod body-fossil taxa. We also note partitioning of ichnofaunas into saurischian-dominated assemblages from low, tropical latitudes and semi-arid, inland basin paleoenvironments, and ornithopod-rich assemblages from higher, more temperate latitudes and humid, coastal paleoenvironments.

Keywords: Cretaceous; East Asia; Paleoenvironmental reconstruction; Dinosaur footprints; Paleoecosystems

1. Introduction

Cretaceous terrestrial biotas in East Asia have recently become world famous, not least because of the discovery of feathered dinosaurs, complete specimens of new birds, mammals and other vertebrate, invertebrate, and plant species from the famous Yixian Formation of northeastern China. However, despite its importance this window into the Lower Cretaceous represents only a relatively small part of the Cretaceous terrestrial biotas of the region, which are widely distributed in space and time. In this paper we focus on the results of several expeditions that attempted a broad survey of biotas with special reference to Cretaceous dinosaur track sites from China, Japan, Korea, Laos, and Thailand. In this and other papers in this special issue, we also discuss the tectonic settings of some of these sites and fossil localities and the potential of selected biotas to provide data for paleoecosystem reconstruction.

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Only a few of the known track sites in East Asia had been described or studied in detail until comparatively recently. For example, there are at least 43 Cretaceous dinosaur egg localities reported from China (Lucas, 2001), but prior to this study only ten Cretaceous track localities had been recorded (Zhen et al., 1989). This number has now more than trebled, just for China and the total is more than 50 for the whole East Asian region (Fig. 1). Historically, another impediment to a broader based knowledge of tracks from East Asia has been the publication of a significant part of the primary literature in obscure outlets and in languages other than English. Even in cases where literature was available in English (e.g., Zhen et al., 1989), much of the documentation was a summary of primary sources, which were often brief, out-of-date, and of questionable value. For these reasons some syntheses have ignored Cretaceous track data altogether (Lucas, 2001).

In recent years, however, particularly in the last decade, there has been a substantial increase in documentation of Mesozoic track sites from China (Matsukawa et al., 1995; Zhen et al., 1995; Lockley and Matsukawa, 1998; Lockley et al., 2002, 2003, 2006a; Li et al., 2005; Zhang et al., 2006), Japan (Matsukawa et al., 1997), Korea (Lim et al., 1989, 1994; Lockley et al., 1994a, 2006b; Lee et al., 2000; Huh et al., 2003, 2006; Kim et al., 2006), Laos (Allain et al., 1997) and Thailand (Buffetaut and Ingavat, 1985; Lockley et al., 2006c). In short, the vertebrate ichnology of East Asia has enjoyed the same renaissance of global interest seen in Asian vertebrate paleontology in general. The result has been a significant increase in the documentation of dinosaur and other vertebrate tracks by international teams of collaborators.

The present volume is the result of just such collaboration between Asian, North American, and European scientists, and this paper, in particular, is a summary of Sino-Japanese-American expeditions to China, Laos, Mongolia, and Thailand in 1999 through 2001. The project, a Grant-in-Aid for University and Society Collaboration, was entitled: *Dinosaur research as a tool for science education, public education and life-long learning, with special reference to East Asia*, and was coordinated by the senior author with funding from The Ministry of Education, Science, Sports and Culture in Japan (Grant number 11791012: see Appendix).

This project had two major aims. The first was the scientific study of dinosaurs and their tracks, their distribution patterns

Fig. 1. Important vertebrate track sites in East Asia referred to in this paper and the two special issues on geology and paleontology of East Asia.

in space and time, and their paleoenvironmental (sedimentological and tectonic) context. Sites were investigated in China, Korea, Japan, Laos, Mongolia, and Thailand, and selected biotas (floras, invertebrate and vertebrate body fossils, and vertebrate trace fossils) and certain sedimentologic and stratigraphic problems were chosen for special attention, as the diversity of titles in this special issue indicates.

The second aim of this project was the conversion of scientific results into educational programs and activities suitable for school educational curricula, teacher training, and lifelong learning. These aims are mentioned only briefly in this special issue and will be published elsewhere.

1.1. Scientific objectives

The first objective, which deals with primary scientific documentation, is the main subject of this special issue. It can be further divided into three components: (1) analysis of East Asian dinosaur track-dominated assemblages and their facies relationships, (2) analysis and reconstruction of Late Jurassic and Cretaceous ecosystems in their temporal (evolutionary) context, and (3) comparison of paleogeographic and tectonic setting of Cretaceous basins of East Asia and North America.

1.1.1. Fossil footprint studies

Our database includes at least 72 vertebrate track sites known from the Mesozoic of China, Korea, Japan, Laos, Mongolia and Thailand (Fig. 1). We were able to visit almost all known sites and their corresponding museum collections, map the tracks, and evaluate the biotas, stratigraphy, and sedimentology with a view to reconstructing paleoenvironments and paleoecosystems to the extent permitted by available data. We stress that in some regions there are multiple sites known from small geographic areas, here treated as single localities, so the number of localities recorded represent minimum estimates (see Lockley et al., 2006b for Korean sites). Moreover, recent finds have added to this number (Li and Zhang, 2005; Li et al., 2005) and we are in collaboration with other ichnologists to help document these.

In the region as a whole, dinosaur track assemblages occur from the Triassic through Cretaceous, though in many areas (central and northern China, Korea, Laos, and Thailand) track assemblages are dominantly if not exclusively Cretaceous in age. In fact we estimate that 54 of the 72 known sites are Cretaceous in age (Matsukawa et al., 2004). As part of this study we made replicas of important specimens from many regions and brought them together into the single largest reference collection of Asian vertebrate tracks, which is shared between the University of Colorado Dinosaur Tracks Museum and the collections from Tokyo Gakugei University Department of Science Education.

In general we found interesting differences in the character of lower and higher latitude assemblages. We also found that while lower Mesozoic (Lower Jurassic) assemblages are similar to those found in North America and Western Europe, and are therefore useful for terrestrial geologic correlation (Lucas, in press), Upper Jurassic through Cretaceous assemblages appear to have unique characteristics, suggesting different evolutionary and/or paleoecological dynamics within in East Asia.

In this paper we briefly introduce a few of the more important Cretaceous track sites from East Asia and their general significance for our understanding of regional vertebrate ichnology. These sites have yielded the tracks of both saurischian and ornithischian dinosaurs, pterosaurs and birds. In the papers that follow we have selected several important sites from China, Korea, and Thailand for special attention. Other more general papers dealing with Chinese and Japanese stratigraphy help place many of the sites in an appropriate chronostratigraphic context.

1.1.2. Paleoecological reconstruction: other biotas and their utility

In addition to track studies, special attention was focused on plant and invertebrate fossils from selected localities. Special studies of the Early Cretaceous terrestrial ecosystem in the fluvio-lacustrine Choyr Basin in Mongolia and the Tetori Basin in Japan were undertaken with the eventual aim of modeling the food web, population structure, and energy flow. Representative results of this work are presented herein (Matsukawa et al., in press).

1.1.3. Tectonic settings

In East Asia, Cretaceous nonmarine back-arc and inner forearc basins provided the stage for dinosaur activities in a continental setting (e.g., Houck and Lockley, 2006). These sedimentary basins, which have a northeast-southwest trend, are distributed across East Asia in several belts from the Asian continent to the Japanese Islands. This asymmetric array may be compared with present settings such as that of the western coast of North America. Climate and biogeographic assemblages of both East Asia and western North America were also affected significantly by oceanic circulation pattern. However, the area of nonmarine basins is extremely different between East Asia and western North America (Haggart et al., in press).

1.2. Educational objectives

With regard to our second objective, public education, we borrowed skeletons from Mongolia (e.g., *Harpymimus*, *Psittacosaurus*) and replicated them for the Nakasato Dinosaur Center, Japan. Also at this well-known site, which is home to Japan's first dinosaur museum, we constructed an interpretive geologic trail along the Mamonozawa valley (in Nakasato village). This trail serves as an educational focal point for local residents including retirees, students, and student teachers, and is in keeping with the project's objectives of integration between university-level science, schools, and society. The results of these educational objectives will be presented elsewhere.

2. Important dinosaur track sites

Although attempts have been made to summarize the dinosaur-dominated vertebrate ichnofaunas known from China (Yang and Yang, 1987; Zhen et al., 1989, 1995), and other parts of east Asia, our understanding is hampered by several problems including uncertainty about the ages of track-bearing units and provincial ichnotaxonomies, which tend to obscure the relationships between Asian tracks and those from other regions. However, progress is being made in the direct dating and biostratigraphic age determination of Cretaceous track sites from China (Chen et al., 2006; Lockley et al., 2006a), Japan (Matsukawa et al., 1997), Korea (Lee et al., 2000; Huh et al., 2003) and Thailand (Racey et al., 1994; Lockley et al., 2006c). Fortunately, the naming of Cretaceous tracks has been somewhat more restrained than the naming of Jurassic tracks, especially in China (Lockley et al., 2003), and for this reason the ichnotaxonomic problems are generally less acute. For example virtually no new or inappropriate "provincial" names have been applied to Cretaceous tracks from Korea, Laos or Thailand.

For the purposes of this paper we deal briefly with only with selected track sites, from each country that are important for historical, ichnotaxonomic and other paleobiological reasons.

2.1. Chinese track sites

Although a paper by the famous authors Teilhard de Chardin and C.C. Young (1929) on the first dinosaur tracks discovered in China, which was later named *Sinoichnites* (Kuhn, 1958) is important historically, the track cannot be located, and the precise origin of the specimen and age of the beds is not well known. As outlined below, the dating of tracks in the Chinese Cretaceous is often difficult owing to the lack of biostratigraphic indicators, especially in red-bed facies. Many localities studied herein, most of which are Early Cretaceous in age, have been in some way associated with the so-called Jehol Biota (see Lucas, 2001, in press, for summary). In the sections that follow we outline some of the more important of the 30 sites reported from the different regions of China (divided clockwise into four main sectors: northeastern, eastern, southern, and north-central).

2.1.1. Northeastern China: Jilin, Liaoning, and Hebei provinces

A track site reported by Yabe et al. (1940) from near the village of Yangshan in Liaoning Province represents the second landmark study in Chinese vertebrate ichnology (site 2, Fig. 1). This track site was reported to have yielded more than 4000 footprints (Lockley and Gillette, 1989; Zhen et al., 1983, 1989). Whether these were ever counted, or merely estimated, is uncertain. However, as part of our study we mapped two main sites associated with the same stratigraphic level and plotted a total of around 1170 tracks on our two maps (Fig. 2).

The tracks in this area were originally thought to be "Cretaceous (?)" by Yabe et al. (1940), but were soon after considered

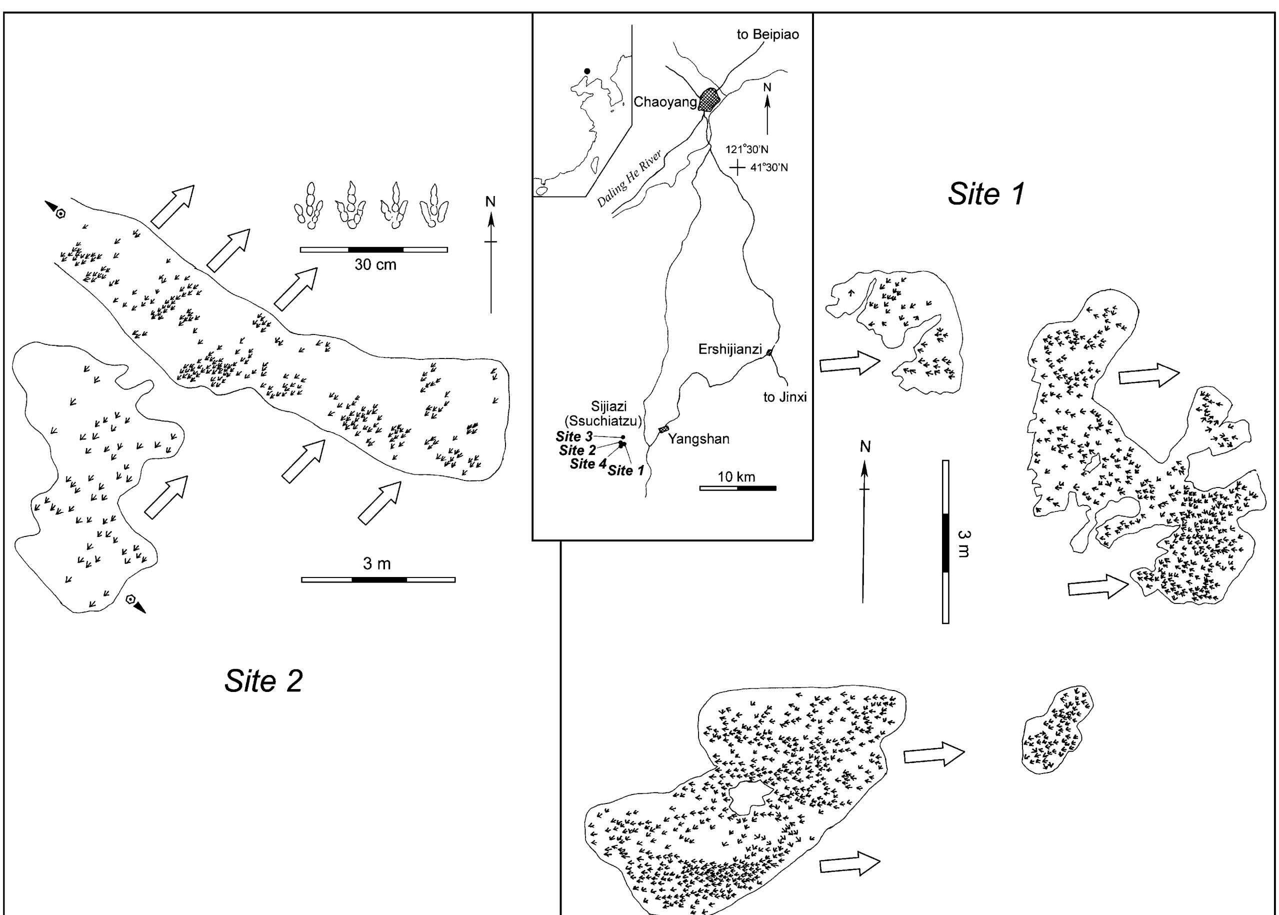

Fig. 2. Tracks from two sites associated with the same surface in the Tuchengzi Formation, Yangshan, Liaoning Province, China. All tracks are provisionally assigned to *Grallator*. Note very high density and preferred orientation. Radiometric dates yielded an age close to the Jurassic-Cretaceous boundary.

"eomesozoic" (Shikama, 1942): i.e., Late Triassic or Early Jurassic. This inference was due to a lack of reliable dating, and their apparent similarity to *Grallator* or *Anchisauripus* from rocks of this age in the Connecticut Valley, as discussed by Yabe et al. (1940), Baird (1957), Young (1960), Haubold (1971) and Zhen et al. (1989). The tracks were therefore referred to as *Grallator s-satori* (Zhen et al., 1989) instead of *Jeholosauripus s-satori* as originally named by Shikama (1942). Careful comparative analysis is needed to establish which ichnogenus is the appropriate label. Clearly the latter label indicated that Shikama (1942) linked these tracks to the Jehol Biota.

Recent studies suggest that the middle and upper part of the track-bearing Tuchengzi Formation, which underlies the famous Yixian Formation in Liaoning province, could be earliest Cretaceous, thus indicating that the original, younger age estimate of Shikama (1942) was perhaps correct. Chen et al. (2006) place the formation in the Upper Jurassic. Radiometric dates suggest that the track-bearing layer, which is in the middle part of the formation, is about 146 million years old (Lockley et al., 2001, 2006a) and thus very close to the Jurassic-Cretaceous boundary. This date is important because the upper part of the formation has also yielded well-preserved shorebird tracks that appear to be among the oldest known from China. (Site 4, Fig. 1; Lockley et al., 2001, 2006a). If they are also inferred to be close to the Jurassic-Cretaceous boundary they would arguably be the oldest shorebird tracks on record.

The morphometrics of the Yangshan tracks have yet to be studied in detail. Likewise other small Tuchengzi Formation sites in the Liaoning, Hebei, and Jilin regions have not yet been described and placed in detailed stratigraphic context. However, if this younger age determination is correct and the ichnotaxonomic assignment of *Grallator* proves robust (rather than the original *Jeholosauripus* label) it suggests that conservative Jurassic elements survived into the later Mesozoic in this area. In this region small theropod and bird tracks seem to be dominant. However, some sites also reveal ornithopod tracks. For example a large exposure along site the railway at Luanping, Hebei Province (You and Azuma, 1995), reveals the first example of trackways of a quadrupedal ornithopod known from China (Fig. 3 herein). Other probable ornithopod and theropod tracks are known from Jilin Province (Matsukawa et al., 1995).

Other interesting track occurrences from the Tuchegzi Formation of Hebei province are those associated with the steps and masonry of the Chengde Summer Palace (Site 6, Fig. 1), where a number of small tridactyl tracks that appear to be of avian origin (Lockley et al., 2006a) have been recovered and traced to the Madigou Quarry from which they were extracted in 1979.

2.1.2. Eastern China: Shandong, Anhui, and Henan provinces

Sites in this region (9, 10, 32-34 and 51 of Fig. 1) have produced only one named footprint: namely the track *Liayangpus liui* (Young, 1960). Most of the sites in this region have produced small theropod and bird tracks whose precise age within Cretaceous successions is uncertain. For example, Young (1960) described *Laiyangpus* as Late Jurassic, but Chen et al. (2006) suggest an Early Cretaceous age. The largest and most spectacular site is found in the Qiyunshan Formation of southern Anhui Province in a thick sequence of otherwise unfossiliferous coarse sandstones and conglomerates (braided river deposits) at a sacred temple locality known as Huansang, Xiahutian, first reported by Yu (1999). As shown in Fig. 4, more than 50 in situ tracks were mapped in the present study, as compared with 35 reported by Yu (1999). These include including several that represent small ornithopods. However, the majority represents theropods.

Recent discoveries in Shandong Province have revealed an abundance of dinosaur and bird tracks, many of which remain

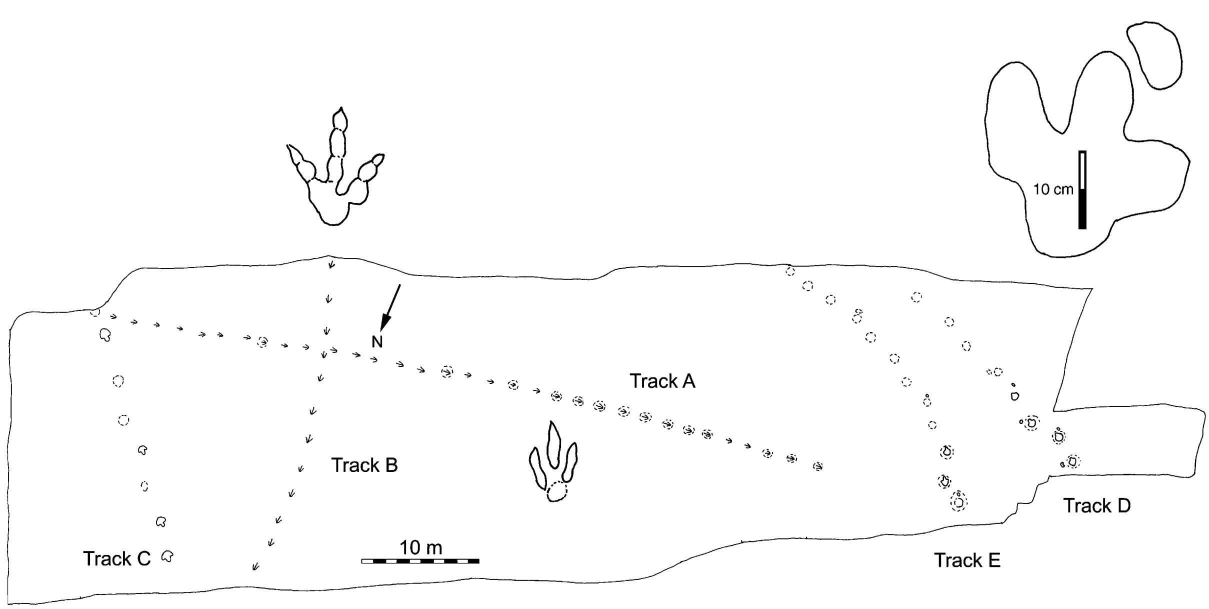

Fig. 3. Map of the Luanping track site, Hebei Province. Top left, showing details of theropod trackway B. Top right, ornithopod manus-pes set from trackway D.

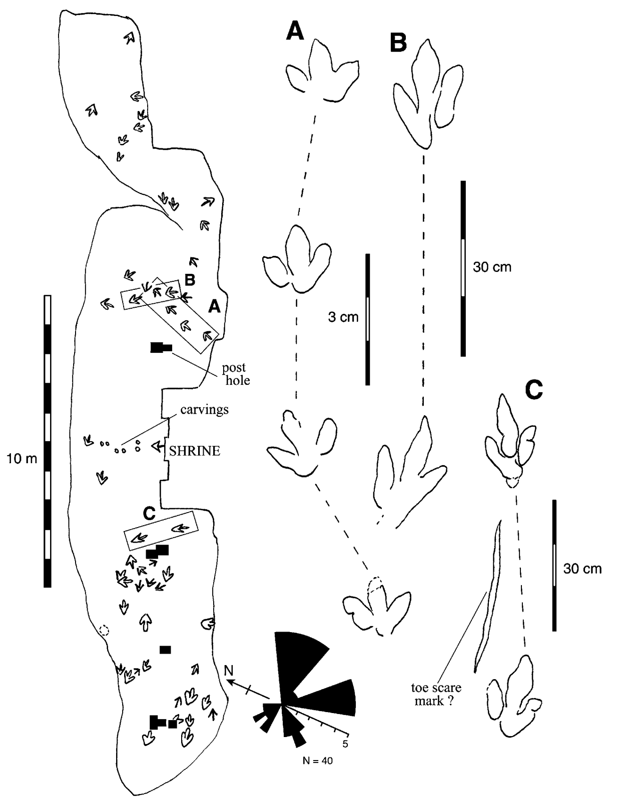

Fig. 4. More than 50 tracks from Huangsang, Xiahutian site, Anhui Province, include segments of trackways attributed to ornithopods (A) and theropods (B and C). Trackway segments A and C correspond to replicas 214.39 and 214.37 in the University Colorado at Denver collections.

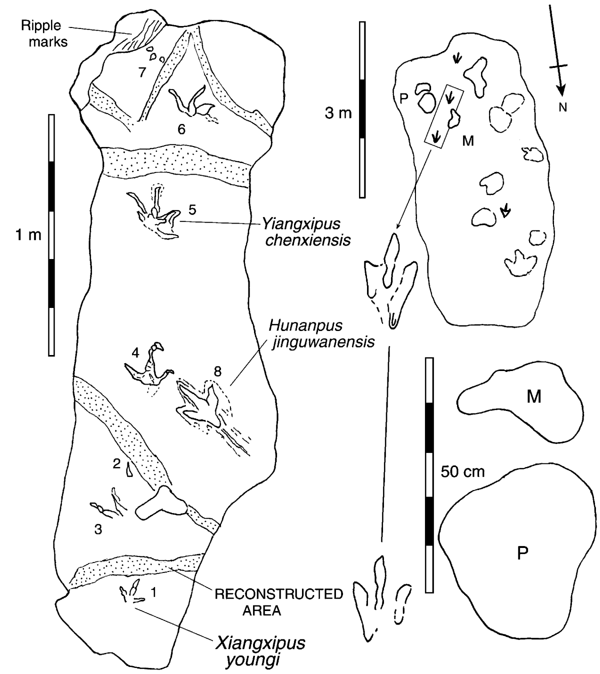

Fig. 5. Left, map of slab with type specimens of *Hunanpus jiuquwanensis*, *Xiangxipus chenxiensis*, and *Xiangxipus youngi* from the Hunan Geological Survey Museum. Compare with Zhen et al. (1989, fig. 19.2G). Tracks 4, 5, and 8 are preserved as University Colorado at Denver replica 214.35, and track 1 is preserved as replica 214.44. Small map (top right) shows remaining in situ outcrop showing theropod tracks and large indentations that resemble poorly-preserved sauropod tracks (M and P represent possible manus and pes tracks).

to be described in detail. However, they include new ichnotaxa of avian and dromeosaurid affinity (Li and Zhang, 2005; Li et al., 2005).

2.1.3. Southern China: Hunan, Yunnan, and Sichuan provinces

Continuing our clockwise tour of China, we find a single small site in Hunan Province that has yielded the type specimens of three ichnospecies: *Hunanpus jiuquwanensis*, *Xiangxipus chenxiensis*, and *Xiangxipus youngi* from the same surface in the Jianjing Formation (Zeng, 1982; Chen et al., 2006). *Hunanpus* is an isolated, typically elongate theropod track that is hard to distinguish from most other theropod tracks. *Xiangxipus*, however, which forms part of a larger, trackway sequence, is distinctive in having very widely splayed toes. It may represent a coelurosaurian dinosaur such as an ornithomimid (Fig. 5).

Most tracks from Yunnan province are Jurassic in age (Zhen et al., 1983). However, Cretaceous tracks include sauropod tracks from the Jiangdihe Formation near Yuanjitun village that have been dated as Turonian (Chen et al., 2006). These sauropod tracks, the first reported from China, were originally described as two ichnospecies of the ichnogenus *Chuxiongpus* (Chen and Huang, 1993), but were later reassigned to a single ichnospecies of *Brontopodus* (Lockley et al., 2002). This area is also the type locality for *Yunnanpus*, which represents the trackway of an undiagnostic biped, probably of theropodan origin. Thus, we consider *Yunnanpus* a nomen dubium.

Probably the most interesting dinosaur track site from the Cretaceous of southern China is that reported from the Emei Mountain region (Zhen et al., 1987, 1995). This site has produced *Aquatilavipes sinensis* (the first bird track reported from China), a diminutive theropod dinosaur track only 2 cm long (*Grallator emeiensis*, Fig. 6), an 11-cm-long didactyl track attributed to a dromeosaurid and named *Velociraptorichnus sichuanensis* (Fig. 6) and an additional 2-cm-long enigmatic tridactyl track *Minisauripus chuanzuensis*, and another much larger tridactyl track labeled *Iguanodon*. We have examined this material and consider that all four ichnotaxa are valid. The latter ichnotaxon (*Minisauripus*) was recently found in South Korea (Lockley et al., 2005). So-called *Iguandon* is an undiagnostic elongate theropod track about 21 cm long, and the ichnogenus name cannot be considered valid (Sarjeant et al., 1998). The tracks occur in the Jinguan Formation, which is placed in the Upper Cretaceous by Chen et al. (2006). Outcrops in this area are very limited owing to dense vegetation. However, it was possible to find a few tracks in situ. A possible sauropod track about 31 cm long, and the 21 cm long theropod track are the largest tracks known from the site. All other tracks appear to represent a diminutive fauna of birds and small theropods. We measured a section at the site that indicates a succession of reddish mudstones alternating with well-sorted sandstone beds, which are in part of aeolian origin.

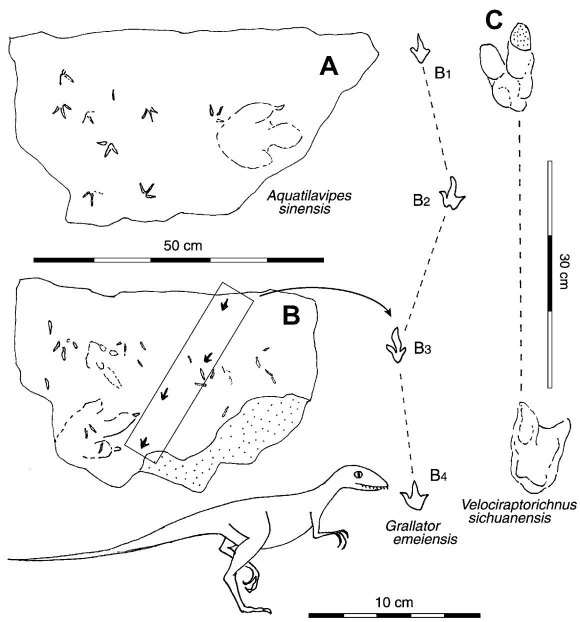

Fig. 6. Track assemblages from the Cretaceous of the Emei Mountain region, Sichuan Province. A, slab with type specimen of *Aquatilavipes sinensis* (University Colorado at Denver replica 214.30). B, slab with type specimen of *Grallator emeiensis* (University Colorado at Denver replica 214.29) with detail of trackway and hypothetical theropod track maker drawn to same scale (B1). C, *Velociraptorichnus sichuanensis*. Note that both slabs reveal poorly preserved large tridactyl (theropod) tracks.

2.1.4. North-central China: Gansu and Nei Mongol provinces

Track sites in north-central China probably have the greatest potential for rapidly increasing our knowledge of Cretaceous ichnofaunas. This region is arid and it has proved easy to find large bedding-plain exposures with diverse vertebrate ichnofaunas. For example, the Gansu track sites described by Li et al. (2002a,b) and Zhang et al. (2006) from the Lower Cretaceous Hekou Formation reveal the tracks of large and small theropods and sauropods, ornithopods, birds, and pterosaurs. The co-occurrence of sauropod and ornithopod tracks is rare at most sites in Asia (see Lim et al., 1994 for notable exceptions).

Track sites in Nei Mongol have also been described recently from the Lower Cretaceous fluvio-lacustrine Jingchaun Formation (Lockley et al., 2002). These reveal ichnofaunas dominated by saurischians (theropods and sauropods) and birds.

2.2. Japan

Sites 64-68 and 70-71 (Fig. 1) represent Cretaceous track sites from the eastern and western sides of Japan. As reviewed by Lockley and Matsukawa (1998) and Matsukawa et al. (2005), the naming and interpretation of Japanese tracks has been somewhat controversial. The first dinosaur tracks reported from Japan (Matsukawa and Obata, 1985) are enigmatic indentations whose origins have not been explained unambiguously (Lockley et al., 1989). Likewise the first dinosaur tracks named from Japan by Azuma and Takeyama (1991) were based on dubious material and so were dismissed as nomina dubia though they probably represent poorly preserved ornithopod and theropod tracks (Matsukawa et al., 1995; Lockley and Matsukawa, 1998). The latter paper also discussed features from the Kitadani dinosaur quarry, which (Azuma, 1995) claims as a diverse assemblage of dinosaur, bird and amphibian traces. The purported dinosaur tracks are probably mere irregularities, possibly trampling, while the purported bird and amphibian tracks were probably made by limulids (Lockley and Matsukawa, 1998). However, bird tracks are known from Japan (Lockley et al., 1992b; Azuma et al., 2002) and have been assigned to the ichnogenus *Aquatilavipes*. Recent reports of ankylosaur tracks (Fujita et al., 2003) are here accepted as valid, although reports of sauropod tracks from the same locality are not convincing.

The largest Cretaceous track site in terms of in situ tracks is the Toyama site (no. 68, Fig. 1), which has yielded the ichnospecies *Toyamisauripus masuiae* from an assemblage of more than 50 tracks (Matsukawa et al., 1997, 2005) and is illustrated herein (Fig. 7). This track type has not been reported elsewhere in Asia. However, a distinctive theropod track, with a rounded heel impression has been named *Asianopodus* (Matsukawa et al., 2005) and is similar to tracks found in Nei Mongol, China and Thailand.

2.3. Korea

South Korea has become well known in recent years for its abundance of well-preserved Cretaceous dinosaur tracks (Lim, 1990; Lim et al., 1989, 1994; Lockley, 1989, 1991, 1994; Lockley and Peterson, 2002; Lockley et al., 1992a, 2005; Lee et al., 2000, 2001; Huh et al., 2003, 2006). They were first reported by Yang (1982) from the Jindong Formation (Gyeongsang Basin) near Samcheonpo, in the central part of the southern coast of the Korean peninsula. These track assemblages subsequently became the focus of attention for a doctoral thesis (Lim, 1990), and it was reported that 516 trackways had been recorded from at least 329 stratigraphic levels in continuously measured sections at Samcheonpo (Lockley et al., 1992b; Lim et al., 1994). Among 388 identified trackways, those of ornithopods (252 = 65%) and sauropods (120 = 31%) predominate, with very few theropods represented (16 = 4%). These totals do not include bird tracks, known from about 30 stratigraphic levels but preserved as individual or overlapping footprints that are not conducive to the counting of individual trackways (Lockley et al., 1992b). These counts also do not include pterosaurs tracks (Kim et al., 2006) or the recently discovered first record of *Minisauripus* outside the type locality at Emei in China (Lockley et al., 2005, 2006b). Similarly they do not include a large amount of new data recorded by S. Y. Yang (pers. comm., 2004) and as yet mostly unpublished (Yang et al., 2003).

Lim et al. (1994) presented size frequency data on 217 ornithopod and 101 sauropod trackways that provided reliable morphometric measurements (after Lockley, 1994; see Lockley et al., 2006b). Lim et al. (1994) also noted that ornithopod and theropod tracks rarely occur together at the same stratigraphic levels. This may indicate some form of ecological exclusion, perhaps caused by seasonal migrations. It was also

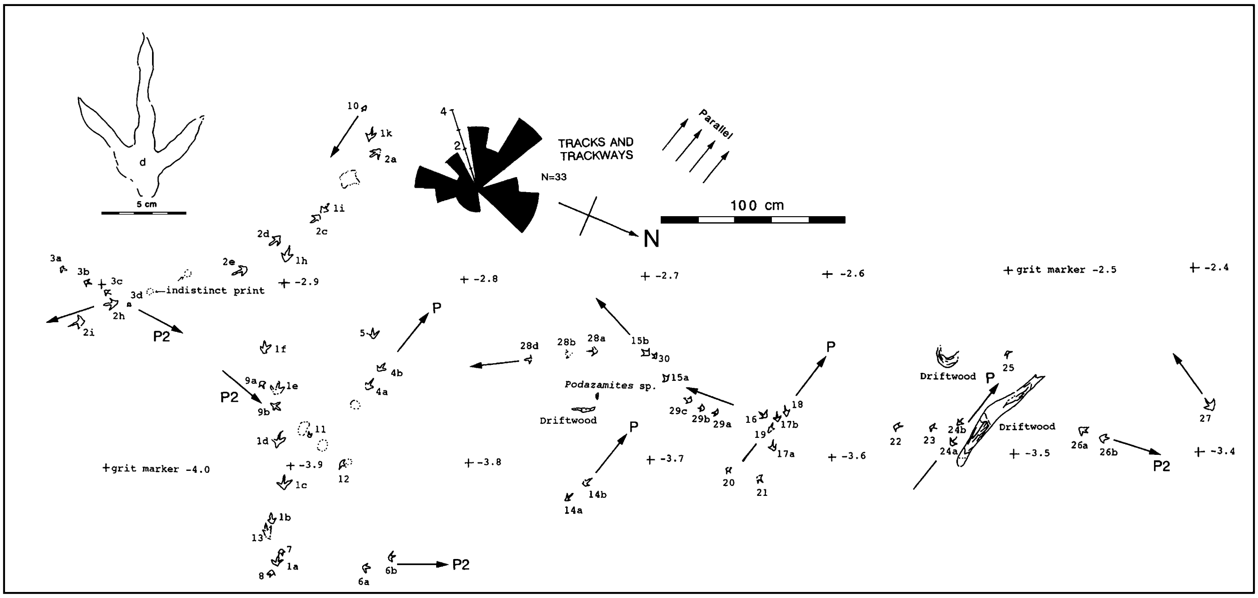

Fig. 7. The Toyama dinosaur track site represents the largest in situ assemblage in Japan that has been studied in detail. After Matsukawa et al. (1997) and Matsukawa et al. (2005).

noted that trackway orientations and population structure also varied considerably between these two groups (see Lockley et al., 2006b). Houck and Lockley (2006) note that many of these substrates represent reworked volcanic ash deposits, which may have contributed to enhanced preservation.

The impressive data available on measurable trackways subsequently generated more statistics, as reviewed by Lockley et al. (2006b). Lee et al. (2000) reported 410 mapped trackways, although maps were not published in that paper (see Lim et al., 1989; Lockley, 1989; Lim, 1990 for selected examples, and Lockley et al., 2006b, for review). This total however, is a composite of 250 trackways counted from the Samcheonpo area in the Hai District, the area described by Lim et al. (1994), and another 160 other trackways from seven other districts in Kosong County, an area of about 30 by 20 (= 600) km^2. It is interesting that the statistics for the whole county, subdivided into 249 ornithopods (61%), 139 sauropods (35%) and 16 theropods (4%), provide figures that are in close agreement with Lim et al. (1994). This may suggest that the proportions of different dinosaur groups remained somewhat constant throughout large areas.

Huh et al. (2003) also presented quantitative summaries of dinosaur tracks from 27 localities in the Gyeongsang Basin, which occupies the southeastern quadrant of the Korean peninsula, and in the Haenam and Neungju Basins, which are located in the southwestern quadrant. Thus, their survey expands from a single coastal section, in a single district (Lim et al., 1994) beyond a county (Lee et al., 2000) to a whole region: i.e., the southern end of the Korean peninsula below latitude 36°N (see Huh et al., 2003, fig. 1). Huh et al. (2003) present a combination of track and trackway data that is difficult to compare directly with the data given by Lim et al. (1994) and Lee et al. (2000). For example they record 252 ornithopod trackways from the Jindong Formation (presumably from all localities), and an additional 315 tracks. Likewise for sauropods, they count 146 trackways and 20 tracks, and for theropods they count 26 trackways. This gives a total of 424 trackways for all Jindong localities known at that time, with ornithopod, sauropod, theropod proportions of about 60, 34 and 6% respectively. Again the proportion seems to remain similar for the district, county, and regional censuses. More details are given by Lockley et al. (2006b).

Bird tracks, named *Koreanornis*, were first reported from the Haman Formation (Kim, 1969), but it was not until the early 1990s that it became known that the overlying Jindong Formation also contained multiple bird track horizons with the small ichnogenus *Koreanornis* and a new larger ichnotaxon: *Jindongornipes* (Lockley et al., 1992b; Baek and Yang, 1997). As noted by Lockley et al. (2006b) there is another ichnospecies of bird track that is intermediate in size (Fig. 8) that has been named *Goseongornipes*. Early studies inferred an Early Cretaceous age for the Jindong Formation, probably Aptian or Albian (Lee et al., 2000), though this age has recently been questioned by Paik et al. (2001) who suggest a late Cretaceous age.

Subsequent studies to the west of the Gyeongsang Basin in the Uhangri Formation, of probable upper Cretaceous age, revealed two more bird track types, *Uhangrichnus* and *Hwangsanipes*, providing evidence of webbed feet (Yang et al., 1995). This same formation yielded the first known pterosaur tracks from Asia (Lockley et al., 1997) later named *Haenamichnus* (Hwang et al., 2002) and a number of *Diplichnites*-like tracks made by large arthropods. More recently other track rich areas have come to light at various island localities in the extreme southwest of the peninsula. Huh et al. (2003, 2006) present data from the Neungju Basin that suggests that more than 4800 tracks have been counted in the Yeosu island district.

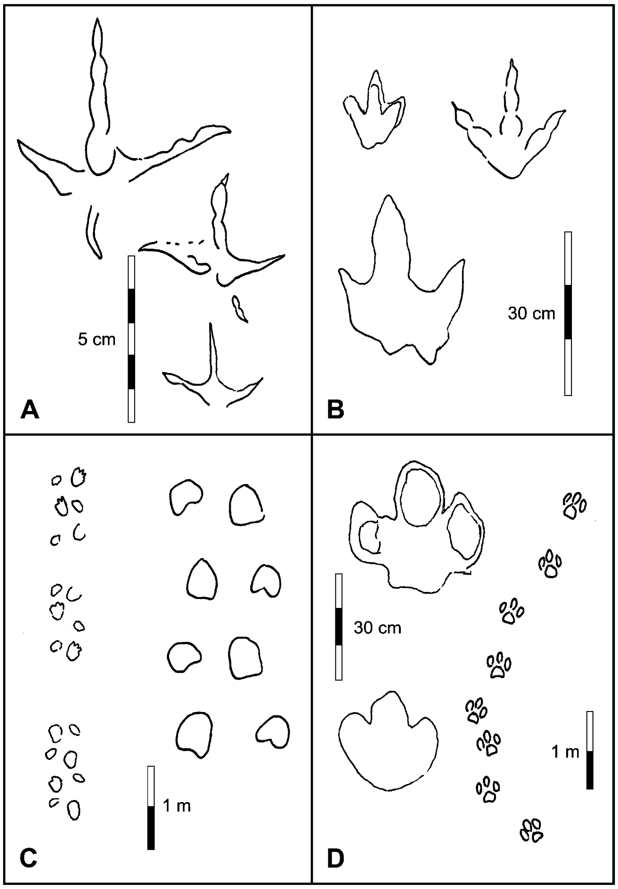

Fig. 8. Tracks from Samcheonpo area, Hai District, Kosong County, Korea. A, small-, intermediate-, and large-sized bird tracks represent *Koreanornis*, *Goseongornipes*, and *Jindongornipes*, respectively. B, theropod tracks. C, small and large sauropod trackways. D, ornithopod trackway and tracks. B-D modified after Lim (1990) and Lockley, Houck et al. (2006b).

The depositional environments of the various Cretaceous track-bearing beds of the Korean peninsula are still under investigation (Houck and Lockley, 2006). Preliminary reports on the Jindong Formation recognized that the sequence is predominantly fine grained, representing a large shallow lake basin with many features (mud cracks and wave ripple marks) indicative of shoreline and emergent conditions. However, Paik et al. (2001) suggested a pedogenic (calcrete) origin for some of the carbonate beds. Chun (1990) and Chun and Chough (1995) interpreted the Uhangri Formation as a facies mosaic from proximal alluvial fan fringe through subaqueous delta to shallow lake. In general the role of volcaniclastic sedimentation has been acknowledged for many of the track-bearing formations, but it has not been adequately investigated (Houck and Lockley, 2006).

2.4. Laos

To date only one dinosaur track site (no. 60, Fig. 1) has been reported from Laos by Allain et al. (1997) who reported theropod, sauropod, and ornithopod tracks, in the outcrops along the Sang Soy river bed at Muong Phalane in Savannakhet Province. We revisited the site and remapped the sauropod trackway exposed in the west bank outcrops (cf. Allain et al., 1997, fig. 1) in sufficient detail to determine that it represents a wide gauge type (Fig. 9A,B). We also mapped and traced theropod tracks exposed in the east bank outcrops (Fig. 9C) as well as replicas in the Savannakhet dinosaur museum. None of the tracks are particularly well preserved, and we were unable to positively identify any ornithopod tracks. Thus, we conclude that the site represents a theropod-sauropod assemblage.

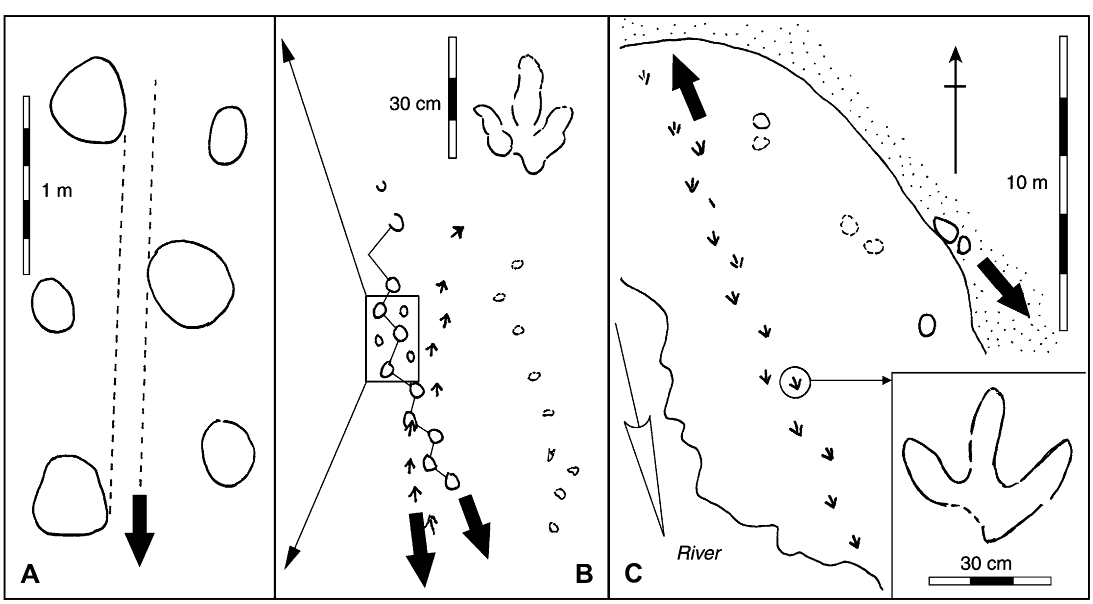

Fig. 9. A, wide-gauge sauropod trackway from Laos. B, map showing context of sauropod trackway, and associated theropod trackway, on the west bank of the Sang Soy River. Detail of theropod track is also shown. C, map of theropod trackway on the east bank of the Sang Soy River, with detail of 5th track in the sequence.

2.5. Thailand

As reviewed by Lockley et al. (2006c) five dinosaur track sites are known from Thailand (nos. 55-59 of Fig. 1). These have been studied in a series of papers by Thai and French researchers (e.g., Buffetaut and Ingavat, 1985; Buffetaut and Suteethorn, 1993, 1998a,b; Buffetaut et al., 1997; Polahan and Daorerk, 1993; LeLoeuff et al., 2002, and references therein). The ages of all the Thai track-bearing formations are somewhat uncertain, but based on published estimates all have been assigned to the Early Cretaceous (LeLoeuff et al., 2002; Lockley et al., 2006c). Until now no tracks have been named. However, we infer that there are at least three different theropod track types present (including *Siamopodus*; Lockley et al., 2006c) as well the trackway of a small quadrupedal ornithischian. The latter trackway originates from the Phra Wihan Formation at the Hin Lat Pra Chad locality (Fig. 10) where a few other enigmatic, possibly non-dinosaurian tracks have been recorded. LeLoeuff et al. (2002) described this trackway type as having a "functionally tridactyl" pes and "apparently tetradactyl manus." However, we infer that the pes is tetradactyl in some cases (based on two trackways; Fig. 10) and that the manus may be pentadactyl. The trackway resembles the Lower Jurassic ichnogenus *Anomoepus* (LeLoeuff et al., 2002). Similar tracks are known from the basal Cretaceous (Berriasian) of Canada (R. McCrea and M. Lockley, unpublished data). LeLoeuff et al. (2002) have suggested that sauropod tracks occur at the Phu Faek locality. Having examined tracks at this site (Lockley et al., 2006c) we see no compelling evidence for this claim.

We also examined theropod tracks from the Khorat Group at a locality near Lao Nat in northeastern Thailand (Fig. 11) that appear to be similar to *Asianopodus* from China and Japan (Lockley et al., 2006c; Matsukawa et al., 2005). As noted by Lockley et al. (2006c) the diversity of theropod tracks in Thailand is high given the small number of sites known.

3. Bird tracks

Two papers in this special issue are devoted almost exclusively to bird tracks from Korea and China, respectively. These are the contributions by Kim et al. (2006) which name a new ichnospecies of *Ignotornis* placed in the ichnofamily Ignotornidae (after amendment), and by Lockley et al. (2006a) which names the new ichnogenus *Pullornipes* (which is placed tentatively in the ichnofamily Koreanornipodidae). Two other

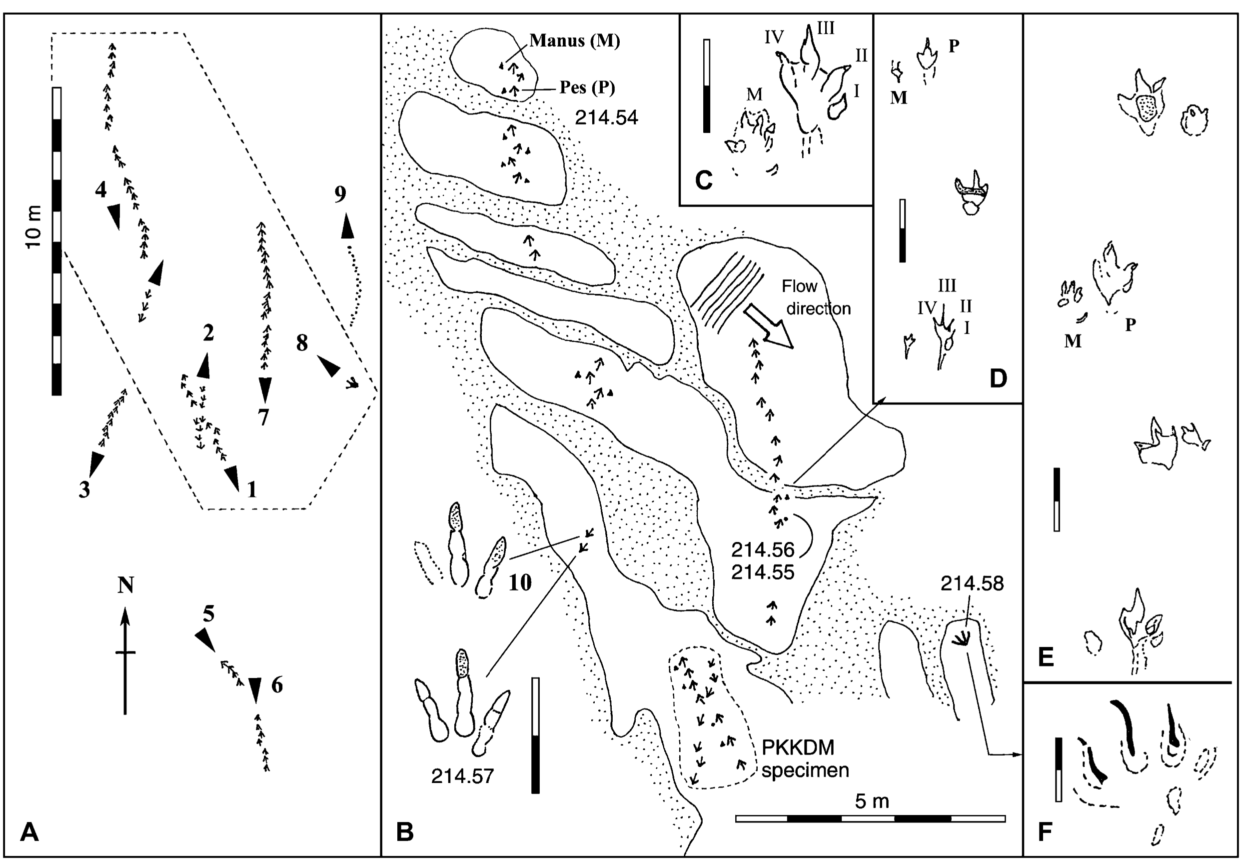

Fig. 10. Tracks from the Hin Lat Pra Chad site in Thailand. A, preliminary map produced in local field guide with numbered trackway segments 1-10. Trackway 4 may be a continuation of 1 and 6 may be a continuation of 7. B, detailed map of northern section showing trackways 1, 2, 4, 7, 8, and 10 (with detail of 10), current ripple vector, and source of track replicas (University Colorado at Denver 214.54-58) and Phu Kum Kao Dinosaur Museum (PKKDM) replica. C, composite of ornithischian manus (m)–pes (p) set from trackway 1, showing 4 pes and 5 manus digit impressions. D, detail of trackway 7 also showing four pes digit impressions. E, detail of trackway 4. F, detail of large track (trackway 8). All track detail scale bars represent 10 cm.

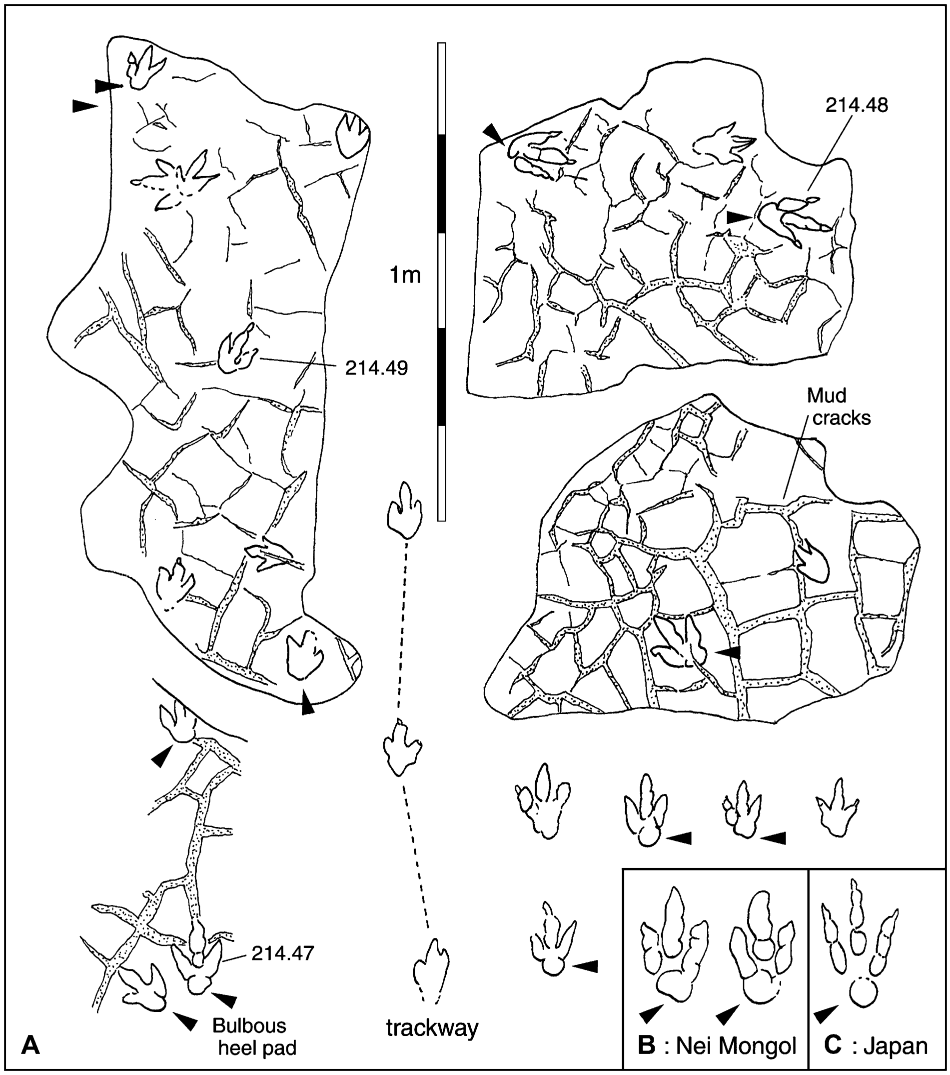

Fig. 11. A, track-bearing slabs from the Khorat Group at a locality near Lao Nat in northeast Thailand show a high density of theropod tracks of the *Asianopodus* type (Matsukawa et al., 2005). Many show the bulbous heel impression typical of this ichnogenus. Compare with B and C from China and Japan, respectively. Numbers (214.47-49) refer to replicas in the University Colorado at Denver collections.

papers name and or describe new discoveries from Korea including *Goseongornipes* (Lockley et al., 2006b) and *Aquatilavipes* from China (Li et al., 2002a,b; Zhang et al., 2006). This latter ichnogenus has also been noted at several sites in Nei Mongol (Lockley et al., 2002) as well as in Sichuan Province (Zhen et al., 1995). In addition we note that *Shandongornipes* was recently described from Shandong Province (Li and Zhang, 2005; Li et al., 2005). These ichnotaxa are in addition to four already named from the Cretaceous of Korea (see Lockley et al., 1992b; Yang et al., 1995; and Kim et al., 2006, for summary).

Despite what may appear like a rapid introduction of many new names, leading to a total of at least nine ichnogenera (Table 1), most of which occur in the Lower Cretaceous, all new ichnotaxa appear to be distinct and readily differentiated on the basis of diagnostic features such as hallux size, rotation and webbing. As noted by Kim et al. (2006) such a significant diversity of bird tracks suggests that East Asia was an important center for avian radiations during the Cretaceous, as has been convincingly shown by the discovery of many important body fossils which point to a fascinating diversity of birds and their relatives the non-avian feathered dinosaurs (Smith et al., 2001; Zhang et al., 2001; Zhou and Zhang, 2001; Zhou, 2004a,b and references therein).

4. Discussion

The summary given here, with details in the accompanying papers of this special issue, indicates that the steady discovery of significant vertebrate track sites in East Asia has established their importance as a major source of information on the distribution and diversity of vertebrates. This applies not just in Korea, where very few body fossils are known, but also in other regions (Japan, China, and Thailand), where the body-fossil record is much better.

Table 1
Distribution of main vertebrate tracks types (ichnogenera) in the Cretaceous of East Asia based on reports from China, Japan, Korea, Laos and Thailand

Track type	China	Japan	Korea	Laos	Thailand
Dinosaur					
Theropoda	*	*	*	*	*
Asianopodus	*	**	–	–	*
Siamopodus	–	–	–	–	**
Toyamasauripus	–	**	–	–	*
Grallator	*	–	–	–	*
Minisauripus	**	–	*	–	–
Velociraptorichnus	**	–	–	–	–
Hunanpus	**	–	–	–	–
Yiangxipus	**	–	–	–	–
Xiangxipus	**	–	–	–	–
Large type	*	–	–	–	*
Other type	–	–	–	–	–
Sauropoda	*	–	*	*	?
Brontopodus	*	–	*	*	–
Ankylosaur	–	*	–	–	–
Ornithopoda	*	*	*	–	*
Caririchnium	*	*	*	–	–
Small type	*	–	?	–	*
Pterosauria	*	–	*	–	–
cf. *Pteraichnus*	*	–	–	–	–
Haenamichnus	–	–	**	–	–
Birds	*	*	*	–	–
Aquatilavipes	*	*	*	–	–
Geongsangornipes	–	–	**	–	–
Hwangsanipes	–	–	**	–	–
Ignotornis	–	–	**	–	–
Koreanornis	–	–	**	–	–
Jindongornipes	–	–	**	–	–
Pullornipes	**	–	–	–	–
Shandongornipes	**	–	–	–	–
Uhangrichnus	–	–	**	–	–
Other	?	?	–	–	?

**, type of named ichnotaxon; *, named ichnotaxon; ?, uncertain occurrence.

Comparing the summary data presented Table 1 with Fig. 1 helps establish a perspective on the geographical distribution of sites and factors that may bias the data set. For example, there is only one site reported from Laos. This reflects the country's small size and difficulty of access. Nevertheless, certain interesting trends appear that we evaluate under the general headings of ichnotaxonomy and paleogeography.

4.1. Ichnotaxonomy

Possibly the most striking feature of the current state of ichnotaxonomy is that there is a relatively large number of names that have been applied to bird and small- to medium-sized theropod tracks (9 and 9 ichnogenera respectively: Table 1). Many of these are endemic to East Asia. By contrast, the valid names applied to large dinosaur tracks are few, generalized and non-endemic (e.g., ichnogenus labels like *Brontopodus* and *Caririchnium*, without ichnospecies names). This pattern is strikingly similar to that reported from the now famous Yixian Formation in China, where, by 2001, the numbers of birds, theropods, and other dinosaurs were reported as 7, 5, and 1, respectively (Smith et al., 2001). These figures are constantly being updated, but the general trend towards more discoveries of birds and small theropods continues (Zhang et al., 2001; Zhou and Zhang, 2001; Zhou, 2004a,b and references therein).

We argue that certain ichnogenus names, i.e., those not used in Table 1, are invalid. For example, the introduction in an abstract of the new names *Hamanisauripus* and *Koreanosauripus* (Kim, 1986) has been rejected on the grounds of multiple ichnotaxonomic errors (Lockley et al., 2006b, and references therein). Likewise the use of the existing name *Hadrosaurichnus* mentioned by Huh et al. (2000) was based on an incorrect understanding by the senior authors of that abstract, of the possible relationship between the hadrosaur affinity of certain tracks and the problematic ichnotaxonomic history of the ichnogenus. Likewise, the introduction by Azuma and Takeyama (1991) of ichnogenus names like *Byakudansauropus*, *Gigantoshiraminesaouropus*, and *Shiraminesaouropus*, some with multiple ichnospecies based on isolated specimens of poorly preserved tracks, has already been criticized (Matsukawa et al., 1995; Lockley and Matsukawa, 1998). We continue to advocate caution in naming tracks, especially when dealing with material that is sparse, poorly-preserved, or inadequately compared with other ichnotaxa. In this regard we have already synonymized *Chuxiongpus* with *Brontopdus* (Lockley et al., 2002) and we regard *Yunnanpus* as the trackway of an undiagnostic biped, probably of theropodan origin. We also consider that the naming of three ichnogenera (Zeng, 1982) from a single slab from Hunan (Fig. 5) is questionable. However, pending further study we have tentatively accepted these three names even if this rather generously enlarges the list. We presently also regard *Laiyangpus* (Young, 1960) as an ichnotaxon of uncertain status.

Each case, like the Hunan example (Fig. 5), must be examined carefully and on its own merits. For example, as noted by Lockley et al. (1994a) and Lockley and Matsukawa (1998), the ichnogenus *Deinonychosaurichnus*, also named in an abstract (Zhen et al., 1987), is invalid as no type material was designated. However, *Velociraptorichnus* (Zhen et al., 1995) was later introduced for *Deinonychosaurichnus* and was based on adequately designated material. Thus, the former name is valid as confirmed by a re-evaluation of the type material by Lockley et al. (2004) and the present authors.

This brief ichnotaxonomic review concludes that there are at least ten invalid or dubious ichnogenus names applied to East Asian dinosaur tracks, as compared with only eleven, considered valid by the present authors (Table 1). This statistic shows how easy it is to inflate diversity estimates as a result of dubious ichnotaxonomic practices. The diversity of most of the archosaur track categories other than theropod (i.e., sauropod, ankylosaur, ornithopod, and pterosaur) is low. This appears to be the typical pattern encountered in most vertebrate ichnofaunas (Lockley, 1997). Thus, it is notable that bird track diversity is high. Although future work will no doubt lead to ichnotaxonomic additions and revisions, we argue that this high diversity is a real reflection of high avian diversity at this time, as the body-fossil record confirms.

4.2. Paleogeography and paleoecology

As noted elsewhere in this special issue (Lockley et al., 2006a,b,c; Zhang et al., 2006), most East Asian track sites are dominated by the tracks of saurischian dinosaurs (theropods and sauropods) and birds. Tracks of ornithischian dinosaurs are rare at most localities, and with the exception of one ankylosaur track site in Japan (Fujita et al., 2003), most other occurrences represent ornithopods. Most ornithopod tracks occur at sites in Korea and Japan and may be locally abundant, but they are also known from Gansu and Hebei provinces in China (Zhang et al., 2006, and Fig. 3). This suggests that it is possible to differentiate a southern and more inland saurischian tracks province associated with red-bed sequences in semi-arid, inland basins, and a more northerly ornithischian province associated with more humid settings along the continental margins (Matsukawa et al., 2005, and Fig. 12 herein).

There are at present no sauropod tracks known from Japan. However, this is the only area where ankylosaur tracks have been reported. It is possible that such differences indicate something of the ecological preferences of these different groups, and it has been noted that sauropods, which show a preference for low latitudes (Lockley et al., 1994a) often do not co-occur with ornithopods (Lockley, 1991; Matsukawa et al., 2005; Lockley et al., 2006b). However, although the association of sauropods with inland semi-arid settings and low latitudes is well established, as is the association of large ornithopod tracks with humid coastal settings (Lockley, 1991; Matsukawa et al., 1995), relatively few ankylosaur track sites have been documented outside North America (McCrea et al., 2001).

The diminutive fauna of bird and small dinosaur tracks from Emei (Sichuan Province) is interesting, and at first site appears to be endemic. However, the discovery of one element (*Minisauripus*) in Korea (Lockley et al., 2005), changes this inference, and suggests that this small track may co-occur with typical ichnofaunas dominated by large tracks. The distribution of bird tracks in East Asia is also somewhat ambiguous. Six of the nine known ichnotaxa appear endemic to the Korean

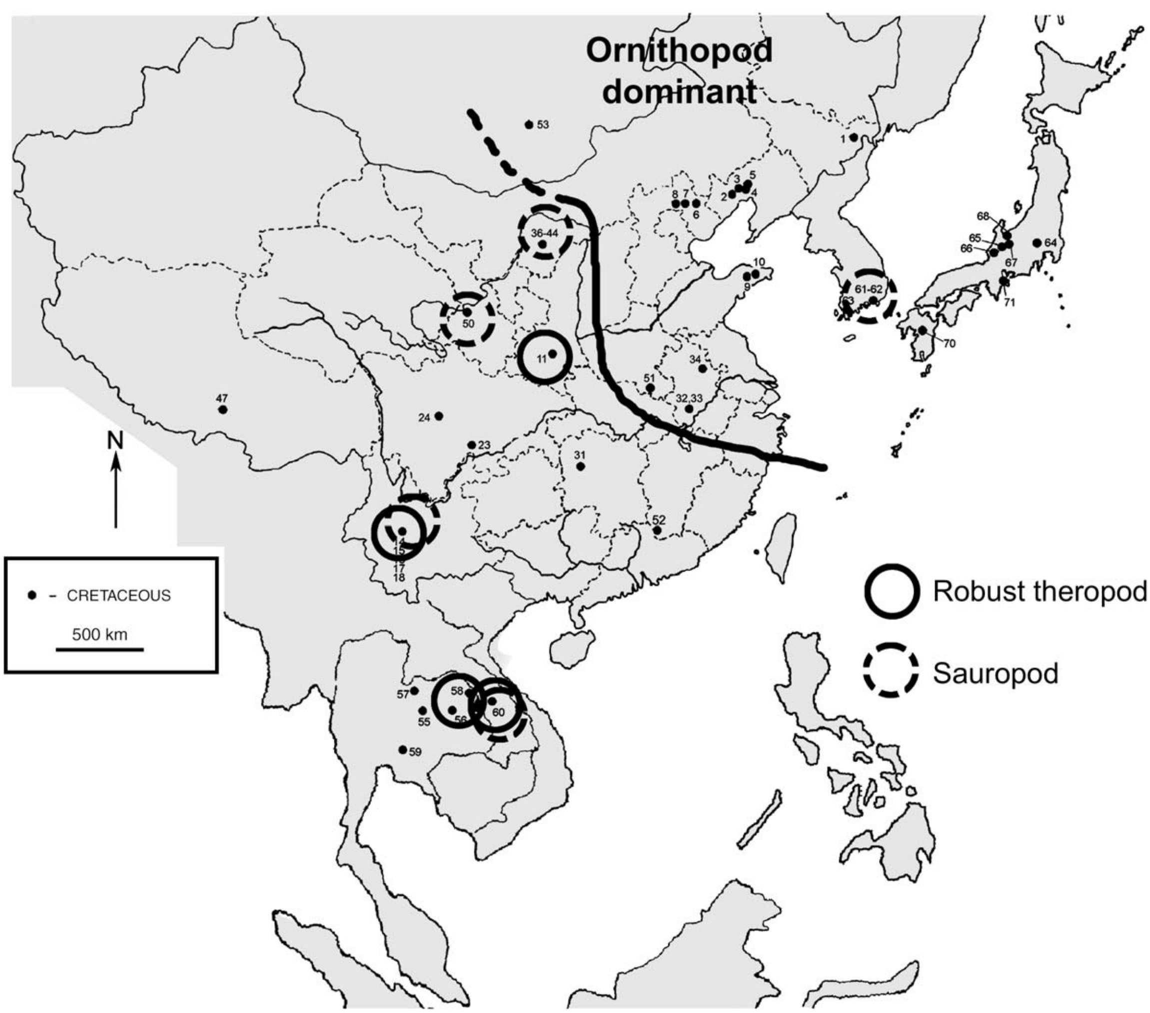

Fig. 12. Distribution of robust saurischian (sauropod and large theropod) and large ornithopod tracks in the Cretaceous of East Asia suggests that the former group is more typical of southern, inland, or continental interior regions and the latter group more typical of northern and coastal or continental margin settings.

peninsula, but this may be in part a reflection of limited search in other areas. The only widely distributed bird track is *Aquatilavipes*, which is reported from several localities in China and in Japan and North America, but not in Korea. *Aquatilavipes* also happens to have the simplest morphology, i.e., it lacks a hallux, and so is sometimes used as a default ichnotaxon label when preservation is poor or the material not studied in detail. Prior to 2005, and the publication of this special issue, *Aquatilavipes* was the only avian ichnogenus known from China. However, *Shandonornipes* (Li and Zhang, 2005; Li et al., 2005) and *Pullornipes* (Lockley et al., 2006a) have recently been added to the Chinese inventory. This somewhat diminishes the apparently anomalously high avian track diversity reported from Korea, which previously appeared to have recorded all but one Asian avian ichnogenus. Nevertheless, as noted by Lockley et al. (1992b) the high abundance and diversity of shorebird-like tracks in East Asia is striking and continues to suggest that this region was a major center for avian radiations in the Cretaceous. This inference is supported by the many finds of avian body fossils, as noted above.

4.3. Future prospects

As indicated in a majority of papers in this special issue, vertebrate tracks are abundant and often well preserved at many sites in the Cretaceous of East Asia. Until recently pterosaur tracks were unknown and the diversity of bird tracks unrecognized. There are still inherently difficult problems associated with the identification and naming of tracks of tridactyl bipeds. However, progress has been made in recognizing and differentiating theropod and ornithopod tracks, not least in cases where the former category (theropods) are didactyl (Zhen et al., 1995; Li and Zhang, 2005; Li et al., 2005) and in the case where the latter category (ornithopods) are quadrupedal (Lockley et al., 2006c). Indeed it is such processes of differentiation that are most useful in advancing ichnotaxonomy.

It is encouraging to find that the general track distribution patterns according to type (e.g., dominance of birds and small theropods) is convergent with evidence from the body-fossil record. Likewise it is also significant that paleogeographic distribution patterns are also consistent with reports from other regions (Lockley, 1991; Lockley et al., 1994b). Such agreement inspires confidence that the data are representative of living communities to some degree. Nevertheless it is not possible to measure this representativeness precisely and, moreover, unless our attribution of known tracks is mistaken, track site data have, as yet, apparently not produced the tracks of certain common dinosaurs such as *Psittacosaurus* (Lucas, 2001, 2006). Thus, new finds and improved correlation between tracks and track makers is still necessary to fill out the track record of East Asia.

The potential for such an improved database will only be adequately realized when track-bearing units are more accurately and reliably dated, as attempted by various traditional correlation methods (Chen et al., 2006; Lucas, in press). This process is always difficult in terrestrial deposits, where marine calibrations cannot easily be applied. Nevertheless, the application of absolute (or numerical) dating has expanded considerably in some areas, not least because of the rush to date the feathered dinosaurs and associated fauna and flora of the Yixian Formation (Smith et al., 2001) and the underlying Tuchengzi Formation (Lockley et al., 2006a). These efforts go hand in hand with interdisciplinary studies that attempt to reconstruct the paleoenvironment and paleoecology. As this special issue shows, vertebrate tracks have figured prominently in East Asian paleontological studies in recent decades, most notably, and inevitably, where body fossils are rare or absent, as in Korea. However, ichnology is inherently a particularly interdisciplinary field and it merits serious attention both in its own right, and as a discipline complementary to others, (regardless of the corresponding body fossil and sedimentary geology record in any given area). This special issue demonstrates the potential of vertebrate ichnology to play an integral role in our understanding of the Cretaceous history of East Asia.

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Appendix

Locality guide and list of dinosaur tracks in East Asia

China

1. Tongfosi town, Yanji city, Jilin Province, 42° 53′ 37.9″ N, 129° 13′ 12.66″ E, three sites; Stratigraphic position: Tongfosi Formation; Geological age: Early Cretaceous or early Late Cretaceous; Tracks: ornithopod and theropod; Collectors: Chen, P.J., Chen, Z.H., Ca, Z.Y., Bolotsky, U.L., Futakami, M., Ito, M., Sakiki, K., Nichols, D.J., Matsukawa, M.
2. Sijiazi (Ssuchiatzu), Yangshan area, Liaoning Province, 41° 11′ 47.52″ N, 120° 18′ 36.36″ E, four sites; Stratigraphic position: Tuchengji Formation; Geological age: Tithonian; Tracks: *Grallator s-satoi*. Yabe et al. (1940) described footprints as new ichnogenus and ichnospecies *Jeholosauripus s-satoi*. However, *Jeholosauripus* was considered a junior synonym of *Grallator* by Zhen et al. (1989); Collectors: White, D., Wright, J., Li, Q.G., Zhang, Y.G., Li, J.J., Lockley, M.G., Matsukawa, M.
3. Nan Pachazu, Beipiao city, Liaoning Province, 41° 40′ 19.5″ N, 120° 42′ 29.22″ E; Stratigraphic position: Tuchengji Formation; Geological age: Tithonian; Tracks: *Grallator s-satoi*; Collectors: White, D., Wright, J., Li, Q.G., Zhang, Y.G., Lockley, M.G., Matsukawa, M.
4. Kan Jia Tun, Beipiao city, Liaoning Province, 41° 44′ 40.92″ N, 120° 56′ 25.74″ E; Stratigraphic position: Tuchengji Formation; Geological age: Tithonian; Tracks: *Pullornipes aureus*, and bird tracks attributed to *Aquatilavipes* or cf. *Aquatilavipes*. Replica of type of *Pullornipes aureus* (CU 214.21 and 214.22); Collectors: White, D., Wright, J., Li, Q.G., Zhang, Y.G., Lockley, M.G., Matsukawa, M.
5. Fuxin open cut coal mine, Haichou, Fuxin city, Liaoning Province, 42° 00′ 5.4″ N, 121° 41′ 33.42″ E; Stratigraphic position: Fuxin Formation; Geological age: Early Cretaceous; Tracks: theropod, ornithopod, and bird. Young (1966) described *Changpeipus carbonicus* as topotype. Replicas of tridactyl tracks (CU Denver replicas 214. 89-93); Collectors: Chen, P.J., Hayashi, K., Okubo, A., Koarai, K., Li, J.J., Zhang H.C., Li, Q.G., Zhang, Y.G., Matsukawa, M.
6. Shibanwo, Majiagou village, Chengde city, Hebei Province, 40° 54′ 58.08″ N, 118° 09′ 51.18″ E; Stratigraphic position: Houcheng Formation; Geological age: Late Jurassic; Tracks: theropod, hypsilophodontids, and bird tracks attributed to *Aquatilavipes*. Young (1966) described footprints as *Jeholosauripus s-satoi*. *Jeholosauripus s-satoi* should be attributed to *Grallator s-satoi*. Replicas of tridactyl ?bird tracks (CU Denver replicas 214.80-82, 85-87 & 94-100); Collectors: Chen, P.J., Hayashi, K., Okubo, A., Koarai, K., Li, J.J., Zhang H.C., Li, Q.G., Zhang, Y.G., Matsukawa, M.
7. Qiaomaigoumen, Luangping County, Hebei Province, 40° 54′ 29.28″ N, 117° 16′ 9.24″ E; Stratigraphic position: Jiufotang Formation; Geological age: Early Cretaceous; Tracks: ornithopod attributed to *Caririchnium*, slender-toed theropod attributed to *Asinodopodus*, large theropod; Collectors: Chen, P.J., Ito, M., Hayashi, K., Okubo, A., Saiki, K., Koarai, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Lockley, M., White, D., Wright, J., Matsukawa, M.
8. Sangyuan, Luangping County, Hebei Province, 40° 53′ 24.78″ N, 117° 07′ 56.22″ E; Stratigraphic position: Jiufotang Formation; Geological age: Early Cretaceous; Tracks: ornithopd, theropod, and bird; Collectors: Chen, P.J., Hayashi, K., Okubo, A., Koarai, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Matsukawa, M.
9. Shuinan village, Laiyang County, Shandong Province, 36° 56′ 15.96″ N, 120° 48′ 41.16″ E; Stratigraphic position: Longwangzhuang Formation, Laiyang Group; Geological age: Early Cretaceous; Tracks: small slender-toed theropod tracks were described *Paragrallator yangi* as new ichnogenus and ichnospecies by Li and Zhang (2000); Collector: Li, R.H.
10. Huangyandi village, Beibozi area, Laiyang County, Shandong Province, 37° 02′ 36.84″ N, 120° 48′ 7.2″ E; Stratigraphic position: Shuinan Formation, Laiyang Group; Geological age: Early Cretaceous; Tracks: theropod (slender toes), birds. *Liayangpus liui*, new ichnospecies, from Lianyang Group was described by Young (1960); Collectors: Chen, P.J., Hayashi, K., Okubo, A., Koarai, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Li, R.H., Matsukawa, M.
11. Shaojian, Shangxian County, Shaanxi Province, 33° 55′ 17.04″ N, 109° 51′ 14.34″ E; Stratigraphic position: Fengjiashan Formation; Geological age: Early Cretaceous; Tracks: gracile-toed and large robust theropods; Collectors: Chen, P.J., Hayashi, K., Okubo, A., Koarai, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Matsukawa, M.
12. Xiiyang, Xiaoheba Village, Jinning County, Yunnan Province, 24° 27′ 49.5″ N, 102° 17′ 45.78″ E; Stratigraphic position: Fengjiahe Formation; Geological age: Early Jurassic; Tracks: theropd. Zhen et al. (1986) described *Grallator limnosus*, *Schizograllator xiaohebaensis*, *Paracoelurosaurichnus monax*, *Eubrontes platypus*, *Youngichnus xiyangensis*, and *Zhengichnus jinningensis*; Collectors: Chen, P.J., Hayashi, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
13. Lufeng Basin, Yunnan Province, 25° 10′ 4.14″ N, 102° 6′ 6″ E; Stratigraphic position: Lower Lufeng Formation; Geological age: Early Jurassic; Tracks: partial theropod track; Collectors: Chen, P.J., Hayashi, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
14. Yuanjitun village near Cangling town, Baomanjie area, Chuxiong County, Yunnan Province, 25° 02′ 28.38″ N, 101° 40′ 31.8″ E; Stratigraphic position: lower part of the Jiangdihe Formation; Geological age: probably Turonian or Turonian-?Coniacian; Tracks: *Brontopdus* (*Chuxliongpus*) *changlingensis*. Replica of type of *Chuxiongpus* (= junior synonym of *Brontopdus*) (CU Denver specimen 214.28).
15. Top of hill, near Fangjiahe, about 1.5 km to the west of Yuanjitun village, Baomanjie area, Chuxiong County, Yunnan Province, 25° 02′ 44.46″ N, 101° 39′ 15.6″ E; Stratigraphic position: lower part of the Jiangdihe Formation; Geological age: probably Turonian or Turonian-?Coniacian; Tracks: theopod. Chen and Huang (1993) described as *Yunnanpus huangcaoensis*.
16. Yuanjitun village near Cangling town, Baomanjie area, Chuxiong County, Yunnan Province, 25° 92′ 23.4″ N, 101° 40′ 13.62″ E; Stratigraphic position: lower part of the Jiangdihe Formation; Geological age: probably Turonian or Turonian-?Coniacian; Tracks: sauropod; Collectors: Chen, P.J., Hayashi, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
17. Yuanjitun village near Cangling town, Baomanjie area, Chuxiong County, Yunnan Province, 25° 02′ 17.58″ N, 101° 40′ 8.58″ E; Stratigraphic position: lower part of the Jiangdihe Formation; Geological age: probably Turonian or Turonian-?Coniacian; Tracks: sauropod and theropod?; Collectors: Chen, P.J., Hayashi, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
18. Yuanjitun village near Cangling town, Baomanjie area, Chuxiong County, Yunnan Province, 25° 02′ 32.4″ N, 101° 39′ 24.12″ E; Stratigraphic position: lower part of the Jiangdihe Formation; Geological age: probably Turonian or Turonian-?Coniacian; Tracks: one large sauropod pes; Collectors: Chen, P.J., Hayashi, K., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
19. Yemaoxi on the south bank of the Yangtze River, Chongqing city, Sichuan Province; Stratigraphic position: Lower Shaximiao Formation; Geological age: Middle Jurassic; Track: *Chongqingpus nananensis*, new ichnospecies, was described by Yang and Yang (1987).
20. Site A (Rice cleaning), Wu Ma Cun village, near Zizhon town, Sichuan Province, 29° 43′ 27.84″ N, 104° 47′ 31.98″ E; Stratigraphic position: Xintiangou Formation; Geological age: Middle Jurassic; Tracks: Yang and Yang (1987) described *Zizhongpus wumanensis*, *Chonglongpus hei*, *Tuojiangpus shuinanensis*, and *Chunannchengpus wuhuangensis* as topotype. Crouching therópd traces was described by Lockley et al. (2003); Collectors: Chen, P.J., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
21. Site B (Large slab), Wu Ma Cun village, near Zizhon town, Sichuan Province, 29° 43′ 19.92″ N, 104° 47′ 35.4″ E; Stratigraphic position: Xintiangou Formation; Geological age: Middle Jurassic; Tracks: Yang and Yang (1987) described *Megaichnites jizhaishiensis* and *Chonglongpus microiscus* as topotype.
22. Dongyuemiao, Gongjing township, Zigong, Sichuan Province, 29° 21′ 20.28″ N, 104° 42′ 32.52″ E; Stratigraphic position: Ziliujing Formation; Geological age: Early Jurassic; Tracks: small grallatorid tracks that exhibited in the Zigong Museum Sichuan.

23. Guanyingchong, Guanying town, Yibien County, Sichuan Province, 29° 06′ 4.5″ N, 104° 23′ 25.32″ E; Stratigraphic position: Jiaguan Formation, Chiating Group; Geological age: Late Cretaceous; Tracks: *Yangtzepus yipingensis* (ornithopod track), new ichnospecies, was described by Young (1960).
24. Xingfu cliff, Chuanzhu village, Emei County, Sichuan Province, 29° 36′ 12.72″ N, 103° 26′ 34.86″ E; Stratigraphic position: Daergun Formation, Chiating Group; Geological age: Late Cretaceous; Tracks: *Velociraptorichnus sichuanensis*, *Grallator emeiensis*, *Minisauripus chuanzhuensis* and *Aquatilavipes sinensis* are described by Zhen et al. (1994) and *Iguanodonopus xingfuensis* is described by Zhen et al. (1996). Theropod. Replica of type of *Grallator emeiensis*, (CU Denver specimen 214.29), Replica of type of *Aquatilavipes sinensis*, (CU Denver specimen 214.30); Collectors: Chen, P.J., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
25. Nianpanshan, Jinlijing township, Zizhong County, Sichuan Province, 29° 47′ 39.12″ N, 104° 38′ 29.28″ E; Stratigraphic position: Xintiangou Formation; Geological age: Middle Jurassic; Tracks: Five trackways consisting of *Eubrontes* and *Anomoepus* type tracks. Yang and Yang (1987) described Eubrontid tracks as *Jinlijingpus nianpanshanensis*; Collectors: Chen, P.J., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
26. Rongseng, Lianjie town, Weiyuan County, Sichuan Province, 29° 45′ 6.96″ N, 104° 34′ 6.78″ E; Stratigraphic position: Zhenzhuchong Formation; Geological age: Early Jurassic; Tracks: Trackway consisting of fix theropod tracks named as *Weiyuanpus zigongensis*. They are housed in the Zigong Museum Sichuan; Collectors: Chen, P.J., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
27. A cliff along side a railway near Changhebian, Youting township, Dazu County, Chongqing city, 29° 27′ 4.08″ N, 105° 47′ 3.9″ E; Stratigraphic position: Zhenzhuchong Formation; Geological age: Early Jurassic; Tracks: the oldest footprints of sauropods in Asia.
28. Panlong Bridge of the Cifeng region, Penxian County, Sichuan Province; Stratigraphic position: Xujiahe Formation; Geological age: Late Triassic; Tracks: Yang and Yang (1987) described footprints as new ichnospecies *Penxianpus cifengensis*. A trackway consisting of two theropod tracks named as *Penxianpus cifengensis* with skin impression. This is the oldest dinosaur skin impression in Asia. Mammal-like tracks.
29. Guangyuan, Sichuan Province; Stratigraphic position. Upper Shaximiao Formation; Geological age: Middle Jurassic; Tracks: Topotype of Kuagyuanpus sichuanensis (renamed Batrachopus sichuanensis).
30. Huanglong, Yuechi County, Chongqing city; Stratigraphic position: Penglaizhen Formation; Geological age: Late Jurassic; Tracks: Zhen et al. (1983) described theropod track with metatarsal impression as *Jialingpus yuechiensis*.
31. Hongwei village near the Jiuquwan copper mine, Chenxi County, western Hunan Province, 27° 55′ 41.28″ N, 110° 04′ 20.28″ E; Stratigraphic position: Xiaodong Formation; Geological age: Late Cretaceous; Tracks: Zeng (1982) described *Xiangxipus chenxiensis*, *X. youngi*, and *Hunanpus jiuquwanensis* as topotype. Replica of types of *Hunanpus jinguwanensis* and *Yiangxipus chenxiensis* (CU Denver specimen 214.35), and *Xiangxipus youngi* (CU Denver specimen 214.44).
32. Xiahutian site, Taoism temples, Qiyunshan, Huanshang city, Anhui Province, 29° 48′ 30.3″ N, 118° 01′ 48.54″ E; Stratigraphic position: Qiuzhuang Formation; Geological age: Late Cretaceous; Tracks: ornithpod and theropod. Theropod track (CU Denver replica 214.37) and Ornithopod track (CU Denver replica 214. 39); Collectors: Chen, P.J., Ito, M., Zhang H.C., Li, Q.G., Zhang, Y.G., Wan Q.F., Li. J.J., Lockley, M.G., Matsukawa, M.
33. Toilet, Shangshangen, Huanshang city, Anhui Province, 29° 47′ 24.36″ N, 118° 01′ 57.78″ E; Stratigraphic position: Qiuzhuang Formation; Geological age: Late Cretaceous; Tracks: theropods and birds. Specimens are housed in the Hefei Geological Museum.
34. Minguan, Gupei basin, Anhui Province, 32° 58′ 38.16″ N, 117° 59′ 49.2″ E; Stratigraphic position: Qiuzhuang Formation; Geological age: Late Cretaceous; Tracks: Jin and Yan (1994) reported bird tracks. The specimens are housed in the Hefei Geological Museum.
35. Haeeshala, Sikeshu coal mine, Wushu County, Xinjiang Uygur Zizhiqu Autonomous Region; Stratigraphic position: Badowan Formation; Geological age: Early Jurassic; Tracks: theropod; Collector: Wang, Q.F.
36. Site 1, Chabu, Otog Qi, Inner Mongolia Autonomous Region, 38° 54′ 37.2″ N, 107° 17′ 43.8″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropods and birds; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
37. Site 2, Chabu, Otog Qi, Inner Mongolia, Autonomous Region, 38° 54′ 30″ N, 107° 16′ 58″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropod and sauropod; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
38. Site 3, Chabu, Otog Qi, Inner Mongolia, Autonomous Region, 38° 54′ 45.8″ N, 107° 17′ 03.1″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropod; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
39. Site 4. Chabu, Otog Qi, Inner Mongolia, Autonomous Region, 38° 41′ 30″ N, 107° 20′ 33″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropod, sauropod and bird-like; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
40. Site 5, Chabu, Otog Qi, Inner Mongolia, Autonomous Region, 38° 54′ 03″ N, 107° 14′ 06″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropod and sauropod; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
41. Site 6, Chabu, Otog Qi, Inner Mongolia, Autonomous Region, 38° 59′ 23″ N, 107° 15′ 57″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: sauropod and theropod attributed to *Asianodopodus*; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
42. Site 7, Chabu, Otog Qi, Inner Mongolia, Autonomous Region, 38° 55′ 49.2″ N, 107° 15′ 36.8″ E; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropod and bird; Collectors: White, D., Wright, J., Lu, F, Li, H., Li, J., Lockley, M.G.
43. Site 8, Chabu, Otog Qi, Inner Mongolia, Autonomous Region; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: sauropod and theropod; Collectors: Hu, B. L., Gao, L.T., Ding, Y., Li, J. J.
44. Site 9, Chabu, Otog Qi, Inner Mongolia, Autonomous Region; Stratigraphic position: Jianchuan Formation; Geological age: Early Cretaceous; Tracks: theropod and bird.
45. Jiaoping coal mine, Tungchuan, Shaanxi Province; Stratigraphic position: Zhiluo Formation; Geological age: Middle Jurassic; Tracks: Young (1966) described new ichnospecies *Shensipus tungchuanensis* as topotype.
46. Shenmu County, Shaanxi Province; Stratigraphic position: Anding Formation; Geological age: Middle Jurassic; Tracks: The first dinosaur track was reported by Teilhard de Chardin and Young (1929). The track was subsequently named as *Sinoichnites youngi* by Kuhn (1958).
47. Rikaze, Xizang Zizhiqu Province (Tibet); Stratigraphic position: Qinwu Formation; Geological age: Late Cretaceous; Tracks: slender-toed theropod.
48. Sungsankang coal mine, Huinan, Jilin Province; Stratigraphic position: Tuntianying Formation; Geological age: Jurassic; Tracks: Young (1960) described *Changpeipus carbonicus* as topotype. The coal mine was closed.
49. Shangba village, Niuchang twon, Zhenfeng County, Guizhou Province; Stratigraphic position: Luolou Formation; Geological age: Early Triassic; Tracks: *Chirotherium*.
50. Laohukou, Yanguoxia town near Lanzhou city, Gansu Province; Stratigraphic position: Yanguoxia Formation, Hekou Group; Geological age: Lower Cretaceous; Tracks: large sauropod, medium and small theropod, ornithopods, pterosaurs and bird. Replicas of pterosaur tracks (CU Denver replicas 214.51-53).
51. Xiaguan basin, Neixiang County, Henan Province; Stratigraphic position: Sangping Formation; Geological age: Early Cretaceous; Tracks: theropod? The dinosaur footprint rests on the dinosaur eggs.
52. Nanxiong, Guandong Province; Stratigraphic position: Nanxiong Formation; Geological age: Cretaceous; Tracks: dinosaurs.

Mongolia

53. Khuren Dukh, Choyr, Mongolia; Stratigraphic position: Khuren Dukh Formation; Geological age: Albian; Tracks: dinosaurs; Collector: Matsukawa, M.

54. Nemegt, Gobi, Mongolia; Stratigraphic position: Nemegt Formation; Geological age: Late Cretaceous; Tracks: hadrosaur, sauropod and theropod; Collectors: Currie, P.J., Badamgarav, D., Koppelhus, E.B.

Thailand

55. Hin Lat Pa Chad, Phu Wing National Park, Thailand, 16° 46′ 13.8″ N, 102° 16′ 34.38″ E; Stratigraphic position: Phra Wihan Formation, Khorat Group; Geological age: Late Jurassic; Tracks: *Anomoepus*?, ornithischian, crocodile.
56. Phu Faek, Changwat, Kalasin, Phu Phan National Park, Thailand, 16° 4′ 26.52″ N, 103° 56′ 12.54″ E; Stratigraphic position: Phra Wihan Formation, Khorat Group; Geological age: Early Cretaceous; Tracks: three trackways consisting of robust theropod. Theropod track (CU Denver replicas 214.54-58).
57. Phu Luang Wildlife S., Phu Luang, Thailand, 17° 18′ 17.7″ N, 101° 31′ 34.2″ E; Stratigraphic position: Phu Puhan Formation, Khorat Group; Geological age: Early Cretaceous; Tracks: robust theropod.
58. Lao Nat, Thaniland, 17° 42′ 27.36″ N, 104° 22′ 55.74″ E; Stratigraphic position: Khorat Group; Geological age: Early Cretaceous; Tracks: slender-toed theropod with skin impression attributed to *Asianodopodus*.
59. Sai Yai River, Thailand; Stratigraphic position: Sao Khua or Phu Phan formations; Geological age: Early Cretaceous; Tracks: *Siamopodus khaoyaiensis* (Lockley et al.). *Siamopodus khaoyaiensis* – original in field – (CU Denver specimen 214.46).

Laos

60. Muong Phalane, Savannakhet Province, 16° 39′ 39.24″ N, 105° 33′ 43.92″ E; Stratigraphic position: "Gres superiors" formation; Geological age: Early Cretaceous; Tracks: sauropod and theropod.

Korea

61. Dukmeyeong-ri, Samcheonpo area and its vicinity, Hai-myeon, Goseong County, Gyeongsangnam-do Province, and Gohyn-ri, Jindong-myeon, Masan city; Stratigraphic position: Jindong Formation; Geological age: Early Cretaceous; Tracks: theropod, ornthopod, sauropod and bird. The first dinosaur tracks in Korea are reported from Dukmeyeong-ri. *Jindongornipes kimi* and *Koreanaornis hamanensis* (bird tracks) were described by Lockley et al. (1992a,b). Replicas of bird tracks from the Jindong Formation Korea (CU Denver replicas 214.59-79). Includes replicas of types of *Jindongornipes* and *Goseongornipes* (originals in Kyungpook National University collections, Taegu, Korea). Ornithopod trackway (CU Denver replica 212. 26) from Haman Formation.
62. Namhae, Gyeongsangnam-do Province; Stratigraphic position: Hasandong and Haman Formation; Geological age: Early Cretaceous; Tracks: ornithopod, tiny track attributed to *Minisauripus*. *Minsauripus* track (CU Denver replica 214.101).
63. Uhangri, Haenam County, Chullanam-do Province; Stratigraphic position: Uhangri Formation; Geological age: Late Cretaceous; Tracks: ornithopod (cf. *Caririchnium*), pterosaur and bird. *Haenamichnus uhangriensis* and *H*. sp. (pterosaur tracks) were described by Hwang et al. (2002), and *Uhangrichnus chuni* and *Hwangsanipes choughi* (web-footed bird tracks) were described by Yang et al. (1995).

Japan

64. Nakasato, Gunma Prefecture; Stratigraphic position: Sebayashi Formation; Geological age: Albian; Tracks: possible dinosaur trackways. This is the first dinosaur tracks in Japan; Collectors: Obata, I., Matsukawa, M.
65. Mekkodani and Byakodan Hakusan city, Ishikawa Prefecture; Stratigraphic position: Kuwajima and Amagodani formations; Geological age: Valaginian to Barremian; Tracks: theropod, *Caririchnium* (from Amagodani Formation). Matsukawa et al. (2005) described *Asianopodus pulvinicalx* as topotype; Collectors: Matsuoka, H., Isaji, K., Hasegawa, Y., Yamaguchi, I., Takada, T., Shirai. A., Koarai, K., Matsukawa, M.
66. Chinaboradani and Izuki , Izumi village, Fukui Prefecture; Stratigraphic position: Izuki Formation; Geological age: Valaginian to Barremian; Tracks: theropod, ornithopod, bird. *Aquitilavipes izumiensis* was described by Azuma et al. (2002); Collectors: Koarai, K., Kukihara, R., Matsukawa, M.
67. Lake Hakusui, Oshirakawa, Shirakawa village, Gif Prefecture; Stratigraphic position: Kuwajima and Amagodani formations; Geological age: Valaginian to Barremian; Tracks: theropod, Trackways suggest herd; Collectors: Shikano, K., Kunimitsu, M., Sugiyama, M.
68. Oyama, Toyama Prefecture; Stratigraphic position: Inotani Formation; Geological age: Early Cretaceous; Tracks: Matsukawa et al. (1997) described *Toyamasauripus masuiae* as topotype. Trackways suggest social behavior. Theropod, ornithopod, ankylosaurid; Collectors: Hamuro, T., Toyama Dinosaur Research Group.
69. Kuruma, Otari village, Nagano Prefecture; Stratigraphic position: Kitamatadani Formation, Kuruma Group; Geological age: Pliensbachian; Tracks: Matsukawa et al. (2005) described *Schizograllator otariensis* as topotype. This is the oldest track site in Japan; Collectors: Hatakeyama, K., Yoshida, Y.
70. Mifune town, Kumamoto Prefecture; Stratigraphic position: Upper Formation, Kuruma Group; Geological age: late Cenomanian; Tracks: theropod.
71. Ise city, Mie Prefecture; Stratigraphic position: Matsuo Group; Geological age: Early Cretaceous; Tracks: ornithopod; Collectors: Tanimoto, M., Takada, M., Kaede, T.
72. Koyamada, Kashima town, Fukushima Prefecture; Stratigraphic position: Tochikubo Formation, Somanakamura Group; Geological age: Oxfordian; Track: theropod; Collectors: Taira, M., Takahashi, T.

Participants

The following persons (with affiliations and discipline specializations in parentheses) participated in the expeditions, research, and authorship or coauthorship of papers in the two special issues on geology and paleontology of East Asia.

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