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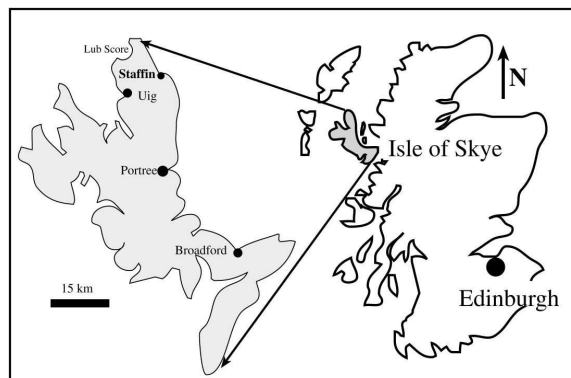
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## Dinosaur in Scotland



View over the Middle Jurassic deposits, that contain dinosaurs, at Port Earlish towards Raasay.

Dinosaurs in Scotland are not something that is generally known. Yet, there are at least three different families represented from bones and a number of different footprint types from the Middle Jurassic. Of the bones, there is a sauropod, a thyreophoran, a coelophysid and another theropod. The footprints include large carnosaur-like footprints, smaller theropod footprints, and ornithopod footprints of different types. All this put together sounds like a decent representative dinosaur fauna from a poorly represented part of the Jurassic worldwide. Sadly, most of these dinosaurs are represented by only one or two identifiable bones. Having said that, the fossil remains that we do have in Scotland, contribute significantly to our knowledge of Middle Jurassic dinosaurs. The footprints are more common but are no less important, helping us to understand little known aspects of dinosaur movement and interactions.



Map of Scotland showing the Isle of Skye

The first dinosaur remains to be found in Scotland was a single footprint. A 49cm long footprint with rounded toes that is now preserved in the collections of the Hunterian Museum at the University of Glasgow. It is now thought that this footprint, which was found on the Isle of Skye in 1982 by researcher Dr Andrews, was made by a bipedal herbivorous dinosaur similar to *Camptosaurus*. There are several difficulties in assigning footprints to particular kinds of dinosaurs. The main one is that we do not have skeletons of all dinosaurs that existed, and another is that there were a large number of dinosaurs with three toes that could have produced very similar footprints depending on the consistency of the sediment. We can only guess which dinosaur made which footprint. Despite this, dinosaur palaeoichnologists (scientists who study dinosaur footprints) are quite happy to give footprints names in the same way that a biologist would name an animal. This is despite the fact that it is possible to have several ichnospecies (footprint species) represented in a single trackway produced by a single animal!



The 49cm long dinosaur footprint from the Lealt Shale Formation.

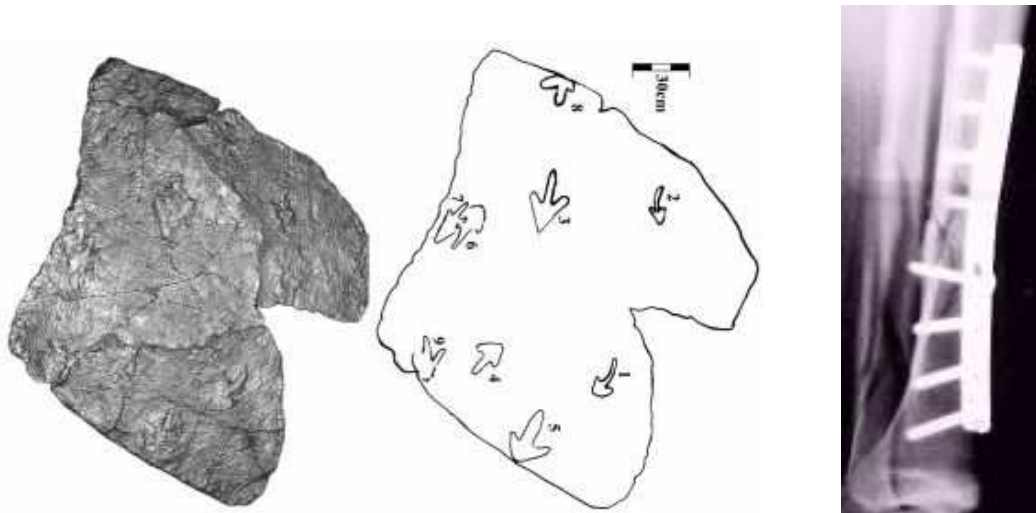
After the first discovery in 1982, it was ten years before the next discovery was made. In 1992, a small fossil partial tibia of a theropod was found in the Lower Jurassic sediments of the south of the Isle of Skye near Elgol by a German collector Herr Metz. At about the same time a Mr Scott Moncrieff discovered a fragment of bone from the north of the Isle of Skye from the Middle Jurassic sediments near to Staffin. This turned out to be a fragment of a sauropod dinosaur – probably a cetiosaur. In 1993 a more substantial bone was found on the rocky foreshore near Staffin on the Trotternish Peninsula, Isle of Skye. Only a third of the bone, discovered by BP geologists Drs Boyd and Dixon, remained on the beach. It was collected for the Staffin Museum by the curator Mr Ross and a team of local enthusiasts.

After receiving a letter from Mr Ross, I travelled to the Isle of Skye to have a look at this bone. It was clear from the rock that encased it, that someone had taken a hammer and chisel to it in order to remove a substantial fragment. Mr Ross and I went to the beach where the fossil had been found and collected a number of small fragments around where the bone had lain. Whilst staying on Skye, I heard of another bone that had been found on the same beach. It had been found by Ms Wolfe of the Oystercatcher Restaurant. The bone, however, did not fit well with the Staffin Museum specimen until we discovered that one of the small fragments of bone we had found on the beach earlier fitted both the rock and the bone from the restaurant. This left a gaping hole in the middle of the bone. The middle piece could have held the muscle attachment protruberances that are crucial to the identification of such bones. After a little bit of publicity that followed the discovery, a parcel arrived anonymously at the Hunterian Museum containing the missing section of the bone. It is now thought that this bone is a humerus of a cetiosaur (a stocky sauropod dinosaur from the Middle Jurassic). Whoever it was who found the bone thought it was a section of a tree when they first found it. This is not surprising, as these large dinosaurs had growth rings on their bones that look very similar to tree rings. This anonymous person played a crucial role in helping us uncover the identity of Scotland's largest dinosaur. One day, I hope to be able to thank them.



The cetiosaur limb bone from Valtos

As I mentioned before, dinosaur bones are not the only remains to be found on the Isle of Skye. Footprints are also an important indicator of dinosaur activity in Middle Jurassic Scotland. In January 1996, I was showing a colleague from America different Middle Jurassic localities around the Trotternish Peninsula when I stumbled upon the second set of dinosaur footprints. There were about nine footprints on one surface of a loose block of limestone on the beach at Port Earlish. There were at least two different types of footprint. One was small with narrow curved toes (about 15cm long), and the other was larger with stubby toes (about 25cm long). They were all much smaller than the first dinosaur footprint and were found in close proximity (within 100m of the first discovery). These footprints were, however, from a different, and slightly younger, rock stratum. These were from the Valtos Sandstone Formation, whereas the first footprint was from the Lealt Shale Formation. As these footprints were so significant, it was decided that they should be removed from the beach and placed in a museum, as winter storms would destroy them quickly. After a week of using rocksaws, pneumatic drills, heavy chisels and sledge hammers, the rock eventually split to allow it to be removed safely. This operation was not without its casualties though. After stopping for lunch on the final day, my leg broke in multiple places and I had to be airlifted to hospital in Stornoway. After 6 months, the cast was removed and after a further 6 months, the metal plates were removed. The lesson here is that, despite being extinct for over 65 million years, collecting dinosaurs can still be a dangerous sport, not for the faint hearted!



The 1996 footprints from Port Earlish, and my broken leg

Whilst still on crutches, I returned to Skye with a group of geologists from an oil industry conference to show them a few of the dinosaur localities and associated sediments. A most productive trip, as I found the tail bone of a small carnivorous dinosaur closely related to the North American Lower Jurassic dinosaur *Coelophysis*. This is the youngest occurrence of this type of dinosaur I know of. The tail bone is indistinguishable from the 17<sup>th</sup> tailbone of the *Coelophysis* displayed at the American Museum of Natural History in New York.



*Coelophysis*-like tail bone

In 1997, there was another dinosaur disaster on the Isle of Skye, as well as a major discovery. Banker Colin Aitken, was on holiday with his family on the Isle of Skye when he noticed a bone in a rock on the beach not far north of the electrical power station at Berreraig Bay. He hid the rock beside a ruined building and returned to Staffin to inform Dugald Ross of the Staffin Museum of his discovery. By the time Dugald had gone to recover the bone, someone had beaten him to it and the rock had been smashed and the bone gone. Thankfully, in the rubble left by the unknown collector, were two bones still barely visible in the rock. When these were analysed, it was found that they belonged to the ulna and radius of the earliest known thyreophoran dinosaur (ones like *Stegosaurus* and *Ankylosaurus*). This means that the bone that went missing was likely to be the humerus of the same animal. We do not have any clues as to where this bone may have ended up, but continue to hope that one day it will be given to a museum somewhere. Perhaps it will even be reunited with the rest of the dinosaur to provide us with a better picture of the dimensions of this important animal.

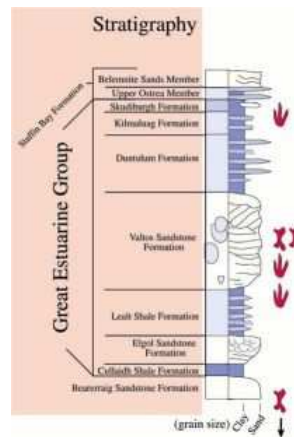


The ulna of the earliest thyreophoran dinosaur



The Staffin Museum has the largest collection of Scottish dinosaur material.

In 2002, local hotelier, Cathie Booth, collected a dinosaur footprint from a much visited beach near Staffin, whilst walking her dog. This stimulated a detailed search of the exposed rocks at the beach in mid January by her husband Paul, Dugald Ross and myself. What we found was not expected. We found some very large *insitu* dinosaur footprints. All of them were between 30 and 55cm long with three narrow toes. These were from the Duntulm Formation, the youngest dinosaur remains yet found on the Isle of Skye. The animal that made these tracks was possibly something related to the large carnivorous dinosaur, *Megalosaurus*. Yet another important addition to the ever growing dinosaur fauna of Scotland.



Stratigraphy of the Middle Jurassic of the Isle of Skye

I returned to Skye in August 2002, to have another look at these footprints only to find them covered by 2m of drifting sands. Every year from March until the end of September, the footprints are protected by a thick covering of sand. Perhaps this is one of the reasons why they were not previously spotted by the hordes of geologists and picnickers to the well known rocks of the Staffin slipway.

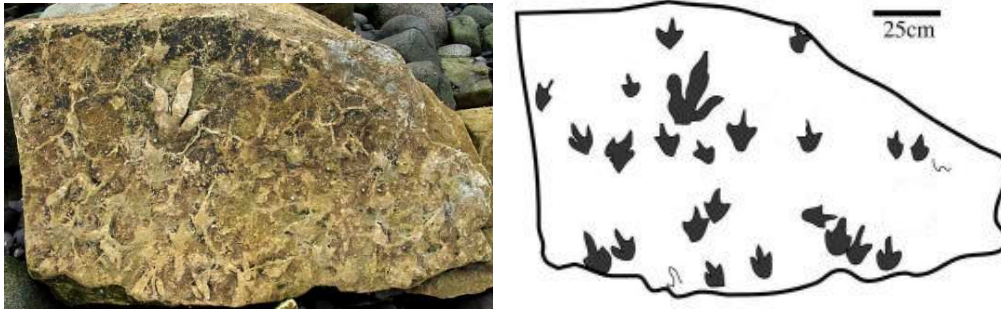


Neil Clark with some large dinosaur footprints near the Staffin slipway

As if this was not enough to shame all those geologists who have researched the sediments on the Isle of Skye for well over a century, another dinosaur discovery was made on the western side of the Trotternish Peninsula later in 2002. These were rocks that had been classified as Duntulm Formation on older geological maps, but actually contain fossils characteristic of the younger Kilmaluag Formation. Scores of dinosaur footprints were found scattered on the beach at Score Bay (Lub Score) by Paul Booth and Dougie Ross. The majority of these footprints were small at about 7cm in length. On one slab there were about 24 footprints of a larger individual with many smaller footprints representing about 4 other animals. After applying rigorous statistical and morphometric analysis to the footprints from this new locality, it was found that the larger footprints could not be distinguished from the smaller ones. What did the footprints on the large slab represent then? Was it a gang of delinquent juvenile dinosaurs ganging up on an unsuspecting adult? Possibly, but all the tracks suggest that the animals were not chasing, but walking. Perhaps the adult and the youngsters



walked over the same damp sediment at a completely different time? There does not seem to be any overprinting of the footprints and the youngsters' footprints are all to the same depth indicating that at least they walked over the sediment at the same time. What about an adult taking its chicks for a walk ... perhaps to a feeding, or watering ground? This is a behaviour that is not unknown in the dinosaurs' closest living relatives, the birds. Ducks are frequently seen taking their young to water. Could this be the explanation for the footprints? If it is, and I don't see why it couldn't be the case, then this would be the first evidence worldwide for post-hatching parental care in theropod dinosaurs.



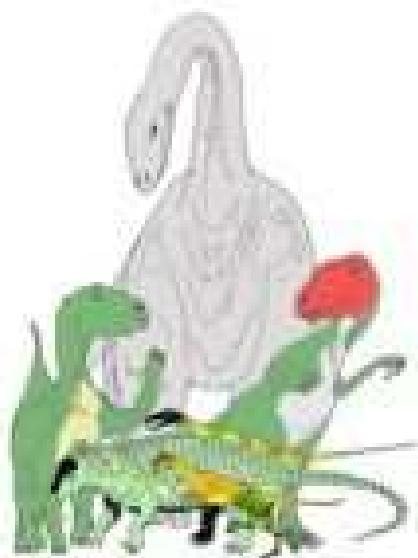
Dinosaur footprints from the Kilmaluag Formation, Score Bay

When I went up to look at the locality again in 2004, I collected a number of footprints for my research and for the Hunterian Museum's collections. Amongst the samples was one small piece of sandstone about 10cm width that had a partial footprint on it. The footprint was about 7cm long, but lacked the proximal end, so was not much use for any statistical analysis I was undertaking. Sitting in my office one day, the sun shining through the window, I examined the piece of sandstone trying to angle the footprint to gain the maximum shadow. In doing so, I could see a much smaller footprint impressed on top of the larger footprint. In fact there were two, but one was more obvious than the other. This got me thinking about how small a dinosaur footprint could get. What size were the hatchlings, and what size of footprint did they produce? I did a search for the smallest footprints from elsewhere and turned up some minute dinosaur footprints from Parrsboro, Nova Scotia, Canada. These were about 1.9cm long and from the late Triassic to Early Jurassic. The ones I had just observed were only slightly smaller at 1.7cm in length. Did this make them the World's smallest dinosaur footprints? Well, the authority on what is the largest, smallest, youngest, oldest, is of course, the book of Guinness World Records. So I contacted them to see if their researchers could come up with smaller footprints. They couldn't, and the footprints from the Isle of the Skye were officially given the status of the World's smallest dinosaur footprints in 2006. This, of course, is not why the footprints are significant. The reason they are significant is because they provide us with evidence of hatchlings leaving the nest at a very young age. The size of the dinosaur that made these tracks would have been no more than 18cm long and 7cm high at the hip. This is less than half the size of the smallest dinosaur fossil yet found (*Microraptor* from China).



The World's smallest dinosaur footprint

Despite the small area of exposed rocks of the right age and environment, and the tiny amount of dinosaur remains, Scotland has proved that it is an important contributor to our understanding of Middle Jurassic dinosaurs, and of dinosaur behaviour. I am constantly amazed that so much has been recovered from the storm swept beaches of the Atlantic island that is the Isle of Skye, Scotland's Jurassic Isle.



Selection of dinosaurs whose remains have been found on the Isle of Skye