

## FOUR NEW DINOSAURS NAMED FROM THE ISLE OF WIGHT

Alex Peaker

### Introduction

In 2021, four new genera of dinosaur were recognised that now reside in the collections of Dinosaur Isle Museum: *Riparovenator milnerae* (Barker et al., 2021), *Ceratosuchops inferodios* (Barker et al., 2021), *Brighstoneus simmondsi* (Lockwood et al., 2021), and *Vectiraptor greeni* (Longrich et al., 2021).

The incomplete nature of the fossil record often creates difficulties in taxonomy. Caution can lead to new species going unrecognised, yet too low a threshold can result in *nomina dubia*. Among the dinosaur fossils found on the Isle of Wight, there are taxa that could possibly be named from very incomplete specimens (Benson et al., 2009, Sweetman, 2004). At the same time, across the world numerous dinosaurs based on fragmentary remains have, or probably should be synonymised or relegated to *nomina dubia* (Batten, 2011).

The dinosaurs of the Isle of Wight have been studied since the start of the 19th century (Torrens, 2014); indeed the type specimens for Dinosauria itself includes the sacrum of an iguanodontian found at Brook, on the south-west coast of the island (Owen, 1842). Eminent palaeontologists such as William Buckland, Gideon Mantell and Richard Owen (amongst many others) all recorded dinosaurs from the island's Wessex Formation, sometimes based on fragmentary remains. Through time, some of these dinosaurs have been synonymised or recognised as *nomina dubia*, making them no longer valid names. However, with continued new discoveries the number of species has slowly increased and today the dinosaur bearing beds of the island (primarily the Wealden Group), represent a highly diverse ecosystem (Austen & Batten, 2018, Batten, 2011, Sweetman, 2016).

Several species are recognised from good partial, or near complete skeletons: *Iguanodon bernissartensis*, *Mantellisaurus atherfieldensis*, *Valdosaurus canaliculatus*, *Hypsilophodon foxii*, *Neovenator salerii*, *Eotyrannus lengi*, and *Polacanthus foxii*. Numerous other species have been identified from partial remains, ranging from an isolated tooth to partial skeletons. Many of these will represent genuine taxa, yet it is likely several will be synonymised and should only be tentatively referred to until more complete remains are found (Batten, 2011, Martill & Naish, 2001). Authors have quantified the island's dinosaur diversity with what are thought to be valid taxa (Lomax, 2014, Batten, 2011, Martill & Naish, 2001), or estimated the likely number based on sampling (Sweetman and Insole, 2010). Published estimates for the number of dinosaur species recognised from the island's Wealden Group vary between 20 and 30.

The taxonomy of iguanodontids has frequently been debated; however, since the 1980s, the presence of just two, medium to large sized iguanodontids on the Isle of Wight has generally been agreed upon (Norman, 1980 and 1986).

For a long time, the taxonomy of the island's theropods has been confused, only starting to become better

understood after the discovery of *Baryonyx walkeri* (Charig & Milner, 1986) in Surrey, and *Neovenator salerii* (Hutt, S. 1999) on the island. Since then, our knowledge of their diversity has been increased by recent finds (Sweetman, 2016, Austen & Batten, 2018).

Dromaeosaurid dinosaurs are represented by scant partial remains including a sacrum (Norell & Makovicky, 2004) and teeth (Sweetman, 2004). A new genus has been erected (Longrich et al., 2021), adding a second formally named dromaeosaurid to the island's dinosaurs.

### Overview of the geology

Most of the island's dinosaur discoveries have come from the Wessex Formation (Wealden Group). To the west between Compton and Atherfield, and to the east at Yaverland, the oldest of the island's rocks, dating back some 125 Ma are exposed (Gale, 2019). The Wealden Group of the Isle of Wight consists of the Wessex Formation overlain by the younger, Vectis Formation. The Wealden of the Isle of Wight is Early Cretaceous in age with the oldest exposure being Barremian, while the Barremian–Aptian boundary passes through the top of the Vectis Formation (Gale, 2019).

The Wessex Formation of the island was deposited by a fluvio-lacustrine system that supported a diverse wetland biota. Active faults during deposition led to the development of low hills to the north, confining the system to a shallow east to west trending valley. Much of the formation consists of purple-red overbank mudstones and siltstones, interbedded with fluvial sandstones. (Gale, 2019, Insole et al. 1998, Osborne White, 1921).

Within the Wessex Formation lie sporadic blue/grey clays that are rich in plant material. Referred to as plant debris beds (Sweetman and Insole, 2010), these beds are thought to have been formed by large scale flooding events, with waters depositing their loads into lower lying areas as they lost energy. The result is relatively thick deposits formed over a short period of time, causing rapid burial and anoxia (Sweetman and Insole, 2010). These few beds are the source of many of the dinosaur remains of the island.

### History of the island's iguanodontids

The iguanodontids are a group of mid-sized herbivorous dinosaurs that share 'leaf shaped' serrated teeth (Fig. 1). In the Late Cretaceous, more derived forms (the hadrosaurids), evolved a dental battery with closely packed teeth stacked over each other providing a large grinding surface (Naish & Barrett, 2016). The name *Iguanodon* (Greek, Iguana toothed) refers to the similarities Gideon Mantell noted whilst naming the dinosaur (Mantell, 1825).

The iguanodontians are the first group of dinosaurs to have been recognised on the island. Bones found at Sandown in the 1820s were initially thought to be cetacean, Mantell later recognising them to be *Iguanodon* (Torrens, 2014). In the succeeding two

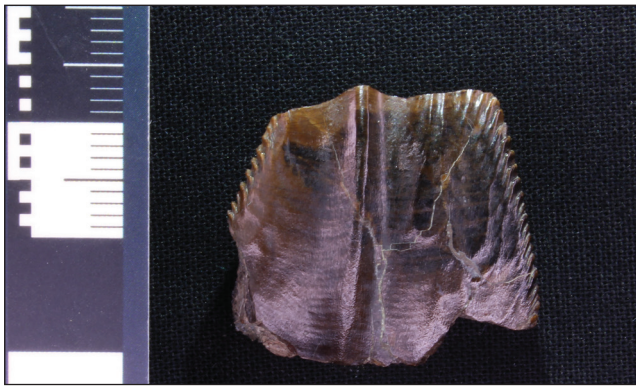


Fig. 1: MIWG : 2142 A partial dentary tooth of *Iguanodon bernissartensis*

centuries, the number of iguanodontids recognised on the island varied, with proposed taxa including *Iguanodon bernissartensis* (Boulenger, 1881), *Iguanodon seelyi* (Hulke, 1882), *Mantellisaurus atherfieldensis* (Hooley, 1925), *Vectisaurus valdensis* (Hulke, 1879) and *Valdosaurus canaliculatus* (Galton, 1975). Of these, *Iguanodon seelyi* and *Vectisaurus valdensis* have been considered synonyms of *Iguanodon bernissartensis* and *Mantellisaurus atherfieldensis* respectively (Lockwood et al., 2021). *Valdosaurus* has been placed in its own group, the dryosaurids (Galton, 1975). The larger, more robust iguanodontian has generally been referred to *Iguanodon bernissartensis*, and the smaller, more gracile one as *Mantellisaurus atherfieldensis* (Lockwood et al., 2021).

The holotype of *Iguanodon* (Mantell, 1825) was based on teeth found in Sussex. Subsequently, due to the lack of comparable material, the International Commission of Zoological Nomenclature (ICZN) recognised a near complete specimen of *Iguanodon bernissartensis* from Bernissart, Belgium, as the lectotype of the genus and species (Charig & Chapman, 1998). The holotype of *Mantellisaurus atherfieldensis* was discovered near Atherfield Point in 1914 (Hooley, 1925), the remains of which are now partly on display in the Hintze Hall at the Natural History Museum (London). *Valdosaurus canaliculatus* was erected from a pair of femora found at Cowleaze Chine by William Darwin Fox<sup>1</sup>. The dinosaur is best represented by a partial, articulated skeleton, displayed at Dinosaur Isle Museum (Barrett, 2016).

Within the collection of Dinosaur Isle Museum, the iguanodontians are the most common dinosaur remains, represented by several partial or near complete skeletons, and numerous isolated bones and teeth. The frequency of their discovery is likely due to them genuinely being a more common animal within the Wessex Formation ecosystem, as well as the dense, robust bones of the larger members of the group having a higher preservation potential (Lyman, 1994., McLain, 2016.).

### ***Brighstoneus simmondsi***

*Brighstoneus simmondsi* (Lockwood et al., 2021) is an iguanodontid known from a single individual. Discovered in 1978, its remains were found scattered in the same deposit as the holotype of the carnivorous dinosaur *Neovenator salerii*. The specimen was

excavated, prepared from its encasing matrix, and placed into the storage of the Museum of Isle of Wight Geology (MIWG, now Dinosaur Isle). Thought to be the more gracile iguanodontid, typically referred to as *Mantellisaurus*, it was given less attention on discovery.

The partial skeleton consists of skull elements, vertebrae including dorsal, sacral, and caudal, ribs, both ilia, the right ischium, a possible prepubic process, and the right femur. The remains show several characters, which were often used to differentiate *Mantellisaurus atherfieldensis* from *Iguanodon bernissartensis*, including relatively tall neural spines, a gracile build, and a smaller adult size.

In 2021 the skeleton was recognised as showing a combination of numerous other features that demonstrated that it belonged to a new genus and species (Lockwood et al., 2021). Most of the differences lie in the skull (Fig. 2), with the nasal and teeth showing autapomorphies specific to *Brighstoneus simmondsi*, which combined with a unique suite of other characters showed it to be a new species of dinosaur. *Brighstoneus simmondsi* was named after Brighstone, a village near to the excavation site, and the finder of the specimen, Mr Keith Simmonds.

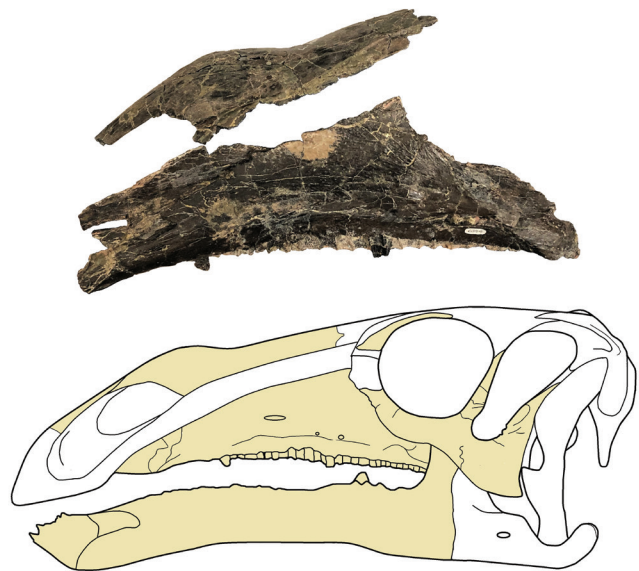


Fig. 2: MIWG : 6344 Nasal and maxilla of *Brighstoneus simmondsi* alongside a reconstruction depicting the known elements

### **Spinosaurids**

The spinosaurids were an enigmatic group of theropod dinosaurs, characterised by numerous features, shared superficially with crocodylians. These include elongate skulls, a large number of teeth, and rounded, conical teeth (Naish & Barrett, 2016). A member of the spinosaurid family, *Spinosaurus aegyptiacus* (Stromer, 1915), is the largest predatory dinosaur to have been discovered (Naish & Barrett, 2016). A skeleton of *Spinosaurus aegyptiacus* found in Morocco had particularly tall neural spines, especially on the caudal vertebrae (Ibrahim et al. 2020). New body reconstructions based on this skeleton, together with older finds, indicate *Spinosaurus aegyptiacus* may have developed an aquatic lifestyle (Ibrahim et al. 2020).

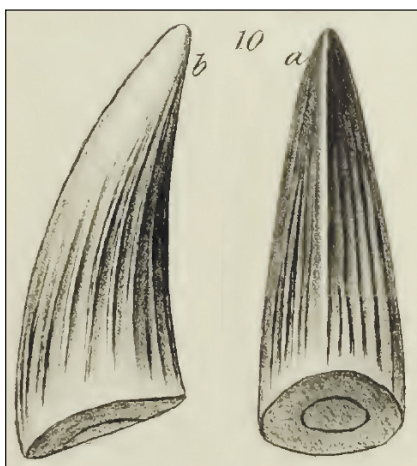
<sup>1</sup> Not to be confused with William Fox of Brighstone. William Darwin Fox was a cousin to Charles Darwin who in 1873 retired to live on the Island and on his death in 1880 was buried in the grounds of Christ Church, Sandown (Munt et al., 2009). William Fox moved to the Island in 1862, becoming curate for St. Mary the Virgin in Brighstone, and later St. James Church, Kingston. William Fox is the better known in paleological circles for his Island discoveries, including *Hypsilophodon foxii*, *Polacanthus foxii*, *Eucamerotus foxi* and more.

The combination of unusual adaptations indicates that spinosaurids were piscivorous (Charig & Milner 1997), adapted to pulling fish from shallow waters (Hone et al. 2021), or even acting as an aquatic pursuit predator (Ibrahim et al. 2020).

It was not until the discovery of a partial skeleton of *Spinosaurus aegypticus*, that the Spinosauridae family was erected. Remains of spinosaurids had been found in England (including the Isle of Wight) for a long time, although they were originally identified as a type of crocodylian; *Suchosaurus cultridens* (Owen, 1841).

### ***Suchosaurus cultridens* and *Baryonyx walkeri***

Described from a single tooth (Fig. 3), *Suchosaurus cultridens* is the first spinosaurid to have been discovered, albeit unrecognised as such, at the time (Owen, 1841). Owen noted the tooth bore more similarities to that of a crocodile than it did to any known dinosaur. Teeth, similar to *Suchosaurus cultridens* were also not uncommonly found on the Isle of Wight. It was only after the discovery of *Baryonyx walkeri* (Charig & Milner 1986) that the presence of spinosaurids in England was recognised. Following this, Martill and Hutt (1996) re-examined the Isle of Wight *Suchosaurus*-like teeth and reclassified them, predicting that it was only a matter of time before baryonychine remains would be found on the island.



**Fig. 3:** Copy of an original etching of NHMUK PV OR 36536, the syntype for *Suchosaurus cultridens*. Original figures 10a & b, Plate 62 of Owen, 1841. No scale provided, tooth length approximately 39mm

### ***Ceratosuchops* and *Riparovenator***

In 2014, Isle of Wight fossil collectors began finding material from the skulls of two spinosaurids, as sandstone blocks containing the bones washed out from the foreshore. As with many of the island's dinosaur discoveries, the bones were eroding out piecemeal. In the succeeding year portions of the jaws, upper skull bones and a brain case were discovered. This continued until 2017, when finds dried up after another brain case and a series of caudal vertebrae had been excavated.

The tail, consisting of 22 partial or complete caudal vertebrae with chevrons (Figs. 4 and 5), was found *in situ* on the foreshore and was excavated by Dinosaur Isle staff and volunteers (Fig. 6). The site was close to the mean low tide level near Chilton Chine. Tides only allowed 2-3 hours of excavation before the area was too waterlogged to carry on. This short period did not allow enough time to jacket the bones in plaster before removal, but with a large group of workers, the tail was removed over five days.



**Fig. 4:** IWCMS : 2020.447 Part of the series of caudal vertebrae of *Riparovenator milnerae*



**Fig. 5:** IWCMS : 2020.447 *Riparovenator milnerae* single chevron



**Fig. 6:** Excavation of IWCMS : 2020.447, the caudal vertebrae and chevrons of *Riparovenator milnerae*

After the initial discovery and preparation of the spinosaurid remains, the next task was to assess whether it represented a new species. Despite the bones bearing some similarities to those of *Baryonyx walkeri*, the geographical range and potential chronological difference (Batten, 2011), suggested the possibility that the remains might not be *Baryonyx*.

A recent study (Barker et al., 2021) reports two new genera and species from the remains; *Riparovenator milnerae* and *Ceratosuchops inferodios*. The new discoveries have left the presence of *Baryonyx walkeri* on the island as ambiguous. The spinosaur teeth and isolated bones previously found on the island show no features that can differentiate them from *Baryonyx*, *Riparovenator* or *Ceratosuchops*. The presence of the two new dinosaurs does not necessarily rule out the presence of *Baryonyx walkeri*, but it also does not confirm it. The study argues that a high diversity of predatory dinosaurs in a diverse ecosystem is quite likely and also reports a European origin for spinosaurids (Barker et al., 2021).

**Dromaeosaurids**

The dromaeosaurids are a group of mid-sized theropod dinosaurs, closely related to today's birds, and includes one of the most (and least) well known dinosaurs, *Velociraptor*.<sup>2</sup> With elongate fore and hind limbs and strongly recurved, sickle-like claws, the dromaeosaurids were likely to be active predators. Numerous dromaeosaurid remains have feather impressions. Studies indicate some members of the group (such as *Microraptor*) may have been capable of gliding (Naihs & Barrett, 2016).

Dromaeosaurid dinosaurs are poorly represented by remains on the island. The first, a sacrum, was discovered in the 19th century, and misdiagnosed as a pterosaur, *Ornithodesmus clunivulus* (Batten, 2011). Later work (Howse & Millner, 1993, and Norell & Makovicky, 1997) show *Ornithodesmus clunivulus* is most likely a dromaeosaur. Five teeth showing much larger denticles on the lingual than the labial carina (Fig. 7), indicate the presence of large form dromaeosaurids. These may represent further finds of *Ornithodesmus*, or may be a new species, but have not been named at present for best practice (Sweetman, 2004).

***Vectiraptor greeni***

*Vectiraptor greeni* is a new genus of dromaeosaurid dinosaur that has been named from two partial vertebrae and a partial sacrum (Fig. 8a, b, & c). The three bones were found loose on the foreshore at Compton by island collectors, Mick Green and Nick Chase. Their affinity as one individual has been recognised from the similarities in preservation, size, and maturity (Longrich et al. 2021). With the slow erosion of the island's coastline, it is highly possible the remains of an individual skeleton may be found over many decades.

The new find gives a better picture of the Wessex Formation dinosaurs, and at the same time potentially complicates future work, due to a lack of comparable material from the specimen. Whilst *Vectiraptor* appears different from *Ornithodesmus clunivulus*, as well as contemporaneous dromaeosaurids from other deposits (*Nuthetes destructor*), its affinities with other fragmentary specimens (unnamed dromaeosaurid teeth, Sweetman, 2004) remains speculative (Longrich et al. 2021).



Fig. 7: IWCMs : 2002.1 Undetermined dromaeosaurid tooth



Fig. 8a: IWCMs : 2021.31.3 *Vectiraptor greeni* partial sacrum



Fig. 8b: IWCMs : 2021.31.1 *Vectiraptor greeni* partial dorsal vertebra



Fig. 8c: IWCMs : 2021.31.2 *Vectiraptor greeni* partial dorsal vertebra

<sup>2</sup> Popularised by Jurassic Park, the film models are reconstructed from the remains of *Deinonychus*, not the relatively diminutive, feathered, *Velociraptor*. The public image and scientific reconstructions are quite different.

## Conclusions

Given the environmental interpretation of the Wessex Formation of the Isle of Wight, a high diversity of dinosaurs is quite likely (Junk, 2006). The flood deposits that dinosaur remains are usually preserved in, can bring together animals that would typically inhabit differing niches, from over a larger area (Sweetman & Insole 2010). It is hard to estimate the number of species present in the island's Wealden Group. With the reasonable likelihood that species named from scant remains will be synonymised; it is also likely for further taxa to be added, as new or more complete specimens are discovered.

The decision on how much comparable material is needed for publication is left to authors and the peer review process. In other fields such as the mollusca, several complete individuals may be needed to describe a taxon (Munt, M. Pers. Comms. 2022). Dinosaurs are often described from few remains leading to taxonomic confusion. This may be unresolved until more complete remains are found. At the time of writing, at least parts of all the new dinosaurs can be seen on display at Dinosaur Isle Museum.

## Acknowledgements

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**Author:** Alex Peaker, Collections Officer (Geology),  
Dinosaur Isle Museum.

**email:** alex.peaker@iow.gov.uk