Stage nomenclature in the uppermost Jurassic rocks of Britain

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Following the ratification of the Tithonian Stage as the Primary Standard Stage for the terminal Jurassic, the Kimmeridgian Stage can only be used in its shorter sense. For those areas of north-western Europe including Britain, where ammonite provinciality precludes use of the Tithonian Stage, the Secondary Standard Stages Bolonian and Portlandian will need to be used for precise intra-provincial correlation pending any future firm correlation with the Primary Standard. The Volgian will continue to be used, but only as an informal unit in Russia and adjacent areas, but cannot be legitimately used outside of Russia, for not only are its ammonites absent from the Jurassic of other parts of Europe, but it belongs to both Jurassic and Cretaceous systems and is thus unacceptable as a formal stage in chronostratigraphy. The Bolonian genus *Pectinatites* is far more widespread than generally recognised and the base of the lowest Bolonian Elegans Zone appears to correlate closely with the base of the Tithonian Stage.

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Introduction

Stratigraphical refinement progressed rapidly during the 19th Century with the introduction of the concept of the stage (d'Orbigny, 1842-51) and the zone (Oppel, 1856-58). Much of this work was pioneered in the Jurassic System in which, over north-western Europe, a succession of ammonite faunas showed that increasing stratigraphical resolution was possible. When Oppel produced his table of zones for the Jurassic Period (1856-58) he recognised 33 zones of which 22 had an ammonite species as their index fossil. Since then progressive refinement has increased the number of zones so that by 1933 Arkell listed 57 zones (all of them with an ammonite as zonal index) and Cope (2006) recorded the then total as 76, most of which are divided into subzones.

In the uppermost Jurassic, however, there are still major problems of correlation, because of faunal provincialism; ammonites became restricted geographically and faunas in one area are totally different from those of another. In a few instances, however, ammonites occur that enable different faunal provinces to be correlated at discrete points.

Development of nomenclature

When d'Orbigny drew up his table of Stages (1840-51) he named the Kimmeridgian and Portlandian Stages after British localities but relied upon the detailed descriptions of Fitton (1836) for knowledge of the British sections. D'Orbigny also, however, defined his stages, in addition to lithological units at different localities, by their fossil content; thus for the Portlandian Stage (named after Portland Isle) he said it was equivalent to the Portland Sand and Portland Stone of Fitton (1836) but also listed the species *Ammonites gigas, A. gravesiana* and *A. irius* as characteristic. These species all occur in the Upper Jurassic of the Boulonnais region of northern France, so that it was natural that the French called these rocks Portlandian, but these species were then unknown in Britain. More than 60 years later, Salfeld (1913) found these ammonite species (which he included in his new genus *Gravesia*) in the middle of the English Kimmeridge Clay at Kimmeridge, and recognised that their occurrence meant that these rocks were already Portlandian to French eyes. British geologists, however, reading that d'Orbigny's Kimmeridgian Stage included the whole of the Kimmeridge Clay of Fitton (1836) continued to regard these rocks as Kimmeridgian; they also restricted their interpretation of the Portlandian Stage to the Portland Sand and Portland Stone of Fitton following the first of d'Orbigny's criteria. In retrospect it seems clear that although d'Orbigny named these stages after British localities his ambiguous definitions arose because he had never seen the British sections, and was totally unaware of the position of *Gravesia* in the middle of the British Kimmeridge Clay.

What was overlooked for many years, however, was that Blake (1880, 1881) had already appreciated this problem. Thus Blake (1880, p.196) wrote: "*The fact is that in England we possess the* ***normal*** *formation, to which the name Kimmeridge was originally applied* [by Webster (1816)]; *while at Boulogne we find an* ***episode*** *having no relation to the Portlandian above, but to which the name of "Boulognian" may well be given… The upper part of their* [the French] *"Middle Portlandian" is our Portland Sand…The lower part of their "Middle Portlandian"…* [is]*… not at all unlike the top of the Kimmeridge at Chapman's Pool. ... Referring to my section on the Kimmeridge coast (1875) … the comparative thicknesses of the deposits are 252 feet* [76.8 m] *in England and in France 44 feet* [13.4 m]. *We are thus forced to look for the normal representatives of the Boulognian episode in the beds from No. 10* [Freshwater Steps Stone Band] *downwards of my succession… The existence of this*

Boulognian episode has misled the French geologists, in spite of their claim to be solely guided by the fauna, to associate these beds with the Portland rocks, with which they have very little in common, their invariant fossils being those of the Kimmeridge Clay." He summarised this (1880, p.221): *"The Boulognian episode to which, unjustifiably, the name Lower Portland has been given, is represented by normal shales and cementstones on the Kimmeridge coast"*.

It is thus clear that by 1880 Blake was in no doubt that there was misunderstanding in the meaning of both the Kimmeridgian and Portlandian stages between the British and the French, and that the true correlation with the English Portland Beds was with beds much higher in the Boulonnais succession than the French then recognised. By the following year, following further fieldwork in France, he felt able to come up with a formal proposal.

Thus Blake (1881, p.581) wrote: *"For the series of deposits which overlie the true Kimmeridgian or Virgulian, and underlie the true Portland Beds, the name of BOLONIAN* [his capitals] *is proposed. It has already been proved (1880, p. 189) that in the Boulogne area these rocks correspond to what had been hitherto considered to be an integral part of the Kimmeridge Clay…The name Portlandian has usually been applied to them; but since it is certain that they do not correspond to our Portland rocks, this name is to the last degree misleading; and the only way out of the confusion is the use of a distinct name"*. And then he continues (Blake, 1881, p.584): *"In our own country the Bolonian strata are pretty nearly synonymous with those shown to be separable under the title Upper Kimmeridge"*. He then goes on to say (1881, p.584) that the Bolonian can be divided into two distinct parts, the lower corresponding to the zone of *Ammonites gigas*. *"On the coast of Dorset the lower limit of the Bolonian must also be drawn in the midst of clays, where the most marked introduction of new species occurs…it will be below Bed No. 29 of the Kimmeridge Bay section, and may be as low as No. 40."* (In fact *Gravesia gigas* occurs in Blake's Bed 41 about 3 m below the horizon Blake believed to be the lowest point of correlation). For its time, before the discovery of *Gravesia* in Dorset by Salfeld, this was a remarkable piece of stratigraphical detective work, for which Blake has received little credit.

Arkell (1946) in a now classic paper proposed a series of rules for Jurassic stage names, suggesting for reason of historical priority alone that d'Orbigny's stage names should have precedence. He advocated the use of Kimmeridgian and Portlandian in their traditional British sense, arguing that this is what d'Orbigny had meant, and suggesting that d'Orbigny's citation of species of *Gravesia* was, in essence, a mistake. His suggestions thus meant that the Tithonian Stage Oppel (1865) widely used for uppermost Jurassic rocks in Tethyan areas, should be invalidated. Later however, Arkell (1956, p.8) realised that the Tithonian Stage, by then used continuously over the majority of the world for almost a century, could not be supplanted. Arkell's views were promulgated by virtually all British workers, but because they were using Kimmeridgian and Portlandian in different senses to those of their continental colleagues, they had to suffix their use with "*sensu anglico*" or "*sensu gallico*" to convey unambiguously their intentions to their readers.

Thus workers in Britain continued to use a long Kimmeridgian Stage and a short Portlandian, whereas workers in northern France were using a short Kimmeridgian Stage followed by a long Portlandian Stage; their colleagues in southern (Tethyan) France used a short Kimmeridgian succeeded by the Tithonian.

The indisputable fact remains that the British and French will not find agreement in their respective interpretations of the Kimmeridgian and Portlandian stages. Both can equally claim to be following d'Orbigny; the British position being based on d'Orbigny's lithostratigraphy and the French on d'Orbigny's biostratigraphy. As d'Orbigny himself gave each equal weight, there simply is no right or wrong to either interpretation and Blake's (1881) suggestion of a Bolonian Stage to solve the problem is unambiguous and practical.

Meanwhile, the Russian Stage Volgian, introduced by Nikitin in 1881 for the condensed succession in the Volga Basin, was used by workers in Russia and parts of Poland. Although of very limited value in the sense that Nikitin had originally proposed it, the name was given a new lease of life in two ways. Firstly, in a purely political move in trying to seize the initiative in getting the Volgian to be accepted internationally as the terminal Jurassic Stage, Gerasimov and Michailov (1966) substantially lowered the base of the Volgian, as defined by Nikitin, down to the approximate level of the base of the Tithonian and the Lower/Upper Kimmeridgian boundary *sensu anglico*. Secondly, Casey (1971, 1973), working on ammonites yielded during flood prevention schemes in the Wash area, identified ammonites of the Upper Volgian in East Anglia. He promulgated the view that the Volgian Stage should be applied to the British succession of the Upper Kimmeridge Clay and Portland Beds, and this idea was echoed in a paper on the North Sea Upper Jurassic by Riley (1981); the result was that geologists working on the offshore Jurassic of the North Sea started to use Volgian as the preferred stage name, although, as shown by Cope (2008) the only Volgian ammonite species in the North Sea area are those of Upper Volgian age, now internationally dated as of lowest Cretaceous age.

At the conclusion of an informal discussion between British delegates and their continental colleagues at the third *Fossili, Evoluzione, Ambiente* symposium in Pergola, Italy in 1990, the British delegates agreed that they would not oppose the proposal for the Tithonian Stage as the terminal Jurassic Stage. This was accepted by the Jurassic Symposium in Poitiers in the following year and subsequently ratified by the IUGS. Thus it was that the Tithonian Stage was internationally adopted as the terminal Jurassic Stage, although over 20 years later its basal Global Boundary Stratotype Section and Point (GSSP) has yet to be selected. However, what was decided was that the base of the Hybonotum Zone (index species *Hybonoticeras hybonotum*) should mark the base of the stage; a new working group has been recently formed to select an appropriate GSSP for the base of the Tithonian Stage. The most likely locality to be selected lies within the Ardèche, Drôme or Var areas of southern France, where there are several candidate sections.

The Tithonian Stage rests on the (shorter) Kimmeridgian Stage, so that the fact that the Tithonian Stage had now been ratified as the International Standard, necessarily means that the Kimmeridgian Stage can now only be legitimately used in its shorter (*sensu gallico*) meaning. Contrary to a suggestion by Gallois (2012, p.132) that the Tithonian was selected because it had priority over the later proposed Volgian, as then a voting member of the Jurassic Subcommission, I can report that the Volgian was never considered by the Jurassic Subcommission as a possible candidate terminal Jurassic Stage; it is too restricted geographically and most of the key sections (including its basal boundary) are punctuated by phosphatic nodule beds showing condensation.

Discussion

The ammonite faunas of north-west Europe differ fundamentally from those of the Tithonian facies of southern Europe and other areas of the world, although until the 1960s the faunas of the lower part of the Upper Kimmeridge Clay were believed to belong to the Tithonian genera *Subplanites* and *Lithacoceras* by Spath (e.g. 1936) and Arkell (e.g. 1933, 1947, 1956, 1957). However, systematic collection of hundreds of these virgatosphinctid ammonites by Cope and close comparison with their Tithonian contemporaries showed that the British forms belonged entirely to the genus *Pectinatites* and that these were quite distinct from the Tithonian genera with which they had been hitherto confused (Cope and Zeiss, 1964; Cope, 1967). Cope's conclusions have been universally accepted and Gallois' (2012, p.132) assertion that the earlier pectinatitids might belong to *Subplanites* or *Lithacoceras* is wishing to take us back some 50 years and is totally without foundation.

At Kimmeridge pectinatitid ammonites are found commonly down to the base of Blake's Bed 42; below this pectinatitids do occur, but they are less common and usually fragmentary. When drawing the basal boundary of the Elegans Zone (Cope 1967) the decision was taken to draw that boundary at the lowest point at which identifiable *Pectinatites* are common; this coincided with Blake's (1875) Bed 42. This was a few metres above the level at which the last *Aulacostephanus* of the underlying *Autissiodorensis* Zone occur, but the pectinatitids hitherto collected from the intervening beds were not satisfactorily preserved. Cope later (1968) found probable precursors of *Pectinatites* some 40 m below this level which were named *Propectinatites*; unlike *Pectinatites* their microconchs bore lappets. Birkelund *et al*. (1983) suggested that *Propectinatites* was probably a junior synonym of *Subdichotomoceras* Spath, 1925, but there are important differences between the two. The latter genus, with type species from the Kimmeridge Clay of Yorkshire, has a higher point of furcation of its ribs and has regular constrictions, which seem absent in *Propectinatites*, and according to Arkell (1957, p.L328) *Subdichotomoceras* lacks lappets and has a simple or trumpet-shaped aperture.

The earliest pectinatitids to be specifically identifiable belong to *Pectinatites (Arkellites) primitivus* Cope; the microconchs of that species do not have the marked ventral horn of later species, but have merely a minor ventral inflation of the peristome (see full description in Cope (1967)). However, there cannot be the slightest doubt that these are pectinatitids, despite the pronouncement that they could "*equally belong to other genera including* Lithacoceras, Subdichotomoceras *and* Subplanites" (Gallois, 2012, p.132). Cope and Zeiss (1964) showed that *Lithacoceras* and *Subplanites* did not occur at all in Britain (or anywhere north of the Tethys) and this, together with Cope's monographic treatment of the pectinatitids (1967) has been universally accepted. Indeed, writing on the Kimmeridge Clay of Dorset, Cox and Gallois (1981, p.40) say of the Hen Cliff Shales immediately above Blake's Bed 42 "*crushed pectinatitids including* Pectinatites (Arkellites) *and* P. (Virgatosphinctoides) *occur throughout*". This statement, with which I concur, is totally at odds with that expressed by Gallois (2012, p.132 and his figure 1). The upper beds of the underlying Autissiodorensis Zone contain, some 3 m below Blake's Bed 42 "*common crushed pectinatitids*" according to Cox and Gallois (1981, p.40) and 8 m below Blake's Bed 42 the same authors record "Aulacostephanus *and pectinatitids*" (Cox and Gallois 1981, p.40). Gallois & Etches (2010, figure 3) also record *Pectinatites* down to the level of Blake's Bed 42. All these references are totally at odds with the opinion expressed by Gallois (2012) and the highly attenuated range of *Pectinatites* shown in his figure (Gallois, 2012, figure 1).

Thus Gallois' (2012, p.132) statement that the lowest undoubted *Pectinatites* are some 20 m above Blake's Bed 42 is totally without foundation, and is entirely contrary to views he himself has earlier stated on numerous occasions. Additionally, his claim (Gallois, 2011) that "*the ranges of ammonites can now be obtained with greater accuracy than was previously possible*" and that the accuracy of recording horizons which yielded specimens "*has mostly been not better than ±2m*" is also challenged. By using 1:2,500 Ordnance Survey plans (on which the ledges are accurately depicted), a tape and an Abney level the accuracy of recording the position of any horizon on the low tide ledges that yield the fossils rivals that claimed as superior by Gallois (2011).

Correlatives of Blake's Bed 42 can be found in other sections (*contra* Gallois 2012, p.132) and indeed one such was identified by Cox and Gallois (1981, p.37) in the Brandy Bay section, Kimmeridge, (on the northern limb of the Purbeck anticline) as a "*laminated oil shale with impersistent calcitic cement in its lower part*" - a correlation which accords with one I had made in the early 1960s (unpublished field notes). I recently led an international party over the Kimmeridge section and learnt (J. Ogg pers. comm., 2012) that Blake's Bed 42 corresponds very closely with the base of Normal Polarity Zone M22 and thus probably close to the base of the Hybonotum Zone; consequently this horizon has wide correlative potential, contrary to the view expressed by Gallois (2012, p.132).

Thus it seems that the boundary chosen by Cope as the base of the Elegans Zone (Cope, 1967) and later as the base of the Bolonian Secondary Standard Stage (Cope, 1993, 1995, 1996) is a readily recognisable and widely correlatable horizon that will serve well as a basis for further work and completely negates the suggestion that "*this bed has no lithostratigraphical,*

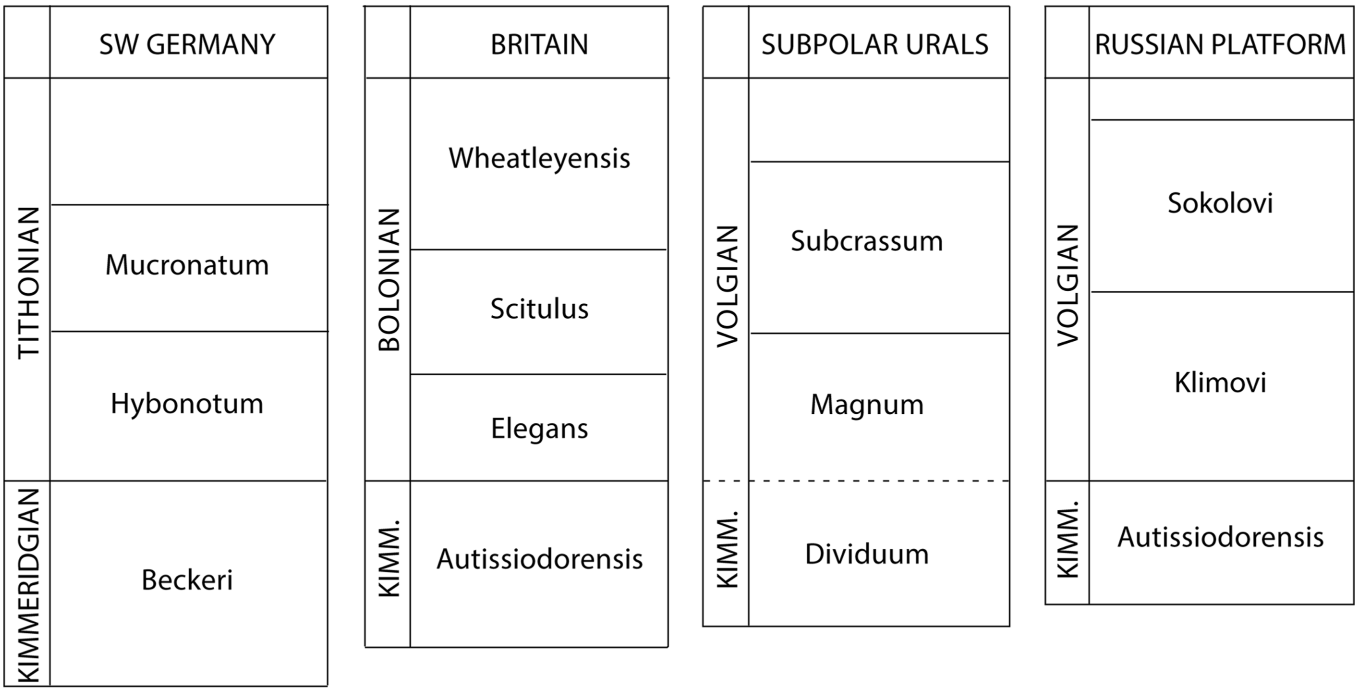

Figure 1. *Approximate correlations between uppermost Jurassic faunal provinces at the level of the top of the Kimmeridgian Stage and the succeeding Primary or Secondary Standard Stages. The correlation at this level is certainly close, but not exact. Thus the bases of the Tithonian Standard with the bases of the Bolonian and Volgian is similarly close, though note also that the correlation between Western Siberia and the Russian Platform is also not exact. Modified after Rogov and Price (2010).*

biostratigraphical or chronostratigraphical value for correlation purposes" (Gallois, 2013, p.132). The suggestion by Gallois (2011) that the Last Appearance Datum of *Aulacostephanus* be used as a proxy for the base of the stage was rightly criticised by Wimbledon (2012). Clearly the top of the Kimmeridgian must lie at or above the highest *Aulacostephanus*, but LADs are never used in Jurassic biostratigraphy or chronostratigraphy and are much more likely to reflect local rather than regional extinctions.

The Volgian Stage has always been properly restricted in use to Russia and parts of Poland and the fact that the Tithonian Stage is now the Primary Standard raises problems with the continued use of the Volgian, as the Tithonian Stage is succeeded by the Berriasian Stage at the base of the Cretaceous (although again a boundary stratotype has yet to be selected). In those areas where the Volgian has legitimately been used, it has been customary to combine its use with a succeeding Ryazanian Stage, but it is now known that the base of the Ryazanian correlates with a level well up in the Primary Standard Berriasian Stage. Thus it has been established that the Upper Volgian is of earliest Cretaceous age. The fundamental problem with this is that, by definition, a Stage cannot belong to two Systems. Recognising this fact, the Russian Interdepartmental Stratigraphic Commission reviewed the status of the Volgian as a stage and withdrew it as a unit for formal use (Zhamoida and Prozorovskaya, 1997). Nevertheless, the use of Volgian as an informal stage continues in those areas where it has traditionally been used, as correlation with the Tithonian is as yet imprecise and it remains a convenient (and at present probably the only) name to use in description of those rocks. Zakharov (2003) proposed the Gorodische section of the Volga River as a Secondary Stratotype Section and Point for the base of the Volgian. This section is thin and condensed but recent work has put forward the view that although there are breaks in the succession, they may not be biostratigraphically significant (Kiselev and Rogov, 2005; Rogov, 2010).

Scherzinger and Mitta (2006) claimed that the base of the Volgian Klimovi Zone correlated with horizons well down in the Autissiodorensis Zone, so that the base of the Klimovi Zone (the basal zone of the Volgian in its type section) lies within the upper part of the Kimmeridgian Stage. Rogov and Price (2010), however, were able to show, by the presence of the Bolonian ammonite *Pectinatites* and its subgenera *Arkellites* and *Virgatosphinctoides* in the Magnum Zone of the Volgian rocks of the Subpolar Urals of Western Siberia, that the Magnum Zone there correlated fairly well with the Elegans and possibly the lower part of the Scitulus zones of the Bolonian; the overlying Subcrassum zone appears to correlate with the Bolonian Scitulus and Wheatleyensis zones. In turn they were able to correlate the Magnum Zone of the Subpolar Urals' Volgian with the Klimovi Zone of the type Volgian of the Russian Platform (Figure 1). There the eudemic virgatosphinctid genus is *Ilovaiskya*, which is unknown outside of the area where the Volgian is used, and that genus is the time-equivalent in that area of *Subplanites* in the Tethyan and *Pectinatites* in the Bolonian areas. Direct correlation between the Upper Kimmeridgian of the Russian Platform and Britain is possible high in the Kimmeridgian, but no higher, so that the *ilovwaiskii* Horizon of the Fallax Zone (Rogov 2010) of the Upper Kimmeridgian yields *Aulacostephanus mammatus*, a species that occurs high in the Autissiodorensis Zone of the Dorset Kimmeridge Clay.

One ammonite genus that is often quoted to show points of correlation between the Tethyan Stage with both the Bolonian and Volgian Secondary Standard Stages is the genus *Gravesia*. There exist, however, problems with establishing the ranges of the various species of that genus with accuracy; not least that the genus is frequently rare. Thus *G. irius* is widely accepted as being characteristic of the upper part of the Upper Kimmeridgian Autissiodorensis Zone of north-west Europe, but undoubtedly also occurs in the basal Bolonian Elegans Zone in the southern English Midlands (Oates, 1991); its presence in the upper part of the Upper Kimmeridgian Beckeri Zone of Franconia (south-west Germany) does, however, provide an approximate point of correlation. Some records of *Gravesia* are in doubt and Scherzinger and Mitta (2006) believe that all identifications of the genus in the Volgian sections of the Russian Platform are in error and that properly those ammonites thus identified belong to the unrelated genus *Eosphinctoceras*.

Conclusions

Thus for the British area, the equivalents of the Tithonian Stage are most appropriately described under the Secondary Standard Stage names Bolonian and Portlandian; the use of Volgian cannot be legitimately defended. These stages are being increasingly recognised as useful names, not only over the British area, but could also be applied as far afield as the Sub-Polar Urals of Western Siberia (Rogov and Price, 2010) whence the Bolonian genus *Pectinatites* and its subgenera *Arkellites* Cope, 1967 and *Virgatosphinctoides* Neaverson, 1925 (Neaverson, 1925) have been identified, providing valuable correlation. In east Greenland the Bolonian genus *Pectinatites* and its subgenera *Virgatosphinctoides* and *Pectinatites* have also been recorded, as have Portlandian genera including *Crendonites* (Spath, 1936; Cope, 1967), showing that Bolonian (and Portlandian) faunas were far from restricted to Britain and northern France. As the Kimmeridge Clay is the principal hydrocarbon source-rock in the northern North Sea, during the exploration phase of oil drilling, I was frequently sent ammonites for dating of the cores. These ammonites were without exception of genera and species well known in the UK Kimmeridgian and Bolonian and not a single Volgian ammonite was seen.

So why should we use Bolonian and Portlandian Secondary Standard Stages for the British area rather than the Tithonian Primary Standard. The answer is quite simply precision. Here a comparison with the Ordovician Period is quite illuminating. The Ordovician was a time of perhaps greater faunal provincialism than the uppermost Jurassic. Divisions of the Ordovician were produced during the 19th and early 20th Century that resulted in different series and stage names for (amongst other regions) Western Europe, Scandinavia, North America and Australia. These were based primarily on largely local graptolite and trilobite zones, but biostratigraphy based on other groups, such as conodonts, and occasionally brachiopods, was also used. Attempts to found a unified chronostratigraphical scheme all failed, so at the beginning of this century it was decided to use another approach by identifying widespread marker species that could provide more widely applicable chronostratigraphical divisions. This was completed in 2007 and the result was that the Ordovician is now divided into three series and seven stages which can be widely, though not universally, identified; but in no one area of the world can all the new divisions be identified. If we compare the conventional, and now by definition Secondary Standard Series and Stages of the North-west European Ordovician, consisting of five series and 15 stages (some divided into substages), it can be seen that a great deal more precision is possible in Britain by using the Secondary rather than the Primary Standard (Cope 2007). Taking the latest time-scale (Gradstein *et al.* 2012) the Ordovician Period lasted 41.6 Ma, thus the mean duration of an Ordovician International Standard Stage is 5.94 Ma, whereas a North-west European Ordovician Secondary Standard Stage has a mean duration of 2.77 Ma - more than twice the precision. That is why British Ordovician workers still use the British Secondary Standards for their greater precision, but usually make reference to the Primary Standard (in parentheses) so that correlation with the international standard is clear.

Exactly the same reasons can be advanced for using our uppermost Jurassic Secondary Standard Stages in Britain. According to Gradstein *et al.* (2012) the Tithonian Stage lasted 7.1 Ma. There is not one Tithonian Standard Ammonite Zone (chronozone) recognisable in Britain, but there are eight Bolonian and five Portlandian ammonite Standard Zones currently recognised (Table 1). Several of these can be divided into subzones and the mean length of a zone is <0.55 Ma. It is important to recognise that whilst it is quite correct to speak of the (basal Bolonian) Elegans Zone as being of Tithonian age, it is equally incorrect to speak of it as the Elegans Zone of the Tithonian. The Elegans Zone can only (at present) be identified within the areas where the Bolonian Secondary Standard Stage can be used and the Secondary Standard Stages can provide quite precise correlation within each faunal province, but as new faunas come to light and methods of geochronology (including magnetostratigraphy) become more widely applied, correlation between faunal provinces can become more firmly founded.

Secondary Standard Stage	Standard Zones
PORTLANDIAN	*Titanites* Anguiformis
	Galbanites Kerberus
	Galbanites Okusensis
	Glaucolithites Glaucolithus
	Progalbanites Albani
BOLONIAN	*Virgatopavlovia* Fittoni
	Pavlovia Rotunda
	Pavlovia Pallasioides
	Pectinatites Pectinatus
	Pectinatites (Arkellites) Hudlestoni
	Pectinatites (Virgatosphinctoides) Wheatleyensis
	Pectinatites (Virgatosphinctoides) Scitulus
	Pectinatites (Virgatosphinctoides) Elegans

Table 1. *The Standard Ammonite Zones (chronozones) of the Bolonian and Portlandian Secondary Standard Stages. For assistance the generic (and subgeneric) names of each species are included in small italic typeface above the name of the zone. It is normal orthographic practice to use Roman letters for chronozones as opposed to italic letters for biozones.*

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