THE *ICHNOS* PROJECT: A RE-EVALUATION OF THE HOMINID TRACK RECORD

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Abstract—More than 63 documented fossil and subfossil hominid footprint sites range in age from the most famous and oldest (Late Pliocene, ca. 3.7 Ma) Laetoli site in east Africa, to sites that are only a few hundred years old. With the exception of the Laetoli site, another Early Pleistocene (~1.5 Ma) site from Africa, and two 300,000-400,000 year old Middle Pleistocene sites from Europe, all other sites are young enough (< ~125,000 years) to represent our own species *H. sapiens sapiens*, or possibly Neanderthals (*H. sapiens neanderthalensis*). This means that the pre-sapiens track record makes up less than 7% of known sites while representing more than 96% of the duration of the known hominid track-making interval. The worldwide distribution of hominid tracksites is also geographically uneven, with the majority of sites being found from the Upper Pleistocene and Holocene of the New World (29) and Europe (21). This leaves only seven sites known from Africa, and three each from Asia and Australasia.

Hominid tracksites are readily divided into two groups: subterranean and open air. Cave sites reveal footprint evidence of hominids and associated Carnivora (e.g., bear, hyena, canid) whereas open air sites commonly reveal associated ungulate, avian and carnivore footprints. Dating of many tracksites is problematic, except in a few cases where suitable volcanic ash or carbonaceous substrates occur. Many sites also reveal only a few poorly-documented tracks, However at some sites, like Acahualinca, Nicaragua and Hawaii Volcanoes National Park, tracks are abundant, providing considerable potential for future study.

INTRODUCTION

This paper is an abbreviated version of a review paper (Lockley et al., in press) currently in press with the journal *Ichnos*. Also accompanying this in press, review paper are 20 other articles dealing with ancient (fossil and subfossil) hominid footprints from all continents except Antarctica (see Appendix). Given the theme of the present volume – **Cenozoic Vertebrate Tracks and Traces** - we consider that failure to refer to these forthcoming special issues of *Ichnos* would be a significant omission. However, in an attempt to avoid unnecessary duplication of an article already written, reviewed and revised, we have selected only the most salient points for discussion herein.

Recent efforts to review the hominid track record reveal that at least 63 sites are documented (Lockley et al., in press; Table 1). However, few of these are documented in much detail or in the mainstream literature. Moreover, the age of many sites is uncertain, and in the case of underground (cave) sites access may be difficult, and the study of related cultural evidence such as artifacts and cave art may take precedence over the study of purely physical evidence such as tracks.

All paleontologists are familiar with the analogy drawn between the 3.5 billion year history of life on earth and the 24 hour clock. On this latter time scale the famous Laeotoli tracks would have been made about 1.5 minutes before midnight and the first *Homo sapiens* tracks would have registered a mere three seconds before the midnight hour. This helps explain from a purely chronological perspective why the hominid track record is so sparse. Thus, in terms of the ichnological register, the track record of vertebrates such as dinosaurs (Gillette and Lockley, 1989; Thulborn, 1990; Lockley, 1991), represents hundreds of millions of years of pre-Cenozoic strata. Likewise, Cenozoic tracks from the Age of Mammals represent only 65 Ma, a duration comprising only 20% of the tetrapod-track bearing record (Leonardi, 1994; Lockley and Hunt, 1995; Lockley and Meyer, 2000). By comparison the hominid track record (dating from about 3.7 Ma to the present) represents a mere 5% of the most recent part of the Age of Mammals, and the record of our own species (*H. sapiens*) represents only the last 100,000 yr) of this short interval.

The impetus for the *Ichnos* volume, and this paper, came from the discovery of the first hominid tracksite in East Asia (Kim, 2004; Kim and Kim, 2004a; Kim et al., 2004, in press) which in turn led to the first mini symposium on this topic “Quaternary Footprints of Hominids and other Vertebrates” held in South Korea in 2004 (Kim and Kim, 2004b) and the subsequent development of the symposium proceedings into two special issues of *Ichnos.* The genesis of this paper can therefore be traced to the original review paper presented in the Korean volume (Lockley and Roberts, 2004). However, we refer the reader to the forthcoming *Ichnos* volume (Lockley et al., in press) for a fuller account.

In this brief review we follow the format of Table 1 and note the main tracksite occurrences in chronological order. To the best of our knowledge this is the first synthesis that provides a reasonably complete list of hominid tracksites for which documentation exists.

As noted by Lockley et al. (in press) we used somewhat arbitrary criteria in deciding which comparatively recent track sites to include, but in almost all cases we selected sites for which some written documentation exists. Thus, reference to sites inevitably depends on the availability of accessible documentation. Likewise, in a review, we rely on the primary literature to provide dates that help construct the chronological framework (Table 1). However, many dates are unreliable, or potentially unreliable for various reasons, and the reader is advised to consult original sources to assess the validity of dating methodology.

THE PRE-*SAPIENS* TRACK RECORD

Four of the six oldest-known hominid tracksites are reported from Africa. The two oldest (from Laetoli and Koobi Fora) clearly represent the footprints of extinct species. These interpretations are non-controversial, given the conventional wisdom regarding the origin of *Homo sapiens* at a much later date.

Pliocene Footprints from Laetoli, Tanzania

The Laetoli tracks have been dated at about 3.7 Ma, and were discovered in 1976 by the Mary Leakey team (Leakey and Hay, 1979; Hay and Leakey, 1982; Leakey and Harris, 1987). The trackmakers’ gait

TABLE 1. List of 63 hominid footprint sites in approximate order of increasing geological age (with numerical dates, where reported). Note 11 sites associated with volcaniclastic substrates (Houck et al. in press) and note distinction between cave and open air sites.

Site Name	age	date in years B. P.	substrate	cave / open air
Laeotoli, Tanzania	Pliocene	~ 3,700,000	volcanic	open air
Koobi Fora, Kenya	Lower Pleistocene	~1.500,000		open air
Roccamonfina, Italy	Mid Pleistocene	~325,000 - 385,000-	volcanic	open air
Terra Amata, France	Mid Pleistocene	~300,000-400,000		open air
Nahoon, South Africa	Late Pleistocene	~ 127,000		open air
Lagebaan, South Africa	Late Pleistocene	~ 117,000		open air
Vartop Cave, Romania	Late Pleistocene	~62,000		cave
Theopetra Cave, Greece	Late Pleistocene	~48,000		cave
Valsequillo, Mexico	Late Pleistocene	~40,000 ?	volcanic	open air
Lascaux, France	Late Pleistocene			cave
Niaux, France	Late Pleistocene			cave
Grotte Aldène, France	Late Pleistocene	~8,000-15,000		cave
Peche Merle, France	Late Pleistocene			cave
Fontanot, France	Late Pleistocene			cave
Ariege, France	Late Pleistocene			cave
Chauvet Cave, France	Late Pleistocene	20,000-30,000		cave
Tana della Basura, Italy	Late Pleistocene			cave
Willandra, Australia	Late Pleistocene	19,000-23,000		open air
Lhasa region, Tibet	Late Pleistocene	~20,000		open air
Ojo Guarena, Spain	Late Pleistocene	~15,600		cave
Jeju Island, Korea	Late Pleistocene	~15,000		open air
Monte Verde, Chile	Late Pleistocene	~12,500		open air
Buenos Aires, Argentina	Late Pleistocene	~11,500		open air
Laguna La Maria	Holocene	~8,000		open air
La Olla, Argentina	Holocene	~7,000		open air
Monte Hermoso	Holocene	~7,000		open air
Demirkopru, Turkey	Holocene	~9,000	volcanic	open air
Kenfig, Wales	Holocene	~8,000 ?		open air
Uskmouth, Wales	Holocene	~ 5,700-6,200		open air
Formby, England	Holocene	~5,500		open air
Acahualinca El Cauce	Holocene	~6,000	volcanic	open air
Acahualinca El Recreo	Holocene	~6,000	volcanic	open air
Rincon de Guadalupe, Mexico	Holocene		volcanic	open air
Cuatro Cienegas, Mexico	Holocene	~10,000		open air
Jalisco 1, Mexico	Holocene			open air
Jalisco 2, Mexico	Holocene			open air
Jalisco 3, Mexico	Holocene			open air
Guerrero, Mexico	Holocene			open air
Chihuahua, Mexico	Holocene			open air
Sonora, Mexico	Holocene			open air
Yucatan, Mexico	Holocene			open air
El Azrag, Mauritania	Holocene	~9000		open air
Oro Grande, California	Holocene	~5,000		open air
Clare Bay, South Australia	Holocene	~5,000		open air
Jaguar Cave, Tennesee	Holocene	~4,600		cave
Unknown cave, Kentucky	Holocene	~3,600		cave
3rd Unnamed,Tennesee	Holocene	~2,000-4300		cave
Mud Glyph, Tennesee	Holocene	<1500		cave
Fisher Ridge Cave, Kentucky	Holocene	~2,700-3,200		cave
Sequoyah Caverns, Alabama	Holocene	~500		cave
Footprint Cave, Virginia	Holocene	~400		cave
Lon Odell Cave, Missouri	Holocene			cave
Pocket Cave, Arizona	Holocene	~1,500		pit house
El Salvador	Holocene	~1,200-1,800		open air
Guaimaca, Honduras	Holocene		volcanic	open air
Naj Tunica, Guatemala	Holocene	~1,500-2,000		cave
Nola, Italy	Holocene	~3,780	volcanic	open air
Chester, England	Holocene	~2,000-3,000		open air
Mauritania	Holocene			open air
Llanes, Spain	Holocene			cave
Gunma, Japan	Holocene	~800-1,600	volcanic	open air
New Zealand	Holocene		volcanic	open air
Greece 2	Holocene			open air

and affinity have been extensively studied (Charteris et al., 1981; Tuttle, 1990; Tuttle et al., 1990; White and Suwa, 1987). Some authors infer that the trackmakers were gracile australopithecines, i.e., *Australopithecus afarensis* (Suwa, 1984; see Lockley, 1999 for summary), whereas others (Tuttle, 1990; Tuttle, et al., 1990) suggest a species more like modern *Homo sapiens*. Three trackways (G-1, G-2 and G-3), of which the latter two are overlapping suggest individuals between 1.32 to 1.52 m in height (White and Suwa, 1987).

There are many other tracksites at Laeotoli that collectively indicated the presence of many mammals and birds indistinguishable from modern species The only exception appears to be the footprints of extinct chalicotheres. The census indicates that, numerically, rabbits (or other lagomorphs) constitute almost 89% of the non- hominid vertebrate tracks. This census is based on counts of individual prints- not trackways and no adjustment is made for biomass (1 elephant has the biomass of ~8000 rabbits). Renders (1984) study of the trackways of the horse *Hipparion* is one of the few to focus on a specific non-hominid group.

Due to their importance the Laetoli hominid tracks are no longer visible. Following their initial study, they were buried in order to protect them. However, this did not adequately protect them from the invasion of plant roots and they were subsequently exhumed by a Getty Conservation Institute funded project that surgically removed the plant roots and then reburied the site with multi-layered protective blankets containing various physical and chemical barriers to further destructive plant growth (Demas and Agnew, 1995; see Lockley, 1999 for summary). Replicas of representative tracks are available from the National Museum of Kenya (Fig. 1).

Early Pleistocene of Lake Turkana

Between Pliocene Laetoli and the 1.5-1.6 million year old Koobi Fora hominid tracksite on the shores of Lake Turkana (dated as Early Pleistocene, sensu Gibbard, 2003) there is a temporal gap of about 2 million years. The site reveals a single trackway inferred to have been made by *Homo erectus* (Behrensmeyer and Laporte, 1981). The tracks are not well preserved but have a mean foot length and width of 26 and 10 cm respectively, suggesting an individual 1.6 to 1.8 m in height.

Another Possible Early Pleistocene Site

Recently reports emerged of a new discovery of purported 1 million-year-old hominid footprints in the Margalla Hills of Pakistan. Based on the scant evidence presently available, we are reluctant to consider this a verified hominid tracksite. Indeed the photographs made available online (e.g., http://www.dawn.com/2007/07/28/nat3.htm) are unconvincing, both in terms of purported track morphology and the apparent preservational and sedimentological context. For these reasons we suspend judgment on this new find until a full scientific report is published. Consequently the material is not included in our summary (Table 1).

Mid Pleistocene of Europe and the Middle East

The Pleistocene Series is divided into Lower, Middle and Upper subseries (Gibbard, 2003), with the Lower Pleistocene dated between about 1.8 Ma and 0.8 Ma B.P., the Middle Pleistocene between about 800 and 130 Ka B.P., and the Late Pleistocene between about 130,000 - 12,000 B.P. It is possible that the appearance of *Homo sapiens sapiens* coincided with the Middle-Late Pleistocene transition. Thus, by definition, pre-Late Pleistocene hominid footprints are unlikely to be those of *H. sapiens sapiens*.

Only two hominid tracksites outside Africa are inferred to represent a non-*sapiens* species. The first site, reported in 1966, yields a single hominid footprint from the Terra Amata site, near Nice in southern France, has been tentatively dated at about 300,000-400,000 years B.P. (de Lumley, 1966, 1967; Miskovski, 1967; Meldrum, 2006, p. 246). The second site, at Mount Roccamonfina in Italy (Mietto et al., 2003; Avanzini et al., 2004, in press), is dated between 385,000 to 325,000 years B.P. The trackways are unusual because the three segments reveal individuals descending steep slopes occasionally slipping and leaving hand prints in the volcanic ash substrate. Unfortunately, details of foot morphology are not preserved, Nevertheless, based on the dating of these tracks, they were probably made by a pre-*sapiens* or pre-*neanderthalensis*. So, the ages of both the French and Italian sites are consistent with the timing of hominid colonization of Europe (Palombo and Mussi, 2006).

Reports of 250,000 year old, Middle Pleistocene, hominid tracks from a site near Demirköprü Dam in Turkey include specimens collected for the Museum of Natural History in Stockholm now in Turkey (Ozansoy, 1969; Barnaby, 1975). However, recent studies suggest these dates are incorrect. One study, using thermo luminescence (TL) revised the dates to give "ages of 65 + 7 Ka for tuff below a footprint and 49 + 9 ka for crystals of orthoclase and hornblende scraped from the footprint

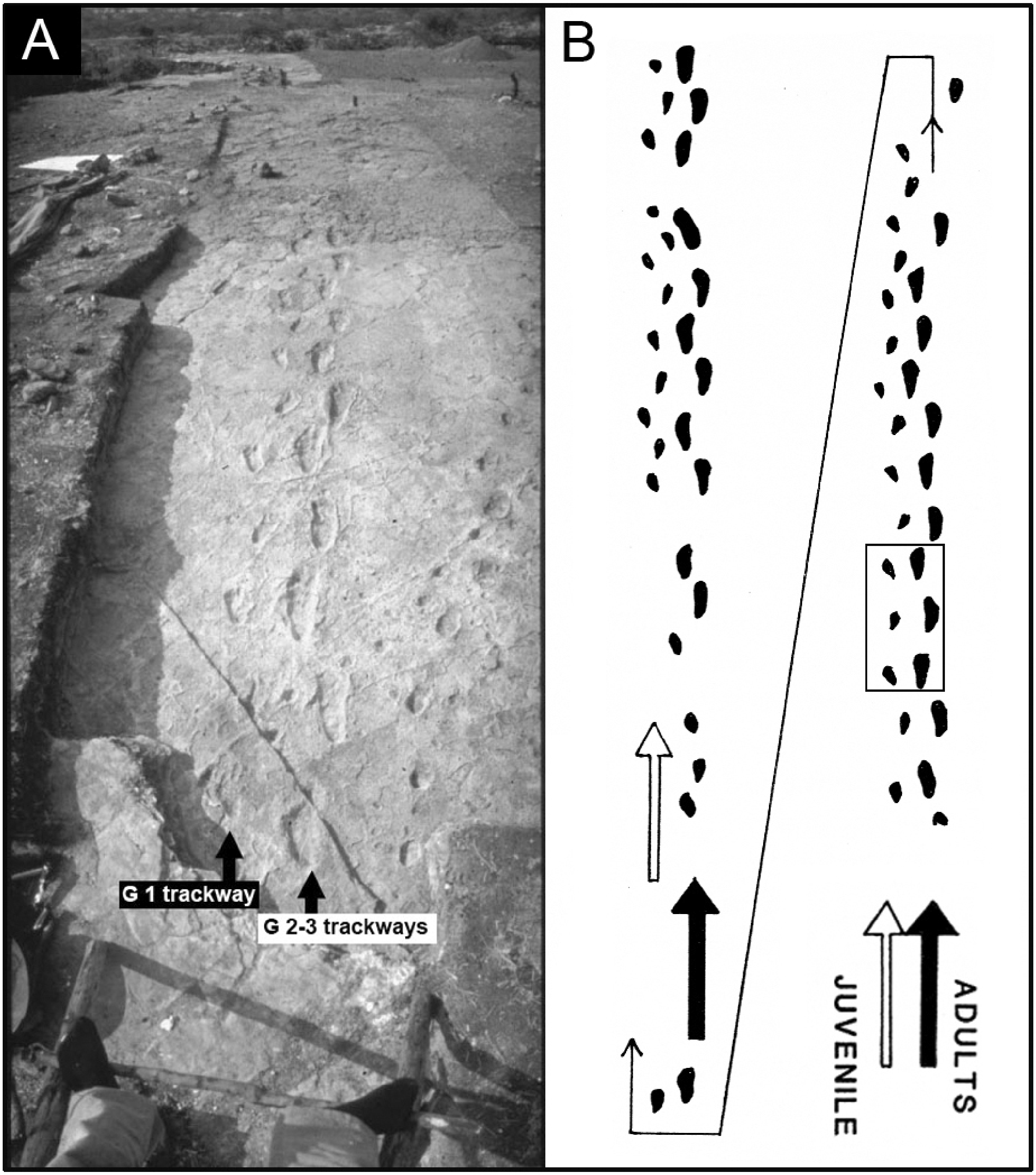

FIGURE 1. The G-1 and G-2/3 trackways from Laetoli. **A**, The original exposure, modified after photograph by John Reader, courtesy of Getty Foundation and **B**, drawing of trackways G1-3 after Lockley (1999, fig. 8.6), with rectangular box showing adult and juvenile trackways available as a replica panel from the National Museum of Kenya.

itself' (Westaway et al. 2003, p. 1095). However, further studies by Westaway and his colleagues (Westaway 2004, 2006, written communication, 2006) suggest problems with the TL dating (Tekkaya, 1976) and the likelihood of a date of only about 12,000 years, which is taken to be consistent with archeological evidence of human (*H. sapiens*) occupation in the area.

Middle-Late Pleistocene Transitions

Roberts (in press) reported two hominid footprint discoveries from South Africa, one at Nahoon Point, near East London (Deacon, 1966; Mountain, 1966) and the other at Langebaan Lagoon, 130 km south of Cape Town, and about 800 km west of Nahoon Point. The Nahoon Point tracks have recently been dated at 127,000 +/- 8, 000 (D. Roberts, in press) – not 29,000 years as reported by Deacon (1966). They include small human footprints, (about 19 cm long), one of which reveals moderately well-preserved toe impressions, and associated bird and mammal tracks. The larger but less well-preserved Langebaan tracks (about 23 cm long) are dated at about 117,000 years (Gore, 1997; Roberts and Berger, 1997; D. Roberts, in press) and are associated with hyena tracks. These dates suggest that both tracksites are associated with the last interglacial period and could represent some of the early modern humans (*H. sapiens*) extant in Africa at about this time.

The Late Pleistocene Track Record of *H. sapiens*

In comparison with the aforementioned tracks associated with the Middle-Late Pleistocene transition (~120,000-130,000 years), all other well-dated Late Pleistocene hominid tracksites are no more than ~60,000-65,000 Ka, and most are much younger. This suggests that trackmakers were modern humans (*H. sapiens sapiens*) or a closely related subspecies (*H. sapiens neanderthalensis*).

There is currently only one documented Late Pleistocene human track site in Africa (Scott et al., 2007 and in press,) reported from the Lake Bogoria area of the Kenyan Rift valley. This site reveals only one hominid track in association with footprints of bovids, suids and birds.

Late Pleistocene Europe

Fossil footprints have been reported from many subterranean cave sites in Europe, some of which, like those in southern France and northern Spain, are more famous for their cave art than they are for tracks.

The oldest Late Pleistocene footprints assigned a numerical age (~62,000 years B.P.). are those reported from Vârtop Cave, Romania by Onac et al., (2005). Only three footprints, including one with a well preserved outline (22 cm long and 10.6 cm wide), were reported and attributed to a Neanderthal. Facorellis et al., (2001) reported human footprints at Theopetra Cave in Thessaly, Central Greece to which they assigned a C 14 date of about 48,000 years BP.

Several brief reports of late Paleolithic cave sites with footprints create an evocative picture of the mysterious subterranean activity of our human ancestors (Kuhn, 1995; Marshack, 1972; Vialou, 1986; Bahn and Vertut, 1988). Tracks have also been reported from Lascaux (Berriere and Sahly, 1964), the Niaux cave system, one of the few sites from which well-preserved tracks have been documented and illustrated in detail (Pales, 1976). These include groupings of footprints (Fig. 2) that may represent children at play (Lockley and Meyer, 2000). Other important sites include Grotte Aldène, which is probably about 8,000 years old (Ambert et al., 2000), not 15,000 B.P. as originally suggested (Casteret, 1948). Tracks from Grotte de Cabrerets (also known as Pech Merle), include traces that suggest an individual with a walking stick (Begouen, 1927; Vallois, 1927, 1931). In Fontanet Cave footprints suggest a child following a puppy or fox into a cave and at Ariège three trails of children were reported (Bahn and Vertut, 1988). In Chauvet Cave near Vallon-Pont-d'Arc in southern France a trail of footprints (Fig. 3) of a young boy (estimated age about 8) extends for about 50 m across the cave floor. Chauvet cave may be between 20,000 and 30,000 years old (Harrington, 1999; Garcia, 1999, 2001).

Tana della Basura cave near Toirano in Northern Italy reveals human tracks (Chiapella, 1952) purportedly attributable to Neaderthal Man (Pales, 1954, 1960). However, as pointed out by Molleson et al. (1972), and more recently by Onac et al. (2005), the date may be as young as 12,000 years B.P., thus precluding a Neanderthal trackmaker. Hundreds of human footprints are also known from Ojo Guareña**,** a cave near Burgos, Spain (Marcos, 2001), and are associated with a C 14 date of 15,600 B.P. obtained from carbonized wood at the site. In 2001, human footprints were reported from Tempranas Cave in the Llanes region of Asturias Spain (Noval Fonseca, 2007).

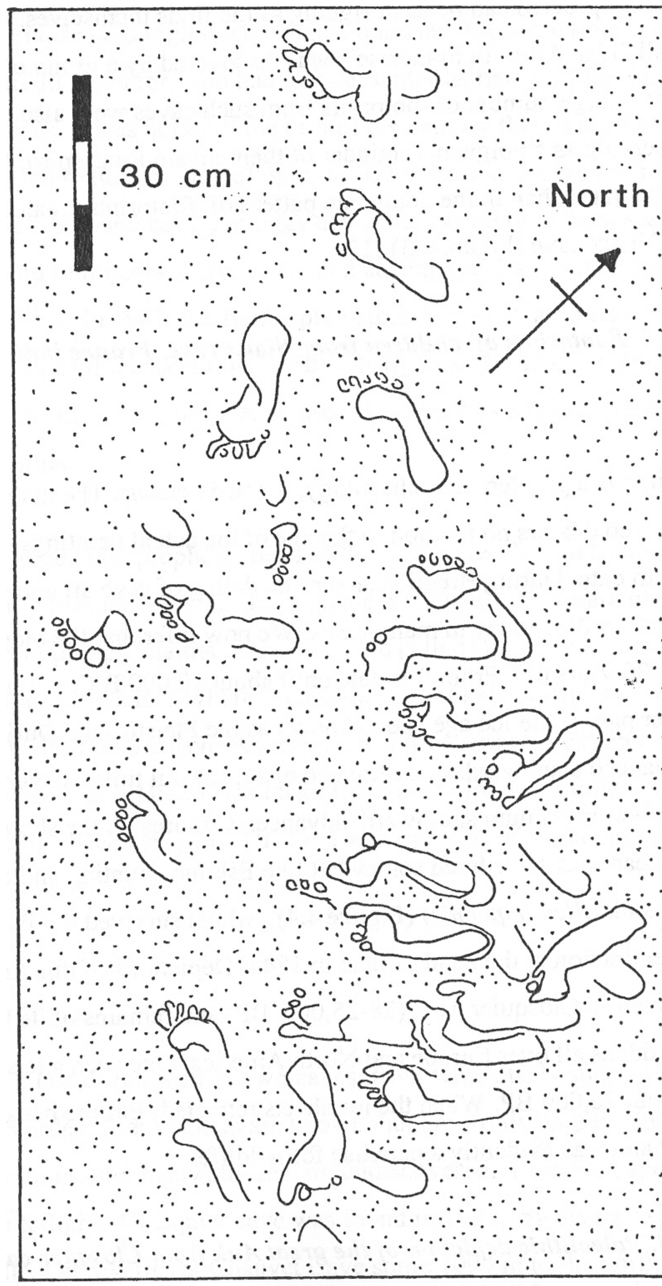

FIGURE 2. Late Pleistocene tracks of children at play, Niaux cave France (after Pales, 1976 and Lockley and Meyer, 2000).

Footprints made in caves have an increased potential for preservation. However they are not easily dated, because neither the substrate nor associated debris on the cave floor provide datable material associated with the time of track making. As noted by Lockley et al. (in press) footprints from cave sites reveal a certain type of ecology. They are mostly or exclusively those of carnivores (including humans, bears, hyena and fox). By contrast tracks of other vertebrate groups such as ungulates and birds, which are common at outdoor sites, are evidently entirely lacking underground, as might be expected.

Late Pleistocene of Australia and Asia

Webb et al. (2005) claim to have documented "the largest collection of Pleistocene human footprints in the world." The tracks, from the Willandra Lakes region of southeastern Australia, were dated at between 19,000 and 23,000 years B.P. Zhang and Li (2002) and Zhang et al.

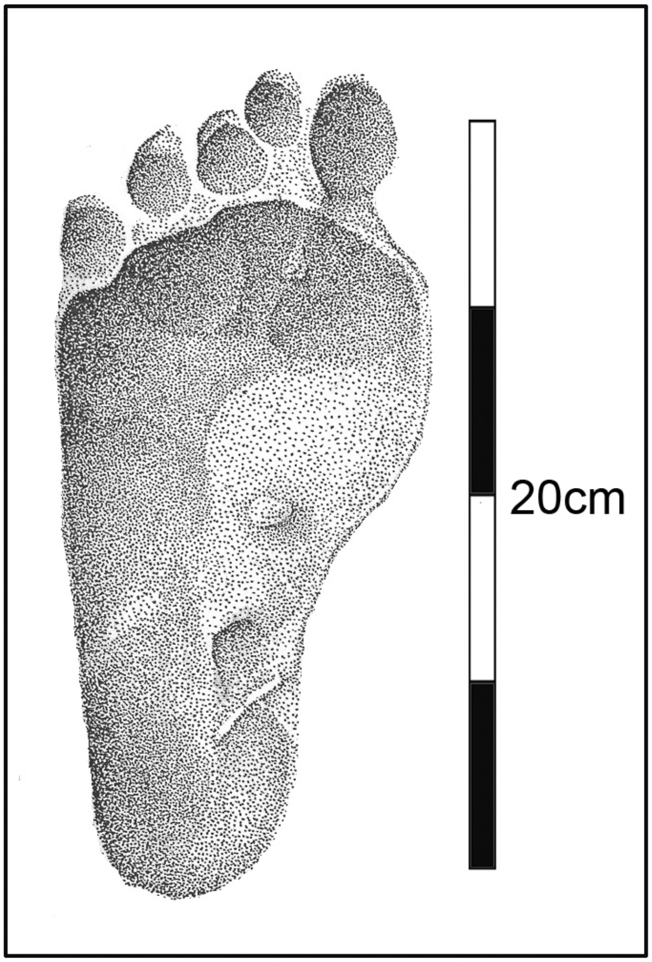

FIGURE 3. Single left footprint from Chauvet Cave (modified after Garcia, 2001).

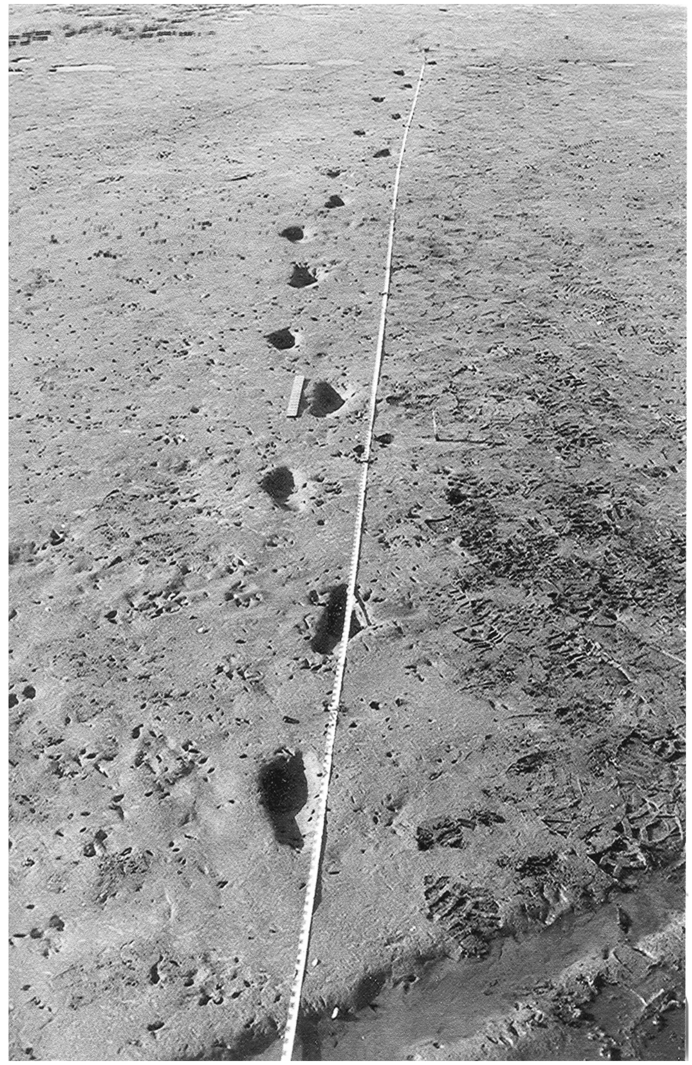

FIGURE 4. Human trackway from Formby Beach near Liverpool, England. After G. Roberts (in press).

(2003) reported hand and footprints associated with 20,000-year-old hot springs (tufa deposits) on the Tibetan Plateau, about 85 km from Lhasa . This is one of only a few sites with hand and foot prints. Prior to this discovery there had been no archaeological evidence of human habitation on the Tibetan Plateau before 4,000 B.P. Kim et al. (2004b, in press) and Kim and Kim, (2004a,b) reported hominid tracks and associated bird and mammal footprints from the Late Pleistocene of a coastal site on Jeju (Cheju) island, South Korea The track-bearing layer has been dated at about 15,000 years B.P. (Kim et al., in press).

HOLOCENE TRACK SITES

Most documented Holocene hominid tracksites are found in Europe and the New World. One exception is a site, designated as site B from the Quaternary of South Australia (Belperio and Fotheringham, 1990) where the tracks are estimated to be about 5,000 years old.

Mesolithic-Neolithic of the United Kingdom

Various significant coastal, hominid tracksites occur in Britain, in the Severn Estuary region, near Uskmouth (Aldhouse Green et al., 1995) and near Formby, north of Liverpool (Cowell et al., 1993; G. Roberts et al., 1996). The Uskmouth site is dated between about 5,720 and 6,250 B.P. and has yielded four hominid trackways in association with the tracks of deer, aurochs and birds. The Formby site, which has yielded more than 180 trackways (Figs. 4 and 5) associated with the footprints of aurochs, red deer, roe deer, horses, cranes and oystercatchers (G. Roberts et al., 1996; Lockley and Meyer, 2000; G. Roberts, in press), is dated at about 5500 BP). Some of the Formby footprints indicate abnormalities and infirmities such as arthritis and congenital bursitis. This evidence contrasts with the scarcity of abnormal footprints in Late Paleolithic caves noted by Andrieux (1974), Pales and St. Pereuse (1976) and Bahn and Vertut (1988). Another British site was recently reported from Kenfig, South Wales and tentatively assigned a date of ~8000 years (Doyle, 2007).

New World Tracksites

Outdoor hominid tracksites are known from Argentina, Chile, Mexico, Nicaragua, El Salvador and California, and subterranean cave sites are known from a number of sites in the southeastern USA. The oldest sites (11,500 to 12,500 years B.P.) reported from Monte Verde, Chile (Dillehay, 1999), and Buenos Aires Province, Argentina (Aramayo and Manera de Bianco, in press) are associated with the Pleistocene-Holocene transition.

Various sites are reported from Mexico (Ordoñez, 1945; Aveleyra Arroyo de Anda, 1950; Rodriguez de la Rosa et al., 2004; Gonzalez et al., 2006a-d), though documentation is sparse and few have been dated reliably. The most controversial of these sites, from Valsequillo (near Puebla Mexico), is purportedly Late Pleistocene, not Holocene in age and dated at about 40,000 years B.P. (Gonzalez et al., 2006a; Huddart et al., in press). This date exceeds any, based on other lines of evidence, normally

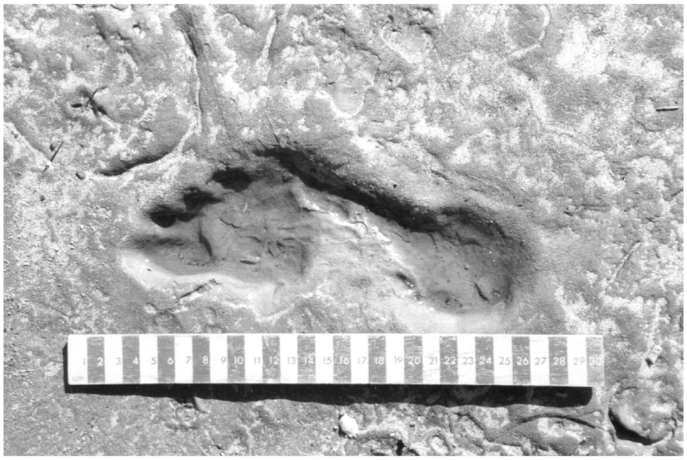

FIGURE 5. Single human footprint from Formby Beach near Liverpool, England. Note well preserved toe impressions. After G. Roberts (in press).

accepted for hominid occupation of the new world by *Homo sapiens*. Consequently the dates have been challenged by Renne et al. (2005) who suggested dates of 1.3 million years. Gonzalez et al., (2006b) countered that the dating of Renne et al. (2005) is incorrect. However, this controversy refers only to the age of the supposed track-bearing units and does not verify that the interpretation of the traces as human footprints is correct.

In March 2006, Gonzalez et al. (2006c,d; 2007) reported the rediscovery of a 'lost' site near Cuatro Cienegas, Coahuila Province from which two tracks had been collected in 1961. About 20 human tracks were found in association with poorly preserved ungulate and bird footprints. The tracks were registered in mineralized tufa deposits that have yielded preliminary dates of about 10,000 years old (Gonzalez et al., 2006, in press). Rodríguez de la Rosa et al. (2004) reported additional, undocumented human footprints, from "three sites near Mezcala" (State of Jalisco), near El Pando del Venado, La Cuchilla and La Ocotera. In Mexico, other human tracksites are known from Guerrero, Chihuahua and Sonora.

Hominid tracksites from Argentina include two sites from La Olla and a site at Monte Hermoso (Fig. 6) These are dated at about 7,000 B.P. (Bayon and Politis, 1996, 1998; Aramayo, in press; Aramayo and Manera de Bianco, in press). Human tracks have also been reported from Laguna La María (near Villa Cañás) and dated to about 8,000 B.P.

Hominid tracks from Acahualinca, near Managua, Nicaragua are evidently one of the best kept secrets in hominid ichnology. Although known since the late nineteenth century (Flint, 1883; Brinton, 1887), they have never been described in detail . The tracks are associated with volcanic ash deposits that have been reliably dated at between 5945 ± 145 B.P. (Bryan, 1973), and 6,500 B.P. by Bice (1979). The tracks are well-preserved in long parallel trackways in a mudstone covered by black volcanic ash (Fig. 7). Since the 1950s, the site has been preserved as Huellas de Acahualinca (Acahualinca Footprints) Museum. However, it has only been in the last two years that the site has subject to preliminary study (Lockley et al., 2007, in press) recording the trackways of at least 15 individuals, an ungulate, a coati and a bird, adding to previous reports of bison and tapir footprints (Williams, 1952).

The Oro Grande Site near Victorville in southern California reveals a total of at least 54 human tracks radiocarbon dated at 5070 ± 120 years (Rector, 1983). According to Rector (1979, 1983, 1999), at least four, or possibly five individuals are represented along with tracks of raccoon, coyote and ungulates. Willey et al. (in press) report a few footprints from Pocket Cave, Arizona, dated at about 1450-1500 B.P.

In contrast to the southwestern sites and those from Central and South America where tracks were registered in outdoor locations, human footprints from eastern North America are found at underground sites

FIGURE 6. Human footprint from Monte Hermoso, Argentina. Courtesy of Sylvia Aramayo (Aramayo, in press).

including Jaguar Cave, Tennessee, Unknown Cave, Kentucky, 3rd Unnamed Cave, Tennessee, Fisher Ridge Cave, Kentucky, Mud Glyph Cave, Tennessee, Sequoyah Caverns, Alabama, Footprint Cave, Virginia and Lon Odell Memorial Cave, Missouri (Watson et al., 2005; Willey et al., 2005, 2008 in press). Collectively these sites yield dates ranging from about 4695 ± 85 to about 400 B.P. (Table 1).

Haberland and Grebe (1957) reported a tracksite with nine footprints from El Salvador, tentatively dated between 200 and 800 A.D. Footprints are also known from a near Guaimaca, Honduras (Veliz, 1978), but no date was obtained (Table 1). Another site is reported from Naj Tunich, Guatemala, (Anon, undated), reveals footprints attributed to indigenous Mayan inhabitants, probably from around 50-550 A.D.

Other Human Tracksites in Cultural Context

Spectacular footprints were recently reported from Nola, a Bronze Age village near Naples, Italy. According to Maestrolorenzo et al. (2006, p. 4368), the 3,780 B.P. eruption of Vesuvius destroyed much of the area with lapilli and ash fallout. To the NNW "thousands of footprints [are] directed NNW away from the volcano … testify to an en masse exodus … during the settling of the surge cloud."

Iron Age footprints were recently revealed by a excavation beneath a Roman Amphitheatre in Chester, England (Edwards, 2006). Two human footprints are also known from Rawthey Cave, Cumbria, England (Chamberlain et al., 1997) The age is unknown but may be as recent

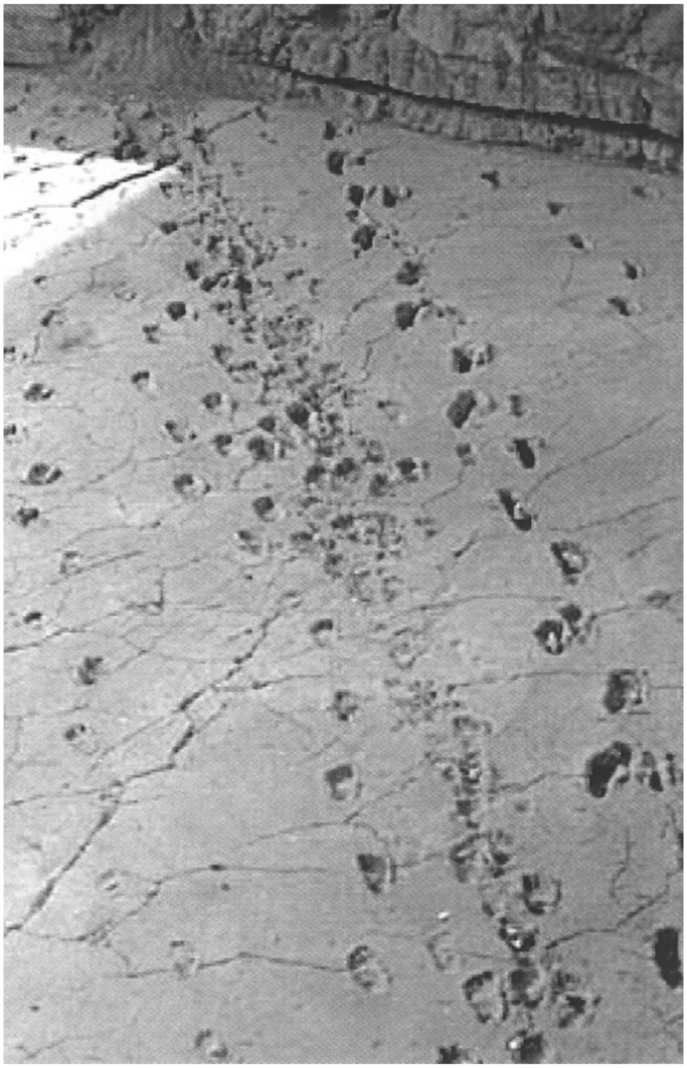

FIGURE 7. Multiple parallel human trackways (dated ~6000-6500 B.P.) from the Acahualinca Footprint Museum, near Managua, Nicaragua (see Lockley et al., 2007, in press).

as the 14th Century A.D.

Human tracks from agricultural sites in Gunma Prefecture, Japan, (Harada and Noto, 1984) date from between 400 and 1280 A.D. (~720-1600 B.P.), and are associated with several different ash layers. Likewise tracks are reported from at least four stratigraphic levels in volcanic ash sequences from Motutapu Island, New Zealand (Nichol, 1982). The site has been dated at about 1400 A.D.

Human tracks have also been reported from Holocene beach rock in Greece (Bromley et al., in press). Human footprints dated at about ~9000 B. P. have also been reported from Sebkra El Azrag, in Mauritania (Mafart, 2006).

Firmly in the historical era, we conclude with brief reference to the precisely dated fossil footprint sites reported from the footprint reserve at Hawaii Volcanoes National Park site. The footprints are associated with a Kilauea eruption and ashfall in 1790. Local tradition claims the local people fled and perished as a direct result of the ashfall, with footprints recording the drama, as happened at the 3,780 year old Avellino site in Italy (Jaggar, 1921, 1934; Meldrum, 2004; Mayor and Sarjeant, 2001). However, Moniz Nakamura (in press) suggests that local Hawaiians made footprints in the area both before and after the eruption, not while fleeing the 1790 eruption. The Hawaii Volcanoes National Park is nevertheless typical of several important human tracksites, such as Acahualinca, Nicaragua (Lockley et al., in press), where a vast wealth of largely untapped data is available for study.

DISCUSSION

The aim of this brief review has been only to provide a convenient summary of the hominid tracksites reported in the literature, some in obscure sources. Based on our survey 63 such sites were identified, of which only four, excluding the unconfirmed report from Pakistan, appear to be mid Pleistocene or older. Of the remainder about one third are probably Late Pleistocene and two thirds are Holocene.

The small size and poor quality of preservation of the sample of hominid tracks attributable to pre-*sapiens sapiens* species such as the Neanderthals (Onac et al., 2005), *H. erectus*, (Behrensmeyer and Laporte, 1981) and *H. habilis* or various species of *Australopithecus* (Stern and Susman, 1983; Tuttle et al., 1990) hampers detailed study of the evolution of the 'living' hominid foot. However, Meldrum (2006, 2007) recently suggested that the important G 1 trail (Fig.1) shows evidence of mid tarsal pressure ridge indicating an ape-like, midfoot (midtarsal) flexibility atypical of modern humans. He also suggests that the 300,000-400,000 year old Terra Amata footprint (De Lumley, 1966,1967) lacks a modern arch. Thus, ichnologists will continue to debate such evidence while awaiting future discoveries of well-preserved footprints that predate the Middle-Late Pleistocene transition.

Clearly then, the track record of early hominids is sparse, and forms like *Gigantopithecus,* which should have distinctive large tracks are unrepresented in the fossil-subfossil record in regions where their skeletal remains occur. This raises fascinating questions about the incompleteness of the hominid track record and focuses new attention on recent efforts to review the abundance of evidence for so called 'Bigfoot' tracks in western North America (Meldrum, 2006, this volume). Such work has the potential to create a new but controversial and potentially high-profile branch of hominid ichnology. Moreover, given the extensive scientific and non-scientific literature available, it would be remiss to comment on the sparse fossil and subfossil hominid track record without mentioning the claims of some that a non-sapiens species 'may' be the extant or recently extant maker of many controversial footprints. Regardless of the validity of the evidence for a *Gigantopithecus*-like trackmaker as the purported maker of Bigfoot (or Sasquatch) tracks, the potential to find actual *Gigantopithecus* tracks and footprints made by other bipedal hominids that existed during the last ~4.0 million years must be admitted. On this basis alone we should confess that the known track record is relatively incomplete and anticipate exciting future discoveries. If nothing else, Meldrum's scientific approach to the study of both the authentic and bogus ichnological evidence, has the potential to suggest methodologies that will help us understand the variation of hominid tracks, their preservation potential in different settings and their distribution in space and time.

As shown in Table 1, the temporal and spatial distribution of hominid tracksites is patchy at best. Less than 7% of known sites occur in the known pre-sapiens hominid track-making interval (3.7 Ma and ~127,000 Ka), even though this time span represents more than 96% of the interval. Does this indicate low population densities among pre-*sapiens* species or some other preservation-biasing factor such as habitat preference in areas with poor track-preservation potential? Uneven distribution of research activity may also be a factor in explaining why only three sites are known in Asia, three in Australia and New Zealand, seven in Africa, whereas 21 are reported from Europe and 29 from the Americas

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NOTE ADDED IN PROOF

In late August 2007, Reuters Press Agency reported the discovery of human footprints at a prehistoric site at Siwa oasis, Egypt. The report contained an illustration of a single footprint, apparently well-preserved, and a positive statement from a representative of the Egyptian Supreme Council of Antiquities. This is a report in need of verification, as no other information is currently available.

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APPENDIX

Provisional list of *in press* papers slated for Special Issue of ***Ichnos*** entitled: **Hominid ichnology: Tracking our own origins.**

1) Hominid ichnology: Tracking our own origins (Kim, J-Y, Lockley, M.G. and Kim, K.S.).

2) In the footprints of our ancestors: An overview of the hominid track record (Lockley, M.G., Roberts, G. and Kim, J-Y).

3) Hominid ichnotaxonomy: An exploration of a neglected discipline (Kim, J.-Y., Lockley, M.G., Kim, K.S. and Matthews, N.).

4) Morphodynamic perspectives on convergence between the feet and limbs of sauropods and humans: Two cases of hypermorphosis (Lockley, M.G. and Jackson, P.).

5) Footprint clues in hominid evolution and forensics: Lessons and limitations (Tuttle, R.).

6) Pliocene animal trackways at Laetoli: Research and conservation potentials (Musiba, C.M., Mabula, A. and Selvaggio, M).

7) The Devil's Trails: Middle Pleistocene human footprints Preserved in a volcanoclastic deposit of southern Italy (Avanzini, M., Mietto, P., Angelis, M., Panarello, A. and Rolandi, G.).

8) Last interglacial hominid and associated vertebrate fossil trackways in coastal eolianites, South Africa (Roberts, D. L.).

9) Preservation and paleoenvironmental significance of a footprinted surface on the Sandai Plain, Lake Bogoria, Kenya Rift Valley (Scott, J., Renaut, R.W. and Owen, R.B.).

10) Analysis and preservation of Pleistocene human and animal footprints: An example from Toluquilla, Valsequillo Basin (Central Mexico) (Huddart, D., Bennett, M.R., Gonzalez, S. and Velay, X.).

11) Preliminary report on hominid and other vertebrate footprints from the Late Quaternary strata of Jeju Island, Korea (Kim, J.-Y., Kim, K.-S. Kim, S.H., Lee, C.-Z. and Lim, J.-D.).

12) Human tracks from Quaternary tufa deposits, Cuatro Cienegas Coahuila, Mexico (Gonzalez, A., Lockley, M.G., Rojas, C. and Lopez, J.E.).

13) Late Quaternary palaeoichnological sites from the southern Atlantic coast of Buenos Aires Province, Argentina: **Mammal, bird and hominid evidence** (Aramayo, S.A. and Manera de Bianco, T.).

14) **Ephemeral, subfossil mammalian, avian and hominid footprints within Flandrian sediment exposures at Formby Point, Sefton Coast, north west England** (Roberts, G.).

15) A brief sketch of the Monte Hermoso human footprint site, south coast of Buenos Aires Province, Argentina (Aramayo, S.A.).

16) America's most famous human footprints: History, context and first description of mid-Holocene tracks from the shores of Lake Managua, Nicaragua (Lockley, M.G., Garcia-Vasquez, R., Espinosa, E. and Lucas, S.).

17) Holocene human footprints in North America (Willey, P., Watson, P.J., Crothers, G. and Stolen, J.).

18) A survey of tetrapod tracksites preserved in pyroclastic sediments, with special reference to footprints of hominids, other mammals and birds (Houck, K., Lockley, M.G. and Avanzini, M.).

19) Preservation of human tracks in an arid environment (Lockley, M.G. and Rodríguez-de la Rosa, R.).

20) Rheotactic *Macaronichnus*, and human and cattle trackways in Holocene beachrock, Greece: Reconstruction of palaeoshoreline orientation (Bromley, R.G., Uchman, A., Milàn, J. and Hansen, K.S.).

21) Hominid footprints in recent volcanic ash: New interpretations from Hawai'i Volcanoes National Park (Moniz Nakamura, J.J.).

22) Do shod humans leave true tracks? (Milan, J. and Bromley, R.G.).