OBSERVATIONS ON THE SUCCESSION OF AMMONITE FAUNAS IN THE BATHONIAN (MIDDLE JURASSIC) OF SOUTH-WEST ENGLAND, AND THEIR CORRELATION WITH A SUB-MEDITERRANEAN 'STANDARD ZONATION'

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Bathonian ammonites are generally rare in Britain, largely as a result of unfavourable environments or non-preservation in shallow water facies. Rich faunas only occur in the earliest Bathonian, Zigzag Zone of Dorset and Somerset, at higher levels, ammonites are usually rare or virtually unknown. Nevertheless, sufficient have been found to enable a basic zonal scheme to be developed which reflects these scattered records. Subsequent detailed work, however, in Germany, France and, more recently, Spain (in progress) has revealed that virtually all the taxa known in Britain occur elsewhere, often abundantly. This emphasises the fact that British faunas, although relatively impoverished, do not belong to any separately identifiable biogeographic province as is often implied, and that only one Standard Zonal Scheme should be necessary for most of Europe.
To emphasise these similarities, the succession of ammonite faunas recorded in south-western Britain is here correlated with a modified Sub-Mediterranean standard as used in central and southern France and Iberia. This Sub-Mediterranean Standard is then used to present a new correlation of the lithostratigraphical units recognised in the Bathonian rocks of south-western England, from Dorset to Avon.

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INTRODUCTION

The Bathonian Stage of the Middle Jurassic in Britain is dominated by shallow marine and non-marine facies - it is hardly surprising therefore that ammonites are typically rare or absent. Nevertheless sufficient have been recorded over the past 180 years that a standard zonation has developed, culminating in the scheme of H.S. Torrens (1965 as later modified in 1974 and 1980). This basic scheme (Figure 2) has become established as characterising a northern European faunal region from Britain to southern Germany (eg. *in* Callomon inWesterman and Callomon, 1988 and Mangold, 1991).

Correlation between Britain and more southerly areas (eg. central and southern France and Iberia) has always been considered to be sufficiently good in the Early Bathonian that essentially the same zonal scheme can be used in both regions. However for the Mid and Late Bathonian separate schemes have developed, in part due to an emphasis on faunal differences rather than similarities (Figure 2). Recent work in Spain, however, in conjunction with Dr G. Melendez (Universidad de Zaragoza) has suggested that virtually all the taxa recorded in Britain either do occur or can be expected to occur in so-called Sub-Mediterranean' areas and that local absences in Britain can be explained as being largely due to overall impoverishment of the fauna as a consequence of unfavourable facies or non-preservation. In fact, with the exception of Phyllo- and Lytoceratina, characteristic of Tethys-influenced areas (Mediterranean Province *sensu stricto,* eg. *in* Cariou *et al.* 1985, Fig. 2), most typically southern genera have a record in Britain, albeit as only single specimens or at fewer stratigraphic levels than farther south.

A case can therefore be made for the adoption of a single Sub-Mediterranean Standard Zonation for the Bathonian of most of northern and western Europe. A potential additional benefit of using such a scheme in Britain would be the possibility of increasing stratigraphic resolution at a zonal and sub-zonal level from 11 successive correlative ammonite-based units to 15. The Sub-Mediterranean zonation adopted here for NW Europe as a whole is shown on Figure 2 and is essentially that of Mangold (1991) with the addition of a Quercinus Subzone (after Callomon and Cope, 1995) and the retention of a Tenuplicatus Zone and a Yeovilensis Subzone (as in Torrens, 1974). Local variations reflecting the relative abundance of different taxa can be accommodated into such a scheme at the level of intra-subzonal units such as *zonules* or *biohorizons (sensu* Page, 1995).

The Bathonian of south-west England (Figure **1)** from the historical 'type area' of the stage in the Bath district of Avon, to the Dorset coast, has yielded the majority of known British Bathonian ammonites in Britain and from the greatest number of stratigraphic horizons. The sequence of faunas in this area is here reassessed and correlated with a Sub-Mediterranean 'standard'. The utility of such a scheme in Britain is then demonstrated by presenting a revised correlation of the Bathonian lithostratigraphic units of this district (Figure 3).

THE SEQUENCE OF AMMONITE FAUNAS IN THE BATHONIAN OF SOUTH-WEST ENGLAND

The base of the Bathonian Stage

The *Bathonian Stage* was created by Alcide d'Orbigny in 1846 in his seminal *work Paleontologie française, Terrains Jurassiques,* undoubtedly influenced by the pioneering work in Britain by William Smith who first characterised the fossils of the Bath district (1816, etc).

Due to a poor faunal record in the early Bathonian in the "type district" of Bath and extreme stratigraphical condensation at the base of the stage further to the south, Britain has no suitable localities at which to define formally a Global Stratotype Section and Point (GSSP) for the base of the stage. An expanded sequence, however, at Bas Auran near Digne in the Basse Alpes of Provence (south-east France) has a much better developed faunal succession and has therefore been proposed as a Bathonian GSSP (Torrens 1987; Innocenti, Mangold, Pavia and Torrens, 1988).

In the following text, key published illustrations are cited to aid discussion of the faunas but these will not necessarily be the original

original type figures. The source of type specimens of any nominal species are indicated by an asterisk (*) and the abbreviation "BA" refers toW.J. Arkell's (1951-1958) monograph of English Bathonian ammonites. [M] and 1m1 indicate, respectively, macroconch and microconch forms. The faunas discussed in this section are the primary evidence on which the lithostratigraphic recorrelation of Figure 3 is based.

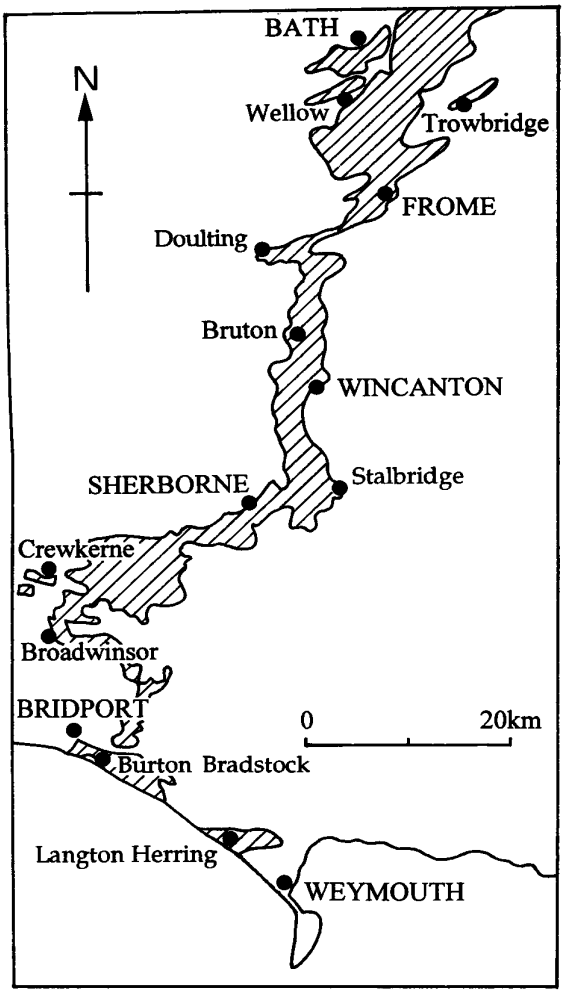

Figure 1: The generalised outcrop (shaded) of Bathonian rocks in southwest England.

Lower Bathonian

1. Zigzag Zone. Index: *Zigzagiceras zigzag* (d'Orbigny). Author: Oppel (1865). Type area of zone: Swabia, southern Germany (Torrens, 1974, p. 583).

(a) Convergens Subzone. Index: *Parkinsonia convergens* (S. Buckman). Author: Mauberge (1950; Torrens 1974, p.583). Type area: Sherborne district, Dorset (as implied by Torrens, loc. cit.). Reference section: Bas Auran, Basse Alpes, SE France (Innocenti *et al*., 1988).

Faunas of the Convergens Subzone are well known throughout south-west England, but typically as poorly horizoned specimens of the zonal index (including "*Pa. pachypleura*" (S. Buckman), the [m] partner of *Pa. convergens*).

At Burton Bradstock on the south Dorset coast, this fauna occurs mixed with younger taxa in a highly condensed Zigzag Bed only around 0.15 m thick (Callomon and Cope, 1995, pp. 6465; BA, p. 252, pl. 18, figs 4, p1.19, figs 8,9). Farther north the `Zigzag Bed' expands to around 0.35 cm in the Beaminster-Broadwinsor district, of which the lower c.0.17 m at Horn Park Quarry yields *Parkinsonia convergens* ([M] and [m]), *Procerites* sp. (including "*Planisphinctes*" [m]), some *Morphoceras* and *Oxycerites aspidoides* (Oppel) ([M] and [m]) (Callomon and Cope, 1995, pp.67-68; J. H. Callomon pers. comm., 1995). The type of *Pa. convergens* is probably from a similar level at nearby Broadwinsor (BA, pl. 19, fig. 1") as is the synonymous *Pa. subgaleata* (S. Buckman) (BA, text fig. 58").

Some of the best records of Convergens Subzone faunas are from temporary excavations in the Crackment Limestones at the top of the Inferior Oolite Group, around Sherborne in north Dorset. These include: *Pa. convergens* and early *Procerites* (= "*Lobosphinctes*" [M] and "*Planisphinctes*" [m]) from at a level around 3.5 m below the top of the Crackment Limestone at Horsecastles (Torrens, 1969b, p.314); *Pa. convergens* (BA, pl. 19, fig. 2), *Pr. subprocerus* (S. Buckman) (pl. 22, fig. 5), *Pr.* cf. *costulatosus* (S. Buckman) (p.189) and *Oxycerites fallax* (Guèranger) from "$3^1/_2$ ft of limestone" at Sherborne Girls School; *Pa. convergens* (p1.18, fig.1; p1.19, figs 4 including *Pa. subtilis* Arkell, pl. 18, figs. *6), *P. subprocerus* (p1.22, fig. 4) and *Pr. incognitus* Arkell (p1.26, fig. 5') from the lowest bed of Kellaway and Wilson (1941) near Ven House, Milbourne Port. The type of *Pa. pachypleura* itself is also from the Crackment Limestone, at Oborne east of Sherborne (BA, text fig. 59*).

Below the level of the characteristic Convergens Subzone fauna, however, in the lower part of the Crackment Limestone is a fauna with 'various oppellids' including the microconchs "*Oecotraustes*" *costiger S*. Buckman (BA, pl. 7, figs 3-5, 6*) and "*O.*" *nodifer S*. Buckman (BA, p1.7. figs. 7,8*) (Torrens, 1974, p.684). This fauna has been assigned to the Bajocian, but in the absence of the more diagnostic parkinsonids, the precise relationship to terminal Bajocian faunas elsewhere is unclear, eg. at the proposed GSSP in south-east France (Innocenti *et al*., 1988).

In Doulting Railway Cutting, north Somerset, *Pa. convergens* ([M] and [m]) occurs 0.3-1.3 m below the top of the 'Anabacia Limestone of the Inferior Oolite (Torrens, 1969a).

(b) Macrescens Subzone. Index: *Morphoceras macrescens* (S. Buckman). Author: Sturani (1967). Type area: Basse Alpes, near Digne, Provence, south-east France (Torrens, 1974, p.584).

In the highly condensed Zigzag Bed of Burton Bradstock, the presence of *Morphoceras macrescens* (BA, pp.134, including "*Ebrayiceras pseudoanceps*" (Ebray) p. 140) indicates the subzone but is associated with other nominal species such as *M. multiforme* Arkell (BA, text fig. 50) andM.patescens (S. Buckman) (BA, p.133) which, according to the records of Sturani (1967) from the Basses Alpes, are just as likely to occur in the Convergens Subzone. *Zigzagiceras* spp. including *Z. plenum* Arkell (BA, pl. 21, fig. 5*) may also be from the Macrescens Subzone.

The richest faunas of the Macrescens Subzone in Britain are probably those of the Broadwinsor-Beaminster district, including Horn Park Quarry where, in Bed 11c of Callomon and Cope (1995, pp.67-68), around 0.17-0.25 m above the base of the Zigzag Bed *M. macrescens* ([M] and [m]) is associated with *Zigzagiceras* ex gr. *zigzag* (including "*Procerozigzag" crassizigzag* (S.Buckman) [M]) and abundant *Procerites* and *Oxycerites* ([M] and [m] (Pers. obs., and J.H. Callomon, pers. comm. 1995). At nearby Broadwinsor the Macrescens Subzone faunas would include *M. macrescens* (BA: pl. 16, figs 4*, also pl. 17, fig. 3; [m] = pl. 17, fig. 9) and *Zigzagiceras* ex. gr. *zigzag* (d'Orbigny) (BA, text fig. 60,3a,b), including the macroconchs "*Procerozigzag*" *crassizigzag* (S. Buckman) text fig. 61*), "*Procerozigzag*", *pseudoprocerus* (S. Buckman) (pl. 20, figs. 1*, pl. 21, fig. 7) and "*Procerozigzag*" *rhabdouchus* (S. Buckman) (pl. 20, fig. 10*)).

At Goathill near Sherborne, *Morphoceras* including *M. macrescens* is recorded *in situ* in the "upper argillaceous part [Beds 8-9] of the Crackment Limestone" by Torrens (1969b, p.318, Bristow *et al*, 1995, p. 23) and Bristow *et al*.(loc. cit.) indicate that the basal beds of the Fullers Earth Clay Formation in the same district also belong to the subzone. Scattered records of *Zigzagiceras* spp. in the area (e.g. BA, pl. 21, fig. 2 and *Z. pollubrum* Buckman, 1909-1930, pl. 259*) are probably also from the same subzone but confirmatory faunal

associations are lacking.

Doulting Railway Cutting and Doulting Bridge (= 'Brambleditch') Quarry in North Somerset have yielded an *in situ* Macrescens Subzone fauna in the top of 0.3 m of the Anabacia Limestones of the Inferior Oolite Group, *Zigzagiceras plenum* Arkell, *Morphoceras* sp. (including *"Ebrayiceras"* cf. *jactatum), Oxycerites yeovilensis* (Rollier) and *Bigotites* sp. being recorded by Torrens (1969a, pp. 818-19; 1980, pp.28-29). Around Bath, the prescence of *"Ebrayiceras" pseudoanceps* at Bitton (Torrens, 1980, p.30) in Anabacia Limestone and *"Procerozigzag" pseudoprocerus* with "Procerozigzag" *crassizigzag* at Kingswood School, Lansdown would indicate the Macrescens Subzone, presumably also in Anabacia Limestone facies (Torrens 1980, p.30; BA, pp. 180, 181).

(c) Yeovilensis Subzone. Index: *Oxycerites yeovilensis* (Rollier). Author: Neumayr (1871) as a Fusca Zone (Torrens 1974, p.585).

As noted by Torrens *(loc. cit.), O. yeovilensis is* not a good subzonal index and very similar species of *Oxycerites* occur higher and lower in the Bathonian, indeed the type horizon of the index species itself, near Yeovil, South Somerset, is unknown (cf. BA, p.60) and it is by no means certain that it falls within a conventionally interpreted 'Yeovilensis Subzone'. An alternative index *of Asphinctes recinctum* S. Buckman has been used (e.g. by Mangold 1991) but as this species may be synonymous with *A. tenuiplicatus* of the succeeding Tenuiplicatus Zone (Torrens 1987p.98; see below also) it would be inappropriate to use *A. recinctum* as an index for an interval equivalent to the Yeovilensis Subzone.

Two main faunas are assigned to the Subzone in Britain. Firstly

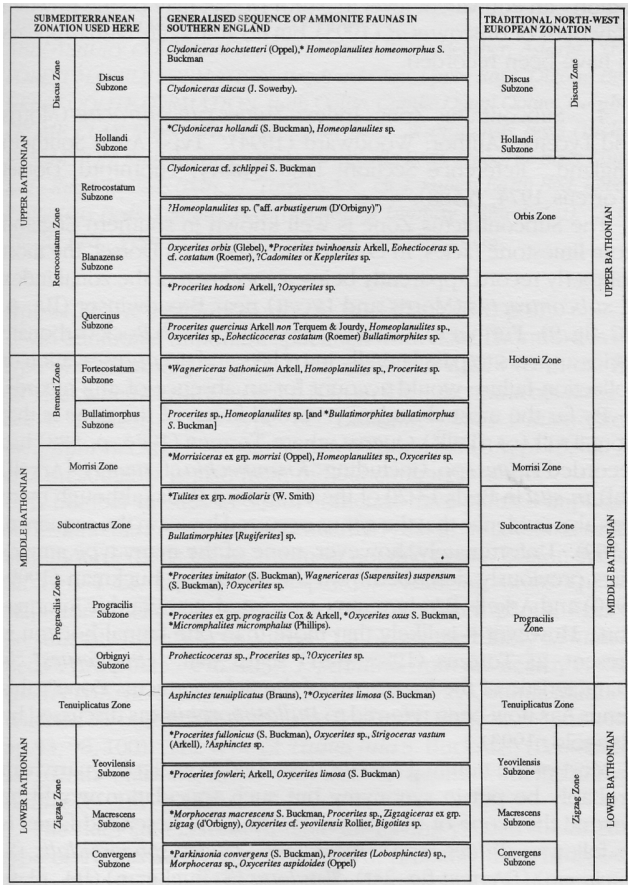

Figure 2: The sequence of ammonite faunas in the Bathonian of southern England and their proposed correlation with 1: a Sub-Mediterranean Standard Zonation, modified from Mangold (1991) and 2: a traditional northern European scheme, modified from Torrens (1980).
Asterisks (*) indicate the known occurrence of the type specimen of the cited species.

there is the fauna of the Fullonicus Beds of north Somerset and Avon which includes *Procerites fullonicus* (S. Buckman) (= Pr. *laeviplex* (Quenstedt) according to Torrens 1980, p.28; BA, pl. 24, fig. 1*, text fig. 69.6*) from Combe Hay Railway Cutting near Bath with an associated microconch identified as *"Siemiradzkia"* aff. *aurigera* (Oppel) from Kelston also near Bath (BA, pl. 33, fig. 10) and also from Bonneleigh Hill, near Frome (BA, p. 228). The *fullonicus* fauna is best known from Doulting Railway Cutting and the adjacent Brambleditch (or Doulting Bridge) Quarry where varients of Pr. *fullonicus* ([M] and [m]) are common in the top limestone band of the Fullonicus Beds (Torrens, 1969d, 1980, p. 28; BA, p. 11, pl. 24, fig 1). The single known specimen of *"Vastites" vastus* Arkell (BA, text fig. 2.3*, pl. 1 figs. 1*) is from the same level and may be a complete adult macroconch of a late species of *Strigoceras* (akin to *S. dorsocavatum* (Quenstedt), a species known from the Convergens and Macrescens subzones of France; Vincent *et al.,* 1988). *Oxycerites* is also present but uncommon. Records by Arkell (BA, p. 11) suggest that *"Morphoceras"* and *"Zigzagiceras"* may also occur in the Fullonicus Beds, and although the latter record is problematic, morphoceratids do occur in the Yeovilensis Subzone of south-east France as *Asphinctes pinguis* (de Grossouvre) (Torrens 1987, p.98).

Secondly, there is the fauna of the Lenthay Limestone (or Lenthay "Bed") of Sherborne, a 0.45 m brachiopod-rich limestone around 2 m above the top of the Crackment Limestone (Fowler 1957, Torrens 1968a). In temporary exposures at the type locality near Lenthay Road, Sherborne, this level has yielded the probably macro/microconch pair *Procerites fowleri* Arkell [M] (BA, text fig 69.4*, pl. 24, fig 5*)/*"Siemiradzkia" lenthayensis* Arkell [m] (BA, pl. 23, figs. 6a, b*) associated with *Oxycerites limosa* (S. Buckman).

The stratigraphical relationship of the *fowleri* and *fullonicus* faunas is unclear in Britain, although the *fullonicus* fauna is associated with *Catinula knorri* (Voltz), an oyster that characterises the Knorri Beds which lie *above* the Lenthay Beds (of Bristow *et al.* 1995, which include the Lenthay Limestone) of the Sherborne district. Some confirmatory indication that this apparent faunal succession may be observable elsewhere is provided by Torrens (1987) revision of Sturani's (1967) faunas from the Basse Alpes. Where *"Pr. fowleri"* appears to occur largely below *"Pr. fullonicus"* at Bas Auran (the latter recorded as *P. laeviplex).* The Lenthay Bed fauna is also recorded in south Dorset in the lower part of the Fullers Earth Clay above the Zigzag Bed at Vetney (= Vinney) Cross, east of Bridport where Callomon and Cope (1995, p.64) record *P. fowleri* ([ml with *" Siemiradzkid'* aff. *aurigerus* [m] and *"S." procerus* (Seeb.) [m] and *Ox. limosa* (with *"Paroecotraustes" formosa* Arkell Em]).

On the Dorset coast the Yeovilensis Subzone is demonstrably condensed into the Zigzag Bed as *Asphinctes pinguis* de Grossouvre is present therein (BA, text fig. 49). *"Morphoceras" replictum* (S. Buckman) may be a synonym of *A. pinguis* and is also recorded from Burton Bradstock (BA, pl. 16, figs 10a, b*, also fig. 5a, b) and also from Crewkerne (pl. 16, figs 9a, b). Other elements of a Yeovilensis Subzone fauna are difficult to identify at Burton Bradstock, as most specimens from the Zigzag Bed are poorly determinable nuclei. An exception, however, may be *Procerites* aff. *schloenbachi* (BA, pl. 21, fig. 9), a species recorded by Torrens (1987) as typical of the Yeovilensis Subzone but ranging up from the topmost Macrescens Subzone.

Elsewhere, for instance at Horn Park near Beaminster, the Yeovilensis Subzone may be represented by the uppermost *c.* 0.08 m of the Zigzag Bed, with abundant *Oxycerites yeovilensis* ([M] and *"Oecotraustes" bomfordi* Arkell [m]; Callomon and Cope 1995, p.67). Nevertheless, in the absence of more diagnostic morphoceratids or proceritids there is usually some doubt as to the correct subzonal assignment of *Oxycerites-rich* faunas such as these.

2. Tenuiplicatus Zone. Index: *Asphinctes tenuiplicatus* (Braun). Author: Rehbinder (1912). Type area: Krakow-Wielun area, Poland (Torrens 1974, p.586).

Historically the holotype of *Asphinctes recinctus* S. Buckman (BA, text fig. 51*) from the Fullers Earth Clay near Midford, Bath, has

been considered to be the only evidence of the zone in Britain (Torrens 1980, p.30). This species may indeed be synonymous with *A. tenuiplicatus* itself (Torrens, 1987, p. 98) and therefore not an earlier form (cf. Mangold 1991). The holotype is unfortunately unhorizoned but Torrens (1980, p. 30) speculated that "either the Fullonicus Limestone or more likely the Knorri Clays" is a possible source level. An association with the *fullonicus* fauna, here assigned to the Yeovilensis Subzone cannot therefore be ruled out, but may be unlikely as this level has yielded good faunas at several localities but no further *A.* ex gr. *tenuiplicatus* seem to have been recorded. In the Sherborne district, the Knorri Beds have yielded a few ammonite fragments including *Oxycerites* sp. (= *"Oecotraustes"* cf. *bomfordi)* and *?Zigzagiceras* (Bristow *et al.,* 1995, p.32) but these records are problematic and not reliable indicators of age.

Additional evidence of the Tenuiplicatus Zone may, however, be available on the South Dorset coast, in the highly condensed Zigzag Bed at Burton Bradstock where *" Polysphinctes" polysphinctes* S. Buckman is recorded (BA, pl. 16, fig 7*, 8). This ?microconch "genus" is characteristic of the Tenuiplicatus Zone in Germany (Buck *et al.* 1966, p.34; Torrens 1974, p.686) and also occurs at this level in south-east France (Torrens, 1987). Indeed Arkells *"Polysphinctes" ebrayoides* (BA, pl. 16, fig. 3*) from the Zigzag Bed at 'Lark Hill', Burton Bradstock may be con- specific with *Asphinctes* aff. *patruli* Hahn of Torrens (1987) from the Tenuiplicatus Zone of the latter area (Basse Alpes). If this zonal assignment is correct, then *Oxycerites limosa* (S. Buckman) as defined by its holotype (BA, pl. 5, figs la, b*) from the basal Fullers Earth at "Black Rocks, Eype" (= West Bay?), west of Burton Bradstock is likely to be a species of the Tenuiplicatus Zone.

A record of *"Polysphinctes" polysphinctes* from Broadwinsor (BA, p1. 16, fig. 6) may indicate that the Zigzag Bed locally ranges to a high zonal level in that district as well.

Middle Bathonian

3. Progracilis Zone. Index: *Procerties progracilis* Cox and Arkell. Author. S.S. Buckman (1913) as a Gracilis Zone. Type area: Stonesfield district, Oxfordshire (Torrens 1974, p. 586).

(a) Orbignyi Subzone. Index: *Cadomites orbignyi* de Grossouvre. Author: Baron (1885) as a 'Zone a *Ammonites linguliferus'.* Type Area: Vendée, France (Mangold *et al.,* 1974, p.124).

In the absence of *Cadomites orbignyi,* the subzone is not clearly distinguishable, but as cadomitids are not necessarily good stratigraphic index fossils due to considerable homeomorphism between different species (Callomon *in* Westerman and Callomon, 1988, p.14), an alternative taxon, possibly a proceritid may be a more reliable stratigraphic indicator.

In the central west of France, the subzone has a varied fauna including *Cadomites, Bullatimorphites, Oxycerites, Procerites ["Gracilisphinctes"]* cf. *prisciasensis* (Lissajous), *Wagnericeras* and *Prohecticoceras* spp. (Gabilly *in* Mangold *et a1.,* 1974, p.107). Although none of the appropriate species are presently recorded in Britain, the occurrence of *Prohectioceras, Oxycerites* and *?Procerites* sp. [m] [= *"Siemiradzkia*"] at Hanover Wood (Kellaway and Wilson, 1941, p.158), presumably in the Hanover Wood Beds of Bristow *et al.* (1995) (i.e. above the probable level of the Tenuiplicatus Zone faunas), suggests that the Orbignyi Subzone may ultimately be recognisable in Britain, but not on the basis of species of *Cadomites.*

(b) Progracilis Subzone. Index, author and type area: as zone (equivalent to the "Horizon a *Gracilisphinctesnov.* sp." of Gabilly *in* Mangold *et al.,* 1974).

The fauna of the Acuminata Beds of south-west England was assigned to the Progracilis Zone by Torrens, 1980 (p. 26, etc). Published records suggest that *Procerites* ex gr. *imitator* (S. Buckman) is typical. It has been recorded near Whatley, Somerset (with *"Pr.* cf. *quercinus"* (Terquem & Jourdy); Sylvester-Bradley and Hodson, 1957, p.316) and also at nearby Leighton (Torrens, 1980, p. 28). *Wagnericeras (Suspensites) suspensum* (S. Buckman) is also recorded from a similar level, from Lovers Lane, Sherborne (BA, p.211; Torrens 1980, p.25) and from near Higher Alham Farm, near Chesterblade, to the SW of Leighton (Torrens, *loc. cit.* BA, pl. 29, fig. 7). In roadworks at Dancing Cross, near Maperton, west of Wincanton, "large faunas of *Procerites* and *Wagnericeras"* were recorded from the Acuminata Beds by Torrens (1980, p.26) and preliminary examination of the fauna, now in Bristol City Museum (H.S. Torrens collection), indicates that *P.* ex. grp. *imitator* is again abundant and typical.

Other records from the Acuminata Beds probably include *?Oxycerites* sp. [m] (= *"Oecotraustes"* cf. *lateumbilicata* Roemer) from the "top part of the Lower Fullers Earth, immediately below the Fullers Earth Rock" SE of Halstock, Dorset (BA, p.73). The *"Parkinsonia",* however, recorded by Sylvester-Bradley and Hodson (1957, p.310) apparently from this level near Frome was collected loose and may be *ex* Inferior Oolite (i.e. Bajocian or early Zigzag Zone).

The type of *Procerites imitator* (S. Buckman) came from the Hampen Manly Formation near Bicester in Oxfordshire (Torrens 1980, p.385; BA, pl. 26, fig.2*, text fig. 69.2*). From stratigraphic relationships in this area and in the North Cotswolds of Gloucestershire, it is clear that *P. imitator* comes from a level *above* the type fauna of the Progracilis Zone of the Stonesfield and Cotswold "Slates". In Gloucestershire, this latter fauna is present in the Eyford member of the Sharps Hill Formation and includes *Procerites* ex. *gr. progracilis* (Cox and Arkell) (including the types of *P. progracilis, P. mirabilis* (Arkell), *P. vineta* Arkell) and *Oxycerites oxus* (S. Buckman) (including the holotype; BA; Torrens 1969c, pp71-72). This fauna does not appear to have been recorded south of Stroud, but this could be due to a lateral passage into Fullers Earth Clay facies and poor or non preservation may account for a lack of records in the Bath to Dorset coast region - an equivalent level in North Dorset may be the Bowden Way Beds of Bristow *et al.* (1995), but no ammonite fauna appears to have been recorded.

4. Subcontratus Zone: Index: *Tulites subcontractus* (Morris and Lycett). Author: Woodward (1894). Type Area: Southern England. Reference Section: Troll Quarry, Thornford, Dorset (Torrens 1974, p.588).

The Subcontractus Zone is well known in southern England from limestone facies, in Oxfordshire to central Dorset, the most southerly record apparently being a specimen of the zonal index *T. subcontractus* (Morris and Lycett) near Broadwinsor (BA, p. 112, fig. 9). Further to the south, the Fullers Earth Rock carbonate facies appears to pass laterally into clays and non-preservation or collection failure would account for an absence of any records.

By far the most abundant recorded fauna of the zone is that from Troll (or "Trill") Quarry where Torrens (1974, p. 588) has recorded *Tulites* spp. (including *"Krumbeckia* cf. reuteri"(Arkell) [m]) *in-situ* in Beds 13-20 of the Thornford Beds (although there was also evidence that the genus occurred lower in the sequence, p.589). Unfortunately, however, none of the many type ammonites previously described from the quarry by Buckman (19091930) and Arkell (BA) have any associated stratigraphic information. However it is likely that more than one faunal horizon is present, as Torrens (1980, p.31) states that *"Rugiferites"* "is characteristic of the lower part of the Subcontractus Zone" (this genus has now been referred to *Bullatimorphites* as discussed by Mangold, 1993).

Most of the nominal species described from Troll Quarry can probably be put in synonymy but such speculation would be beyond the scope of this present work. The described fauna is as follows: *Tulites* "spp." including: *Tulites sphaeroidalis* (S. Buckman) (BA, text fig. 23*), *T. tulotus* (S. Buckman) (BA, pl. 9, figs 5*), T *praeclarus* (S. Buckman) (BA, text fig. 2a, pl. 9, figs. 5*), *T. calvus* (S. Buckman) (BA, text fig. 31*), *T. pravus* (S. Buckman) (BA, pl. 11, fig. 5*), *T. subcontractus* (Morris and Lycett) (BA, text fig. 30), *T. modiolaris* (W. Smith) (BA, p.97), *T. pumilius* (Arkell) and *T.* aff. *pumilius* (BA, p103, p.l. 12 figs. 7), *T. glabretus* (S. Buckman) (BA, text fig. 33); also *Bullatimorphites ["Rugiferites"] rugifer (S.* Buckman) (BA, pl. 13, figs

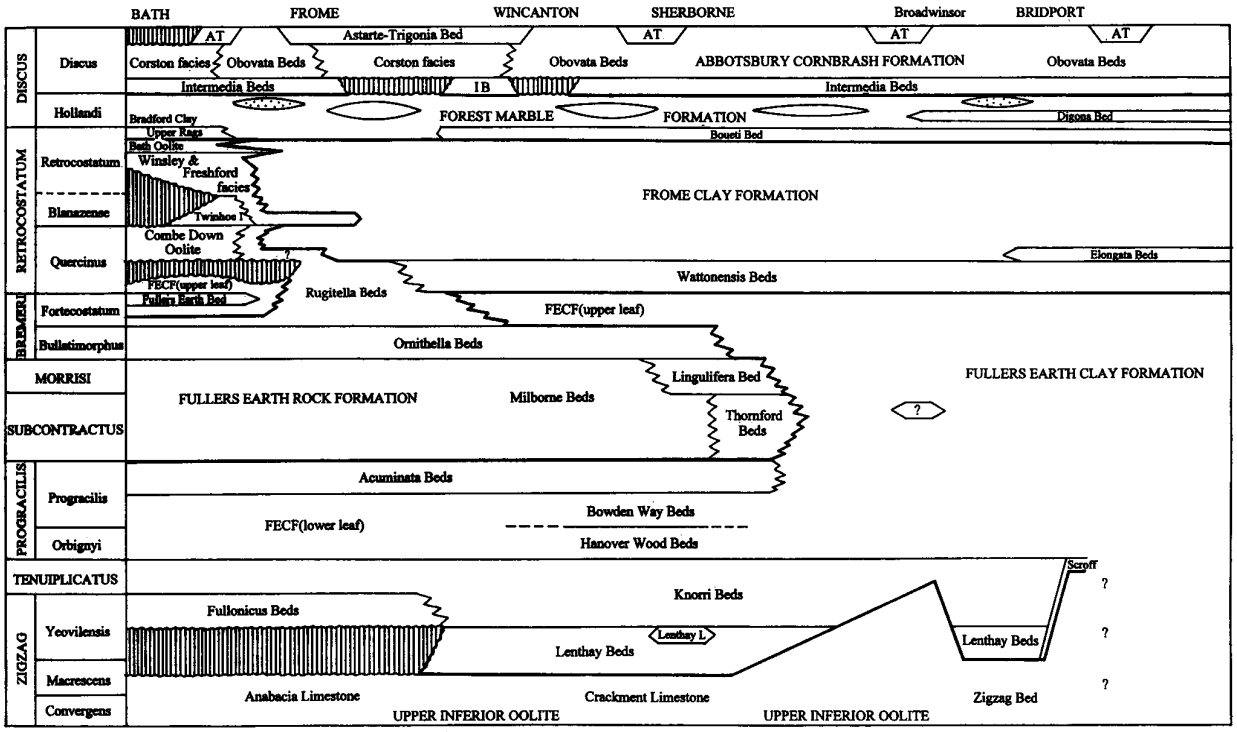

Figure 3: A revised correlation of the Bathonian of south-west England between Langton Herring (Dorset) and Bath (Avon). Lithostratigraphic Framework and abbreviations as follows:

ABBOTSBURY CORNBRASH FORMATION: Berry Member: Astarte - Trigonia Bed (AT), Obovata Beds including Colston facies, Intermedia Beds (IB). FORESTMARBLE FORMATION: Bradford Clay, Upper Rags, Digona Bed. Boueti Bed, speckled lenses represent sands, unornamented lenses limestone. GREAT OOLITE FORMATION: Bath Oolite, Combe Down Oolite, Twinhoe Beds (including Winsley and Freshford facies and Twinhoe I (ronshot facies). FROME CLAY FORMATION: Elongata Beds, Wattonensis Beds (including Rugitella Beds, part, cf. Torrens, 1980, p.27). FULLERS EARTH ROCK FORMATION: Rugitela Beds (part), Ornithella Beds, Milborne Beds, Lingulifera Bed, Thornford Beds. FULLERS EARTH CLAY FORMATION (FECF): Upper leaf - Rugitela Beds (part, cf. Torrens, loc. cit.), Fullers Earth Bed; lower leaf - Acuminata Beds, Bowden Way Beds, Hanover Wood Beds, Knorri Beds, Fullonicus Beds, Lenthay Beds (including Lenthay L(imestone)), "Scroff". UPPER INFERIOR OOLITE: Anabacia Limestone, Crackment Limestones, Zigzag Bed. Vertical hatching indicates non-sequences.

1*), and the type of B. ["R."] pleurophorus (S. Buckman) (BA, p.87).

An additional important specimen from near Thornford is the type of *Bullatimorphites* (B.) *serpenticonus* Arkell (BA, text fig. 38*) but whether the specimen is from the Subcontractus Zone or not is unclear. The type of *Bullatmorphites* ["*Rugiferites*"] *defontiformis* Arkell is from nearby Yeominster (BA, pl 13, fig. 3*) and presumably is also from the Subcontractus Zone.

A number of sites in South Somerset have yielded important Subcontractus Zone faunas, primarily *T.* ex. gr. *modiolaris* in situ in Milbourne Beds facies, the most notable being: Bruton Station (in Bed 1 of Torrens 1974, p.587), Dancing Cross Quarry, Maperton (including *Tulites mustela* Arkell, BA, pl. 13, figs. 4*; presumably mainly from a level "1 ft below the rubbly *Ornithella* Beds", BA, pp.235-246, 103); *T. pumilius* from the nearby Holton Quarry (BA, pl. 12, fig. 3*) and Laycock Railway Cutting, Milborne Wick (in "Woodward's thicker beds of buff earthy limestone"; BA, pp.93, 98, 100). The type of *Tulites tula* S. Buckman (BA, text fig. 22'), from "Milborne Wick" may also have come from the railway cutting (cf. BA, p.124).

The Bath area is most notable for having yielded the original type of *Tulites modiolaris* (W. Smith), probably from Lansdown (BA, p.97, pl 11, fig. 3). The original specimen is lost but Arkell (BA p1.11, fig. 4*) selected a neotype, derived in Pleistocene gravels of the River Avon, at Twerton. Other records in the district include *T.* ex gr. *modiolaris* from Kingswood School, Lansdown (probably from landslipped blocks of Fullers Earth Rock; BA, pp.95, 96) and also from Dunkerton (BA, pl 12, fig. 2; p1.11, fig. 6, respectively), although *in situ* records appear to be largely lacking.

5. Morrisi Zone. Index: *Morrisiceras morrisi* (Oppel). Author: Mühlberg (1898). Type area: SW Germany. Reference section: Bruton Station, Somerset (Torrens, 1974, pp. 589-560).

The Sherborne area yields a number of significant records of the zone in Fullers Earth Rock facies, the most notable *in-situ* records being at Goathill Quarry where *Morrisiceras morrisi* is recorded from the Lingulifera Bed (Torrens 1964, p.39) probably associated with the microconch form *"Holzbergia" ["Berbericeras"]* ex gr. *schwandorfense* Arkell (BA, p.231) and at Laycock Railway Cutting, Milborne Wick, a formerly rich source of M. ex gr. *morrisi* in Milbourne Beds facies (BA, p.121 with M. *["Lycetticeras"] lycetti* Arkell (p.128) and the type specimen of M. *holmerum* S. Buckman (BA, p.124)). Arkell believed that many additional specimens labelled simply "Milbourne Wick" came from the cutting, including the nominal species M. *sphaera* S. Buckman (BA, text fig. 3a*), *M. homaeoticum* S. Buckman (BA, text fig. 40*), *M. fomicatum* S. Buckman (BA, p1.14, fig. 12*; labelled "Sherborne" but assigned to Milbourne Wick based on matrix) and *M. ["L".] sknipum* S. Buckman (BA, pl 14, figs. 1*). *Morrisiceras sphaera* and *M. sknipum* are also known near Purse Caudle (BA, pl. 14, fig. 2 and pl. 14, fig. 10 respectively).

The reference section of the Morrisi Zone at Bruton Station has yielded *M.* ex gr. *morrisi* (including *M. sphaera* [M]) and *Oxycerites, in-situ* in Beds 4-3 (Torrens 1974, p. 560) and at the nearby Cliff Hill section, Shepton Montague, Beds 6-9 have yielded another important *in-situ* fauna with *M.* ex gr. *morrisi,* (including *"Holzbergia"* [M]; Torrens, 1969a, Callomon and Cope, 1995, p.25). In the Shepton Montague railway cutting *Homeoplanulites* ['*Subgrossouvria*'] [M] is also recorded by Torrens (1980 p.40) from the Morrisi Zone and M. ["Lyc."] *comma*

(S. Buckman) is presumably also from one of these two sections from "Shepton Montague" (BA, text fig 44*).

Morrisiceras ex gr. *morrisi* is relatively common in the Bath district notable records coming from Kelston Round Hill (with an associated oxyceritid; BA, pp. 121-125, pl. 33, figs 4-6), Dunkerton (BA, pl. 14, figs 4-6, p1.15, fig. 3, pl. 15, fig. 4, text fig 46, and possibly pl. 15, fig. 8) and from Kingswood School, Lansdown (BA, p1.14, fig. 9, pp. 121, 123, 127; probably all from landslipped blocks of Fullers Earth Rock).

6. Bremen Zone: Index: *Cadomites bremeri* Tsereteli. Author: Kopik (1974). Type area: Krakow-Wielun region, Poland.

(a) Bullatimorphus Subzone. Index: *Bullatimorphus bullatimorphus* S. Buckman. Author: Baron (1885) as a "Zone à *Am. ymir*" (Gabilly in Mangold *et al*., 1974). Equivalent to S. Buckman's hypothetical *bullatimorphus* Hemera (1909-1930). Type area: Fontenay-le-Comte, Vendée, France for Ymir Zone; Tiltups End, Nailsworth, Gloucestershire for *bullatimorphus* Hemera.

When Buckman created the species *Bullatimorphites bullatimorphus* (1921, pl. 2 62*; BA, text fig. 24*) he also hypothetically proposed a *bullatimorphus* Hemera (conceptually the time equivalent of a biohorizon; cf. Callomon, 1985). Unfortunately, however, the type of *B. bullatimorphus* and a (lost) topotype are the only recorded specimens of the species in Britain and their precise stratigraphical relationships to other known faunas is unclear - all that can really be stated is that in the type area the species appears to post-date the Morrisi Zone (cf. Torrens 1980, pp. 32-33) and pre-date the Discus Zone.

In more southerly areas of France, however, the species is common and typical of a level apparently above the Morrisi Zone where it is associated with "many large *Procerites*" and "*Homeoplanulites* sp. aff. *arisphinctoides*" (Arkell) (Gabilly *in* Mangold *et al*. 1974, p. 107, Mangold 1984, p.69, etc). Just such a perisphinctid-dominated fauna does occur in south-west England in the Ornithella Beds of the Fullers Earth Rock overlying the Milbourne Beds of the Morrisi Zone, for instance at Goathill Quarry, near Sherborne where *Procerites* and *Homeoplanulites* sp. are recorded by Torrens (1980, p. 25); the latter may include the "*Choffatia*" *arisphinctoides* recorded by Arkell (BA, p.219) and a Bullatimorphus Subzone has already been applied to such levels by Callomon and Cope (1995, fig. 13).

At Cliff Hill Quarry, Shepton Montague, *Procerites* sp. is recorded in-situ in Beds 11 and 13 (Callomon and Cope 1995, p.24; Torrens, 1969a) but this section could also include a Fortecostatum Subzone fauna (see below). Common *Procerites* and rare *Oxycerites* from around 0.45 m above the base of Bed 5 at Bruton Station (Torrens 1974, p.590; pens obs.) could also belong to the *Bullatimorphus* Subzone although records of *Procerites* and *Homeoplanulites* from the Fullers Earth Rock around Bath (e.g. at Kingswood School, Lansdown, BA, pp. 193, 219, etc) are more problematic but they probably mainly represent Bremeri Zone forms (i.e. from the Ornithella Beds).

(b) Fortecostatum Subzone. Index: *Wagnericeras fortecostatum* (de Grossouvre). Author: Gabilly (1964) as Horizon H or "Horizon à *Wagnericeras*" (e.g. in Mangold *et al*., 1974). Type area: Vendee, France.

Scattered records of *Wagnericeras* including the subzonal index in Fullers Earth Rock matrix, suggest that the subzone is recognisable in south west England. However, none appear to have been recorded in situ, although most might be expected to have come from the upper part of the Ornithella Beds, or more likely from the lower part of the overlying Rugitela Beds. Examples include *W. fortecostatum* from Cliff Hill, Shepton Montague (BA, p.205; a specimen of *Homeoplanulites* aff. *cerealis* Arkell recorded from here on p.222, is also consistent with Fortecostatum Subzone records, but may have come from lower, e.g. from the Bullatimorphus Subzone) and possibly also from the Rugitela Beds at Whatley, near Frome (BA, pp. 218, 227, 239). *W. fortecostatum* is also known from the Fullers Earth Rock at Lansdown and Upper Swanswick near Bath (BA, pl. 29, fig. 2 and pl. 29, fig. 3 respectively).

The type of *W. bathonicum* Arkell is from the commercial Fullers Earth Bed, 11 m below the top of the Fullers Earth Clay (upper leaf) at Combe Hay, near Bath (BA, pl. 29, fig. 1*) and not from the Fullers Earth Rock of Odd Down Bath, as believed by Arkell (Torrens, 1966, p. E17). Associated taxa at Combe Hay include *W. detortus* (de Grossouvre), *Homeoplanulites* aff. *homeomorphus* S. Buckman (including BA, pl. 30, figs 4,5, pl. 31, fig. 2) and *Procerites* sp. (Torrens,1980, p. 30). This level is clearly assignable to the Fortecostatum Subzone as indicated by Callomon and Cope (1995, fig. 13) and this therefore suggests that the Fullers Earth Bed may pass laterally into a level in the lower part of the Rugitella Beds of the Fullers Earth Rock Formation (cf. Penn *et al*., 1979, fig. 2), especially as, south of Bath these beds also yield a younger fauna, of the Quercinus Subzone (see below).

Upper Bathonian

7. Retrocostatum Zone. Index: *Prohecticoceras retrocostatum* (de Grossouvre). Author: Lissajous (1923). Type area: Maçon, France (Mangold *et al*., 1974, p. 192; Torrens, 1974, p. 590).

(a) Quercinus Subzone. Index: *Procerites quercinus* Arkell (non Terquem and Jourdy?). Author: Mangold (1970a) as a "*mirabilis*" Horizon. Used as a Quercinus Subzone by Callomon and Cope (1995).

The "*quercinus*" fauna has been assigned to the upper part of the Hodsoni Zone, e.g. by Callomon and Cope (1995) but following the suggestion of Callomon *in* Mangold (1984), it is here considered to form a valuable and internationally correlatable base to the Upper Bathonian. The identification of the index species has always been problematic, as a degree of homeomorphism with Progracilis Zone forms had led to some confusion (hence Mangold's, 1970a, b, use of *Pr. mirabilis* Arkell, a Progracilis Zone species as an index). This homeomorphism is often superficial and ribbing style, whorl section and more evolute coiling serves to separate most of the earlier forms.

In south west England the Quercinus Subzone is well developed in the Wattonensis Beds at the base of the Frome Clay in Dorset and south Somerset and their lateral equivalents, the Rugitela Beds at the top of the Fullers Earth Rock in north Somerset. At least two faunas characterise the subzone in Britain, the lower is characterised by *Procerites* ex gr. *quercinus* sensu Arkell (BA; ?*non* Terquem and Jourdy) and an upper with *P. hodsoni* Arkell. Although this sequence is not readily demonstrable in Britain, new information from Spain confirms this ordering (Melendez and Page, MS).

The lowest fauna of the Weymouth anticline from "just above the Wattonensis Beds" near Rodden Hive Point includes crushed *P.* ex gr *quercinus* (including BA, text fig. 69.7 and *"P. mirabilis",* p.201) and *Eohecticoceras costatum* (Roemer) (BA, p1.8, fig.5) (Callomon and Cope 1995, p.249). To the north west, the Wattonensis Beds at the type locality of Watton Cliff near West Bay, have yielded the type of *Procerites wattonensis* Arkell (BA, text fig. 69.9*, pl 2, fig. 2*, = *P. quercinus* according to Callomon and Cope, 1995, p.74) apparently from *an Acanthothyris-rich* bed near the middle of the Beds (BA, p. 196; section recorded by Buckman, 1922b, p. 381). *Homeoplanulites* sp. [M] [= *"Subgrossouvria"*] is also recorded (Torrens, 1980, p.24). Similar faunas are known from north Dorset with *P. quercinus* and *Homeoplanulites* aff. *homeomorphus* S. Buckman, from Lake Farm, Thornford (BA, p. 196; Torrens 1980, p.25). The occurrence of a nucleus of *Bullatimorphites* here (H.S. Torrens collection, HT 481, Bristol City Museum) suggests that spurious records of *"Morrisiceras"* in the Wattonensis Beds (e.g. by Kellaway and Wilson, 1941, p.160) may actually represent the former genus. *Eohecticoceras costatum* is also known in thedistrict, from Beer Hacket "in loamy clay with abundantR. *[hynconelloidea] smithy* (BA, p.73) and the microconch form *"Parecotraustes maubeugei* Stephanov "is recorded from equivalent levels in the Purse Caundle Borehole" (Bristow *et al.,* 1995, p.40).

A very rich *P.* ex gr. *quercinus* fauna was reported by Torrens (1980, pp.27-28) in Rugitela Beds at the junction of the Fullers Earth

Rock and Frome Clay in excavations near Merehead Quarry, West Cranmore, west of Frome, but not described. This fauna, now in Bristol City Museum (H.S. Torrens collection) is dominated by very large *P*. ex gr *quercinus* including individuals septate to around 315 mm diameter. Rarer associates include strong ribbed *Homeoplanulites* sp. ([M] + [m]) and *Oxycerites* sp. The specimen of "*P. quercinus*" from West Cranmore figured by Arkell (BA, p. 126, fig. 1) is presumably from an equivalent level.

Notably, *P. hodsoni* appears to be absent from the West Cranmore fauna, and from other known faunas to the south. At Whatley nearer Frome, however, a rich Rugitela Beds assemblage identified by Arkell in Sylvester-Bradley and Hodson (1957), includes both *P. hodsoni* Arkell (BA, pl, 25, fig. 1*, text fig 69.8•*, and probably also pl. 25, fig. 2) and *P.* ex gr. *quercinus* (p1.25, figs 4, 5). The latter appear to be identical to specimens from Merehead and it thus suggests that the c.2.5 m of Rugitela Beds from which the fauna was apparently collected included both an ex gr. *quercinus* and a *hodsoni* horizon. Associated ammonites from Whatley cannot be clearly assigned to either horizon, and they may also represent lower levels (as already noted above) as "*Wagnericeras fortecostatum*" is recorded (BA, p. 239).

In the Bath area the Wattonensis Beds/Rugitela Beds pass latterally into Great Oolite facies (Penn *et al*, 1979, fig. 2, Bristow *et al*., 1995, fig. 23) as *P. hodsoni* is recorded in the Combe Down Oolite at Lansdown (BA, p.191). "*Parecotraustes maubeugei*" J. Stephanov is also recorded from the same unit, at Ilford (Green and Donovan, 1959, p.40). *P. quercinus* does not seem to be recorded in the Bath district, and it is therefore difficult to place precisely the base of the Upper Bathonian; a level at or near the base of the Combe Down Oolite is likely.

(b) Blanazense Subzone. Index: *Prohecticoceras blanazense* Elmi. Author: Mangold (1970a part, excluding a "*mirabilis*" horizon). Type area: Jura, France.

The use of a Blanazense Subzone is perhaps not ideal as the change from the earlier *P. ochraceum* Elmi to P. *blanazense* Elmi may already have take place within the Quercinus Subzone, below the *P. hodsoni* level (Melendez and Page, MS). Nevertheless, pending a revision of the standard zonation, a conventional sequence of Sub-Mediterranean subzones is followed here.

Prohecticoceras has not yet been recorded in the Retrocostatum Zone of Britain but other faunas can still indicate the appropriate levels. In particular the fauna of the Twinhoe Ironshot facies of the Twinhoe Beds (of Green and Donovan, 1969) is compatable. This fauna, classicly represents a restricted "Aspidoides Zone" sensu Torrens (1974, 1980) later, and more correctly renamed as an Orbis Zone (Dietl, 1982). At the type locality in the former Twinhoe quarry near Wellow, in the Bath district, large *Oxycerites* ex gr. *orbis* Gumbel is frequent with its probable [m] "*Parecotraustes*" ex gr. *waageni* Roemer and is associated with *Procerites twinhoensis* Arkell (BA, text fig. 68.4a, b, pl. 26, fig. 6*, text fig. 69.3*). Other records of *Procerites* species (eg. *P. mirabilis*, p. 201) may simply varients of *Pr. twinhoensis*. Other sites in the area have yielded similar faunas from the ironshot including Hassage Hill (with P. cf. twinhoensis, BA, pl. 28, fig. 7, text fig. 72.2, recorded as *P. mirabilis*) and a scarp exposure north-east of Wellow has yielded *O*. ex gr. *orbis*, *P. twinhoensis* and *P.* cf. *twinhoensis* (coarsely ribbed variant) (Bristol City Museum coll.).

At other sites in the area, precise faunal relationships are not proven but additional faunal elements present include *Eohecticoceras* ex gr. *costatum* Roemer in Tytherley Farm cutting, Hinton Charterhouse (Bristol City Museum, no. Ce 4) associated with with *Procerites* (Green and Donovan, 1969, p. 38), and *?Homeoplanulites* sp. (figured as *P. imitator*, BA, pl. 26, fig., 3) and "*Parecotraustes*" cf. *variabilis* in Hinton Hill Road cutting. The precise stratigraphical relationships of these faunas is not clear and slight age differences cannot be ruled out, especially in view of the condensed ironshot facies.

Elsewhere in south-west England, clear "Orbis Zone"-type faunas have not been recorded although scattered records, may hint at their presence (eg. ?Choffatia, Oxycerites and "Parecotraustes" maubergei from "above the Wattonensis Beds" in the Purse Caundle Borehole: Bristow *et al*., 1995, p. 41, and Arkell, BA, pl. 8, fig. 7, figures cf. *Eohecticoceras* ex. gr. *costatum* from the "Upper Fullers Earth Clay at Sherborne).

(c) Retrocostatum Subzone. Index: as zone. Author: Mangold (1970a). Type area: Jura, France.

The "*Wagnericeras arbustigerum* (d'Orbigny)" figured in ventral view only by Arkell (BA, text fig. 76.3) from the Winsley and Freshford facies of the Twinhoe Beds, overlying the Twinhoe Ironshot facies in Tytherley Farm Cutting, Hinton Charterhouse (Green and Donovan 1969, p. 389), is problematic. It is in a highly unlikely stratigraphic position for a true *Wagnericeras* but may well represent a coarsely ribbed *Homeoplanulites* of Horizon 13 of Mangold (1984) which is equivalent to the Retrocostatum Subzone. The same species is also cited from the nearby Hay Wood, presumably from a similar stratigraphic level.

In the same district, *Clydoniceras* cf. *schlippei* S. Buckman is known in the Winsley facies, at Winsley itself (Green and Donovan 1969, p. 15) and *Clydoniceras* sp. is known from a similar level on Baggridge Hill, near Wellow (Penn *et al*., 1979, pp. 45, 63). Farther south, near Frome, *Clydoniceras* sp. and "oppelliids" are again recorded, at equivalent levels to the Bath Oolite, but here within the Frome Clay (Penn *et al* 1979, p. 46). In the topmost 10 m of the Frome Clay at Walton Cliff on the Dorset coast, *Clydoniceras* sp. [m] [= *Delecticeras* aff. *legayi* Rigaux and Sauvage] is recorded (BA, p. 44; Torrens 1980, p. 24). Taken together, these records of early, i.e. pre-Forest Marble, *Clydoniceras* may indicate the Retrocostatum Subzone where the genus first becomes a significant element of Upper Bathonian faunas (Mangold, 1970b, p. 304). Similarly, records from the Boueti Bed at the base of the Forest Marble probably indicate a similar correlation (eg. "*Delecticeras*" cf. *ptychophorum* (Neumayr) from Herbury near Langton Herring;BA, pl. 4, fig. 8; Torrens, 1980, p. 23; and "D." sp. from Honeycombe Wood, Sherbourne; Fowler, 1957, BA p. 244).

8. Discus Zone: Index: *Clydoniceras discus* (J. Sowerby). Author: S.S. Buckman (1898). Type area: Southern and eastern England (Torrens 1974, p. 596).

(a) Hollandi Subzone. Index *Clydoniceras hollandi* (S.S. Buckman). Author: Buckman (1924 *in* 1909-1930). Type area: Southern England. Reference section: Neue Tongrabe Temme, near Hildesheim, north-west Germany (Torrens 1974, p. 597).

The presence of the zonal index is virtually the only means of identifying the subzone, but it is very rare in Britain largely due to unfavourable facies within the Forest Marble. Known occurrences include a specimen "found loose beneath the outcrop of the Digona Bed", at Herbury near Langton Herring (Torrens 1980, p. 23), a specimen from the Bradford Clay, at Bearfield, Bradfordon-Avon (BA, pl. 1, figs. 5); and probably also the *Clydoniceras* sp. recorded in the Bradford Clay at Bradford-on-Avon by Stinton and Torrens (1968, p. 247). The only other positively identified specimen of the species in Britain appears to be the holotype itself from Tetbury Road Station, Gloucestershire, also from the Bradford Clay (BA, p1.1, figs. 6*, text fig. 6.4 A, B*), although a possible ?*Clydoniceras* from the Shelly beds overlying the Upper Rags, near Hintonfield Farm, Baggridge is a possible fifth record (Penn *et al*., 1979, pp. 50, 63).

A second even rarer species which may occur in the Subzone in Britain is a possible *Homeoplanulites*, recorded as "*Siemiradzkia*"' *pseudorjazenensis* by Arkell (BA, pl. 32, fig. 2) from Gloucestershire (although Torrens, 1974, p. 596 considered it to be from an older horizon) a second species; *Polyplectites periami* Arkell is not from the Forest Marble and is in fact a Lower Callovian keppleritid (Torrens, *loc. cit*.).

(b) Discus Subzone. Index: as zone. Author: as zone. Type area: as zone .

The Discus Subzone is well developed in southern and eastern England in "Lower Cornbrash" (= Berry Member) facies. At least two horizons are recognisable in the subzone, as first demonstrated by Pocock (1926) in the Oxford district. The lower horizon yields typical *C. discus*, the upper includes *C. hochstetteri* (Oppel), the two forms being distinguished by sutural differences, the latter tending to develop

latter tending to develop elongated parallel sided lobes as illustrated by Arkell (BA). This younger fauna often includes *Homeoplanulites homeomorphus* Buckman. The close similarity, however, of the two *Clydoniceras* species and Arkell's (BA) grouping together of sutural variations, means that most records are of *Clydoniceras discus* and only rarely is *hochstetteri* separated; *C.*ex gr. *discus* is therefore used here where determinations might be open to question.

It is notable that a *hochstetteri* Horizon has recently been recognised in the upper part of the Discus Zone in southern Germany, again with typical common *H.* ex gr. *homeomorphus* (Died, 1994). This fauna with *C.* ex gr. *discus andHomeoplanulites* sp. [M] (= *"H. cerealis"* Arkell) is known from Bed 3 at the type locality of the Member at Berry Knap, south-east of Abbotsbury in south Dorset (Page 1988, p. 69; Douglas and Arkell 1928, p. 153). *C.* ex gr. *discus* is also known in west Dorset at Corscombe (BA, as *C. douglasi* Arkell pl. 3, fig. 11*). In north Somerset and south Dorset, *Clydoniceras* occurs at at least two levels in the Berry Member, as in the Oxford district, for instance in the lower part (Bed 3 of Page, 1988; Bristow *et al.,* 1995, p. 52) near Yenston and in the upper part at Holwell (Douglas and Arkell, 1928; Page 1988). A similar level to the latter at nearby Stalbridge Weston yielded *Homeoplanulites homeomorphus* (Buckman) (BA, pl. 30, figs. 4*). The same species is also known at Stalbridge (Page 1988) and the type of *H. arkelli* Mangold, a probable synonym is also likely to be from the same district (BA, pl. 30, fig. 2*). Whether these other records are all from the upper part of the Berry Member is unknown, but it is certainly quite likely based on known *in situ* records.

Clydoniceras is present in the Astarte-Trigonia Bed in the upper part of the Berry Member in the Wincanton district (probably including *C.* var. *blakei* of Arkell, BA, pl. 2, fig. 7, text fig. 6.1 c from South Brewham) and an unhorizoned *Homeoplanulites* ex gr. *homeomorphus,* possibly from a similar level is also known in the district (Page 1988).

A rich perisphinctid fauna from railway cuttings at Frome, apparently in the topmost Berry Member was described by Arkell (BA) as including *Homeoplanulites homeomorphus* (p. 227), *H. subbakeriae Arkellnon* d'Orbigny, *H. arisphinctoides(Arkell)* (pl. 32, fig. 3*) and *H. kranaiformis* (Arkell) (text fig. 82*). In the apparent absence of *Clydoniceras and Macrocephalites/Kepplerites* a Bathonian or Callovian age is not provable but the latter is here regarded as more likely as earliest Callovian, *keppleri* Biohorizon *(sensu* Callomon *et al., 1989) Macrocephalites* and *Kepplerites* are very rare in Britain, whereas *Clydoniceras* is relatively common and widespread.

In north Somerset and west Wiltshire, *Clydoniceras "thrapstonense"* Arkell is known from Trowbridge (BA, pl. 3, fig. 14) and *C.* ex gr. *discus* near Bradford-on-Avon (Page 1988, p. 107) but from unrecorded horizons. Whether *C. thrapstonense* is a separate species or a variant is unclear but it is readily separable from typical *C.* ex gr. *discus* by its relatively strong secondary ribs.

The base of the Callovian

The earliest Callovian faunas in south-west England typically occur in the lowest part of the Fleet Member (= "Upper Cornbrash" *aucct.)* and correspond to the *keppleri* Biohorizon of the Herveyi Zone (Callomon *et al.,* 1989; Page, 1989). On the Fleet Shore, in south Dorset, *Macrocephalites cf. jacquoti* Douvillé may indicate the biohorizon (Page 1988, pp. 60-72), and in central Dorset, the presence of *M.* cf. *jacquoti* and *K. keppleri* (Oppel) at Corscombe are clearer indications (Page, 1988, pp. 76-77). In the Stalbridge - Bishops Caundle district, the biohorizon is relatively well represented with *M. jacquoti* (Page 1988, p. 82), *K. keppleri* (including BA, text fig. 42) and possibly also *Homeoplanulites* ex gr. *homeomorphus* (Douglas and Arkell, p. 7; Page, 1988).

As suggested above, the perisphinctid fauna from Frome could be of earliest Callovian age but throughout much of Somerset, Avon and Wiltshire, there is a non-sequence at the base of the Callovian (Page 1989) which omits the Fleet Member. However an isolated record of *K. keppleri* from Westwood, Bradford-on-Avon (Page 1988, pp. 106-107) indicates that, at least locally, the basal Callovian is still present.

CONCLUDING REMARKS

As demonstrated above, a Sub-Mediterraenean-style zonation (based on Mangold, 1991) is perfectly well applicable to the sequence of ammonite faunas in the Bathonian rocks of southwest Britain. This scheme is used to construct a revised correlation of Bathonian Lithostratigraphic units in south-west England as illustrated in Figure 3. The utility of a Sub-Mediterranean zonation in Britain indicates that perhaps only one standard zonation is necessary for the Bathonian of Europe as a whole. The use of restricted "northern" terms such as the Hodsoni and Orbis zones is unnecessary as the characteristic elements of these faunas occur throughout Europe. Genera with a southern preference or greater abundance do exist (eg. *Cadomites, Epistrenoceras, Hemigarantia, Prohecticoceras, Bullatimorphites,* etc) and this geographical restriction makes their widespread use as correllative tools (as opposed to simply zonal-indices) limited. For long distance correlation, it is clearly the perisphinctidae, especially *Procerites* and *Homeoplanulites* that have the greatest potential, and it is therefore these groups that have most potential for building a Europe-wide correlative framework for the Bathonian. Further stratigraphic and taxonomic work in Britain and in key areas elsewhere in Europe, for instance in Spain, will aid the construction of this framework and help finally to establish a true *Standard Zonation* for the stage.

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