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THE PORTLANDIAN, THE TERMINAL JURASSIC STAGE IN THE BOREAL REALM

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Abstract: The Portlandian is preferred as the name for the terminal stage of the Boreal Jurassic. Ten ammonite faunas are described from the north-west European sections, and correlations made with the incomplete sections of Greenland and the USSR.

INTRODUCTION

Recent years have seen a reawakening of interest in Portlandian ammonite faunas in England and France and with it a realisation that the stage contains a larger and more diverse series of faunal assemblages than was previously thought (Buckman 1923-30, Arkell 1933, 1935). Arkell's (1956) division of the stage into three zones now seems very conservative. The expansion of our knowledge of Portlandian faunas leads one to the unavoidable conclusion that the north-west European sections are the most complete in the Boreal Realm. Their minimum of 10 distinct zonal and subzonal faunas have no rival in the much more broken sequences of Greenland, Siberia or the Russian Platform.

In historical terms Portlandian has every right to be considered the senior available name for the terminal Jurassic stage (Brongniart 1829, d'Orbigny 1842-51), its rivals coming much later (Tithonian, Oppel 1865; Volgian, Nikitin 1881). In the Boreal Realm it has priority over the Volgian, a stage based on condensed and broken sequences, latterly modified (Gerasimov & Mikhailov 1966) to include a large part of the Kimmeridgian (see Wimbledon 1980). Apart from its historical status the Portlandian is founded in a type area with many kilometres of accessible sections in coastal cliffs and quarry faces, and its ammonite faunal succession is more complete that that of the Volgian.

The English and French sections are here taken as a standard with which other Boreal sections may be compared. National and/or drafting conventions have tended to conceal major non-sequences in previously produced correlation charts comparing the Portlandian standard with other Boreal sections. I would like to outline the characteristic faunas of the type Portlandian sections and then examine what points of faunal similarity and precise correlation can be derived with Greenland and the USSR. Figure 1 herein shows the equivalence of zones in the late Kimmeridgian - basal Ryazanian interval in N.W. Europe and the Volga Basin.

The Portlandian is here used for all post-Kimmeridgian Jurassic strata (i.e. albani-lamplughi zones) following its redefinition (Wimbledon & Cope 1978, Wimbledon 1980). It is clear that the topmost part of the stage in this way defined overlaps with the Berriasian, as does the Russian Volgian. The zonation of the stage is here refined, and further faunal subdivisions are described.

ZONES AND FAUNAL ASSEMBLAGES

No Portlandian section has thus far produced a complete faunal succession. In England the Dorset sections are most complete, faunal deficiencies being made up by making use of richer but geographically separated faunal assemblages in other southern English counties and northern France.

The following faunal assemblages characterise the stage:

1) albani Zone - Known only in Dorset and the Boulonnais (Wimbledon & Cope 1978, Townson & Wimbledon 1979), it is characterised in Dorset by Progalbanites albani, Epivirgatites nikitini and E. vulgaris in the Massive Bed and Emmit Hill Marls and Epipallasiceras in the Massive Bed. In the Boulonnais Progalbanites albani and related species are found in the Assises de Croi. In association with the distinctive small species of this assemblage are found small Pavlovia spp. and poorly preserved larger forms.

2) glaucolithus Zone - Best known in the rich faunas of the Vale of Wardour but only patchily represented in the basal Glauconitic Beds of the north Wiltshire-Buckinghamshire outcrop (see fig. 2). In Dorset the fauna is easily observed in the extensive sections of Gad Cliff and Hounstout -

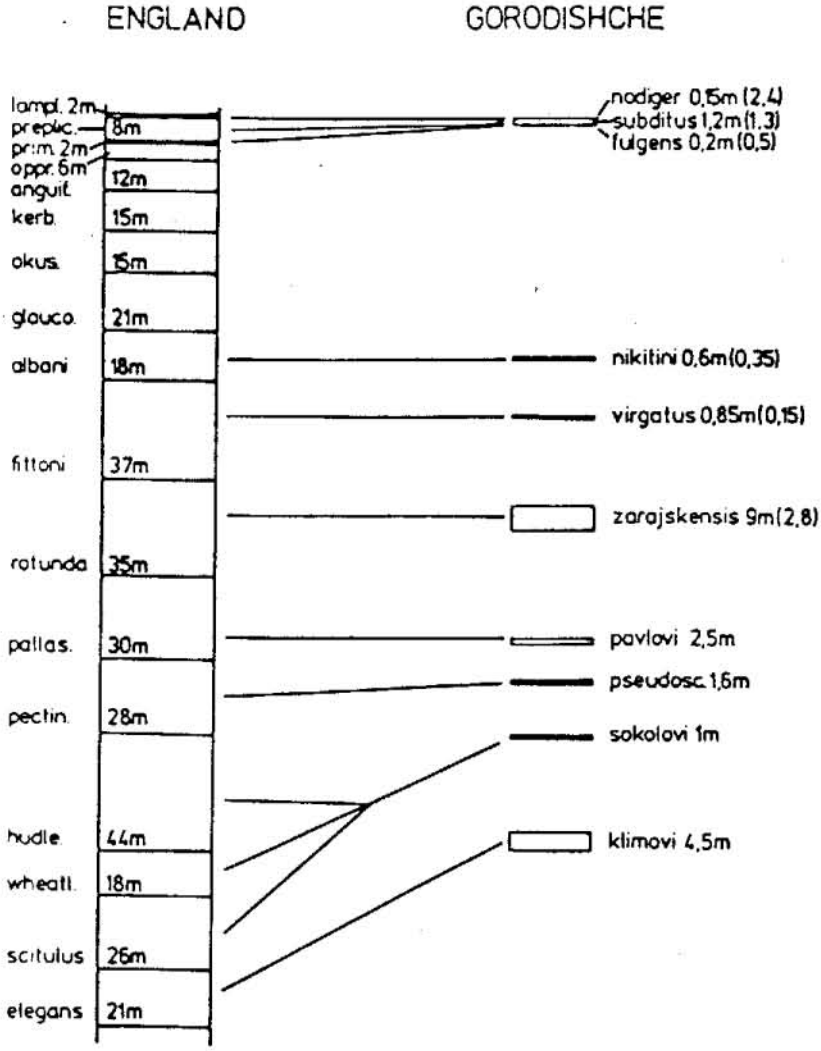

Figure 1. A comparison of Late Jurassic zonal thicknesses in Southern England with equivalent zone at Gorodishche (Volga) (thickness in brackets for Kashpir)

St Aldhelms Head, in the White Cementstone, St Albans Head Marls and lower 'Parallel Bands', but on Portland its presumed distribution within the West Weare Sandstone has yet to be established. The fauna is made up almost exclusively of Glaucolithites species. In the Vale of Wardour giants like G. glaucolithus predominate together with G. aquator and related middle sized species. Less common are a smaller (c. 300mm, microconch?) as yet unnamed species, and a very small, biplicate and collared species perhaps close to the adult of 'Lydistratites' biformis Buckman (1925 pl. 605B) (assigned to

Epivirgatites by Casey 1967). G. caementarius is the lowest species of the assemblage known on the Dorset coast.

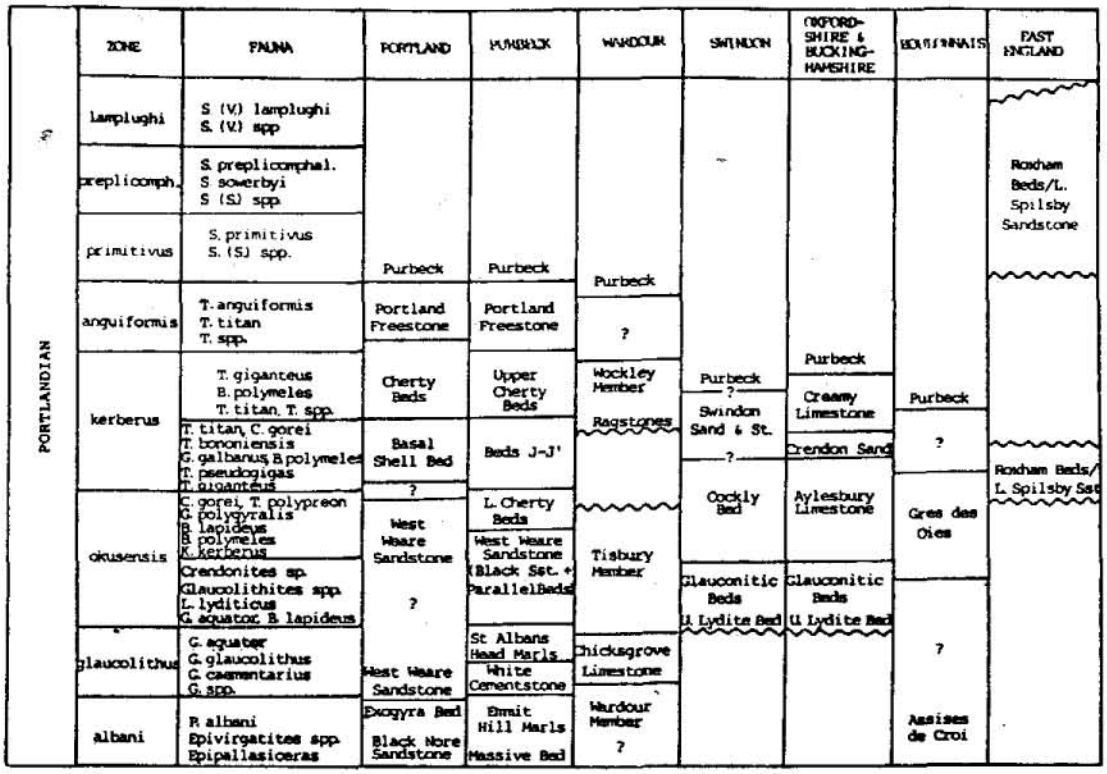

Figure 2. A correlation of Portlandian strata in England and northern France.

3) okusensis Zone - subzone a - Extensive collections made in the Vale of Wardour in the early 1970's indicated that the fauna of the glaucolithus Zone (Wimbledon 1976, Wimbledon & Cope 1978) was distinct and never occurred with forms like Crendonites and Galbanites (typical, for example, of the famous fauna of the Cockly Bed at Swindon). However, further collecting in other districts has shown that there is a degree of overlap between these faunas. This mixed or passage fauna is given expression here by the creation of a lower okusensis subzone.

This is the least well known of the Portland ammonite faunas, occurring in the most inacessible portions of the Dorset coastal cliffs and in the poorly exposed basal beds of some inland sections. Its fauna consists of large and small Crendonites spp. (including forms like C. pregorei) the very distinctive Lydistratites lyditicus Buckman (holotype only, 1922, pl. 353A) 'Behemoth' lapideus Buck., evolute Glaucolithites (e.g. G. cf. aquator and G. cf. polygyralis) and small species like those assigned above provisionally to 'L.' biformus (occurring with Vaumegalites in the Vale of Wardour). With Glaucolithites and early Crendonites there are larger, evolute, strongly ribbed biplicate - triplicate pavlovid types, which predominate in the upper okusensis Zone and persist into the kerberus Zone. This subzonal fauna has been identified from the Glauconitic Beds of the Wheatley-Milton outcrop of Oxfordshire, in the Glauconitic Beds of Swindon where preservation is very poor, and the Tisbury Member (Main Building Stone of Arkell, 1933). In Dorset the distinction of this fauna from those above and below remains a problem.

4) okusensis Zone - subzone b - This is characterised by the rich fauna found in the Cockly Bed of Swindon. Crendonites species (e.g. C. gorei) are the most common element in the fauna. Evolute, strongly biplicate-triplicate ribbed pavlovids (e.g. G. okusensis and 'B.' lapideus) are the dominant larger forms, but even larger Briareites polymeles and Titanites polypreon herald the incoming of the giants of the Portland Sand. Smaller forms, the presumed microconch equivalents of larger species, include 'K. kerberus' Buckman (1926, pl. 520 a&b) and 'Galbanites' mikroloba Buckman. Glaucolithites polygyralis is the last representative of the genus. Besides its occurrence in the Cockly Bed, the fauna is well represented in the dolomites of the topmost Portland Sand (West Weare Sandstone), in the Glauconitic Beds - Aylesbury Limestone of Buckinghamshire and in the Lower Grès des Oies of the Boulonnais whence came the holotype of C. gorei (Salfield). This ammonite assemblage, and possibly that of the kerberus Zone (subzone a), is the fauna described as the 'giganteus/oppressus fauna' of eastern England (Casey 1973) (see below). There it would appear that late Kimmeridgian and Portlandian times are mostly represented by a hiatus terminated finally by the broken deposition of the primitivus-lamplughi Zones. Casey's (1977) record of Epilaugites from the Fordington borehole is interesting, but the specimen figured can not be related to a reliable stratigraphy. Its relation to other ammonite finds is largely conjectural

since it can only be broadly assigned to the Spilsby 'Basement Beds'. If the species is truly associated with the Portland fauna typical of the so-called 'oppressus Zone' in Lincolnshire then it may give a useful indication of the equivalence of a genuine okusensis(-kerberus Zone) fauna there with the vogulicus Zones of Greenland and Siberia (see Greenland correlation below). If the basement beds of Lincolnshire with Epilaugites are of upper okusensis Zone age this would fall into line with the correlation of groenlandicus-anguinus Zone Crendonites in Greenland with those of the lower okusensis Zone in England (see below).

5) kerberus Zone - subzone a - This fauna shows a great diversity of giant Titanites and these (with those of subzone b, see below) are the species which have most often been recorded and collected in the past. Buckman described them under a multiplicity of names, reflecting the variability of the genus. Species include T. giganteus (Sowerby), T. bononiensis (de Loriol) T. pseudogigas (Blake), T. titan Buck. the first three have played a major part in the general confusion which has typified Portlandian stratigraphy in years gone by. Ammonites giganteus Sowerby, a name applied to any Portland Stone ammonite but latterly more particularly to the Portland Freestone giants, was originally based on a type series which apparently straddled three zones (glaucolithus-kerberus). However, it is now restricted to forms in the kerberus Zone (Buckman 1923-30, Wimbledon & Cope 1978). T. bononiensis is, again, a name that has been used indiscriminately by past authors, and used wrongly as an index for the Freestone 'Series' by Salfeld (1914). In the Boulonnais (Middle Grès des Oies), as in Dorset (Basal Shell Bed), the species is associated with other Titanites and Galbanites spp. T. pseudogigas (Blake), with its extreme whorl inflation, is the species which led d'Orbigny to confuse English Portland Stone ammonites with mid-Kimmeridgian Gravesia, and all the consequent confusion amongst continental workers over stage nomenclature. With Titanites occur Briareites polymeles and smaller (c. 300mm) Galbanites (e.g. G. galbanus and G. forticosta) and remnants of the coarsely ribbed species of the okusensis Zone in the form of Galbanites zeta (Buckman). Dominant and distinctive small species are: Kerberites kerberus Buck., Kerberites audax (Buckman) and 'Galbanites' mikroloba Buckman and the last Credonites, C. gorei Salfeld (=C. leptolobatus Buckman) and larger Crendonites spp. The kerberus zone-subzone (a) faunas are best known in Dorset, from the abundant specimens of the Basal Shell Bed on Portland and in the 'West Mainland'

in particular, and in Buckinghamshire, where Buckman obtained the majority of the specimens he figured in Type Ammonites.

6) kerberus Zone - subzone b - With the disappearance of Crendonites species and other smaller forms like K. kerberus the fauna of subzone b is dominated by species of Titanites and Galbanites, but with less diversity in the assemblage than below. B. polymeles persists in the lower part of the subzone. With the falling-off in numbers Titanites is reduced to T. titan, T. cf. trophon, T. giganteus (in the lower part) and a coarsely ribbed species, T. glottodes, makes its first appearances. Galbanites galbanus and G. forticosta both persist into at least the lower part of the subzone, as does K. audax. This assemblage is common in the Upper Cherty Beds of Dorset, especially on Portland, in the Creamy Limestones of Oxfordshire and Buckinghamshire (e.g. Long Crendon), and in the Wockley Member ('Ragstones' and 'Chalky Series') of Chicksgrove and Chilmark in the Vale of Wardour (Wimbledon 1976). In the Isle of Purbeck the fauna extends apparently up to the 'House Cap' in the Freestone Member, and possibly even higher.

7) anguiformis Zone - This faunal assemblage contains the largest (c. 900mm), most densely ribbed and apparently last Titanites. Previously the fauna was used to characterise a giganteus Zone (='Freestone Series')(Salfeld 1913, Arkell 1933 etc Casey 1963, 1973 and others) but as seen above the giganteus fauna is that of the kerberus Zone (see Wimbledon & Cope 1978). This assemblage is limited in comparison to those of the preceding zones. It includes only Titanites anguiformis Wimbledon and one or two other species of similar, inflated, densely-ribbed giants, with a small (microconch?) species, 300-400mm in diameter (e.g. GSM 74321). Coarser ribbed, less inflated types similar to T. titan appear to persist, from finds in the Titanites Bed - Shrimp Bed in east Dorset. The anguiformis fauna is restricted to Dorset where it is seen to the top of the Portland Beds. Elsewhere in southern England and in northern France, Purbeck deposition commenced prior to anguiformis Zone times (Wimbledon & Hunt 1982). In Dorset, the fauna is best known from the oolites, Roach, Curf and Base Bed Roach of the Isle of Portland. The ammonite fauna of basal Shrimp Bed and the Titanites Bed of the Isle of Purbeck does include some very densely ribbed forms like T. anguiformis but also species more typical of the Cherty Beds of Portland like T. titan, perhaps indicating an intermediate fauna between the kerberus (subzone b) and anguiformis assemblages, rather than the precise equivalents of the

Portland Isle Freestone fauna. The anomalous (in the sense that it consists for the most part of inner whorls) 'oppressus Zone' fauna (Casey 1973) is not here regarded as any more than an assortment of unassigned and perhaps unassignable inner whorls of larger Titanites. The restriction of this 'fauna' to an impersistent horizon (upper Shrimp Bed) in a geographically restricted area makes it of little zonal use. The 'fauna' is not known west or east of St Aldhelms Head. The 'oppressus Zone', and the fauna it is supposed to contain both in Dorset and in eastern England is fraught with such confusion that its use is not continued herein.

Casey has figured a specimen of 'Paracraspedites' (1973 pl. 1, fig. 4) from Gorodishche. This specimen and others from the same locality collected by Casey, now in the Geological Survey Museum (London), have atypically feeble ribbing for a Portland Beds ammonite and I feel bear little resemblance to other specimens figured under the same name by that author (plate 1, figs. 1, 2 ? 3, plate 6, fig. 1). I believe the specimens figured include at least three distinct and not closely related species. The equation of this mixture of forms with such a nondescript ammonite as the Gorodishche species is a dubious proposition. The fauna of the 'oppressus Zone' in eastern England is rather different to that in the upper Shrimp Bed. The stratigraphy of the basal Spilby-Sandringham beds is problematic, because so much of the faunal material, including ammonites, is found ex situ in glacial erratics. However, there does appear to be a consistent ammonite assemblage made up of Titanites spp., Galbanites, Crendonites and possible Kerberites. The presence of this fauna in these beds, however, only allows correlation with the okusensis (or kerberus) Zone of Dorset etc, i.e. in the Portland section, the topmost Portland Sand or basal Portland Stone, but no higher. The comparison of these 'oppressus Zone' faunas I intend to describe in a separate publication, but from the above outline I would suggest that this fauna is in fact two faunas of two quite distinct ages in the widely separated areas where Casey first described it.

(8-10) primitivus - lamplughi Zones - Described by Casey (1973) these Zones have no non-craspeditid fauna persisting from earlier Zones (i.e. pavlovids); a gap is therefore inferred between the primitivus and anguiformis Zones.

CORRELATIONS WITH THE USSR

The type Volgian totals no more than 24 metres (7.1m lower, 12.95 middle and 4.2m upper Volgian) at Gorodishche and Kashpir on the Volga, equivalent to 338 metres of Upper Kimmeridgian and Portlandian strata in Dorset (see fig.1)

The correlation of the Russian pavlovi subzone with the pallasioides Zone has been well attested by previous authors. The virgatus Zone may equate with the fittoni Zone (see Zeiss 1983). The fulgens-nodiger Zones are here correlated with the primitivus-lamplughi Zones following Casey (1973). The problematic part of the Russian Volgian sequence is the nikitini Zone and the correlation of its faunas with those of western Europe. The Epivirgatites fauna of the albani Zone strongly suggest equivalence of that Zone with the nikitini Zone (see Wimbledon 1980).

		ENGLAND	GREENLAND	VOLGA
BERRIASIAN	RYAZAN.	kochi	kochi	kochi
		runctoni	mayncl	rjazanensis
	PORTLANDIAN	lamplughi	Chetaites sp.	
		preplicomphalus		nodiger
		primitivus	tenuicostatus	subditus / fulgens
		anguiformis		
		kerberus subz. b / subz. a		
		okusensis subz. b / subz. a	vogulicus / groenlandicus	
		glaucolithus	anguinus	
		albani	pseudapertum	nikitini
	KIMM.	fittoni	gracilis / liostracus	virgatus
		rotunda	communis	panderi
		pallasioides	rugosa / iatrensis / primus	

Figure 3. A comparison of Upper Kimmeridgian-Portlandian ammonite zones in England, Greenland and the Russian Platform.

Casey (1967) both disputed Mikhailov's use of English generic names and pointed out the incomplete nature of the Volgian. Later (1973) he suggested the Volgian was less incomplete than he had previously inferred and stated that most of the missing western European strata could be equated to a pre-nikitini Zone hiatus. Callomon (Callomon & Birkelund 1982 p. 366) follows Casey in trying to equate some of the nikitini Zone ammonites with Portland Stone species. The question remains; how can the nikitini Zone, only 0.5m thick at Moscow. 0.6m at Kashpir and 0.35m at Gorodishche, be simultaneously equatable with the albani and with some Portland Stone fauna (kerberus-'oppressus' Zone)?

If we turn to the summary of Mesezhnikov (1983) we find as follows: there are apparently variations in the ammonite assemblages within the zone; Lomonossovella, E. lahuseni and E. bipliciformis occur at Moscow, at Kashpir E. nikitini predominates, while at Gorodishche E. bipliciformis and 'Paracraspedites' occur. Thus, E. nikitini and rare Lomonossovella occur below and E. bipliciformis, Paracraspedites and abundant Lomonossovella above. Mesezhnikov states that E. nikitini occurs in both assemblages; thus both contain that species and Lomonossovella spp., and there is faunal continuity. It is difficult to reconcile this state of affairs with the simultaneous correlation by some authors of nikitini Zone Epivirgatites with Epivirgatites spp. in the albani Zone, and nikitini Zone Lomonossovella spp. with the somewhat similar Kerberites, two zones or more higher in the English sequence.

Spath, many years ago, recognised Epivirgatites in Britain, as is evidenced by his notes on specimens in British museums. Casey (1967) reviewed the importance of finds of the genus and Wimbledon & Cope (1978) placed it in the albani Zone faunas of Dorset. Epipallasiceras and poorly preserved Epivirgatites are also found in the Assises de Croi of the French coast from the evidence of more recent collecting. This correlation therefore seems irrefutable. Examination of the suggested equivalence of Lomonossovella and 'Kerberites' mosquensis Mikhailov with English Kerberites becomes more necessary as a consequence. I will therefore compare these species. Lomonossovella lomonossovi, L. michalskii and L. blakei all have shell whorl shapes which differ considerably from K. kerberus Buck. In Lomonossovella specimens larger than 20mm the percentage ratios of umbilical diameter : diameter overlaps the range for K. kerberus. Similarly there is partial overlap in the whorl height:

diameter ratio of the three species with the upper end of K. kerberus' range. When, however, whorl width as a percentage of diameter is examined, the greatest difference is apparent. The Volgian species have a much wider and deeper impressed area, and whorl width: diameter ratios far in excess of any English specimen (4-12% more than the highest English figure). Also the distinctive high ratio of secondary to primary ribs in K. kerberus is not seen in the Lomonossovella species. A typical specimen of K. kerberus (A. triplicatus Blake 1880, refigured Spath 1936, pl. 16, fig. 2) of comparable size to the Lomonossovella holotypes shows a secondary to primary rib ratio (with 16 primary ribs) of 3.6:1. K. kerberus specimens up to 50mm have a ratio which is always above 3:1 and often reaches 4:1. This compares with a Lomonossovella maximum of 2.8:1. (See Ivanov (1979) for Lomonossovella measurements).

Kerberites mosquensis does have a set of shell proportions close to K. kerberus although its whorl height as a percentage of diameter is significantly greater than the English species. K. mosquensis has cruder ribbing than that found in K. kerberus, lacking the spaced, regular strong ribbing of that species, while its secondary:primary rib ratio is only 2.8:1, again, well below any comparably sized K. kerberus (see above).

My conclusion would be that Lomonossovella and 'Kerberites' mosquensis are Pavlovia derivatives, but not closely allied to Portland Stone species. Their stratigraphic association with Epivirgatites makes it difficult to correlate the nikitini Zone fauna on the Russian Platform with any part of the Dorset succession but the lower half of the Portland Sand (albani Zone).

The only outstanding problem of correlation between the Volga and England then, remains the 'oppressus Zone'. As indicated above, there appears little in common between the oppressus Zone faunas in southern and eastern England. The Gorodishche specimen figured as a Paracraspedites (Casey 1973, pl. 1, fig. 4) is dealt with in the relevant part of the description of English faunas. I do not believe that the weakly ribbed individual illustrated by Casey bears any more than a passing resemblance to the British species with which it has been compared. As I have stated, Casey's comparison appears to have been simultaneously with ammonites from different faunal horizons, possibly spanning two or three zones.

The persistent habit of authors in equating modern western European and

Soviet zones on a one to one basis (e.g Mesezhnikov 1983, fig. 17) has the effect of concealing major correlative discrepancies. From the account given above, I would conclude that most of the middle Portland Beds sequence (glaucolithus-anguiformis Zones) finds no equivalent on the Russian Platform (see fig. 1 & 3).

The 'Crendonites' of western Siberia (Zakharov & Mesezhnikov 1974) have been used to correlate middle Volgian sediments there with Crendonites horizons in Greenland and the okusensis Zone of England. (Mesezhnikov 1982, Zeiss 1983). The Siberian forms are small, seemingly mature species typified by dominant biplicate ribbing, fading on the later part of the rapidly expanding body-chamber. Such a description does not accord with the diagnosis for a typical Crendonites (e.g. C. gorei Salfield) which is much larger, and has frequent simple ribs and constriction when mature. Accordingly, C. subleslie is not here taken to be congeneric with true Crendonites from the Grès des Oies of Boulogne, Basal Shell Bed or Cockly Bed of England. However, rare specimens, similar to C. subleslie have been collected by the author from the glaucolithus Zone and basal okusensis Zone in Wiltshire. These are as yet poorly known and await further study.

CORRELATIONS WITH GREENLAND

By comparison with England, there is a very large break in Greenland between late Kimmeridgian-lower Portlandian levels and late Portlandian remnants, the latter perhaps only attributable to the primitivus and lamplughi Zones (Wimbledon 1980, Callomon and Birkelund 1982).

Consideration of the faunas 40-46 of Callomon & Birkelund (1982) suggests that they correlate with the Portland Sand faunas of Dorset. Epipallasiceras in their faunas 40-42 invite comparison with that genus in the albani Zone (Emmit Hill Marls) and with as yet poorly known forms in the Assises de Croi of the Boulonnais. Callomon's comparison (op cit 1982 p. 356) of Epipallasiceras from fauna 41 with a Boulogne specimen in the Pellat Collection must be based on an incorrect specimen label. The Lower Grès des Oies does not yield such material, but instead species of the okusensis Zone (see above). Callomon also compares the unique specimen of Behemoth groenlandica Spath with Glaucolithites from the mid-Portland Sand, but a closer match of this species is

with the extremely evolute (non-glaucolithitid) pavlovids of the okusensis Zone. However, its association in Milne Land with a small Pavlovia sp. and Dorsoplanites, and its position lower in the sequence than the Crendonites of faunas 45-47 contraindicates this correlation. The large pavlovids of the lower Portland Sand are very poorly known, and it is probably in that part of the Dorset section, if anywhere, that 'B.' groenlandica and its associated fauna should be sought. The small Crendonites of the anguinus Zone (faunas 45-47) I would correlate with the lower okusensis Zone, This is because the Crendonites of Milne Land are comparatively small (a maximum of c. 110mm), much smaller than a typical C. gorei (c. 150mm) from the upper okusensis Zone (or kerberus Zone), and much smaller than large (macroconch?) individuals of 190mm max. from this level. Smaller, more crudely ribbed Crendonites are found in the uppermost Assises de Croi of France, and in the lower okusensis Zone (Glauconitic Beds) of southern English counties (e.g. C. subgorei Spath 1936, pl. 9, fig. 5, pl. 14, fig. 2). If the Epilaugites vogulicus Zone of the Wollaston Foreland and Siberia and the horizons with Epilaugites sp. in Lincolnshire are time equivalent then the vogulicus Zone in Greenland may be only slightly younger than the Crendonites anguinus Zone and its presumed lower okusensis Zone equivalents.

STAGE NOMENCLATURE

A standard single stage nomenclature for the uppermost Jurassic may never be possible. The base of the Berriasian still awaits definition. I am strongly of the opinion that a dual nomenclature (regardless of whatever names may be used) should be retained for the Tethyan and Boreal Realms. The latest Jurassic ammonite sequence in the Boreal areas of Greenland, Siberia, Russian Platform, Poland, Denmark, Norway, Britain and France have a 'community of character' which requires expression in separate stage status. The Boreal and Tethyan stage schemes may never be accurately integratable except in a few geographically limited areas. For the purposes of day to day practical correlation within Realms these odd areas will be of limited relevance. What will continue to matter is the usefulness of the zonal schemes applied within a Realm. I am not convinced of the desirability of choosing a single stage nomenclature (e.g. Tithonian-Berriasian) and applying this universally. The chronostratigraphical stages are and will continue to be recognised and applied through the use of a series of biostratigraphic zones. If a proposed universal stage name cannot be applied accurately outside its realm of origin it has

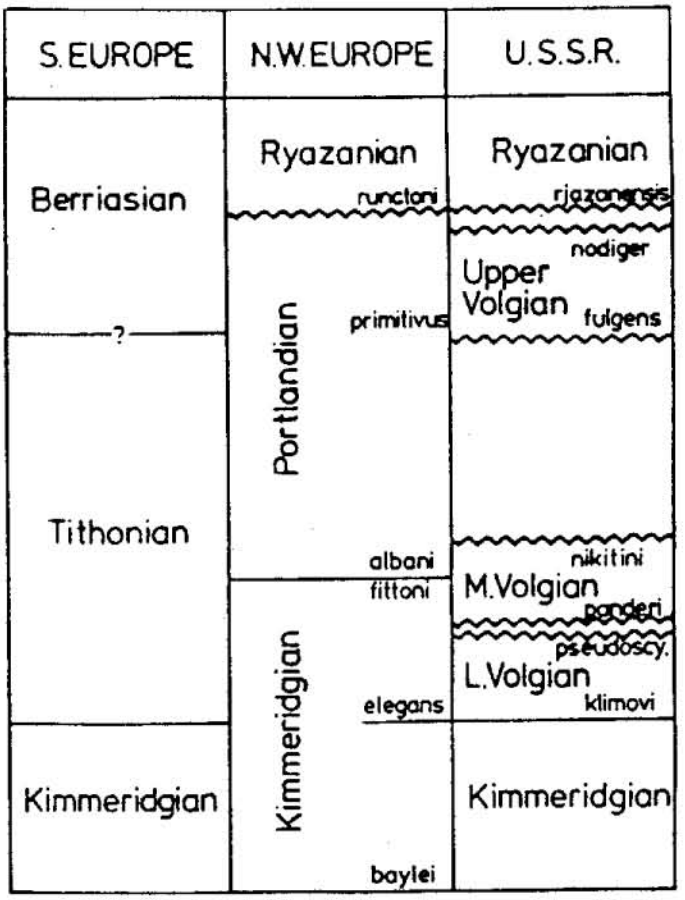

Figure 4. Comparative stage nomenclature across the Jurassic - Cretaceous boundary.

little practical use. One certainly cannot define a stage using the constituent zones of another stage in another realm (see for example Zeiss 1983 fig.1) The immediate problems facing us are problems of accurate correlation within Realms. I propose adoption of a dual system of stage nomenclature in the Tethyan and Boreal Realms, Tithonian-Kimmeridgian and Portlandian-Kimmeridgian (sensu anglico) respectively, the upper limits of both Portlandian and Tithonian to be set when a decision is made on the placing of the base of the Berriasian Stage.

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