On the taxonomy and diversity of Wealden iguanodontian dinosaurs
(Ornithischia: Ornithopoda)

David B. Norman

Abstract
The taxonomy of Wealden-aged iguanodontians is reviewed in the light of recent publications that indicate higher levels of taxonomic diversity existed compared to estimates from the recent past. Of the seventeen taxonomic names that have been suggested to date, four represent taxonomically valid morphological types: Barilium dawsoni, Hypselospinus fittoni, Iguanodon bernissartensis and Mantellisaurus atherfieldensis. The other thirteen taxonomic names are either objectively synonymous with one or other of the valid taxa, or are nomina dubia. The recent spate of taxonomic proposals appear to be driven by a belief that greater diversity must exist within the Wealden succession (Weald: Hastings and Weald Clay Groups; Wessex: Wealden Group) given that it spanned approximately 20 million years of geological time. However, critical evaluation of the actual material, and the stratigraphic levels from which specimens have been collected in the Wealden geological succession, confirms the imperfect nature of the fossil record. As a consequence fossil collectors have only been able to sample two comparatively time-restricted horizons: one in the middle Valanginian (~138-136 Ma), the other in the middle-upper Barremian-lowermost Aptian (~128-125 Ma). The plethora of new, yet invalid, taxonomic names suggests some inconsistency in the maintenance of standards associated with good taxonomic practice. The dangers inherent in allowing poor taxonomic practice to generate false measures of fossil diversity are outlined.

Keywords
Iguanodon, Iguanodontia, Dinosauria, Taxonomy, Diversity, Wealden, Stratigraphy.

1. INTRODUCTION
The geographic area occupied by the English Wealden District (which straddles the counties of Surrey, Kent, Sussex [East and West] and Hampshire) in south-east England (Fig. 1) has a long history associated with the discovery and interpretation of dinosaurs (Norman, 2011a). This history commenced, in scientific terms, during the early decades of the 19th century as a consequence of the empiricism embedded within the works published by two pioneering intellectuals: Georges Cuvier (1769-1832) and Alexandre Brongniart (1770-1847), who were both based in Paris. Cuvier established a system of study (‘l’anatomie comparée’) that permitted plausible interpretation of fossil material that relied upon comparative skeletal observations taken from living organisms that was linked to their architectural and biomechanical significance; this led directly to the appreciation that some fossils represented animals that were quite different from those living today and had become extinct (Cuvier, 1812). The concept of deep time, that implied an age for the Earth that greatly exceeded biblivably derived estimates (Ussher, 1650; Barr, 1984) added considerable interest to the interpretation and significance of fossils and encouraged many people to collect and study fossils with considerably greater vigour and interest (Rudwick, 1976). In 1808 Cuvier and Brongniart drafted a biostratigraphical method for mapping geological units of rock (strata); this enabled them to assemble a temporal succession of strata that relied upon the comparative similarity (or dissimilarity) of their contained fossils (Cuvier & Brongniart, 1811).

With hindsight it can be seen that a number of people in Britain benefited from these, then new, approaches. William Smith (1769-1839) was able to incorporate biostratigraphic principles into the first geological map of England and Wales in 1815 (Winchester, 2001). Likewise the remarkable fossil collector Mary Anning (1799-1847) was able to capitalize upon the interest in (and market for) ancient fossil remains through discoveries that she was able to make in the rapidly eroding and highly fossiliferous cliffs and foreshore exposures between Lyme Regis and Charmouth in Dorset (Torrens, 1995). Equally importantly, Gideon Mantell (1790-1852) a physician and noted amateur geologist (Dean, 1999) collected and described geological specimens from the Weald of Sussex in order to illustrate his Geology of the South Downs (Mantell, 1822). Among these remains he was able to identify a number of bones of large size and teeth of unusual shape from quarries in the vicinity of Cuckfield (West Sussex – see Fig. 1). Some teeth were sent to Cuvier for advice concerning their identity. Though at first these were suspected to belong to large...
Fig. 1: Wealden-aged outcrops of south-east England. The Weald covers nearly all of East and West Sussex, the south-western edge of Kent, southern Surrey and a small eastern portion of Hampshire. The Isle of Wight expose outcrops of the adjacent Wessex Basin that are equivalent to the upper half of the stratigraphic succession of the Weald. Adjacent areas of the Dorset coast – NW of the IoW also expose part of the Wealden succession. The location of some key places is marked: 

- **Cuckfield** (where the first *Iguanodon* teeth and bones were collected by Mantell); 
- **Maidstone** (where Bensted’s “Iguanodon Quarry” is located) and **Smokejacks** Brickworks, where abundant *Mantellisaurus* remains (as well as those of the unusual spinosaurid theropod *Baryonyx* *walkeri*), have been collected during the latter half of the 20th century. A large number of temporary quarries were located in and around the **Hastings-St Leonards** area of the central Weald, almost all of which are long since filled in or built upon.
herbivorous mammals, further research by Mantell prompted Cuvier to reassess the specimens and his comments were prophetic:


Mantell (1825) described the teeth as belonging to a gigantic, extinct, terrestrial herbivorous reptile that he named Iguanodon (in recognition of the fact that its teeth resembled those seen in living iguanas). From that time onward Iguanodon became a name that was synonymous with the Wealden District of south-east England. Mantell continued to work on Iguanodon for several decades (Norman, 1993), but his work was eventually superseded firstly by the prodigious output of Richard Owen and later by John Hulke, Louis Dollo, Harry Seeley, Richard Lydekker and finally in 1925 (exactly a century after Mantell’s first paper on Iguanodon) by Reginald Hooley (Hooley, 1925; see Norman, 2011a, 2012).

The subsequent half century saw little further research on these Wealden dinosaurs, until detailed descriptions of closely similar material from contemporaneous exposures in Belgium appeared during the 1980s (Norman, 1980, 1986, 1987a) and also in Germany (Norman, 1987b; Norman, Hilpert & Hölder, 1987). A further two decades elapsed before a minor avalanche of papers, focused primarily upon the taxonomy and anatomy of these dinosaurs, have appeared (Paul, 2007, 2008, 2012; Norman, 2010, 2011a, b, 2012, in press b; Carpenter & Ishida, 2010; McDonald, Barrett & Chapman, 2010; McDonald, 2012).

Some of the more recent contributions (particularly those by G.S. Paul and K. Carpenter & Y. Ishida) have posited a variety of new taxonomic names that are suggestive of high levels of taxonomic diversity of Iguanodon-like dinosaurs in the general Wealden succession (Valanginian-Lower Aptian: Batten, 2011). Part of the reasoning that underpins this shift toward comparative taxonomic profligracy is the taxonomic diversity of the Cedar Mountain Formation of N. America, which spans a somewhat younger geological interval (Barremian-Cenomanian: Hunt, Lawton & Kirkland, 2011, contra Carpenter & Ishida, 2010, who claimed that the CMF extended to the base of the Valanginian Stage). In recent years the Cedar Mountain Formation has generated a higher level of taxonomic diversity among their constituency of ‘iguanodonts’ (Carpenter & Ishida, 2010; McDonald et al., 2010a; McDonald et al., 2010b; Paul, 2012). It is also claimed that these geographically distinct units of geological time are approximately equivalent; however, the Cedar Mountain Formation (~95-130 Ma: Hunt, Lawton & Kirkland, 2011) has a duration that is approaching twice that of the Hastings, Weald Clay and Wealden Groups (~125-142 Ma: Batten, 2011 – Fig. 2). These more recent contributions to Wealden taxonomy might therefore be interpreted as a notional evening-up of tallies. Additional motives apparently driving the new Wealden taxonomic proposals are also revealed remarkably candidly:

‘Norman’s (2010) basic argument that there were just two European iguanodonts in the Valanginian, and then just two more in the next two stages [sic] up into the early Aptian, is so simplistic in evolutionary terms that it must be rejected unless future discoveries actually do show that specimens from such long spans of time must be placed in so few taxa.’ (Paul, 2012: 125).

A little later he adds:

‘Because the cross channel beds [sic] containing the Valanginian to Aptian iguanodonts under discussion herein are hundreds of meters deep and formed over 20 million years they should contain a long multiplicity [sic] of faunas each with distinct and often diverse set [sic] of taxa.’ (Paul, 2012: 126).

In summary, it is claimed that the Wealden, insofar as its representation of iguanodontian (Norman, in press a: ‘iguanodont’ sensu amplo) dinosaurs is concerned, is taxonomically depauperate. The foundations for this assertion are that: the geological time, encompassed by the succession of stratigraphic Stages that constitute the Hastings and Weald Clay Groups, is long (~20 Ma: Batten, 2011) and sufficient for a large number of taxa to have evolved and left their remains in the fossil record; and that species duration in the fossil record may be relatively brief. ‘As noted by Paul … it is vital to consider stratigraphic information in determining dinosaur taxa, especially at the level of species which can have rapid turnover rates on the order of a few hundred thousand years.’ (Paul, 2012: 124). ‘Because simplistic schemes of iguanodont diversity in Europe are improbable’ (Paul, 2012: 130), G.S. Paul as well as K. Carpenter & Y. Ishida are claiming to have found evidence for the (allegedly) missing Wealden taxa.

Table 1 illustrates the contrast between a relatively conservative Wealden taxonomy (in essence that advocated by Norman and more recently McDonald) and a cumulative alternative taxonomy that has been proposed mostly as a result of the taxonomic revisions published by Paul, Carpenter & Ishida, along with the inclusion of earlier proposals dating back to the late 19th century. If the latter are to shown to be correct then the Combined Hastings, Weald Clay and Wealden Groups do indeed possess a substantial record of species diversity for large-bodied herbivores. An asterisk is used to signify and emphasize the addition of the allegednon-Wealden taxon “Mantellodon carpenteri” (Fig. 13) that was recovered from Maidstone, Kent (Fig. 1). This contribution offers a review of the evidence and the arguments that have been used in favour of the view that there was a comparatively high level of taxonomic diversity among iguanodontian dinosaurs in
Table 1: The taxonomy of Wealden *Iguanodon*-like dinosaurs tabulated according to (in the left column) the interpretation of Norman (2010, 2011a, b, 2012, in press b, and updated in the light of comments from Andrew McDonald, pers. comm. 29 Sept. 2012), compared with the taxonomy (in the right column) introduced by G. S. Paul, K. Carpenter & Y. Ishida, A. T. McDonald, P. M. Barrett & S. J. Chapman (more recently) and the older proposals that emanated from J. W. Hulke, H. G. Seeley and R. Lydekker. Abbreviations: * – indicating a geographically non-Wealden taxon; jos – junior objective synonym; jss – junior subjective synonym; nd – nomen dubium; v – valid taxon. No synonymy is implied between *I. anglicus* and any other Valanginian taxon name at present, this name has simply been given reserved status.

<table>
<thead>
<tr>
<th>WEALDEN TAXA (Norman/McDonald)</th>
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<tr>
<td><strong>Barremian/Aptian</strong></td>
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<td><em>Iguanodon bernissartensis</em></td>
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<td><em>Dollodon seelyi</em> (Carpenter &amp; Ishida, 2010) [nd-jss]</td>
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<td><strong>Mantellisaurus atherfieldensis</strong></td>
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<td><em>Vectisaurus valdensis</em> Hulke, 1879 [nd]</td>
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<td><em>Sphenospondylus gracilis</em> (Lydekker, 1888) [nd]</td>
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<td><em>Proplanicosa galtoni</em> Carpenter &amp; Ishida, 2010 [nd-jss]</td>
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<td><em>Dollodon bampingi</em> Paul, 2008 [nd-jss]</td>
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<td><em>Mantellodon carpenteri</em> Paul, 2012 [nd-jss]</td>
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<td><em>Iguanodon anglicus</em></td>
<td><em>Kukufeldia tilgatensis</em> McDonald, Barrett &amp; Chapman, 2010 [nd-jss]</td>
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<td>Holl, 1829 [servo statua]</td>
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<td><em>Sellocxa pauli</em> Carpenter &amp; Ishida, 2010 [nd-jss]</td>
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<td><em>Hypselospinus fittoni</em></td>
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<td>(Lydekker, 1889) [v]</td>
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<td><em>Wedhurstia fittoni</em> Carpenter &amp; Ishida, 2010 [jos]</td>
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<td><em>Huxleysaurus hollingtoniensis</em> Paul, 2012 [nd-jss]</td>
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<td><em>Darwinsaurus evolutionis</em> Paul, 2012 [nd-jss]</td>
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the Weald of south-east England (and an adjoining area of southern Belgium). The focus of this article is upon the stratigraphic evidence, the anatomical basis for the taxonomic proposals and the general sense of the arguments used to support the assertions of G.S. Paul, K. Carpenter & Y. Ishida.

Institutional abbreviations
NHMUK – The Natural History Museum (London).
RBINS – Royal Belgian Institute of Natural Sciences (Brussels) – formerly IRSNB: Institut Royal des Sciences Naturelles de Belgique.

II. THE STRATIGRAPHIC OCCURRENCE OF IGUANODONTIANS

Hastings Group, Valanginian Stage: distribution

Wadhurst Clay Formation (Fig. 2)
During the second half of the 19th century considerable building work was undertaken near the coastal town of Hastings in East Sussex (Fig. 1), which resulted in the construction of a range of temporary quarries that provided clays and sands for brick/tile-making as well as some inferior quality building stone (Tilgate Stone) – Norman (2011b). The quarrying occurred very locally (Brooks, 2011; Norman, 2011b and in press b). The quarrying yielded a substantial number of partially articulated skeletons of Iguanodon-like ornithopods that can be separated into two distinct morphological types: *Barlium dawsoni* (Norman, 2010, 2011a, b, 2012) and *Hypselospinus fittoni* (Norman, 2010, 2011a, 2012, and in press b). These taxa are middle Valanginian in age (~137-138 Ma).

Lower Tunbridge Wells Sand Formation (Fig. 2)
During the 20th century some articulated large-bodied ornithopod material has been recovered from Philpott’s Quarry, which exposes the top of the Wadhurst Clay (the Ardingley Sandstone). This is again middle Valanginian in age. These specimens have not yet been studied.

Grinstead Clay Formation (Fig. 2)
Some of the original specimens collected and described by Gideon Mantell most likely came from the quarries located near Whiteman’s Green, Cuckfield in West Sussex (Fig. 1). Several of the paratype specimens and the originally designated lectotype of *Iguanodon anglicus* (see below) in the Mantell Collection, retain the calcareous, gritty sandstone (Cuckfield Stone) that was quarried for road repairs and general building work. The type material (an isolated dentary) of *Kukufeldia tilgatensis* (Fig. 4) was also collected from one of the

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**Fig. 2: Wealden Stratigraphy.** The Weald Sub-basin exposes an almost complete stratigraphic succession from the upper Berriasian (Ashdown Beds Formation) to the top of the Barremian (Upper Weald Clay Formation). The Wessex Sub-basin on the Isle of Wight exposes only the upper part of the Wealden succession. This distribution of taxonomically valid large-bodied ornithopods within this succession, is indicated by the lightly-toned horizontal bars.

Abbreviations: Berr – Berriasian; GC Fm – Grinstead Clay Formation; L. Apt: Lower Aptian; LGS – Lower Greensand; LTWS Fm – Lower Tunbridge Wells Sandstone Formation; UTWS Fm – Upper Tunbridge Wells Sandstone Formation. Modified from Batten (2011: text-fig. 2.1).
Whiteman’s Green quarries. These quarries, long since filled in, exposed Hastings Group Beds of the Grinstead Clay Formation (Fig. 2: GC Fm), which is a mappable lithological unit that is exposed in the more westerly parts of the Weald (Topley, 1875; Batten & Austen, 2011). These outcrops are regarded as being of upper-middle Valanginian in age (~137 Ma).

Summary
The large-bodied ornithopod material recovered from Hastings Group localities is distributed within the middle and upper-middle Valanginian (a span of ~2-3 Ma: Fig. 2).

Weald Clay Group, Barremian-Lower Aptian Stages: distribution

Upper Weald Clay Formation (Fig. 2)
Nearly all the Iguanodon-like ornithopod material (the majority of which is referable to Mantellisaurus atherfieldensis, with Iguanodon bernissartensis being comparatively rarely preserved) has been collected from the Upper Weald Clay Formation (Fig. 2) exposures in quarries such as Smokejacks Brickworks, near Ockley in Surrey (Fig. 1) and Henfield in West Sussex. These exposures have been dated as middle Barremian (~128 Ma) (Batten, 2011).

Wessex Formation of the Isle of Wight (Fig. 2)
Ornithopod remains have been collected from the Wealden Beds on the south-west coast of the Isle of Wight (and a small area to the south-east near Sandown), since the time of Mantell. The high rates of erosion of these poorly lithified sea cliffs ensures a more or less continuous supply of new material. The principal exposures that have yielded large-bodied ornithopods are located on the flanks of an anticline that cuts obliquely across the south-western sea cliffs (Sweetman, 2011) between Brook Bay to the west and Shepherd’s Chine to the east. In these areas the upper part of the Wessex Formation contacts the base of the Vectis Formation. The latter marks the onset of brackish-to-marine influence on the environment of deposition. Ornithopod remains have been recovered within a number of discrete horizons in the upper part of the Wessex Formation, although footprints indicating the likely presence of large ornithopods are rather more ubiquitous throughout this part of the succession. The exposures of the Wessex Formation on the Isle of Wight correlate with the middle to upper Barremian (130-126 Ma: Fig. 2). The Atherfield Clay Formation (top Barremian-basal Aptian) marks the onset of deeper-water marine conditions and it appears that rare ornithopod material from the base of the Aptian (~125 Ma) collected at Blackgang Chine and farther east at Yaverland, includes reworked upper Wessex/Vectis Formation material that may be collected occasionally (Sweetman, 2011).

Summary
In both the Weald and the Wessex Sub-basins of south-east England the younger ornithopod fossil record spans just the middle-upper Barremian with a possible range-extension into the lowermost Aptian (an interval of approximately 3 Ma – Fig. 2). According to Paul (2012) and the stratigraphic chart produced by Carpenter & Ishida (2010: fig. 7) the Wealden exposures of south-east England express a more continuous record of deposition (of ‘iguanodont’ dinosaurs). If the latter authors are correct, one inevitable consequence of the steady sampling of fossils across this period of elapsed time (c. 20 Ma) by a variety of collectors ought to be a diverse range of ornithopods distributed across the entire stratigraphic range. The fact that this theoretical scenario does not apply in reality reflects in large measure the above authors’ unfamiliarity with the geology and palaeontology of the area in question.

As highlighted in Figure 2 there are two comparatively short intervals of time alone: middle Valanginian and middle-upper Barremian/lowest Aptian that have yielded well-preserved and comparatively abundant ornithopod remains that are of sufficient quality to allow description, anatomical comparison and taxonomic diagnoses to be made. Given the known range of estimates for species duration in the fossil record, which can range between 2.33 Ma and ~25 Ma (Bozas & Culver, 1984; Willis, Vrba & Degusta; 2004; Vrba, 2000) this is equivalent to an assessment that just two distinct palaeofaunas have been sampled from the Wealden of southern England.

III. THE TAXONOMY OF WEALDEN IGUANODONTIANS

Iguanodon anglicus Holl, 1829
Without fear of dispute, the most renowned specimens in the history of dinosaurs collected from the Weald are the remains first referred to and subsequently described as Iguanodon by Gideon Mantell (1822, 1825, 1827, 1833, 1848). The first specimens to be described and illustrated comprised a series of isolated dentary and maxillary teeth displaying various stages of eruption and wear. Norman (1986) attempted to stabilize the nomenclature linked to these specimens by relocating five of the seven teeth that were illustrated by Mantell (two fine examples of which are shown in Figure 3) in the Mantell Collection at the Natural History Museum (London). He designated the most commonly illustrated specimen (NHMUK OR2392 – Fig. 3A) as the lectotype. Friedrich Holl was the first author to propose a Linnean binomial for Mantell’s original material: Iguanodon anglicus (emended to I. anglicus by Norman, 1986).
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Charig & Chapman (1998) asserted that the type-specimen of the genus *Iguanodon* was based upon non-diagnostic material and that its designation should be set aside. An alternative lectotype was proposed, based upon an almost complete skeleton of *Iguanodon bernissartensis* (RBINS R51 [IRSNB 1534 – Norman, 1980]). The opinion expressed by the International Commission on Zoological Nomenclature, following the publication of a range of observations on the topic, was one of unopposed acceptance of Charig & Chapman’s proposal (ICZN 2000).

**Status.** The genotype *Iguanodon* and its associated binomen: *I. anglicus* have been declared a nomen dubium. However it is suggested here that, while the current wave of taxonomic reassessments is taking place, the taxonomic name *Iguanodon anglicus* and the material to which it refers should be considered to have ‘reserved status’ (Table 1).

*Kukufeldia tilgatensis* McDonald, Barrett & Chapman, 2010

An isolated, large and robustly constructed dentary (Fig. 4), with two attached dentary crowns, was designated the type of a new taxon *Kukufeldia tilgatensis*. The material was identified as distinct, in part, on the basis of the incorrect association of referred material to the taxon named *Barilium dawsoni* (Norman, 2011a, b). Norman (2010, 2011a, b) opined that *Kukufeldia* most probably belongs to the latter taxon, which itself has a robust construction and dentary teeth that are very similar to those described in *Kukufeldia* (compare McDonald et al., 2010a: fig. 4 and Norman, 2011a: text-fig. 20). Following the reassessment of *Kukufeldia* there remains a single autapomorphy: the pattern of neurovascular canals on the external surface of the dentary near its anterior tip. This latter is regarded as more likely to represent an individual variation, given the variability in the positioning and pattern of vascular openings seen in vertebrate jaws more generally. McDonald (2012) has defended the status of *Kukufeldia*; however, more recently (McDonald, pers. comm. 29 Sept 2012) he has expressed the view that his defence of the validity of this taxon is lessenings.

**Status.** On the basis of the potential unreliability of the single remaining autapomorphy, *Kukufeldia tilgatensis* is regarded as a probable nomen dubium. In the opinion of this author the name *K. tilgatensis* should probably be suppressed and the material to which that name was applied may be subjectively referred to the taxon *Barilium dawsoni*.

*Barilium dawsoni* (Lydekker, 1888)

Richard Lydekker (1888) described the remains of a partial, associated skeleton of an *Iguanodon*-like ornithopod collected at Shornden quarry near Hastings (Fig. 1). The ilium (Fig. 5) and vertebrae are highly distinctive and in the month of May, Norman (2010) diagnosed and illustrated this material and proposed a new generic name *Barilium dawsoni* in recognition of the distinctiveness of this skeletal material when compared to other known Wealden taxa. See Norman (2011a), for a more complete description of the type and referred material associated with this taxon.

**Status.** *Barilium dawsoni* is diagnosable and considered to be a valid taxon.

*Torilion dawsoni* Carpenter & Ishida, 2010

Shortly after the publication by Norman (2010), an article appeared that was published in the month of October by Carpenter & Ishida (2010) proposing the name *Torilion dawsoni* for exactly the same material that forms the holotype of *B. dawsoni*, although the locality information and its stratigraphic age were recorded incorrectly.

**Status.** The name *Torilion dawsoni* can be suppressed because it is without doubt a junior objective synonym of *Barilium dawsoni*.

*Sellacoxa pauli* Carpenter & Ishida, 2010

Carpenter & Ishida (2010) further proposed the creation of a completely new binomial (*Sellacoxa pauli*) to

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1 † A.J. Charig died in 1997

2 “Knowing what I do now, I don’t think I could justify to myself naming a new taxon based upon NHMUK [OR]28660.”
recognize the existence of another, and allegedly distinct, partial skeleton collected from Old Roar Quarry, Hastings. The specimen in question (NHMUK R3788) had been earlier referred to *B. dawsoni* (Norman, 2010). Carpenter & Ishida described a range of very distinctive characters exhibited by the right-hand-side pelvic bones (Carpenter & Ishida, 2010: fig. 6). Norman (2011a, b, 2012) has shown that the pelvis that was illustrated is incomplete and, more importantly, displays substantial post-mortem crushing, displacement and distortion (Fig. 6A). Critically, the left ilium (Fig. 6B, the existence of which was unrecognized by Carpenter & Ishida) differs significantly in shape from that seen on the right side of the same skeleton (see Norman, 2011a, for an explanation of these differences). Other characters, such as details of the shape of the pubis and ischium, which were used by Carpenter & Ishida to diagnose their new taxon, are also the result of distortion. The robust form and shape of the ilium seen on the left side of this specimen (Fig. 6B) and the form of the posterior dorsal vertebrae, display an overall similarity to the type material of *B. dawsoni* (Norman, 2011a). Consideration of the anatomy of this specimen results in the conclusion that the authors established no valid diagnostic characters for specimen NHMUK R3788, named *Sellacoxa pauli*. The original referral of this specimen to *B. dawsoni* by Norman (2010) appears to be confirmed.

**Status.** In the absence of an accurate description of this specimen or diagnostic characters, combined with its anatomical similarity to the sympatric contemporary

Fig. 4: *Kukufeldia tilgatensis* McDonald, Barrett & Chapman, 2010. NHMUK OR28660. Probably collected from the Grinstead Clay Member (upper middle Valanginian), the almost complete right dentary was collected from one of the quarries near Whitman’s Green, Cuckfield, West Sussex and first described by Mantell (1848). A. Medial (internal) view. B. Lateral (external) view.

Abbreviations: alv – alveolus; br – broken areas where the inner wall of the dentary has been eroded; mg – Meckel’s groove; pdg – predentary attachment area; sy – dentary symphysis.
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Fig. 5: *Barilium dawsoni* (Lydekker, 1888). NHMUK R802. Collected at Shornden quarry (Wadhurst Clay Formation, middle Valanginian). Left ilium in lateral view (A – photograph, B – interpretative line drawing). Abbreviations: ac – acetabulum; b.inf – inflected ventral margin; inf – inflection; ip – ischiadic peduncle; ms – muscle scar; pp – pubic peduncle; prp – preacetabular process; srf – sacral rib facet.

Fig. 6: *Barilium dawsoni* Lydekker, 1888). NHMUK R3788. A. “ Sellacoxa pauli” was described as a new iguanodontian taxon on the basis of a poor-quality photograph (Carpenter & Ishida, 2010). This interpretative drawing (after Norman, 2011b) shows the right pelvis and associated axial skeleton of a large iguanodontian collected from Old Roar Quarry (Wadhurst Clay Formation, middle Valanginian), Hastings (Fig. 1). The right ilium, in particular, shows considerable evidence of spackle-like plaster repair because the bone surface is so broken and friable, its general form reflects the fact that a considerable amount of rebuilding has taken place after excavation. B. The left side of this specimen (of which Carpenter & Ishida seemed to be totally unaware) exhibits an ilium that is more consolidated and of very different morphology compared to the right side: it has a very thick, robust preacetabular process and a thick dorsal margin that arches and develops into a curved postacetabular process that forms a deep, ventrally inflected plate – in nearly all respects this ilium conforms closely with that of the type ilium of *B. dawsoni* (Fig. 5).

Abbreviations: ac – acetabulum; arm – iron armature for support; ip – ischiadic peduncle; is – ischium; obt – obturator process of the ischium; ots – ossified tendons; pp – pubic peduncle; prp – preacetabular process; pu – pubis.
taxon Barilium dawsoni, Sellacoxa pauli is considered to be a nomen dubium. The latter name should be suppressed. The partial skeleton NHMUK R3788 may be referred to the hypodigm of Barilium dawsoni.

**Hypselospinus fittoni (Lydekker, 1889)**

Richard Lydekker (1889) established a new taxon, Iguanodon fittoni on the basis of a partial skeleton (of which the ilium is shown in Figure 7) collected from Shornden, Hastings (Fig. 1). Norman (2010) reviewed the original material and some similar, associated skeletal remains, collected from nearby quarries and proposed the new combination Hypselospinus fittoni, in recognition of a set of diagnostic characters that distinguished it from other Wealden ornithopods and, in particular, the sympatric contemporary Barilium dawsoni (Norman, 2011a, b, 2012, in press b).

**Status.** Hypselospinus fittoni has been diagnosed and is considered to be a valid taxon.

**Wadhurstia fittoni (Lydekker, 1889)**

Shortly after the publication by Norman (2010) an article appeared that was published in the month of October by Carpenter & Ishida (2010) proposing the name Wadhurstia fittoni for exactly the same material that was named H. fittoni.

**Status.** The name Wadhurstia fittoni can safely be suppressed because it is clearly a junior objective synonym of Hypselospinus fittoni.

**Huxleysaurus hollingtoniensis (Lydekker, 1889)**

Lydekker (1889) proposed the species Iguanodon hollingtoniensis for some associated skeletal material (Fig. 8) that was collected from one of the quarries near Hollington, Hastings (Fig. 1). Norman (2010) referred this material to Hypselospinus fittoni on the basis of careful comparison between the type and referred material attributable to both taxa. Paul (2012) claimed that a new taxonomic name should be erected for this material on the basis of three characters: ‘Femur robust [no diagnostic value], moderately curved [no diagnostic value], 4th trochanter pendent [incorrect].’ (Paul, 2012: 124). The comments in square brackets represent this author’s evaluation of each character. This assertion was not supported by an illustration of the original material or formal description and comparison with other known taxa. In addition, Paul claimed that a range (unspecified) of skeletons were collected from different stratigraphic levels in the Wadhurst Clay Formation and that using just the taxonomic name Hypselospinus fittoni for all of this (unspecified) material ‘risks creating multi-taxa chimeras’ (Paul, 2012: 124). This unsubstantiated claim appears to be founded upon no knowledge or understanding of the geology of the area around Hastings, or of the proximity of the relevant quarries. There is no indication of the extent of the material, nor is there any evidence of a visit in order to study and assess the original material (confirmed by visitor records to the Natural History Museum collections: Sandra Chapman, pers. comm. June 2011). Although I risk appearing excessively judgemental, it is hard to avoid the conclusion that Paul is making unfounded taxonomic proposals based upon preconceptions alone.

**Status.** Huxleysaurus hollingtoniensis was not described adequately and was founded upon a combination of non-diagnostic characters. Huxleysaurus hollingtoniensis is therefore a nomen dubium and its name can safely be suppressed. NHMUK

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**Fig. 7: Hypselospinus fittoni (Lydekker, 1889). NHMUK R1635.** Collected from Shornden Quarry (middle Valanginian). The left ilium in A. Lateral view; B. Medial view; C. Interpretative line drawing in lateral view.

Abbreviations: brf – brevis fossa (wide and well-defined compared to that of B. dawsoni); ip – ischiadic peduncle; lr – lateral ridge (bounding the brevis fossa); mr – medial ridge on the preacetabular process (poorly developed compared to that of B. dawsoni); ms – muscle scar; pp – pubic peduncle; prp – preacetabular process (transversely compressed and narrow dorsally, compared to the transversely thick and robust form seen in B. dawsoni).
R1148 (and a series of additional specimens that were given different numbers, but together form an associated set of skeletal remains collected at the same time from the same quarry – Norman, in press b) has been referred to the hypodigm of *Hypselospinus fittoni*. Darwinsaurus evolutionis Paul, 2012

Paul (2012) named this new taxon on the basis of a holotype that comprises a series of allegedly associated specimens: ‘NHMUK R8131[sic]/1833/1835/1836’ (Paul, 2012: 124). Figure 9 shows the dentary of NHMUK R1834. No location is specified and the horizon is given as the Wadhurst Clay Formation (Valanginian). The majority of these specimens were collected by Samuel Beckles from the foreshore near St Leonards, Hastings (Fig. 1: Norman, in press b). Paul also included, as part of the holotype, an associated partial skeleton (NHMUK R1836) that was collected from the late Barremian of the Isle of Wight (Norman, in press b). In addition, Paul failed to recognise other registered numbers linked to material that was collected at the foreshore locality near Hastings. The diagnosis contains a series of anatomical errors (Norman, in press b) that confirm Paul’s lack of familiarity with the original material and an inability to distinguish between anatomical features and post-mortem or artefacts resulting from amateurish attempts at restoration of an extremely fragile specimen. It can be observed that one of the underlying reasons for Paul’s claims for the existence of a new taxon in the Valanginian (Paul, 2008, 2012) reflects the fact that he believes that he has identified a highly unusual ornithopod that can be diagnosed by the possession of an unusually long ‘diastema’ (the space between the posterior end of the predentary and the first dentary tooth) in the lower jaw. The area is question (Fig. 9) is badly damaged (br), but the remnants of a vascular channel (vc) that underlies the alveolar parapet, as well as fragments of broken teeth (tf) in the region of the alleged diastema, demonstrate that an elongate diastema was unlikely to have been present; this alternative claim is further supported by a partial anterior dentary attributable to *H. fittoni* (NHMUK R1834 – Norman, in press b), which shows the presence of a comparatively modest diastema. Additional claims that Norman is unable to correlate the stratigraphy, or to compare material adequately because of the lack of overlapping skeletal elements, are simply untrue and reflect (again) a lack of familiarity with the original material on the part of Paul.

**Status.** Darwinsaurus evolutionis was not described adequately and the ‘holotype’ includes specimens from different geographic areas and different stratigraphic horizons. The diagnosis is based upon a combination of non-diagnostic characters and ones that are anatomically incorrect. The principal material of the partial associated skeleton (from the foreshore locality near St Leonards – NHMUK 1831) can be assigned, with confidence, because of overlapping comparable material (Norman, in press b) to the sympatric contemporary Hypselospinus fittoni; NHMUK R1836 can be referred with confidence to Mantellisaurus atherfieldensis (Norman, in press b). Darwinsaurus evolutionis is a nomen dubium and this name can safely be suppressed. The alleged holotype material can be referred Hypselospinus fittoni and Mantellisaurus atherfieldensis.

**Iguanodon bernissartensis** Boulenger, 1881

The type species of the genus *Iguanodon* (RBINS R51 – formerly IRSNB 1534) has been diagnosed, extensively illustrated and described (Fig. 10: Norman, 1980). Its binomial status has not been challenged seriously in any of the recent taxonomic literature. Work on the stratigraphic correlation of the Sainte-Barbe Clays Formation, Belgium with the Wealden of England has been summarized recently (Yans, Robaszynski & Masure, 2012). The Sainte-Barbe Clays Formation has been dated consistently as middle-to-upper Barremian in age, with a possible extension into the base of the Aptian.
Fig. 9: Hypselosinus fittoni (Lydekker, 1889). NHMUK R1831 /Fig. 1). A. Medial (internal) view; B. Lateral (external) view; C. Dorsal (occlusal) view. Collected from the foreshore at St Leonards, along with the substantial portion of an associated skeleton, this crushed and heavily restored right dentary has been claimed by Paul (2008, 2012) to indicate the presence of an unusually long-snouted (hadrosaur-like) iguanodontian with a very large diastema. Paul named this partial skeleton “Darwinsaurus evolutionis” and included, with the alleged holotype, a partial skeleton collected from the Barremian of the Isle of Wight. As can be seen here much of the anterior and dorsal dentition has been sheared away and the dentition, whose presence is indicated by the vascular canal (vc) extended forward toward the predentary suture leaving only a modest diastema.

Abbreviations: am – actual remnants of the dorsal alveolar margin; br – broken area along the anterior dorsal edge of the jaw; cp – coronoid process; ds – dentary symphysis; m – matrix; mgr – Meckel’s groove; pr – anterolateral process of the dentary; sl – slot-like symphyseal suture; tf – tooth fragments in the broken alveolar region of the dentary; vc – vascular groove found beneath the alveolar parapet.
Wealden ornithopod taxonomy and diversity

Fig. 10: *Iguanodon bernissartensis* Boulenger, 1881. The skull in lateral view as reconstructed by Norman (1980) based on material recovered from the Sainte-Barbe Clays Formation (upper Barremian), Bernissart, Belgium.

(Yans et al., 2006; Yans et al., 2012a, b). This correlates well with the middle-upper Barremian beds in both the Weald District and the Wessex Basin of the Isle of Wight (Fig. 2), both of which areas have yielded remains that are anatomically indistinguishable from *I. bernissartensis*.

**Status.** *Iguanodon bernissartensis* Boulenger, 1881 is considered to be a valid taxon.

**Dollodon seelyi** (Hulke, 1882)
John Hulke collected a partial articulated skeleton of a large ornithopod dinosaur from Brook Chine on the Isle of Wight in 1870. He eventually published a report on this material (Hulke, 1882), and in doing so proposed the name *Iguanodon seelyi*. The skeletal material is closely comparable in all respects to that named *Iguanodon bernissartensis*, and has been regarded as a subjective junior synonym of the latter species since the work of Dollo, Seeley and Lydekker during the 1880s (Norman, 1980, 1986). Hulke’s partial skeleton was collected from the upper part of the Wessex Formation (upper Barremian: Fig. 2) and is therefore contemporaneous with the material described from Bernissart (Norman, 2012).

Carpenter & Ishida (2010) proposed that the ilium of the type of *Iguanodon seelyi* (NHMUK R2502, Fig. 11A) was indistinguishable from the equivalent bone of a new taxon named *Dollodon bampingi* Paul, 2008 (see below, Fig. 11B): ‘The ilium of *Dollodon bampingi* is practically indistinguishable from that of *Iguanodon seelyi* Hulke, 1882, and therefore the species has priority over *bampingi*.’ (Carpenter & Ishida, 2010: 148). Norman (2011b, 2012) rejected this proposal, observing that the basis for this assertion was the use of overly simplified 2D outlines of the ilia that were not drawn to scale, and that the two ilia bore no similarity in their detailed structure. McDonald (2012) independently reviewed the status of *Dollodon seelyi* and similarly concluded that the ilia bore no resemblance to each other and that ‘... *I. seelyi* is best considered a junior synonym of *I. bernissartensis*, as originally proposed by Norman (1986).’ (McDonald, 2012: 2).

**Status.** *Dollodon seelyi* is neither described nor diagnosed formally, and the comparisons drawn are superficial and inaccurate. *Dollodon seelyi* is therefore a nomen dubium and the name can safely be suppressed. The material, which was regarded as the holotype of *I. seelyi* is considered to be referable to the taxon *Iguanodon bernissartensis*.

**Mantellisaurus atherfieldensis** (Hooley, 1925)
Reginald Hooley discovered a near-complete skeleton (NHMUK R5764) of a medium-sized ornithopod near Atherfield Point, Isle of Wight in 1914 (Fig. 12). The description was published posthumously, with the assistance of Arthur Smith Woodward (Hooley, 1925), exactly a century after the founding description
Fig. 11: *Iguanodon bernissartensis* Boulenger, (1881). A. The left ilium of the holotype of *Iguanodon seelyi* Hulke, 1882, from the upper Barremian of Brook Chine, Isle of Wight (from Norman, 2012). The preacetabular process is thick and robust (the base of which appears to be slightly distorted by a bony callus); the dorsal margin is transversely thickened and becomes more everted laterally above the ischiadic peduncle; the postacetabular process tapers but is transversely expanded to form a large brevis shelf. Carpenter & Ishida (2010) claimed, on the basis of highly schematic 2D outlines of this ilium and that of RBINS R57 (illustrated below) that these belonged to the same taxon “*Dolodon*” and on this basis they proposed the new combination “*Dolodon seelyi*”. B. The ilium of the skeleton of *Mantellisaurus atherfieldensis* from the Sainte-Barbe Clays Formation (upper Barremian) of Bernissart (RBINS R57); this is the right ilium (image reversed) as an interpretative line drawing (after Norman, 1986). The entire skeleton was renamed *Dolodon bampingi* Paul, 2008 on the basis of alleged differences between this skeleton and that of the holotype of *Iguanodon atherfieldensis* (NHMUK R5764). None of these alleged differences has any validity and the taxon is regarded as a nomen dubium and a junior subjective synonym of *M. atherfieldensis* (McDonald, 2012; Norman, 2012). Although the outlines of A and B may look similar the bones are very distinct: the preacetabular process shown in Fig. 11B is elongate, slender and laterally compressed; the dorsal margin of the ilium is narrow and compressed; the dorsal margin develops a modestly expanded bevelled facet above the ischiadic peduncle; there is a ventral inflection to the dorsal border (partly disguised by extensive crushing and distortion – a feature that complicates interpretation of the anatomy of the Bernissart material); and the brevis shelf is narrow and poorly developed. All these features are quite distinct from those seen in Fig. 11A.

Abbreviations: ac – acetabulum; brf – brevis fossa; call – callus; edm – thickened and everted dorsal margin; ef – everted facet; ip – ischiadic peduncle; n.sp – neural spines of the sacral vertebrae; ots – ossified tendons; pp – pubic peduncle; prp – preacetabular process; srf – sacral rib facet.
of *Iguanodon* by Mantell. In the absence any detailed description of the material recovered at Bernissart, this account became the standard reference for all future work on the genus *Iguanodon*. Norman (1980, 1986) offered the first detailed descriptions and diagnoses of the Bernissart ornithopod skeletons and, in doing so, drew comparisons with the contemporaneous English skeletal material from the upper Wealden. Comparisons suggested that *Iguanodon atherfieldensis* was closely similar to the smaller and more gracile ornithopod (of which there was one almost entire skeleton [RBINS R57, formerly IRSNB 1551] and two other very fragmentary individuals also collected from Bernissart). The gracile specimens were therefore referred to *I. atherfieldensis*. In a brief, and somewhat confused, review Paul (2007) proposed that the differences in anatomy that distinguished *Iguanodon bernissartensis* and *I. atherfieldensis* and used by Norman (1986) to identify these taxa as ‘osteological species’ were sufficiently great that they justified the creation of a distinct generic name: *Mantellisaurus* for the gracile taxon. This proposal has been generally accepted in the recent literature.

**Status.** *Mantellisaurus atherfieldensis* (Hooley, 1925) is diagnosed, described in detail and is regarded as a valid taxon.

**Dollodon bampingi** Paul, 2008

G.S. Paul presented a longer and more detailed review of the taxonomy of *Iguanodon*-like dinosaurs (Paul, 2008). Among a range of radical, and inconsistent, proposals he suggested that the gracile Bernissart taxon (RBINS R57 – see above) merited an entirely new Linnean binomial: *Dollodon bampingi*, because he claimed that it differed in many of its anatomical characteristics from those seen in the holotype of *Mantellisaurus atherfieldensis* (NHMUK R5764). Paul supported this proposal with a combination of lengthy diagnoses for each taxon, some highly stylized ‘life restorations’ of fleshted heads, highly simplified 2D outlines of a few appendicular bones, and ‘technical skeletal restorations’ that purported to show differences in body proportions (see Norman, 2012). McDonald (2012) and Norman (2011a, 2012) reviewed this proposal of Paul and demonstrated, independently, that the taxon named *Dollodon bampingi* is not diagnosed on the basis of any taxonomically valid characters and that it should be regarded as a nomen dubium and that the material upon which this name was based should be referred to *Mantellisaurus atherfieldensis*. Paul (2012) attempted to defend his position on *Dollodon bampingi* in the face of criticism by McDonald (2012), but was apparently unaware of the critique by Norman (2012). Paul’s defence presents no new data, and ultimately his case for retention of the name relies upon body proportions derived from his own skull and skeletal reconstructions, which are, ultimately, simply artistic interpretations.

**Status.** *Dollodon bampingi* was not described adequately, has not been diagnosed on the basis of unique anatomical characteristics and is therefore a nomen dubium. The name *Dollodon bampingi* can safely be suppressed, and the skeleton (RBINS R57) upon which *D. bampingi* was founded can be referred to *Mantellisaurus atherfieldensis*.

Fig. 12: *Mantellisaurus atherfieldensis* (Hooley, 1925). A skull reconstruction based upon material that includes the holotype (NHMUK R5764) and an articulated skull collected more recently from the Isle of Wight (Norman, in prep).
Mantellodon carpenteri Paul, 2012

In 1834 Gideon Mantell was presented with a disarticulated, but associated, partial skeleton (NHMUK OR3741 – Fig. 13) of a medium-sized ornithopod collected from Bensted’s Quarry (‘The Iguanodon Quarry’) in Maidstone, Kent (Fig. 1, Norman, 1993); this locality is technically outside the geographic limits of the Weald (that is why it is indicated with an asterisk in Table 1). The rock in which the specimen is embedded is known as Kentish Ragstone (a tough, glauconitic, sandy limestone), which is part of the shallow marine Lower Greensand Formation (Lower Aptian – Fig. 2) that was deposited cyclically from ~126 Ma. The specimen was obtained after blasting using charges of dynamite and, as a result, the skeletal bones were broken and scattered across the quarry floor. The specimen was assembled and, in effect, re-built by the quarry owner William Bensted (1836) before it was purchased privately and presented to Gideon Mantell by a group of friends (Spokes, 1927; Curwen, 1940) and was charmingly christened ‘The Mantel-piece’. Norman (1993) re-examined the specimen and, although the bones are poorly preserved (many bones are crushed and distorted) sufficient of the skeleton can be seen to interpret its basic anatomy and tentatively assess its affinities.

A dentary tooth impression confirms that the teeth of this animal generally resemble those seen in Iguanodon-like ornithopods. The size and general morphology of the vertebrae and individual limb bones are very similar to those described in Mantellisaurus atherfieldensis, and the distinctively slender and twisted proximal 2nd phalanx of the manus also closely resembles that seen in the holotype (NHMUK R5764 – Norman, in press a).

It is claimed that the form of the ilium in this specimen may be used to distinguish this specimen from those seen in closely-related taxa (Paul, 2012: 125) but both left and right ilia are somewhat compressed and distorted. Most significantly the left ilium, that is preserved with its lateral

Fig. 13: ‘The Mantel-piece’ (NHMUK OR3741). An iconic specimen in the history of the study of Iguanodon, this block of Kentish Ragstone was re-assembled following dynamite blasting in Bensted’s Quarry (‘The Iguanodon Quarry’) near Maidstone in Kent. Much of the skeleton of a medium-sized iguanodontian can be recognised and some parts of the anatomy appear to suggest affinities with Mantellisaurus atherfieldensis (Norman, 1993). A stratigraphic horizon from which this specimen was collected is conjectural, it could be basal Lower Aptian (~125 Ma). Width of entire specimen ~2 metres.
surface exposed is overlain by the ischium, and is very 
crushed, while the right ilium is preserved in medial view
and is less informative of its structure; it is also missing 
the posterior half of the postacetabular process. On the
basis of the osteological similarities that can be seen on
this specimen it is still true to say that this skeleton most
closely resembles that of Mantellisaurus atherfieldensis 
(as originally claimed by Norman, 1993). The geological
age of the specimen is in part conjectural. At its oldest it
would be basal Aptian (~126 Ma), which would make it
contemporaneous with known occurrences of the latter
taxon elsewhere. However, until the matrix can be dated
accurately this age remains purely conjectural because
this particular lithology recurs cyclically through the
lower part of this Lower Greensand succession in Kent.
Paul (2012) proposed the taxon Mantellodon carpenteri
without the benefit of illustration of any kind and with a
completely incorrect diagnosis. It should be mentioned
that this diagnosis is identical with that used to define
the nomen dubium Darwinsaurus evolutionis (compare
Paul, 2012: 124 and 125). For completeness the proposed
diagnosis of this alleged new taxon is given verbatim
below (comments [in square brackets] have been added
simply as observations by this author).
‘Diagnosis: Dentary straight, elongated diastema
present, dentary shallow ventral to diastema and
deeper astride dentary battery, anteriormost dentary
teeth reduced. [There is no dentary with its dentition
preserved in this specimen – see Fig. 13]. Forelimb
robust, olecranon process well developed, some carpals
very large, metacarpals fairly elongated, thumb spike
massive. [The forelimb elements preserved are gracile,
carpals are not preserved, the metacarpals are elongate
and slender, and a thumb spike is not preserved].’ (Paul,
2012: 125). Status: Mantellodon carpenteri has not been adequately
described and its diagnosis is entirely incorrect and
anatomically irrelevant; it is also a little curious that
the ilium, regarded by Paul as an important anatomical
feature, was not used in the diagnosis.
M. carpenteri is clearly a nomen dubium and this name can
safely be suppressed. The original specimen (NHMUK
OR3741) is considered, on the basis of the anatomy that
is visible (geological evidence notwithstanding), to be
referable to Mantellisaurus atherfieldensis.
The dubious statuses of Vectisaurus valdensis,
Proplanicoxa galtoni and Sphenospondylus gracilis have
been commented upon by McDonald (2012) and Norman
(1986).

IV. DISCUSSION

In recent years attempts have been made to increase,
dramatically, the number of large-bodied ornithopod
taxa in the English Wealden (Lower Cretaceous). Several
authors appear to think that new taxonomic names can
be generated without reference to, or formal study of, the
original material, referred material or relevant geological
information. This review suggests that such attempts
at taxonomy risk being flawed scientifically, and are
unwarranted and misleading.
The recent taxonomic contributions concerning the
Iguanodon-like ornithopods from the Wealden of
England (and the isolated locality of Bernissart in
Belgium) appear, when subjected to critical evaluation,
to have been prompted, in part at least, by ‘expectation’
derived from a misguided logic, rather than occurring as
a result of accurate, dispassionate and critical observation
of original material. New taxonomic names have been
erected with scant regard to the formal procedures that
link careful study with detailed description of the original
material and an assessment of any cognate additional
material, or geological (stratigraphic provenance)
information that may have a bearing on such judgements.

Apart from just one instance, in which the generic name
of a well-established taxon has been altered: Iguanodon
atherfieldensis is now regarded as Mantellisaurus
atherfieldensis, all of the taxonomic names that have
been proposed for Wealden ornithopod material by G.S.
Paul, K. Carpenter & Y. Ishida have been revealed to be
either objectively synonymous with existing taxa (Table
1), or founded upon misunderstanding, preconceived
notions or inaccurate anatomy (or various combinations
of these factors).
It is also regrettable that the majority of these
taxonomic contributions contain errors that are
inconsistent with what might normally be expected in
literature that has been published following the process
of peer review and editorial supervision. In addition,
fundamental errors in these contributions betray what
is normally regarded as good practice in taxonomic
procedure. This combination of observations suggests
that the peer review system has not operated so as
to maintain standards. It is furthermore quite clear
(following personal enquiry) that at least one of the
authors (G.S. Paul) has never seen or inspected at first
hand any of the material in the Natural History Museum
(London) for which he has felt able to propose new
taxonomic names.

Accurate and reliable taxonomy is of crucial importance
to palaeontology as a science and to interpretative
palaeobiology more generally because estimates of
taxonomic diversity among related groups of organisms
within the geological timescale are invariably used to
create metrics that attempt to measure rates of evolutionary
change. Data concerning such change may contribute to
the understanding of change within particular taxonomic
groupings, or manifest patterns of evolutionary change
that reflect organismal responses to external factors
such as tectonics (e.g. time-based palaeobiogeography,
vicariance or dispersal), palaeoecology (e.g. regional,
latitudinal or climatic influences) or evolutionary
processes (e.g. intrinsic lineage dynamics, directional
change, stochastic change).
Evidence from the fossil record of the Wealden suggests that, contrary to recent suggestions, large-bodied ornithopod taxonomic diversity was not high, but this simply reflects the imperfection of the fossil record (Darwin, 1859). Only two relatively short and widely separated fossil-bearing time horizons have been sampled. There is little doubt, from a generalized stratigraphic and evolutionary perspective, that during the ~20 Ma of elapsed time represented by the sedimentary pile accumulated during the Wealden succession, that a number of distinct ornithopod taxa probably evolved and became extinct. These taxa had the potential to leave a rich and diverse record of their existence. However, the Wealden fossil record is effectively mute with respect to a significant proportion of this time-dependent diversity.

V. CONCLUSIONS

Recent proposals concerning the taxonomic diversity of Iguanodon-like dinosaurs in the Wealden rocks of England and Belgium have been reviewed. It is concluded that four diagnosable taxa can be recognised at present: Barilium dawsoni, Hypselospinus fittoni, Iguanodon bernissartensis and Mantellisaurus atherfieldensis. These four taxa are distributed within beds that comprise two short intervals of time: the middle Valanginian, and the upper Barremian-lowermost Aptian (see Table 1). The 13 additional taxa (Table 1), whose names have appeared in recent articles (2008-2012) are all considered to be nomina dubia whose names can be suppressed safely, with their material being referred to one or other of the four established taxa.

Conventional standards of taxonomic practice have not been adhered to, and normal editorial procedures (editorial review and peer review) appear to have been abandoned for reasons that are unclear. The quest for higher levels of taxonomic diversity in the Wealden has been driven by the expectation that a large interval of geological time (~20 Ma) should equate to a substantial diversity of fossil taxa. The imperfect nature of the fossil record and the limited range of horizons that yield ornithopod dinosaur remains frustrates such expectations. Until fresh geological horizons that sample more of the Wealden succession are identified it is regarded as unlikely that a substantially greater diversity of Wealden ornithopods will be identified.

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