

A Fossil Proboscidean Trackway at Mleisa, Western Region of Abu Dhabi, United Arab Emirates

Will Higgs, Drew Gardner & Mark Beech

Abstract

In 2001 and 2003 staff from the Abu Dhabi Islands Archaeological Survey (ADIAS) visited an area with level white stone plains to the east of Ghayathi, in the western region of Abu Dhabi emirate, UAE. Several footprints were discovered at two sites in the Niqa area. A large number of footprint-like impressions were also discovered in a series of apparent trackways criss-crossing an outcrop at a locality called Mleisa. These prints strongly resembled elephant tracks.

The trackways at Mleisa consists of a group of up to fourteen roughly parallel tracks, with one larger track crossing them. From the size and subcircular shape of the footprints, the tracks are very likely to be those of proboscideans. Measurements suggest that the trackmakers were larger than modern female Asian Elephants, *Elephas maximus*. Footprints were found within the main trackway indicating travel in opposite directions, and in similar sediments above the main trackway, suggesting multiple track-making episodes.

If the track-bearing sediment can be shown to be of similar age to the fossil site at Ruwais, which dates to between 6-8 million years ago (see Beech & Higgs, this volume), the possibility arises that we have complementary types of fossil tracks from a proboscidean such as *Stegotrabelodon syrticus*. The Mleisa trackways are unparalleled in the Arabian Peninsula, and provide a unique opportunity to research the palaeontology, sedimentology and palaeoecology of the Late Miocene period. Measures have already been taken to ensure the preservation and protection of these important sites.

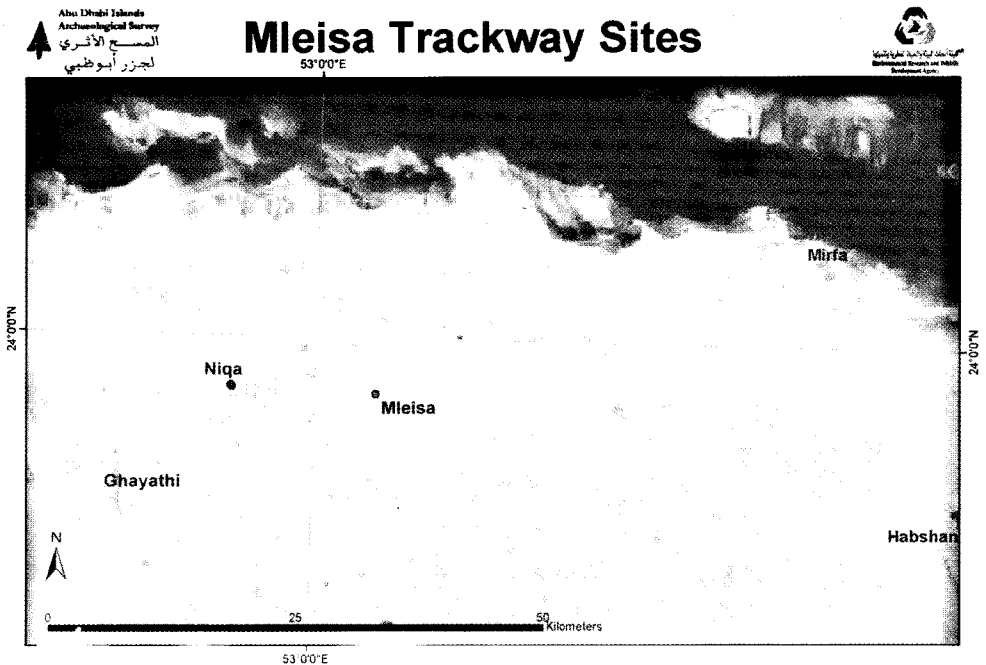


Figure 1. Satellite image of the Ghayathi area, with fossil footprint sites at Niqa and Mleisa marked as red dots. An arc of whitish surfaces can be seen stretching across the centre of the image.

Keywords

Proboscidea, fossil footprints, Late Miocene, Niqa, Mleisa, Abu Dhabi, UAE.

Introduction

In April 2001 ADIAS staff (Dan Hull and Stephen Rowland) visited an area of level white stone plains outcropping in an arc running approximately 80 km eastwards from Ghayathi in the western region of Abu Dhabi, UAE. They were accompanied by Mubarak bin Rashid al-Mansouri, a UAE national employed by the Abu Dhabi Company for Onshore Oil Operations, ADCO, at Jebel Dhanna, who showed them a number of fossil footprint sites. These were located at two sites, Niqa and Mleisa (Figure 1).

At Niqa, about 9km north-east of Ghayathi, isolated footprints of two types were observed at two locations on a fossilised mud plain. These were three prints left by an animal with a five toed foot around 28cm across (Figures 2-3). At Mleisa (Figure 4), located about 70km ENE of Ghayathi, multiple tracks were noted (Figure 5) which appeared to made by proboscideans (any of the order Proboscidea, large mammals comprising the elephants and extinct related forms).

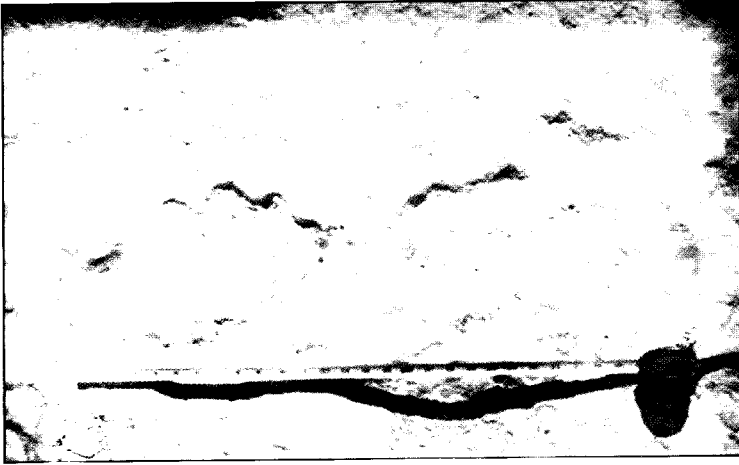


Figure 2. Fossil footprint from Niqa.



Figure 3. Fossil footprint from Niqa.

A second visit during February 2003 was made by ADIAS staff (Will Higgs and Dr Mark Beech) together with Dr Drew Gardner (Zayed University) to examine the Mleisa site in more detail. This enabled the collection of more comprehensive data suitable for description of the footprints in ichnological terms. The footprints at Mleisa form a series of impressive fossil proboscidean trackways.

Study of trace fossils such as footprints comes under the heading of ichnology, a relatively new sub-discipline within geology. It is appropriate to begin this paper with a brief introduction to the subject.



Figure 4. General view of the Mleisa plain with the outlier/sedimentary block visible at its centre.

Ichnology

The word ichnology is derived from the Greek word 'ichnos' meaning a track. Ichnology covers distinctive traces such as footprints, and also less well-defined evidence of animal activities such as bioturbation of seafloor sediments caused by the burrowing and feeding of invertebrates. This latter type of evidence is of increasing importance in the analysis of cores, for instance in oil prospecting, enabling geologists to identify ancient seabed surfaces and to assess water depth, temperature and oxygen levels from the types of invertebrate activity.

In more traditional areas of palaeontology, ichnology can complement studies of fossil bones in several ways:

- by revealing the presence of animal species not recorded from skeletal remains.
- by revealing aspects of behaviour and ecology which are not obtainable from bones.
- by providing direct evidence of modes of movement, including gait and relative speed.

Within geology proper, studies of the footprints of large animals such as dinosaurs are providing opportunities for an experimental approach within sedimentology. Examples include the study of the deformation of underlying layers by the weight of large animals, the differential formation of minerals within the compressed sediments of a footprint, and the possibility that footprints may act as information traps accumulating, for instance, pollen from their surroundings before being covered.

Basic measurements required to describe a track are illustrated in Figure 6, following Thulborn (1990). Tracks made by a quadruped often appear, as in this diagram and at Mleisa, to consist of alternating imprints which could have been made by a biped. This is due to registration of front and hind feet on the same side, meaning that the hind foot is placed precisely on top of the imprint of the front.



Figure 5. Fossil trackway at Mleisa. Note the footprint in the foreground. The well-marked subcircular 'plate' within the footprint is unlikely to represent an imprint of the trackmaker's foot, and is probably a distinct zone of compression transmitted from a higher level.

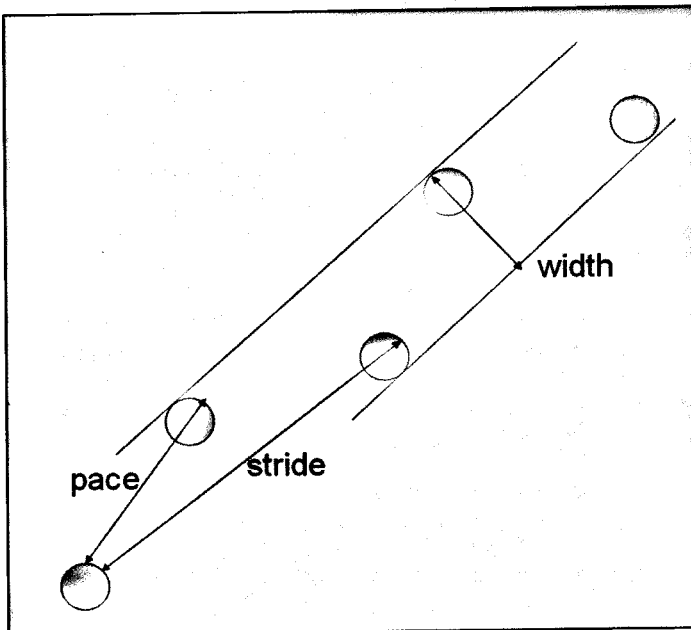


Figure 6. Basic measurements used to describe a track, after Thulborn (1990).

The extensive and well-preserved late Miocene fossil surfaces of the Mleisa area, therefore, provide many opportunities for further research. It is of particular interest that the trackways lie within 70km of Ruwais and many other late Miocene fossil sites from which extensive collections have been made, particularly of proboscidean bones. Fossil footprints often complement data from fossil bones in a general way, where the links between the trackways and the fossil bones are tenuous due to wide separation in time and space. The Mleisa footprints may, however, have been made by proboscidean populations close in time and space to those whose remains have been recently excavated (*cf.* Beech and Higgs, *this volume*).

The Mleisa Site

The level whitish stone plain at Mleisa is oval in shape, approximately 500m long by 300m wide, the long axis being orientated NW – SE. The track-bearing substrate has been characterised as a “... highly mud-cracked, grey marl which is both underlain and overlain by other mud-cracked horizons of similar lithology” (Higgs *et al.* 2003). The surface geology of the Ruwais and Ghayathi areas has been characterised as Late Miocene by Whybrow & Hill (1999) and first impressions of the geology of the site suggest that it lies in the fossiliferous upper part of the Baynunah Formation.

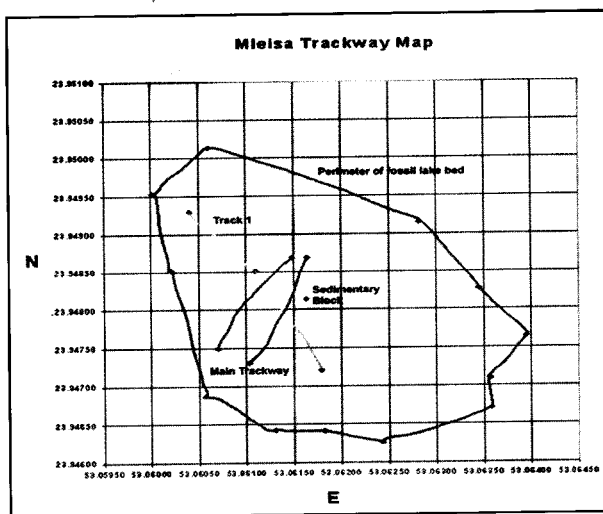


Figure 7. Map of the Mleisa plain with location of trackways.

Due to encroachment by sand dunes, it is not clear whether the Mleisa outcrop is an isolated basin or part of a much larger area of similar deposits, but interleaving of the whitish, calcareous, track-bearing rock with marls along the north-eastern side of the Mleisa site may define one edge of it. A preliminary map has been created by plotting GPS points taken around the perimeter of the plain and at the ends of the trackways (Figure 7). At the centre of the stone plain is a remarkable outlier of overlying sediments approximately 2m high, from which samples of five distinct layers have been taken for analysis (Figure 8). While taking these samples it was noted that small gastropod molluscs were present in one of the upper horizons. These were identified as a species of *Melanooides*, a genus found today in aquatic habitats with a wide range of salinities.

It can be seen from the map that the main trackway is approximately 170m long and 20-38m wide, crossing the area on a NE–SW axis. It is crossed by track 1, which is 290m long, on a NW–SE axis. The footprints are well-marked (Figure 5), apparently having been made in drying sediments. Due to the featureless shape of the footprints, it is difficult to identify the direction of travel in each example, but as long series are available for most of the tracks, a clue can usually be found from the direction of displacement of surrounding and underlying material, more material tending to be projected forwards by the initial footfall. Tracks apparently travelling

It would appear from this data that the Mleisa trackmakers were considerably larger than modern Asian elephants, but precise correlations of track measurements with body size are complicated by various factors such as:

- **Morphology** – The Mleisa trackmakers may have had different body proportions and different gaits from modern elephants. If, as conjectured, the author of the large 'track 1' at Mleisa was a mature adult male *Stegotetabelodon*, it may have been carrying four tusks, two of which could have been over two metres in length, creating a very different weight distribution to that of the 'tuskless' female Asian Elephant at Blackpool Zoo.
- **Relative speed** – Stride length increases and track width tends to narrow with increasing speed. It is reasonable to assume that the Mleisa trackmakers were walking slowly.
- **Type of substrate** – The Blackpool elephants were walking on a solid substrate with which they were familiar. The Mleisa trackmakers may have been walking in soft mud. If this was the case, they may have been cautiously 'feeling their way' which might explain the relatively greater width of track 1, in particular.
- **Natural gait** – The Blackpool elephants are captive-bred, so their gaits may not be identical to those of wild animals, and they were guided along the sand avenue making their tracks, so may not have been travelling at their preferred walking pace.

Further experimental work and data from wild elephants may clarify these issues.

Further Research

Preliminary investigations are already in progress, under three headings.

* **Stratigraphy** - It is important to be able to place the trackway in the local geological sequence and to obtain as accurate a date as possible. Current evidence as to the stratigraphical position of the Mleisa site will be reviewed in a paper in *Tribulus* (Higgs *et al.*, 2003).

* **Sedimentology** - The strata containing the trackways need more detailed description. Samples have been taken for analysis, both from the trackway surface and from overlying sediments preserved in the outlier at the centre of the site. Detailed studies of the interaction between the footprints and the substrate are also planned.

* **Zoology** - Comparative biometrical studies have been initiated by observations of the tracks of captive Indian elephants (*Elephas maximus*). Detailed measurements of Indian elephant bones will enable comparison with fossils excavated in Abu Dhabi Emirate. In conjunction with stratigraphical studies, these measurements will enable assessment of the probability that the footprints and bones represent the same fossil species.

The Mleisa site and related outcrops in the immediate area provide a focus and unrivalled opportunities for the development of palaeontology in Abu Dhabi Emirate, building on the data and fossil collections now held by the Abu Dhabi Islands Archaeological Survey (ADIAS).

Authors' addresses:

Will Higgs, Department of Archaeological Sciences, University of Bradford, West Yorkshire, BD7 1DP, UK.
Email: will@willhiggs.co.uk

Dr. Drew Gardner, Zayed University, P.O. Box 4783, Abu Dhabi, UAE.
Email: drew.gardner@zu.ac.ae

Dr. Mark Beech, Abu Dhabi Islands Archaeological Survey, P.O. Box 45553, Abu Dhabi, UAE
Email: adias@erwda.gov.ae

References

- Beech, M. and Higgs, W. (2004). "A New Late Miocene fossil site at Ruwais, United Arab Emirates." In: P. Hellyer and M. Ziolkowski (eds.), (*this volume*).
- Higgs, W., Kirkham, A., Evans, G. and Hull, D. (2003). "A Late Miocene Proboscidean Trackway from Mleisa, United Arab Emirates." *Tribulus* 13/2: 3-8
- Thulborn, R.A. (1990). *Dinosaur Tracks*. Chapman & Hall: London.
- Whybrow, P.J. and Hill, A. (1999). *Fossil Vertebrates of Arabia*. Yale University Press: New Haven.