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TRACE FOSSILS IN THE MUSEUM

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GEOLOGICAL CURATORS' GROUP - June 2006

DINOSAUR TRACKS FROM DORSET: A TWENTY-FIVE YEAR RETROSPECTIVE

by Paul C. Ensom

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The practicalities of and issues connected with the collection of dinosaur tracks are considered in the light of the writers experience while Assistant Curator at the Dorset County Museum from 1978-1989, and subsequently. A number of short case histories are given.

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Introduction

This article is based on a talk, 'Dinosaur tracks from Dorset (A twenty year retrospective)', given at the GCG Seminar meeting held at the Yorkshire Museum on December 4th 2000. My brief was to review my experience of dinosaur tracks in Dorset and the impact they had on both the Dorset County Museum (DORCM), and, by extrapolation, could have on other museums. The seminar was divided into two parts. Firstly I offered a cautionary introduction under six headings which looked at how such material had been collected and the impact such specimens may have on the recipient institution, before giving 'A twenty year retrospective' of my Dorset experiences with dinosaur, and other, tracks. This article broadly follows the same format, with the addition of sections considering why dinosaur tracks are important and why we should consider their collection. In view of the lapse of over five years since the GCG seminar, I have expanded the retrospective's time-span to 25 years.

Catalogue numbers (Cat. No.) given in the text are those used by me (Ensom 1995a) when I reviewed the majority of Purbeck Limestone Group track discoveries, published and unpublished, and provided a comprehensive indexed catalogue of them. The indexes covered stratigraphy, locations, persons, repositories/institutions, palaeontology, and others – which included load-casts and water-hole.

The importance of dinosaur tracks

Before considering the practicalities of collecting dinosaur trackways, why are dinosaur tracks of such interest? Trackways (two or more tracks) or an *in situ* track (an individual print) provide unequivocal evidence for the presence of a dinosaur at that locality when the sediments had recently been laid down. Dinosaur bones found in sedimentary rocks may be derived from older strata or be parts of 'recently dead' animals washed down by a river. Complete carcasses may have drifted down a river and out to sea, before sinking to the sea-floor and being buried by sediment. The presence of the bones and even skin of scelidosaurs in the marine shales and clays of the Lower Lias of west Dorset is a good example of a dinosaur being found in a fully marine environment (Norman 1985). Tracks may be made in shallow water and there are well documented examples of swimming traces (Whyte and Romano 2001), which at least indicate the close proximity of land. Dinosaur tracks may provide useful information about the environments in which they were made and the state of sediments when walked on (Ensom 1995a, Romano and Whyte 2003). Dinosaur tracks have the potential to provide valuable information on the distribution, social groupings, behaviour, biomechanics and locomotion of these extinct creatures (Alexander 1989, Thulborn 1990, Romano and Whyte 2003).

Why collect them?

Any museum confronted with the opportunity to collect dinosaur tracks should be asking some searching questions before doing so. Some of these considerations are raised under the 'Practicalities of collection' heading below. Fundamentally, before a decision to collect them is made, thought must be given as to whether the trackways or individual track would be better left where they are. Do they represent something new, either ichnotaxonomically

(preservational considerations are likely to be relevant in this context) or stratigraphically? Do they have display potential? While in Dorset, I was responsible for publishing a number of short accounts recording the discovery of dinosaur tracks which were recorded *in situ* and not collected (Ensom 1995a, b).

In working quarries, there will almost certainly be financial reasons why the destruction of trackways will be inevitable if they are not collected. Either that or they will be broken up and sold off piecemeal to the curious. The collection of pavements of any size will cause some disruption to an industry which relies on extraction taking place primarily during the 'dry' summer season, so that stone can dry and 'cure' before the winter months. Delay to stone extraction has an economic impact; the heavy plant, hired to dig the stone, once on site costs money regardless of whether or not it is working! Exceptionally (see 'Kevin Keates Quarry', below) there may be agreement to sacrifice reserves of valuable stone in order to leave a pavement *in situ*. Coastal sections are likely to be under constant attack from the sea and with the reality of rising sea levels this will become increasingly so. Can representative prints or sections of a track be lifted and preserved which allow the relationship of the different tracks to be studied, especially if the track is new to science or shows features not previously observed? Collecting representative tracks of a large quadupedal dinosaur will be a significant challenge in itself! The case for preserving large parts of multiple trackway sites (see 'Townsend Road' and 'Sunnydown Farm Quarry', below) may be compelling.

Practicalities of collection

Any prospective collector would do well to remember that there are not many geological specimens which come bigger and heavier than dinosaur tracks. They should consider very carefully a number of issues before embarking on their collection. They include the following:

- The ownership of the site. Permission to investigate a site, then to excavate and collect, must be obtained from the landowner(s). Issues of ownership and where any specimens collected will go should be addressed as soon as practicable, unless the exercise is seen as purely an opportunity to record and publish the occurrence. The owner's agreement that the information will be published and/or placed in a public archive should be obtained.

- Legislation and planning. Not only should permission from the owners of a site be obtained, but consideration should also be given to whether local or national laws might be infringed, e.g., National Park and/or National Trust Byelaws, and restrictions pertaining to a site's designation as an SSSI. Consulting representatives of English Nature or their equivalents in Wales and Scotland (both countries have trackway sites), or the local Minerals Officer with the County or District Councils, may be informative. Large-scale excavations may require planning permission if such a consent does not already cover the site.

- The accessibility of the site. Access to remote or inaccessible sites can present huge problems, both during the excavation phase and, critically, during the recovery operation. While quarries will normally have reasonable vehicular access, there may be restrictions on the number of vehicle movements which can take place each day. Coastal locations usually present most of the difficulties confronted at the worst inland venue, with the additional hazards of rocky shores, and tides which can inundate sites and cut-off the unwary. Access by sea could be an advantage. An alternative is collection by helicopter (Figure 1). Access rights will at least need to be checked and may need to be cleared with the owners of adjacent land or land crossed to reach the site.

- Manpower and equipment. Trackway sites will often require several very fit and suitably equipped individuals with appropriate skills in handling heavy blocks of stone with weights up to, and sometimes more than, a tonne. Access to equipment to lift and position such material may be possible through contacts in the local quarrying industry (see also 'Risk assessment', below). Angle grinders were used at a site in 1981 (Figure 2) and can still be hired, though I understand that fitting the blade is a process for which the user should have received training. These are highly dangerous machines, but very effective for isolating and thinning slabs of rock with trackways preserved.

- Costs. Recovering a trackway site will often involve a considerable amount of time. If salaried staff are involved or temporary labour is being contracted, salary costs with attendant overheads should be taken into account. Travel to and from the site will also need to be factored in along with subsistence costs, and, possibly, overnight accommodation. In the absence of friendly support from local industry, the full costs of equipment hire and transport will also have to be taken into account. In the case of the Sunnydown Farm excavation in 1986/87, the Dorset Natural History

& Archaeological Society paid for the cost of the removal of over 300 tonnes of overburden.

• Impact on work. In a world where so much of the working year is mapped out in great detail at an early stage, the serendipitous discovery of important fossil sites may have a significant impact on how that work schedule will then develop. Modification of forward job plans is likely to be essential.

Risk assessment

While I believe that there is a real danger of staff in institutions becoming bogged down with increasingly elaborate and convoluted risk assessments, there is no doubt that a simple and effective process of risk identification is essential before undertaking fieldwork. This is especially so in quarries, whether they are working or not. Coastal locations bring their own set of hazards. Examples of issues which need to be considered are as follows:

• The physical hazards of quarries; unstable faces, falling rocks, trip hazards, unstable and slippery surfaces, the weight of blocks of stone, slurry lagoons and deep water.

• The quarrying process and any linked activity, e.g., waste disposal site, generates large numbers of vehicle movements and many of the vehicles are of such a size that being visible is crucial. In addition, shot-firing may be carried out and the levels of noise encountered in such places is often considerable.

• Environmental factors. The weather can cause considerable discomfort and in extreme cases may result in the need for medical attention. Ill-equipped individuals may suffer from hypothermia or sun stroke and the glare from a large expanse of pale sedimentary rocks is not much different to that from snow.

Actions should be taken to mitigate risks. Of course, this may all seem very obvious and in a sense it is, but there is still no harm in thinking through the issues, and making sure that the correct kit and attitudes are taken into the field.

Collections impact

When I gave the seminar in 2000, the expression 'collections impact' was not something which could be ignored. In the intervening 5 years, a former colleague of mine, Dr Paul Davis, who is the Registrar at the Natural History Museum, London (NHM), has coined the expression 'collections enhancement' as a substitute and, in my opinion, it is a great improvement! A good analogy is the question of whether a half-drunk glass of beer or wine is best described as half empty or half full. Certainly, I have always felt that there is something inherently negative about the word 'impact'. The cynic will accuse Paul Davis and myself of playing word-games, and put it all down to management-speak, and in any case, there is no difference, is there? Well, I think there is. Curators are not just the custodians of a museum's collections on behalf of a society, local authority or the nation, neither is their job solely concerned with the acquisition and preservation of knowledge on those collections. From my days as a curator, I recall a significant part of my job was having the responsibility for enhancing the museum's collection. Of course, collecting enhances the coverage a collection has or, if you like, its excellence. Often there is a consequent increase in understanding of the rest of the collection. All these areas of responsibility have seemed increasingly under threat over the last few years, so I have taken some comfort from some of the articles on aspects of collections and those that care for them published in the June 2005 issue of *Museums Journal*. Having said my bit on this, I can admit that while dinosaur tracks have certainly enhanced collections I have been responsible for, there is no denying that they have had an impact as well!

Collections impact can be considered under the following headings:

• Long term storage and handling. Is the surface to be stored in 'one piece' or as palletised sections on suitable heavy duty racking? Mechanical handling equipment may be essential. Avoid having to handle collections like this more than is absolutely necessary and take into account the requirements for research. The sauropod trackways discovered at Kevin Keates Quarry in 1997 (Figure 3), on land owned by the National Trust, were exposed, recorded and reburied with protective layers on top. Arguably this approach has solved several issues at a stroke, particularly long term storage, and access for research – there is none!

• Access for research. This may influence the long term storage method adopted. A pavement spread out has advantages in providing easy access, but this may not be practicable and racked storage may provide the most space-efficient solution. Reassembling palletised sections for study requires space, is invariably time consuming and potentially damaging for the specimens.

• How a museum displays such material. Single tracks are more readily displayed than rock pavements with trackways preserved over their surface. The latter can provide a spectacular display and several museums have gone down this road, e.g., Hunterian Museum, Royal Scottish Museum (now Museum of Scotland), DORCM and NHM. In the latter case, trackways are stored/displayed outside the Palaeontology Building. In any display situation, good lighting is essential, with low light raking the surface of the slab to show off the moulds or casts of the tracks to best effect; trackways going in a variety of directions present their own problems!

Responsibilities

With the discovery of trackway sites comes a responsibility to record and, if appropriate, publish accounts of them, bringing the discoveries to wider audiences. The data from such sites must not be lost. Writing up a site for publication is time consuming, but such activity falls within the remit of scholarship, a quality espoused by Johnson (2005), who commented that there is a need to redress the balance in museums between 'edutaining' and the 'in-depth understanding of collections'. The responsible pursuit of scholarship is a great opportunity to forge links with local, regional and even national learned societies, universities and other museums.

The big pluses

My experience in Dorset has shown that there are a number of very valuable spin-offs from the discovery of dinosaur tracks.

• Networking. The forging of strong or stronger links with the local quarrying community and with statutory/non statutory organisations, *etc*., can bring on-going benefits at many levels, e.g., being alerted to rediscoveries, new discoveries, early warnings of new excavations, publicity for your museum (see below), access to sites and support when in the field.

• Scientific potential. This may include the publication of papers, new research and the attraction of experts to your museum, benefiting the discovery and existing collections. There is also the potential for day symposia and conferences.

• Display potential. Though challenging (Figures 4-6), as has already been noted, trackways can provide the basis for displays. These have the potential to be spectacular, allowing reconstruction of habitats and the animals which lived in them, and providing an opportunity for visitors to make the connection between an extinct animal and something which actually lived – and left the evidence.

• Potential for a PR goldmine. Dinosaurs have always the potential to capture the interest of the press. What follows is a summary of the 'media-circus' attracted by the Townsend Road discovery in 1981, happening as it did in that period of the summer when Parliament was in recess, and what had become known as the 'Scilly Season', despite a change of occupancy at No.10, was in full swing! The story broke on Thursday 20th August with an article in the *SwanageTimes*, by which time we had been on site for approximately 4 weeks. The author of that article, a local journalist, Andrew Wyllie, was what I think in the trade is called a 'stringer' and a very effective one at that. His story was widely circulated. BBC Radio was quick to enter the arena along with BBC Southern (TV) (Figure 7). Interviews were carried on Radio Solent, Radio 4 (The World Tonight) and Southern Television's 'Nationwide'. The main early evening Radio 4 news (18.00 – 18.30) mentioned the discovery as had an earlier bulletin during the afternoon. Independent Television also gave coverage at this early stage. An active interest throughout was taken by 2 Counties Radio with several broadcasts. Later, Radio 2 carried a live interview on the John Dunn Show, Monday September 14th. Reports indicated that Eire television gave coverage and that the New Zealand press also carried a note. Reports are known to have appeared in Australia and Canada. Local and national press coverage was good, though the accuracy of some of the reports left much to be desired; 'Builder digs up giant lizard fight' and 'Dinosaurs' graveyard discovered' were two of the more entertaining ones in nationals! *The Times*, *Daily Telegraph*, *Daily Mail*, *Daily Express* and latterly *The Sunday Times* all carried articles. In most cases the DORCM and/or the Dorset Natural History & Archaeological Society (DNH&AS), which owned and ran the museum, were mentioned. Similar publicity continued during the lifting of the site and the transport of the pavement back to Dorchester. Purchasing such publicity, much of a high profile nature, would have cost a small fortune and was way outside the DORCM's pocket. Dr David Norman, who visited the site while on holiday, recorded an interview for BBC's 'The Living World' which was broadcast on 30th August and repeated on 3rd September. This demonstrates nicely the potential for involving researchers in such discoveries.

Figure 1. A Westland Wessex helicopter landing dinosaur track casts (DORCM G 866) at Tyneham, Dorset, 1981.
Figure 2. The author uses an angle grinder to cut the trackway pavement (DORCM G 11047) at Townsend Road, Swanage, in preparation for its lifting. (Copyright of Mr S. Price.)
Figure 3. Sauropod tracks at Keates' Quarry, 1997. The broom provides a crude scale.
Figure 4. The Geology Gallery with polythene plans laid on the floor to indicate the position of the pavement blocks as they are brought in from the store.
Figure 5. A breather is taken as a section of the pavement from Townsend Road, Swanage, is carried from the ground floor to first floor Geology Gallery at the Dorset County Museum, March 1983.
Figure 6. The Townsend Road trackway blocks being reassembled.

Of course there were those who would spurn such publicity, seeing it as an inappropriate place for science to be. However, the DORCM took publicity very seriously, seeing it as an essential part of its armoury for getting noticed by local and not so local politicians, the residents of the county and the considerable numbers of tourists who visited Dorset each year. There is a valuable lesson here – being noticed helps you survive.

Alternatives to collection

There are alternatives to the collection of tracks. As happens in one of the cases below (Keates' Quarry), reburial is an option, provided that in a quarry the underlying strata are not required or can be sacrificed. The trackways can be mapped though, in that context, remember that casts on an underside will require turning over before the extent of the trackways can be seen and plans drawn. Another is to take moulds/ casts of the tracks which may be particularly attractive where recovery of the blocks from isolated coastal sections, for example, is impracticable. Latex may provide one particularly useful option. Provided the environmental conditions allow the latex to cure, the suitably strengthened mould can be lifted and rolled up before being carried off-site. A draw-back of this non-rigid medium is that taking a cast from the mould will require a former to permit the original shape of an irregular surface to be restored and held rigid while the cast is taken.

A twenty five year retrospective

When I took up my post as Assistant Curator at the DORCM in 1978, there were several individual dinosaur tracks preserved as either 'moulds' or 'casts', all from the Early Cretaceous Purbeck Limestone Group and Wealden Group. The challenge with these specimens was to see to their curation, linking together the various documentary records. They remained visual reminders of what was becoming clear from the scientific literature, that is, Dorset, and specifically the Isle of Purbeck, was what could be termed a mega-dinosaur trackway site (Ensom 1995a). In 1978, the NHM, Hunterian and Royal Scottish Museums all had displays of trackways collected during the 1960s and 1970s. Over the next eleven years the DORCM would see its own collections enhanced by new discoveries of trackway sites.

Townsend Road – 1981 (Cat. No. 50): The first of these new sites was a chance discovery of dinosaur tracks while digging the footings for a new property at 21 Townsend Road, Swanage, Dorset. It was reported via Mr David Lewer, a local historian and member of the DNH&AS, to the Curator of the DORCM. This led to an excavation carried out by staff and volunteers of the DORCM and members of the DNH&AS, which owned and ran the museum. This was by kind permission of the owner and developer, Mr Dave Selby and his wife Joy. Four horizons with >170 prints were revealed. The tracks were preserved as moulds, casts, transmitted moulds and transmitted casts (for an explanation of these terms, see Ensom 1995a, p. 78). Plans were drawn of the site and eventually the main surface, with a covering of dessication cracks and more than twelve trackways, made on at least two different occasions in the history of the site, was lifted and transported back to Dorchester. The discovery attracted a great deal of public (Figure 8) and media interest, the latter noted above.

This site brought home to me the importance of dedicated volunteer support. Without the help of so many people with different skills we could not have achieved all we did. The tracks and other features were drawn onto Kodatrace by an archaeological draughtsman (Figure 9), forming the basis of Ensom (2002, text-fig. 1). The DORCM's Conservator cast the most important tracks as keyed, multi-part Plaster of Paris slabs (Figure 10) and masterminded the production of archival plaster casts of each individual print before the site was lifted. These were marked with an identifying alphanumeric code and magnetic north. Each print was drawn and measured. A Dyeline of the detailed site-plan was used to plan which, and how, the tracks would be lifted, and to mark out the lines for the cuts to be made with the angle grinder (Figure 11). All joints and incipient fractures were marked with small lines or symbols in black emulsion paint, and zinc-tape numbers which linked to the plans were attached (Figure 12); this helped relocate and assemble pieces of a very heavy and intricate, 3-dimensional 'jig-saw puzzle' at a later stage. The first use of 1:1 polythene plans, in reality tracings of the joint surfaces with numbers written on in spirit felt tip, was made here and proved to be of considerable value. Some parts of the site, where the tracks were more readily separated on slabs only a few centimetres thick and, as a result, were more fragile, were recovered in advance of the main lift (Figure 13). English China Clay Quarries Ltd kindly provided a couple of sacks of locally produced Tertiary ball-clay to help hold fragmentary pieces of the pavement together or support slabs which had lost some of their original thickness. These sections of pavement were stacked on old doors to be lifted onto a flat-bed lorry in due course.

The remaining areas of the site were lifted and recovered using some of the volunteers who had

Figure 7. A BBC Southern TV crew filming on site at Townsend Road, August 1981.

Figure 8. Outreach. Members of the public and parties of schoolchildren, as seen here, were given impromptu lectures! (Copyright of Mr S. Price.)

Figure 9. Townsend Road with volunteers in the background and Derek Moody, the archaeological draftsman, mapping the site in the foreground.

Figure 10. Rodney Alcock, Archaeological Conservator, works with dental plaster to produce a keyed, multi-piece, plaster cast of one of the trackways.

Figure 11. The dyeline plan with cutting lines, block numbers and joints, *etc*., all marked on it in preparation for the lifting of the site.

worked on the site, but also, and most importantly, an enthusiastic band of young offenders from Portland Borstal. The weather, which had been hot and dry throughout the excavation and preparation for removal, broke the night before with strong winds and rain. Fortunately, the day was essentially dry, though the overnight rain had made everything rather greasy underfoot. Remaining slabs were lifted, and either loaded directly onto the lorry or placed on pallets and then loaded. The flat-bed lorry with driver was on loan from Mr Bill Jesty, a local watercress grower and a member of the DNH&AS. Driven to an overnight location for safe-keeping, the lorry arrived in Dorchester on the Saturday morning. With the help of a fork-lift and several trusted, enthusiastic and jemmy wielding(!) inmates from H.M.Prison in Dorchester, and colleagues from the Museum, the pavement was reassembled in a range of outbuildings owned by the DORCM. The plans of the pavement, which had been prepared on-site, proved invaluable, both in the calculation of how the large slabs would need to be orientated to get them to fit into these confined spaces, and when it came to the re-assembly of the pavements. The mission was accomplished with minimum fuss.

Approximately one year later, on a Sunday, with the Museum closed to the public, a team of six, composed of staff and friends, transported one section of the pavement to the first floor Geology Gallery (Figures 4-6). Floor loading had been discussed with a structural engineer beforehand. In the course of a long day, the slabs were brought from the store, about 200 m away, and reassembled. Arranging the lighting was carried out at leisure. Experimentation showed that fluorescent tubes down one side provided a wash of light across the surface to show-off the tracks to best effect (Figure 15). The tracks have been on display since March 1983. In the summer of 2005 the gallery closed in order to start work on the new and enlarged *Jurassic Coast Gallery*, and after 22 years the tracks will be taken off-display.

Worbarrow Tout – 1981: While excavations were proceeding at Swanage, Trev Haysom, a local quarry owner, spotted a fallen block of limestone with two well preserved casts of a dinosaur track on one surface (Cat. No. 59). The Army use this section of coast as a gunnery range and became involved. Through their good offices, the specimen was collected from Worbarrow Tout using an helicopter and flown to the deserted village of Tyneham (Figure 1), a short distance inland. Accessioned into the DORCM's collection, the specimen was loaned to the Army and put on display in the old schoolroom at Tyneham.

The discovery of this single specimen led to a thorough investigation and logging of the strata at Worbarrow Tout in order to ascertain the exact horizon from which it had fallen. Worbarrow Tout had already one documented dinosaur track horizon described first in the 1960s (West *et al*. 1969). In the course of this work, the source of the 1981 track was discovered along with a further eight track-bearing horizons (Ensom 1995b). A published section of the Tout (Ensom 1985) was a valuable spin-off from the initial discovery. Additional specimens were added to the collections of the DORCM including a spectacular block with a pair of superimposed casts of tridactyl tracks (Cat. No.114; Figure 14).

Durlston Bay – 1982: Dr Simon Kelly reported fallen blocks (Figure 16) with tracks in December 1981. Following up these reports in the spring of 1982 I discovered that Durlston Bay, like Worbarrow Tout, had many track producing horizons. Previously, there had been a tendency to correlate discoveries in quarries inland with the section in Durlston Bay. The literature recorded no tracks from Durlston Bay with any accuracy. Fieldwork identified nine track-producing horizons at this locality (Ensom 1995b).

***Purbeckopus pentadactylus* Delair: The holotype rescued and a figured specimen rediscovered - 1983-1985:** In 1963 Justin Delair described a block of limestone with a series of curious tracks over the surface (Cat. No. 12). The specimen, belonging to Mr W. J. Haysom, became the holotype of *Purbeckopus pentadactylus*. The specimen remained in the possesion of Mr Haysom, forming part of his garage drive. Despite this, the surface remained remarkably intact, which says much for the quality of this Purbeck stone! In 1983, Mr Haysom donated the slab to the DORCM. The slab was put on display in the geology gallery.

When Delair described the specimen, he also figured a second slab (Cat. No. 23) bearing further examples of these tracks. The photograph had been taken in a quarry yard. The specimen had then disappeared and attempts to relocate it, as revealed in correspondence in the DORCM, had failed. The author made several attempts to relocate this specimen, including spending some time tramping around a garden in Swanage looking at crazy-paving slabs in the forlorn hope that this important specimen might be there! Some time later, a visit to the DORCM by Mr A. Kirk and his daughter led to a discussion on dinosaur tracks. During that conversation we suddenly realised that a slab of limestone in their garden at Church Knowle might be the missing specimen. Armed with photocopies of the original plate, the Kirks returned to their home and were able to confirm the rediscovery

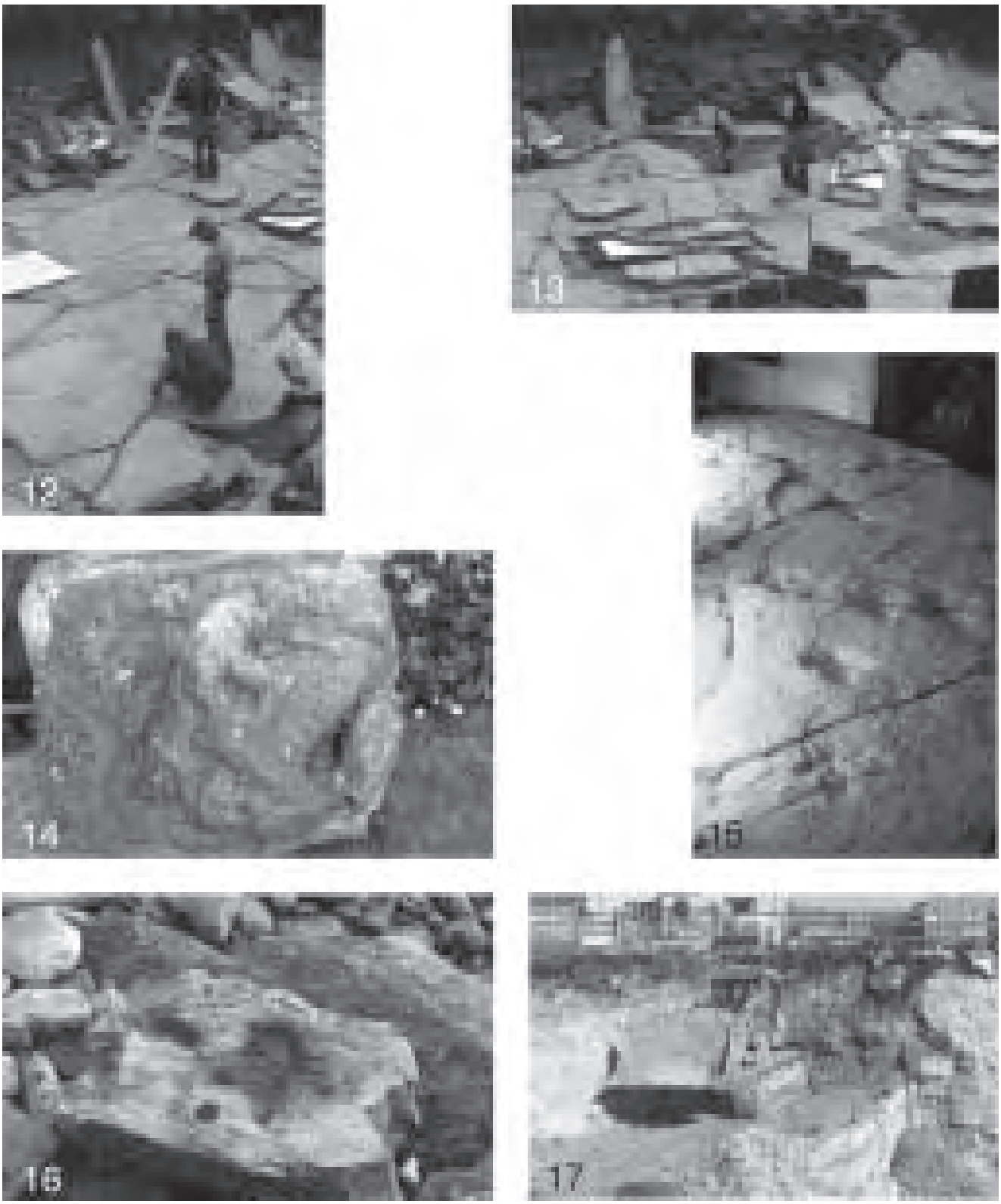

Figure 12. In the foreground, volunteers are marking the blocks and the fractures onto a plan and the pavement at Townsend Road, to allow reassembly.
Figure 13. Sheila Gowers and Rodney Alcock lifting part of the limestone pavement.
Figure 14. Two superimposed tridactyl track casts from the shore at Worbarrow Tout (DORCM G 11374).
Figure 15. Fluorescent tubes throw a wash of light across the reassembled pavement.
Figure 16. A fallen block of limestone with tracks in Durlston Bay, Swanage, Dorset.
Figure 17. Overburden is removed at Sunnydown Farm Quarry, autumn 1986.

of a long lost specimen. Bonuses included the discovery of a further print on the surface of that specimen and the recovery of an hitherto unrecorded slab (Cat. No. 130) with yet another track on the surface, also in their garden. Both specimens were presented to the DORCM. A full account of the discovery of these specimens is given by Ensom (1984, 1986). Subsequently, Wright *et al*. (1997) re-described all these specimens and assigned the assemblage of tracks to pterosaurs.

Sunnydown Farm Quarry – 1986-87: In the summer of 1986 I was asked if I was interested in having a look at a small quarry near Worth Matravers where the geology was not turning out to be quite as expected. There was a carrot in all this; soil-like horizons were present. The Purbeck Limestone Group had become especially famous during the 19th century as an important source of mammals (e.g., Owen 1871); searches made in the following 130 years had produced very little new material, so a chance to examine deposits laid down in conditions where mammals may have lived would always be very attractive. The site proved even more extraordinary than could have been imagined. A second quarry at the same location, slightly higher in the sequence, provided an horizon within the Cherty Freshwater Member. This bed went on to yield a diverse range of tracks including those made by a sauropod or ankylosaur, preserved as casts, some of colossal size, on the underside of the bed of limestone (Cat. No. 125). Permission was granted by the owner of the site for the DNH&AS to fund the removal of the overburden (Figure 17) in order to investigate these unusual trackways. This took the best part of a week, providing a clean top surface of the bed which had to be lifted and turned over to expose the casts of the tracks on its underside. Polythene plans were drawn of each section of the site to be lifted, marking the block joints with spirit based felt tip (Figure 18). The limestone pavement, later estimated to weigh in the order of 34 tonnes, was gradually turned over rather like the page of a book, but thankfully in lots of pieces. The polythene plan when turned over provided the 'template' upon which the blocks could be reassembled. We had hoped to take the blocks straight out of the quarry to lay out on the field above. The weight of the blocks made this impracticable and initially half the site was used as a laying-out space. Of course, the smallest error in the repositioning of one or more blocks ensured that our very heavy 3-dimensional jigsaw showed what resembled the effects of continental drift (Figures 19, 20). The elements eventually intervened and we withdrew for the remaining winter months. On our return, the first half of lifted pavement was removed with the aid of the owner of the site by tractor and trailer. Once this had been completed, the remainder of the site was lifted section by section onto a trailer and removed to join the previously lifted sections.

The limestone pavement on the surface of the field adjacent to the quarry provided the centre of attraction for several open-days organised jointly by the DORCM and the owners of the site. When not on show a large tarpaulin, sponsored by the Curry Fund of the Geologists' Association, covered the overturned blocks. Such was the success of these that the then owners of the site negotiated with the Museum for the use of the pavement as the centre-piece for a dinosaur visitor attraction at Sunnydown Farm. The tracks were placed in a concrete pit where they could be viewed from the raised surround and a purpose-built building was erected around them. The transfer of the pavement to the new venue was a major feat carried out over one week and requiring precision placement of the blocks in order to fit them into a very tight space (Figures 21-23). Sadly, the venture proved unviable and the property was sold with the tracks, which are part of the DORCM collection, still in place. A removable floor has now been placed over the trackways so that at a later stage they can be removed. Discussions have taken place about their use as part of an accessible public display, but nothing has yet come to fruition. While presenting a significant access problem at present, the very fact that this extraordinary site is still extant, under cover and can at some later date be accessed is most fortunate.

Sedimentary rock samples collected from this site require a mention. Their collection and subsequent processing had both short and long-term implications for the DORCM, as well as scientific repercussions. Following the discovery of a small (*c*. 0.05m long) tooth of a theropod dinosaur, the writer became aware of the potential for the recovery of a range of microvertebrate remains, including mammals, one of the reasons the site had been so attractive in the first place. A small test sample of the poorly consolidated sedimentary rock was removed from an upturned block, processed at home and almost immediately yielded an incomplete tooth of a multituberculate mammal. Further sieving yielded more mammal teeth. From then on, after each slab was lifted, the top *c*. 0.02 m of the clay in which the dinosaur tracks were made was collected. Fertiliser sacks were donated by a sympathetic farmer, thoroughly washed and then filled with around 15 – 23 kg of sedimentary rock. Each carried the number of the block(s) from under which the sample had been taken. An important lesson learnt was that plastic plant pins, with the number penciled or marked with indelible ink and inserted inside the sacks, would have been more reliable than numbers applied on the sometimes damp,

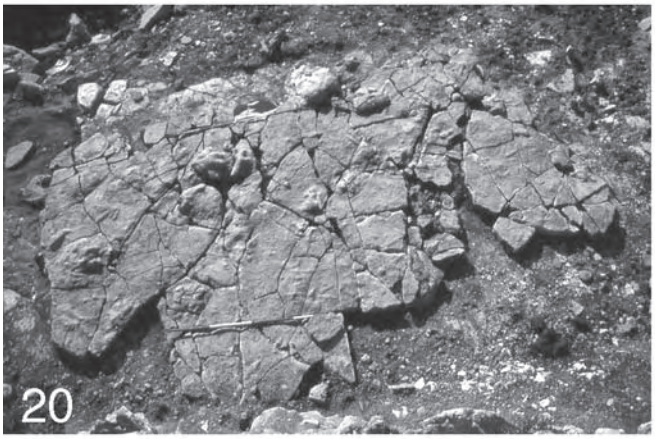

Figure 18. The exposed surface of the trackway bed at Sunnydown Farm Quarry. Note the polythene sheet at the right-hand end. Steve Etches is the figure on the right.

Figure 19. The lifted pavement, autumn 1986; note the 'continental drift' effect (see text) which has resulted in gaps opening-up between the blocks in the foreground.

Figure 20. The pavement has been 'juggled' back into position, winter 1987.

Figure 21. The concrete pit in which the trackway pavement was reassembled. Note the polythene plan on the floor which was used to get the best fit. The first pieces have been positioned.

Figure 22. The pit is gradually filled.

Figure 23. The *c*. 34 tonne pavement (DORCM G 11050) now occupies the whole of the pit.

and often grubby, surfaces of the sacks. This, combined with the abrasive effect of sack-upon-sack as they were moved around over the weeks before their contents were emptied and sieved, ensured that some numbers were lost. The total sedimentary rock sample amounted to approximately 3 tonnes. The samples were dried and then processed by wet sieving. Initially, this was carried out manually, working from home where the author had a dedicated space for processing sediment. The scale of the operation was such that a bulk sieving machine (Ward 1981) was commissioned from Steve Etches, known principally in geological circles for his internationally important collection of Kimmeridge Clay fossils. This labour-saving system greatly increased the rate at which samples could be reduced to 5% of their original weight. Picking the residues was enormously time-consuming and carried on outside museum working hours. The rewards were great, with new species of amphibian (Evans and McGowan 2002), the first from the Dorset Purbeck Limestone Group, and mammal being recovered and described, and a review of both the lepidosaurian reptiles and mammals being undertaken, leading to taxonomic revisions (see papers by Evans & Searle and Sigogneau-Russell & Kielan-Jaworowska *in* Milner & Batten 2002a). The significance of the mammal fauna recovered from Sunnydown Farm and other sites has been acknowledged by Kielan-Jaworowska *et al*. (2004, p. 45).

The discovery of the rich microvertebrate fauna highlights the serendipitous nature of field collection. Such discoveries were not predicted when the excavations began and I have often wondered what other organisation would have wished to, or could have become involved and been so willing to, provide the resources for this work. Yet, without the commitment of the DORCM/DNH&AS, their staff and volunteers, and research workers in other institutions, science would have remained blissfully unaware of the remarkable range of new vertebrates and other material, including eggshells, yielded by these strata. These new collections, combined with the already substantial collections from these strata, led Milner and Batten (2002b, p. 6) to say "….. no other vertebrate fauna from before the Campanian of North America approaches this diversity". The resurgence of interest in these strata stimulated by these discoveries led to a well attended symposium, 'Life and Environments in Purbeck Times' held at the DORCM in March 1999, and supported by Amerada Hess and The Palaeontological Association. The latter published many of the papers in *Special Papers in Palaeontology* (Milner and Batten 2002a).

The initial implications for the DORCM were what would happen to the trackways, if present, once recovered. Then, unexpectedly, it was compounded by the question of how the museum would, in the longer term, deal with the substantial collection of microvertebrates and the inevitable research interest they would generate. Collections of tiny fragile teeth mounted on pins in glass tubes, and other picked residues also stored in small glass tubes, present significant collections management issues especially in museums where resources are stretched.

Acknowledgement of this as an issue brings me back to the matter of 'collections impact' and 'collections enhancement', and in this case the unquestionable enhancement of our knowledge of these extraordinary strata and the filling of gaps in the 'Tree of Life'. What should the attitude of the museums' profession be to collection on such a scale? What is the purpose of museums? Should the woeful lack of resources to support collections in so many, and the Nationals are not immune (Morris 2005), mean that opportunities for serious collection and preservation to underpin long-term research be passed by? Wilkinson (2005, pp. 5, 15), in the potentially influential report of the Museums Association Inquiry into collections, acknowledges the lack of 'vibrancy and rigour' in the development of collections. There is a real danger that the 'bean-counter mentality' which has developed and then driven so many museums over the last 15 or so years with targets for this and for that, along with the growth in 'edutainment' (Johnson 2005), is having an increasingly serious effect on their ability to reach out at a scholarly level, interacting with local extractive industries, members of the public, local societies, local authorities, civil engineering contractors, *etc*. I do not speak for the DORCM, but I would be surprised if in 2006 they would let themselves become involved in another Sunnydown Farm site, and the potential loss to communities, both local and national, both public and academic, and to that august museum of over 150 years standing, is plain to see.

Kevin Keates' Quarry – 1997: In 1997, Trev Haysom, who had spotted the fallenWorbarrow Tout block in 1981, was walking with his family through that area peppered by quarries around the Langton Matravers and Acton areas of the Isle of Purbeck. One of the family noticed some large (maximum diameter seen was 1.14 m) oval to circular, shallow depressions across a recently cleared area of limestone in a quarry being worked by Kevin Keates. These strongly suggested dinosaur track moulds of a rather different sort to those found before.

Figure 24. The 1 m^2 stringed grid being used to measure and draw the track surfaces. The large feature on the far side of the block is a sauropod track.

Figure 25. A mini-blackboard with block number and feature number. The scale bar is 0.1 m.

I was fortunate enough to be on holiday in the area soon after their discovery and was able to visit the site. Armed with brushes, the features were swept clear of debris revealing a considerable number of tracks (Figure 3).

The University of Portsmouth visited the site early on and carried out some recording. The National Trust (whose land was leased by Kevin Keates) involved the University of Bristol and, as a result, Dr Jo Wright, then based at Bristol, was commissioned to document the site. A short report was published (Wright 1998). Once recorded, and after an open day when the public could view the discovery, the site was reburied *in situ* in order to preserve it for the future.

Belle Vue Quarry – 1997 to date: The discovery of identical prints to those seen at Keates' Quarry at the same horizon heralded the start of what continues to be a fascinating opportunity to watch a quarry develop, exposing a succession of bedding planes through the 'Middle Purbeck Beds' with tracks preserved as moulds or casts, and other features including microvertebrate horizons. Through the kindness of the owners, Mr and Mrs W. T. Haysom, access has been freely given and research at this site is ongoing. Track-bearing pavements have been recovered and are being held by the Haysoms.

The Isle of Portland dinosaur tracks – 2002 to date: During 2002, tipped blocks of Purbeck limestone from the 'Thick Slatt' were observed to have dinosaur tracks on one of their lower surface. The author, then employed by the NHM, was invited by Richard Edmonds, on behalf of Dorset County Council, to assist with the recording and decision making process which would lead to the recovery of these specimens. The recording was carried out in 2003/04 and priority lists made for the recovery of the blocks.

The recording process started with a check of the numbering of the blocks identified as having tracks preserved on their lower surface. Some blocks had been numbered with a spray can, as used in the stone industry, as they were lifted from the heaps of tipped stone where they had first been spotted. Those that had been omitted at this stage were added to the sequence and, as an insurance, the numbers were carved with hammer and chisel into the sides of the blocks. The recording of the track surfaces was carried out using a 1 m^2 stringed grid which was laid on the surface with data being transferred to squared paper at a scale of 1:10 (Figure 24). Polythene plans were made of each block; these are available as templates in planning displays in the future. Photography was carried out when the sun was low in the sky to provide a raking light, showing the features to best effect. With only a short period of time with optimum lighting, and over 100 features to record, this required considerable speed, and a method for identifying each feature and the block it was on. To achieve this, a set of tiny black-boards (0.045 x 0.09 m) were made. These had the block number and feature reference denoted by a letter, as previously allocated on the plans of the blocks, written in blackboard chalk. A general oblique view was taken of each block before individual features were recorded (Figure 25). A 0.1 m scale bar with cm gradations was included in each picture. The blackboards could be wiped clean with a damp cloth and recycled very quickly.

The tracks are preserved as 'casts' on the base of a thick bed of limestone. Unfortunately, only a small percentage of the original blocks of limestone from this bed were preserved at the time of extraction, sometime before their discovery! Trying to make sense of the remaining pieces can be likened to having a 100 piece jigsaw, throwing away 95 pieces,

and then trying to work out what is going on with the remaining five. Despite this, the site is fascinating, providing only the second recorded occurrence of dinosaur tracks from the basal part of the Purbeck sequence; both these are from the Isle of Portland. Their discovery fills a gap in our knowledge of the distribution of dinosaurs in Dorset successions deposited during the Late Jurassic - Early Cretaceous, a gap which the writer had been attempting to fill. A footnote to this story was the discovery of a metatarsal of a sauropod from the same part of the succession in a neighbouring quarry, shortly after the recording work had been carried out and, during which process, the presence of a substantial sauropod track was recognised (Figure 24). These tracks are currently owned by the quarry company whose land they are from. They are involved in discussions to ensure their long-term preservation.

Isolated discoveries and donations – 1981 to date: As was noted in the introductory paragraphs, an active interest with a network of contacts can be very rewarding for one's institution. The collections of the DORCM have benefited from a number of what can be best described as isolated discoveries and donations which largely came about through such contacts. In 1984, Mr P. A. Brown presented the DORCM with a very curious specimen consisting of what appeared to be the pad of a foot with several toes arranged around it (Cat. No. 106). In 1985, a small excavation for Purbeck Marble near Harman's Cross to the west of Swanage yielded a substantial 'mould and cast' (Cat. No. 124) of a tridactyl print. The slab with the cast on the base was sectioned parallel to the bedding plane and then polished by Trev Haysom, providing a spectacular view of burrows and other sedimentary structures. In 1992, two intriguing sets of tracks (Cat. Nos 131, 132) were spotted by Trev Haysom on limestone slabs from the 'Downs Vein' of the Intermarine Member. They have been ascribed to a small quadruped. These and the 'Purbeck Marble track' were all presented to the DORCM by W. T. Haysom.

Conclusion

The above serves to show that the investigation and collection of tracks is both feasible and potentially invigorating for both museums and science. While enhancement should certainly be seen as a key aim, the impact of such large specimens on a museum, on the storage and display space available, and on the staff who have to manage them, both currently in post and in the future, cannot be ignored.

Acknowledgements

I take this opportunity to thank all those that have assisted over many years with the excavation, planning, recovery and display of these extraordinary records of life that once existed in what is now Dorset. There are too many to thank them all by name, but a few must be mentioned. Firstly, the owners of the sites whose willingness to grant access has made so much of the above possible. Dave and Joy Selby who presented the Townsend Road pavement to the DORCM; Richard and the late Mary Notley; Trev and Sue Haysom, who have reported so many unusual finds, given specimens and much support; Hanson Bath and Portland Stone; and the Commandant of the Royal Armoured Corps at the West Lulworth Gunnery School. The DORCM and its parent body the DNH&AS, the Yorkshire Museum and latterly the NHM have all been supportive of my involvement. Derek Moody and Diana Lill both made a very important contribution to the drawing of the plans of the Townsend Road site in 1981. Bill Jesty was hugely supportive with the provision of transport and organising a forklift truck to help with the unloading. Sheila Gowers, who helped with much of the track lifting on site, Rob and Ian Curtis, and Tim Batty gave up a Sunday to install one section of the Townsend Road pavement in the Geology Gallery – an amazing achievement!

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