1st. Oxfordian Meeting, Zaragoza, 1988 | PUBL. SEPAZ, 2, 1990 | 119-127

ON THE DEFINITION OF THE BASAL BOUNDARY STRATOTYPE OF THE JURASSIC OXFORDIAN STAGE

J. H. CALLOMON
University College London, 20 Gordon Street, London WC1H OAJ.

Abstract

The definition of the standard Oxfordian Stage in terms of its contained standard chronostratigraphical Zones and Subzones and their statotypes was essentially completed in 1964, published in the volume of Proceedings of the first International Symposium on Jurassic Statigraphy at Luxembourg 1962. The basal boundary stratotype of the Stage is that of its lowest member of lowest rank, the Scarburgense Subzone. This can now be specified to lie at the base of bed 10 of the section at Osgodby Nab, Scarborough, Yorkshire, as described by WRIGHT (1968). Some recently proposed alternatives calling for changes in the established definitions seem to be unjustified and are rejected.

INTRODUCTION

EFFORTS continue, largely at the behest of the International Commission of Stratigraphy, to define geological Stages as the units of lowest rank for world-wide time-correlation, in terms of Stage Stratotypes. As has been explained repeatedly, most recently and comprehensively perhaps in the Proceedings of the International Symposium on Jurassic Stratigraphy held at Erlangen in 1984 (CALLOMON 1985), workers on the Jurassic have long gone beyond this attractive and apparently simple goal in two respects.

Firstly, because of the availability of what are exceptionally good guide-fossils, time-correlations in the Jurassic have been carried to levels of refinement beyond that of Stages ever since OPPEL's time. Stages in the Jurassic are currently at the third level in a *hierarchy* of standard chronostratigraphic classification, the units at the lowest, first level being standard Subzones. The implications of such hierarchical classification for typological definitions have also been pointed out repeatedly. To avoid ambiguity, higher members of a hierarchy have to be defined in terms of the units of lower rank contained within them; and in chronostratigraphy, in which units are in linear relationship to each other, following the arrow of time upwards, units have to be defined by their *bases*.

Secondly, the very successes in world-wide correlation achieved in the Jurassic in the last 150 years have made it clear that Stages, as somehow *natural* units for world-wide correlation, are a chimera. The Stages set up by D'ORGIGNY reflected his knowledge of the Jurassic of NW Europe at the time, not the French manifestations of the Pulse of the Earth - even less the capricious moods of a Creator deciding repeatedly and at widely different intervals of time to repopulate the world with new (improved?) biotae. D'ORBIGNY's Bathonian, no matter how carefully redefined, is of little help to Jurassic workers in the Arctic, the Pacific, North or South America. D'ORBIGNY's Portlandian is of little help to workers even in most of Europe. And almost all of D'ORBIGNY's Stages are largely irrelevant to Jurassic workers in New Zealand. The reason why we continue to use them is that they are *convenient* as one standard of reference. They are not unique. They can now be widely *recognized* more or less approximately all over the world. But this is the result of *correlation*, not of *definition.* Had D'ORBIGNY and OPPEL been Californians *("Die Kordilleraformation Nord-und Südamerikas und des Stillen Ozeans"),* we would perhaps to-day have a standard Jurassic statigraphic classification every bit as good as the one we do have. But it would be very different.

The present definition of the Oxfordian Stage

If we accept the principles of stratigraphic classification referred to above, the Oxfordian Stage is one of the first to whose definition these principles were applied almost *in toto.* The principles and definition were published in the Proceedings of the first of the symposia on Jurassic stratigraphy held in Luxembourg in 1962 (CALLOMON 1964).

The Oxfordian Stage was defined in terms of its standard ammonite Zones in the NW European, Boreal/Subboreal classification. The lowest Zone of the Stage is the Mariae Zone. This Zone is itself subdivided into two Subzones: Scarburgense and Praecordatum Subzones. Of these the lower is the Scarburgense Subzone, which is thus the basal Subzone of the Oxfordian Stage. For various reasons, largely historical but at no cost in geological precision, the type-locality and hence statotype of the Scarburgense Subzone were chosen in the permanent cliff-sections of the Yorkshire coast. (We note in passing two consequences of this choice. The first is that the basal stratotype of the Oxfordian Stage is nowhere near Oxford. The second is that the type-locality of the Scarburgense Subzone - a stratigraphical entity - coincides with that of its *index*-species, *Cardioceras scarburgense,* a zoological entity. Both are details requiring no further formal comment. We shall however be spared the kind of confusion that has arisen in other cases in which type-horizon and locality of a standard Zone and of its index-species were not the same, and in which subsequent rectification of zoological classification showed that the index-species did not in fact occur in its nominal Zone).

There remained two steps to complete the definition that could not be taken in 1964 because of a lack of sufficiently precise information. These were the choice of an actual described stratotype section in Yorkshire, and the designation within this section of the basal boundary stratotype of the Scarburgense Subzone. This information has since become available following a detailed resurvey of the Yorkshire Callovian and Oxfordian by J. K. WRIGHT (1968, 1983). The most suitable section for the definition of the Scarburgense Subzone is that at Osgodby Nab, 4 km SSE of Scarborough Castle, at the north end of Cayton Bay, WRIGHT's Section 11 (1968, p. 382), beds 10-13, totalling 0.50 m in thickness. Its advantages lie in the fact that it is permanently exposed and accessible, and that the boundary at the base of bed 10 is readily recognizable. Its disadvantage is that the Scarburgense Subzone is here strongly condensed, thickening to 10 metres or more elsewhere in Britain. This disadvantage is however not a serious one, as will be shown below.

Alternative definitions

A different definition of the base of the Oxfordian has been put forward by MARCHAND (1979). In the course of widespread stratigraphical surveys he succeeded in identifying a new faunal horizon based on an assemblage of ammonites described by LANGE (1973), from the Wiehengebirge of NW Germany, that contained a previously undescribed species which he named *Cardioceras paucicostatum* sp. nov. This faunal horizon lies below the levels with *Cardioceras scarburgense.* It could, moreover, be recognized very widely in Europe, from NW Germany through the Ardennes, to the southern Paris Basin (Cher) and thence to the edge of the Boreal Realm itself, in the Alpes Maritimes. It has since been recognized even further afield, including Yorkshire (WRIGHT 1983; bed 9 in the section at Osgodby Nab) and eastern Scotland (MARCHAND 1986). Because of the ease with which it could be recognized, MARCHAND proposed that it be taken to be the "premier horizon paléontologique de l'Oxfordien inférieur" (1979, p. 124).

The excellence of the *paucicostatum* horizon (not Paucicostatum Horizon) as a marker for correlations at or near the Callovian-Oxfordian boundary is therefore not in doubt. The reasons why this should necessarily qualify it to become the basal horizon of the Oxfordian, thereby changing existing definitions and displacing the base of the Stage downwards, are less clear. The account of 1979 makes no reference to the arguments and definitions of 1964. Neither does it give any reasons why the *paucicostatum* horizon should be more easily or more widely recognizable than the *scarburgense* horizon (s) above. This has always been *de facto* the practical means of tracing the base of the Oxfordian Stage since ARKELL's classical description (1939) of the stratigraphy of the Oxford Clay at Woodham in southern England. The implicit reasons seem to have surfaced later (MARCHAND 1986, p. 286): "Le genre *Cardioceras...* apparait par définition à la base de l'Oxfordien inférieur...". Inclusion of the *paucicostatum* horizon already in the Oxfordian would thus depend on the identification of the species *paucicostatum* as already a *Cardioceras* rather than as still a *Quenstedtoceras*. This is a classic example of the confusion of biozones with chronozones that I explicitly warned against at Erlangen in 1984 (see also CALLOMON & DONOVAN 1974, p. 76). A standard chronostratigraphical unit - the Oxfordian Stage - defined in such a way would depend on the subjective judgment involved in the generic identification of a zoological unit - the species *paucicostatum.*

LANGE's original description of the characteristic fauna of the *paucicostatum* horizon assigned it in fact to nine (morpho)species. The combination of all of these as merely variants of a single horizontal (bio)species was due to MARCHAND. But in then deciding whether this whole assemblage should be assigned to the one genus rather than to the other, one is forced by the *Rules* to consider particularly the type-specimen of the name-giving species. The holotype of *Cardioceras paucicostatum* is the specimen figured by LANGE on his pl.20, fig. 4. It is a crushed complete adult microconch, showing no signs of a differentiated keel, typical in my view of *Quenstedtoceras sensu stricto.* (MARCHAND's concept of the differences between *Quenstedtoceras* and *Cardioceras* may have been influenced by his belief (1986, p. 206) that the type-species of the former is *Amm. lamberti* J. SOWERBY, 1819).

Even leaving aside the merits of this particular case, it would be intolerable if the boundaries of standard stratigraphical units were changed every time a palaeontologist revised the taxonomy of a particular group of fossils. MARCHAND himself admits repeatedly that the genera *Quenstedtoceras* and *Cardioceras* were merely successive segments of a single evolving lineage, smoothly linked by overlapping intermediates. A case could therefore be made for abandoning one of the names altogether, making *Cardioceras* (1881) junior synonym of *Quenstedtoceras* (1877). Such a move, although unlikely to be very popular, would certainly be strongly justifiable. Would it mean moving the lower boundary of the Oxfordian down now even further into the Upper Callovian, to incorporate the whole of the Lamberti Zone, making it synonymous with RENEVIER's Divesian Stage of 1874? And so on.

As already pointed out, any such adjustments of stratigraphical definitions are quite unnecessary. The *paucicostatum* horizon loses none of its value for correlation by being left as the top faunal horizon of the Callovian Lamberti Zone. And as MARCHAND himself points out, the faunal horizons of the overlying Scarburgense Subzone are at least as widely and easily recognizable. They are in fact even better, as indicated below.

Correlations, parastratotypes, references-sections

Besides serving to define a stratigraphical unit and its boundaries, a stratotype should offer an exposed section that is well-described, readily and permanently accessible. One of its purposes would be to provide authentically-dated samples, for example for micropalaeontology. The stratotype should, moreover, show the unit that it defines in typical and tolerably complete development. It goes almost without saying that it should have yielded at least some of the leading guide-fossils used to recognize the unit elsewhere - to correlate it. Ideally, a standard Stage or Zone stratotype should have all these attributes. In practice, few ever will. In the case at issue here, the development of the Scarburgense Subzone, whose base defines the Oxfordian Stage, is not ideal in its stratotype because of condensation. Fortunately, it is usually accessible at any one time at other localities where it is well developed. So, moreover, is the boundary between it and the top of the underlying Lamberti Zone (*paucicostatum* horizon) in the Upper Callovian. The correlation of the basal boundary is exact over large distances, and there is hence no loss of precision in sampling the Scarburgense Subzone at localities other than at the primary stratotype. Well-described sections thus correlated may be designated secondary or parastratotypes, or reference-sections. Such sections come and go, and vary in quality. Once a primary stratotype has been fixed, there will inevitably come a time when some other sections show the unit it typifies even better than the primary stratotype does. Little would be gained by moving the primary stratotype every time this happened, for it would negate the principal purpose of a stratotype, which is to confer stability on a definition.

The only exception arises when knowledge of a standard stratigraphical unit has increased to the point where it is decided to subdivide the unit formally into two or more new, narrower units. Each of these has then to have its own stratotype, which may, but need not, coincide with that of the original unit being subdivided. Thus, for example, had it been agreed to accept the *paucicostatum* horizon as the lowest horizon in the Scarburgense Subzone of the Mariae Zone, and should it have been decided to distinguish it formally as a new standard Subzone of the Mariae Zone by subdivision of the Scarburgense Subzone, the primary stratotype of the Paucicostatum Subzone would have been selected to be in a section in which the Subzone was best developed according to the state of knowledge at the time, 1979. This would presumably have been in the section in NW Germany described by LANGE in 1973, not in the cliff-sections of Yorkshire, even though the *paucicostatum* horizon was subsequently recognized there also, in 1983. (MARCHAND makes no mention of stratotypes in his stratigraphy anywhere).

The leading candidate for designation as a parastratotype of the Scarburgense Subzone would have to be the succession at Woodham, Buckinghamshire, in south-central England described by ARKELL (1939), with additions by CALLOMON (1968, p. 287). Unfortunately, the section has now completely disappeared. The brick-pit in which it was exposed has been filled in. But the descriptions based on many years' collecting are by far the most detailed account of the faunas of the Scarburgense Subzone we have and provide the yardstick by which the Subzone is correlated. They demonstrated clearly the diagnostic faunal elements. Leading among them are the Boreal Cardioceratidae, which show a progressive transformation of successive faunal assemblages from early ones in which *Cardioceras (scarburgense)* and *Quenstedtoceras (woodhamense, mariae)* are equally abundant, to later ones in which *Cardioceras* dominates (90%). But of equal importance for correlation are the Thethyan Taramelliceratinae: *Taramelliceras richei (M)/Creniceras renggeri (m).* Macroconchs differing relatively little from those of the Lower Oxfordian are known, if rarely, already from the Upper Callovian *(T. taurimontanum* ERNI, 1934: cf. CARIOU & SEQUEIROS 1987). But the unmistakable, ventrally creniculate microconch *Creniceras* seems to have appeared sharply at the base of the Scarburgense Subzone. It has certainly proved to be a reliable guide-fossil throughout almost all of northern Europe ("Renggeri Marls"), and has in the past even been used as index of a Renggeri Zone, equivalent more or less to to-day's Mariae Zone. It will prove to be the key to many outstanding problems of correlation in regions in which the Cardioceratidae are absent, e.g. the southern margins of the Tethys. Thus, for example, the Taramelliceratinae with typical *C. renggeri* unequivocally date the dark shales on Mount Hermon in Syria (HAAS 1955). Other potentially useful guide-fossils are the Peltoceratinae, but these remain to be evaluated. They may become the best indicators of Lower Oxfordian in Madagascar, Cutch, Indonesia and South America. The predominantly pyritic faunas of juveniles or nuclei found in the Oxford Clay or Renggeri Marls cannot contribute much to this, however, as the age-diagnostic characters of the group lie in the adult stages, which are generally not preserved in these facies.

There have been numerous other exposures of the Upper Callovian - Lower Oxfordian in the English Midlands. One is currently still visible in one of the London Brick Company's brick-pits at Stewartby, south of Bedford, 40 km NE of Woodham. It is well keyed into the complete succession from Bathonian to Upper Oxfordian in the area. Extensive reference-collections made carefully bed by bed are conserved in the British Geological Survey, which has published a summary of the succession (WYATT et al. 1988, text-fig. 4). The Lamberti Limestone is reduced to a vestigial stone band in which the *paucicostatum* horizon can no longer be identified, but the Scarburgense Subzone is as clearly and sharply developed here as at the stratotype in Yorkshire and as it was at Woodham.

Further afield, the Upper Callovian - Lower Oxfordian succession is well developed and permanently exposed in the Hebrides, on the foreshore of Staffin Bay in Skye (TURNER 1966; SYKES & CALLOMON 1979, p. 897). It is less fossiliferous here than in the English Midlands, but the ammonites are in normal biofacies and consist of complete adults. The Peltoceratinae are particularly fine, but the Taramelliceratinae are absent.

On the Dorset coast, exposures of the Upper Callovian - Lower Oxfordian succession tend to be masked by slumping or superficial deposits. A good exposure can however generally be obtained with a little digging in the Furzedown Clays at Ham Cliff, just to the east of Redcliff Point, 4 km NE of Weymouth (ARKELL 1947, Weymouth Memoir, p. 33).

In Normandy, the precise level of the base of the Scarburgense Subzone was described in CALLOMON 1964 (p. 281), but these beds do not appear to have been exposed in recent years. The development of the Lower Oxfordian in much of the rest of Europe has been well summarized by MARCHAND (1986). A good exposure has recently been described in Franconia, S Germany (CALLOMON et al. 1988).

That leaves large areas of the world in which the Upper Callovian - Lower Oxfordian successions remain to be characterized. They include many of the classic localities in eastern Africa, India and the Himalayas, the East Indies and the Andes. In all of these the Cardioceratidae are absent and alternative guide-fossils will have to be found. As in other parts of the geological column, this may make it expedient to establish independent, separate provincial standard zonations, to be correlated with the European standard as well as provincial overlap will allow.

Conclusion

Of all the Stages of the Jurassic, the Oxfordian is one of the best defined according to modern principles, in terms of hierarchical standard zonal chronostratigraphy and basal boundary stratotypes. These definitions were essentially complete in 1964 and have stood the test of time. Changes in these definitions implied in some recent alternative proposals are quite unnecessary and should not be adopted.

REFERENCES

ARKELL, W. J., 1939.- The ammonite succession at the Woodham Brick Company's pit, Akeman Street Station, Buckinghamshire, and its bearing on the classification of the Oxford Clay. *Quart. Jl geol. Soc. London 95,* 135-222, pls. 8-11.

ARKELL, W. J., 1947.- The geology of the country around Weymouth, Swanage, Corfe & Lulworth. *Mem. Geol. Surv. Gt Britain,* 386 p., pls. 1-19.

CALLOMON, J. H., 1964.- Notes on the Callovian and Oxfordian Stages. *Compt. rend. Mém. Colloque Jurassique Luxembourg 1962,* ed. P. L. Maubeuge, 269-91. Inst. grand-ducal, Sect. Sci. nat. phys. math., Luxembourg.

CALLOMON, J. H., 1968.- The Kellaways Beds and the Oxford Clay. In: *The geology of the East Midlands,* eds. P. C. Sylvester-Bradley & T. D. Ford, chapter 14, 264-90. Leicester University Press, Leicester.

CALLOMON, J. H., 1985.- Biostratigraphy, chronostratigraphy and all that - again! *Intl Symp. Jurassic Stratigraphy, Erlangen 1984,* eds. O. Michelsen & A. Zeiss, 3, 611-24. Geological Survey of Denmark, Copenhagen.

CALLOMON, J. H., DIETL, G., GALACZ, A., GRADL, H., NIEDERHÖFER, H.-J. & ZEISS, A., 1987.- Zur Stratigraphie des Mittel-und unteren Oberjuras in Sengenthal bei Neumarkt/Opf. (Fränkische Alb). *Stuttgarter Beitr. Naturk. B 132,* 53 p., pls. 1-5.

CALLOMON, J. H. & DONOVAN, D. T., 1974.- A code of Mesozoic stratigraphical nomenclature. *Mém. Bur. Rech. géol. min. France 75,* 75-81.

CARIOU, E. & SEQUEIROS, L., 1987.- Les *Taramelliceras* (Ammonitina, Taramelliceratinae) du Callovien: découverte de formes ancestrales et origine progénetique presumée a partir du genre *Paralcidia* (Oppeliinae). *Geobios 20,* 495-515, pls. 1, 2.

HAAS, O., 1955.- Revision of the Jurassic ammonite fauna of Mount Hermon, Syria. *Bull. Amer. Mus. Nat. Hist. 108,* 3-210, pls. 1-30.

LANGE, W., 1973.- Ammoniten und Ostreen (Biostratigraphie, Ökologie, Zoogeographie) des Callovium/Oxfordium-Grenzbereichs im Wiehengebirge. *Münster. Forsch. Geol. Palaeont. 27,* 209 p., pls. 1-25.

MARCHAND, D., 1979.- Un nouvel horizon paléontologique: l'horizon à *Paucicostatum* (Oxfordien inférieur, zone à *Mariae,* base de la sous-zone à *Scarburgense*). *Compt. rend. somm. Soc. géol. France, 1979* (iii), 122-4.

MARCHAND, D., 1986.- L'évolution des Cardioceratinae d'Europe occidentale dans leur contexte paléobiogéographique (Callovien supérieur - Oxfordien moyen). *Thèse Doct. ès Sci. Univ. Bourgogne,* 601 p., pls. 1-22. Dijon, U. A. CNRS no. 157.

SYKES, R. M. & CALLOMON, J. H., 1979.- The *Amoeboceras* zonation of the Boreal Upper Oxfordian. *Palaeontology 22,* 839-903, pls. 112-121.

TURNER, J., 1966.- The Oxford Clay of Skye, Scalpay and Eigg. *Scott. Jl Geol. 2,* 243-52.

WRIGHT, J. K., 1968.- The stratigraphy of the Callovian rocks between Newtondale and the Scarborough coast, Yorkshire. *Proc. Geol. Assoc. 79,* 369-99, pls. 10, 11.

WRIGHT, J. K., 1983.- The Lower Oxfordian of North Yorkshire. *Proc. Yorks. geol. Soc. 44,* 249-81, pls. 18-22.

WYATT, R. J., MOORLOCK, B. S. P., LAKE, R. D. & SHEPHERD-THORN, 1988.- Geology of the Leighton Buzzard - Ampthill district. *Brit. Geol. Surv. Tech. Rept .WA/88/1,* 66 p., pls. 1-4.