



Photo courtesy Joyce Foulkes

Paul Foulkes points to two large dinosaur tracks at Riddell Beach in 1990 (above). Tracks from this area, along with a succession of footprints at Gantheaume Point, (top left) were identified by Colbert and Merrilees as belonging to a five-to-six-metre-long carnivorous dinosaur similar to *Megalosaurus*. Totalling about 20 prints, the 37cm long tracks (bottom left) were consequently assigned the name *Megalosauropus broomensis* in 1967 and were the only fossil evidence of dinosaurs in the entire western half of the Australian continent at the time.

Photos on facing page by Nigel Clarke

morning due to long shadows cast over the beach by cliffs on the eastern side of the shore. Thus it is only in the late afternoon of a low tide that this job can be done effectively.

By the end of his field trip, Long and his Broome colleagues had documented six new footprint types including large three-toed carnosaur prints (similar to those at Gantheaume Point), huge sauropod tracks and the tracks of both small and large ornithopods. However, most intriguing of all were smaller five-toed tracks and stubby three-toed footprints. Upon his return to Perth, Long contacted Dr Tony Thulborn from The University of Queensland who identified the unusual footprints as the hand and foot prints of Thyreophora or 'Shield Carrying' dinosaurs. The Thyreophora group includes both ankylosaurs, which have been found in Australia, and stegosaurs, which have not, but due to the lack of information on footprints of this group, it was impossible for Thulborn to

identify the tracks any further. Even now, though he believes the evidence tips slightly towards ankylosaur, the possibility of a stegosaur cannot be ruled out.

In 1991, John Long was approached by the Perth Logistics Battalion of the Australian Army to run a joint training exercise. In this venture the Army offered to provide equipment and personnel if the Western Australian Museum could provide a scientific quest. The purpose of the exercise was for the Army to test logistics by working in remote locations while carrying out a legitimate project. Long did not hesitate in nominating visits to remote fossil sites in the Great Sandy Desert and the Kimberley region. It was labelled 'The Great Aussie Dinosaur Hunt'. Long was accompanied by a diverse group of people: Anne Warren and Natalie Schroeder from Latrobe University, a student from Cambridge, two competition prize winners plus Tony Thulborn and PhD student Tim Hamley from

The University of Queensland who, upon hearing of John's intention to revisit the Broome sites, 'volunteered' their services as de facto team members. The expedition left Perth in July 1991 along with a film crew, 40 army personnel and a contingent of vehicles and equipment.

When the expedition reached Broome, Tony Thulborn was finally able to see the real fossils instead of photos. In the short time available he was shown several sites by John Long, including some of the huge sauropod footprints – which Natalie Schroeder described as "two lines of rock pools – until you looked at them from just the right spot"! The site of the rare Thyreophoran tracks was also inspected and further attempts were made to secure some casts. When the expedition departed soon after, Thulborn and Hamley remained, trying to glean as much information on the tracks as possible before they too had to return to other commitments.



Photo John Long from "A Century of Australian Dinosaurs" by Tom and Pat Rich

In the 1980s, Paul Foulkes began searching along the coast north of Broome for dinosaur tracks. Drawing on the knowledge of local Aboriginal people, he discovered numerous sites where dinosaur tracks were present and was the first person to recognise that strange rounded pads through the Cretaceous sandstone were actually sauropod tracks. Late in 1989 Foulkes sent photos of his discoveries to Dr John Long, Curator of Geology at the Western Australian Museum (left) who visited Broome in mid-1990 and again in 1991 to document the new tracks. Long was astounded at the quantity and variety of the dinosaur footprints and was able to record the tracks of sauropods, large theropods and both small and large ornithopods. However, Foulkes' discovery of this stubby three-toed footprint (below) and related five-toed tracks turned out to be the most significant, later being identified as belonging to Thyreophora or 'Shield Carrying' dinosaurs.



Photo courtesy Joyce Foulkes

With so little time to study the dinosaur tracks during his 1991 visit, Tony Thulborn was determined to return and the following year, upon receiving a small grant, he and Tim Hamley returned to Broome where they met with Paul Foulkes. This was to be the first of several trips Thulborn and Hamley made to Broome over the coming decade and, as Hamley pointed out in Tom and Pat Rich's book "A Century of Australian Dinosaurs", they were seldom uneventful. Undoubtedly, the biggest hurdle they faced was the sheer magnitude of the task in hand. New discoveries of footprints were coming to light faster than they could document them, making the job of identifying and scientifically describing them a daunting and overwhelming prospect. To make matters even more difficult, many of these sites could only be seen at low tide and were scattered over a distance of around 200km of isolated coastline.

In spite of the difficulties, the research into different track localities by Thulborn, Hamley and Foulkes soon identified a wide range of palaeoenvironments including flood plains, deltas, lakes, swamp-forests and lagoons. They noted that the sauropod tracks were most conspicuous in the lagoonal settings (although not confined to them), but the theropod tracks showed up everywhere – albeit in small numbers. Before long they had identified at least 16 different types of dinosaur tracks scattered throughout the different environments, but it was impossible to tell exactly how many different types of dinosaurs the tracks represented. Animal tracks can be affected by many variables, such as the consistency of the ground on which they are walking. What this means is that, depending on its circumstances, one dinosaur could possibly produce two or three different types of tracks ... and two completely different dinosaurs could conceivably produce identical tracks.

In June/July 1997 Thulborn and Hamley travelled to Perth to attend a CAVEPS (Conference on Australian Vertebrate Evolution, Palaeontology and Systematics) conference where they presented their findings at Broome to an international audience of palaeontologists. From there they returned once again to Broome, where they joined Paul Foulkes and recommenced their research. During this trip they were accompanied by Italian vertebrate palaeontologist Dr Giuseppe Leonardi, a renowned dinosaur footprint expert whom Thulborn had invited to join them. Leonardi

In 1991, Dr Tony Thulborn (right) and Tim Hamley (below) visited Broome to inspect the dinosaur tracks – the first of several trips made to the site over the following decade. Their return in 1991 saw the development of a research partnership with Paul Foulkes that led to the publication of a preliminary account of the Broome sauropod tracks in 1994.

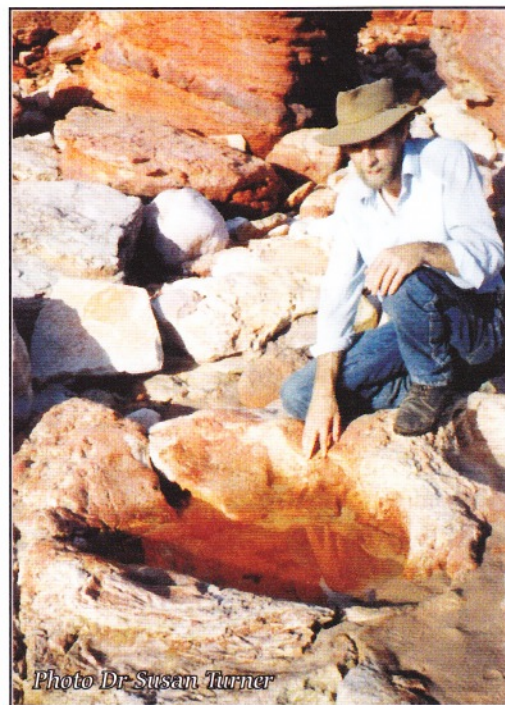


Photo Dr Susan Turner

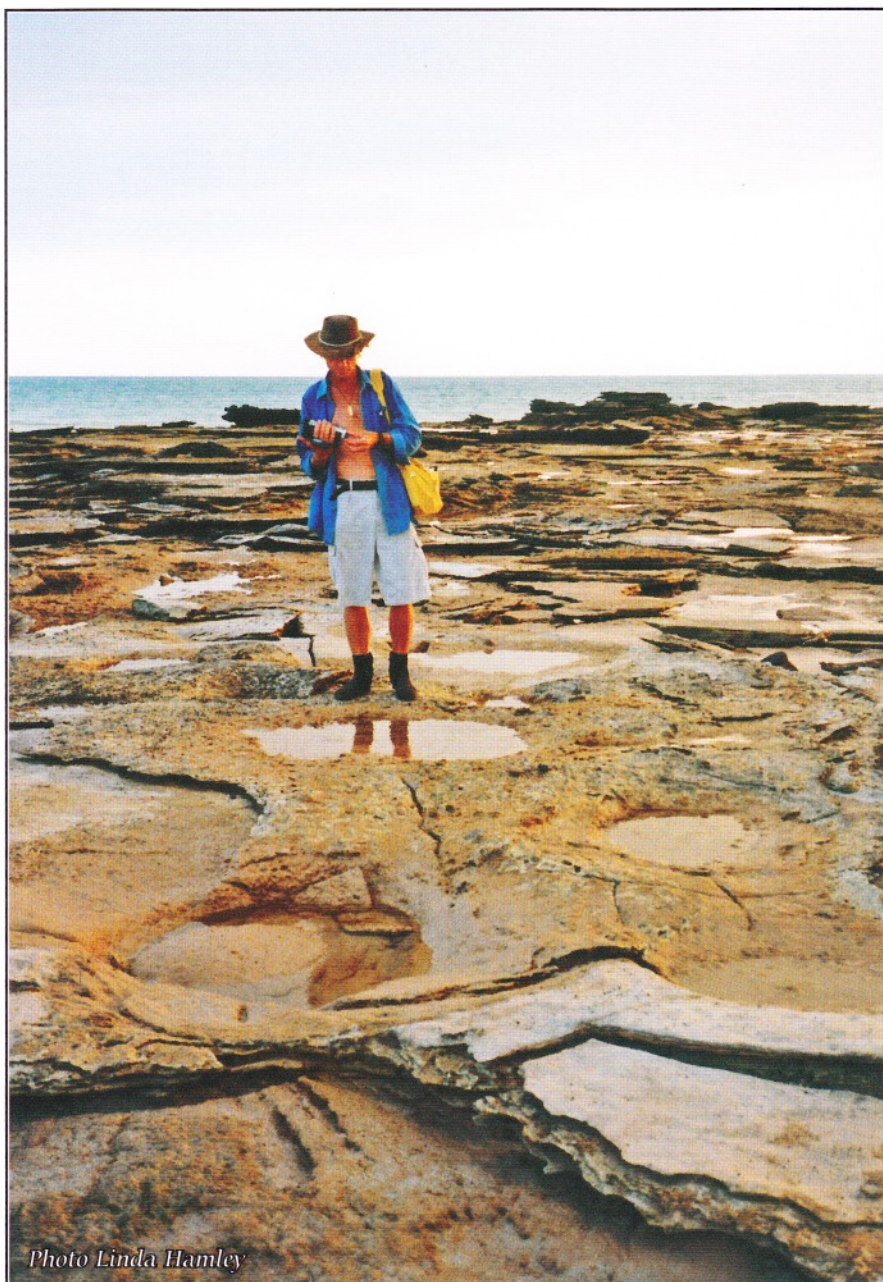


Photo Linda Hamley



Photo Nigel Clarke

had spent 17 years documenting fossil footprints in Brazil, but this was his first visit to Australia and he was quick to acknowledge the international significance of the dinosaur sites at Broome. Leonardi pointed out that the discovery of sauropod and ornithopod footprints together is very rare in any part of the world and described the ancient Broome environment as a plant-eaters paradise. He also confirmed that the sauropod tracks which he described as 'virtual bathtubs' were from animals up to 30 metres in length and were some of the largest sauropod tracks ever discovered.

Following international interest sparked by their CAVEPS presentation in 1997, Thulborn and Hamley were successful in obtaining funding from the Reid Foundation for the 1999 field season to further their research. One problem they immediately set about addressing was getting an accurate plan view of a succession of dinosaur tracks – something they had been unable to achieve previously. Over

the years they had spent a lot of time trying to photograph entire trackways 'frame by frame' to compile a photo mosaic, but when dealing with a trackway of eight to 10 sauropod tracks – each measuring over a metre across – it was impossible to gain the height required to document them accurately. After testing numerous methods of photography from high positions, such as balancing precariously on ladders and planks, they settled on an idea of digital cameras mounted on the base of a remote controlled helicopter. This they hoped to position above the tracks through the use of a video camera transmitting to a monitor on the ground.

In early 1999 the pair returned to Broome, bringing their new equipment with them in the hope that it would enable them to photograph and map entire trackway areas. However, although this system of aerial mapping appeared feasible in theory, in practice it proved very complicated so, although results

were mixed, they were generally not very successful. Unfortunately this was to be Thulborn and Hamley's final trip together to Broome. With no immediate funding available for research, further visits had to be postponed and their working partnership was terminated when, in 2004, Tim Hamley died at the young age of 52 from melanoma-induced cancer. Paul Foulkes, the catalyst who attracted the scientists to Broome through his discoveries, had already passed away in 1998. Nevertheless, the group did manage to record some of their findings before his death, with a preliminary account of the Broome sauropod tracks published in 1994.

Tony Thulborn did not visit Broome again until 2009, where he met up once again with Louise Middleton and inspected the condition of some of the sites. However, this field trip had a slightly different purpose – it was also related to a gas processing hub that had been proposed previously for the area. The hub was becoming



Photo Nigel Clarke

In spite of numerous discoveries, Paul Foulkes is best remembered for his recognition of the giant sauropod tracks along the coastline north of Broome. However, not all of these tracks are as easily identified as the trackway (left) which clearly shows the 1.4 metre footprints of a very large sauropod. Many tracks have weathered away to the extent that all that remains today is a huge underprint, such as this specimen being studied by Tim Hamley and Paul Foulkes (below). Preservation of underprints is caused by the compaction of mud in a dense, dish-shaped circle below the footprint (above) and is testimony to the massive weight of these Cretaceous giants.

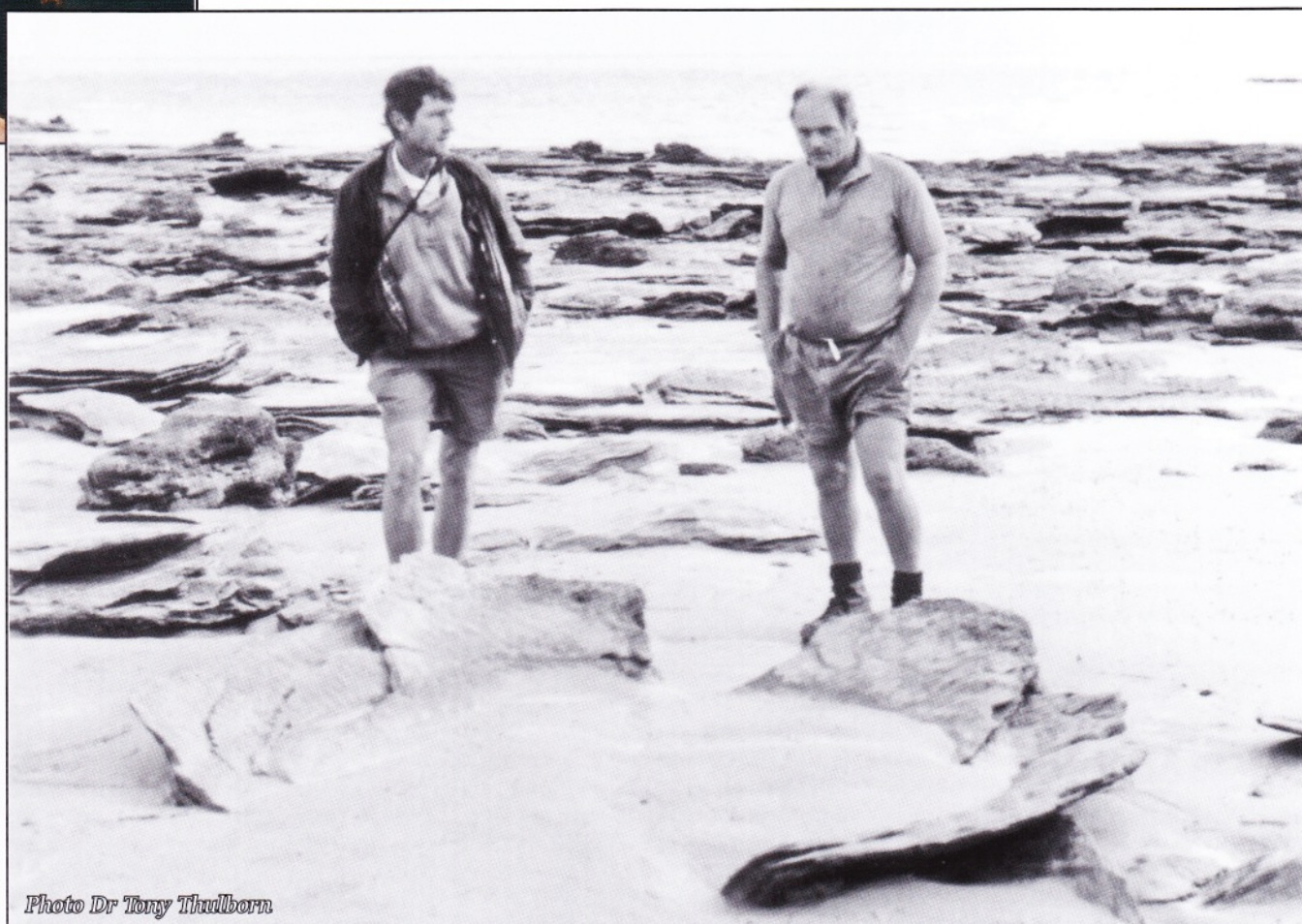


Photo Dr Tony Thullborn

Broome Times

Incorporating ENTERTAINMENT, ARTS, LOCAL HISTORY, HABITAT

Dinosaur hunters excited by sandstone treasures

THE confirmation of the Dampier Peninsula coastline as one of the richest dinosaur footprint sites in the world is expected to create intense international interest in palaeontological circles.

DAWN GIBSON spoke to two of the world's leading palaeontologists during their visit to Broome this month.

About 115 to 120 million years ago, the sandstone coastline of the Dampier Peninsula was a dinosaur paradise.

Situated a couple of kilometres further west from Cable Beach than it is now, the region was home to a rich dinosaur fauna, including the plant-eating species sauropods, such as brontosaurus, and the two-legged plant-eating ornithomids.

Although not as common as the Kimberley stamping grounds, flesh-eating theropods and thyreophoran dinosaurs (such as stegosaurs) also lived here.

The sheer abundance of these dinosaurs and their different associations with each other has been put in the international spotlight recently, due to a visit by Italian verte-



UNIVERSITY of Queensland palaeontologist Tony Thulborn, Broome resident Paul Foulkes and University of Queensland senior research assistant in palaeontology Tim Hamley, with Italian vertebrate palaeontologist Giuseppe Leonardi (kneeling). They are holding an imprint of an plant-eating ornithomid dinosaur footprint on the left and a meat-eating theropod dinosaur footprint on the right.

In 1997, Tony Thulborn extended an invitation to Italian vertebrate palaeontologist Dr Giuseppe Leonardi, a renowned dinosaur footprint expert, to join him and his colleagues in Broome (above). Leonardi was quick to acknowledge the international significance of the dinosaur sites at Broome, stating that the sauropod tracks were made by animals up to 30 metres in length and represented some of the largest footprints ever discovered.

Article © Broome Advertiser

a reality, with mining giant Woodside Energy wanting to build the facility at James Price Point, about 30km north of Broome. The plant was to be the second largest in the world, with an industrial precinct extending over 20km of coastline containing the dinosaur tracks. Due to his long-standing research into the Broome dinosaur tracks, Thulborn was a valued authority on their scientific importance, and was contacted by members of the Broome community for support when they were threatened with the compulsory acquisition of 2,500 hectares of land containing the tracks.

The area covered by the dinosaurs tracksites has immense significance

to the local Aboriginal people, incorporating a vital segment of their mythology and cultural spirituality. The Aboriginal Law encoded in the song cycle has an unbroken tradition through to the present day, with people in the area retaining traditional links with their law, land, and resources, despite immense external pressures. The song cycle associated with the Broome coastal area relates the adventures of beings who travelled across the seas creating and naming islands, reefs, sandbanks, and marine species. They brought with them laws and rituals, their ritual paraphernalia often becoming metamorphosed into marine and coastal

features. There was concern that any adverse impact on the integrity of any trackway sites would have far-reaching effects on Aboriginal people throughout the Dampier Peninsula.

Upon his return from Broome, Thulborn was soon busy submitting reports to major advisory and decision-making bodies, including the Department of Environment and the Australian National Heritage Council, to inform them of the importance of the tracks, and the effects the proposed development could have on them. He met with some success, with a National Heritage Listing being secured for the dinosaur tracks in the Broome Sandstone. However, this



The rear footprint of a Thyreophoran dinosaur. The Thyreophora group includes both ankylosaurs and stegosaurs but recent interpretations suggest that this track belongs to an ankylosaur.
 Photo Dr John Long courtesy Dr Tom Rich and Dr Pat Vickers-Rich

A very well preserved sauropod trackway showing the prints of both back and front feet.
 Photo Nigel Clarke



Footprint of a very large ornithopod with a smaller print superimposed over one toe.
 Photo Nigel Clarke



Small 18cm-long theropod tracks.
 Photo Nigel Clark



Large 37cm-long theropod track.
 Photo Nigel Clark





Photo Nigel Clarke

Goolarabooloo Law Man Richard Hunter points out an exceptionally well preserved sauropod track to Dr Tony Thulborn in 2009 (left). Dinosaur tracks along the coastline north of Broome hold great significance to the traditional owners of the area, with some forming part of a 'song line' of sacred sites used in Aboriginal ceremonies. The long-term safety of the tracks led to National Heritage listing of the area in August 2011 following opposition to a gas hub facility proposed for James Price Point (above).

listing does not provide protection against industrial development – it just requires any development to mitigate impact on the heritage values of the area. In order for this to occur, the heritage values of the area need to be understood, something that concerns Thulborn as he does not believe this is the case. Another very real concern is the increased exposure of individual tracks to theft – something that has happened in the past and generated misunderstandings and ill feelings throughout the Broome community.

These issues have led to the suggestion that preservation of the tracks would be best addressed by removing them and placing them in a museum. Having studied the Broome tracks *in situ* for nearly 20 years, Thulborn was disappointed with the suggestion for a number of reasons. Apart from the cultural heritage devastation an action of this magnitude would cause, removing the footprints

from their environment would make understanding their relevance impossible. A dinosaur track is a complex, four-dimensional object, an outcome of a dynamic interaction between a dinosaur and its environment, rather than just a neat impression on a rock surface. A selection of pristine specimens in a museum cabinet is merely one small photogenic sample from a much bigger scientific story, which, even today, is barely understood. Thulborn's research into the Broome sandstone has identified a remarkable array of sedimentary rocks and structures which were laid down in an equally wide array of ancient environments. Each of these environments has its own distinctive suite of dinosaur tracks which offer an unrivalled opportunity to investigate the habitat preferences and numbers of different dinosaurs – the removal of the tracks from their environments would mean the loss of this opportunity.

Like all contentious issues, there are several sides to the story. While the proposed facility would lead to jobs and money, it could well lead to the degradation and possible destruction of an area with World Heritage values while radically changing the social and cultural values of the region's inhabitants. The whole issue is complicated even more by conflicting reports throughout the media with opinions and counter opinions being constantly badgered back and forth between different parties. This has only served to make matters worse, with the general public getting, at best, an incomplete or distorted understanding of the issues. Thulborn is certain that there are solutions that are workable. One can only hope that, somewhere in the chaos, one of these can be reached that will satisfy all parties without jeopardising an Australian national treasure of such unparalleled significance as the dinosaur tracks of Broome.



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