The Graphoceratid Ammonite Succession in the Aalenian and lowest Bajocian (Middle Jurassic) at Horn Park, Dorset, UK

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Summary

In 1990 Callomon and Chandler set out a scheme of 16 faunal horizons for the Aalenian-Lower Bajocian of Dorset and Somerset based principally on graphoceratid ammonites. One locality, Horn Park, stands apart in displaying strata from almost all the horizons identified in that work. Yet little material from it has ever been figured. Here a section is given together with exhaustive tables of existing nominal morphospecies collected at each level and with figures that allow the variability of the successive, probably in most cases, monobiospecific assemblages to be assessed. A revised generic classification of the Graphoceratidae is presented.

Introduction

The highly discontinuous, condensed and rapidly varying development of the Inferior Oolite in southern England was first perceived by S.S. Buckman (e.g. 1891, 1893, 1910) during his attempts to correlate sections by means of ammonites. Leading amongst these in the Aalenian part of the succession are the Graphoceratidae, including such well known genera as *Leioceras, Ludwigia, Brasilia, Graphoceras* and *Hyperlioceras.*

An enormous number of these ammonites have been described over the years. The first extensive treatment was that of the collections made by the Buckmans in Dorset, in S. S. Buckman's *Monograph of the Ammonites of the Inferior Oolite Series* (1887–1907). Descriptions of equally rich faunas in other parts of Europe soon followed, notably in works by Hoffmann (1913), Althoff (1940) and Spiegler (1966) from northern Germany; Horn (1909) and Rieber (1963) for southern Germany; Contini (1969) for eastern France; Géczy (1967) for Hungary; and Ureta (1983) for Spain.

Yet despite this profusion of described material, many uncertainties remain. Firstly, the majority of existing nominal species were based on type series whose horizons are not precisely known. This applies particularly to Buckman's species, for he was discovering and working out the stratigraphical refinements hand in hand with the description of the material over a period of many years. His earlier descriptions therefore lacked the precision of his subsequent stratigraphical knowledge. Elsewhere, few accounts were based on stratigraphical evidence of comparable precision at all, relying heavily on material in old collections in the museums. Secondly, previous classifications were almost always in conventional, purely morphological terms. It is therefore very difficult to assess the true, natural, relationships between existing nominal species: to distinguish differences representing merely morphological variation within single biospecies from differences of age, and hence from genuine evolutionary development. Such ambiguities have in the past led to both taxonomic and stratigraphical misidentifications, often locked in circular argument, and failure to resolve them precludes almost any satisfactory discussion of phyletic relationships and hence of the overall evolution of the group.

The biostratigraphy of the Graphoceratidae has now been rather well documented, for example by Rocha *et al.* (1990), Henriques (1992; *et al.* 1994) in Portugal; Linares and Sandoval (1990) in Spain, Sadki (1994) in Morocco. In Britain, Morton (1990; 1994) and Morton and Hudson (1995) have described the succession in Scotland and compared it with Dorset (Morton and Chandler 1994). In Dorset it is represented in terms of a succession of faunal horizons, the modern successors to Buckman's hemerae, based on the closest-spaced succession of distinguishable faunal assemblages (Callomon and Chandler 1990; 1994, Callomon 1995; Callomon and Cope 1995; Chandler and Sole 1995). A full list of the fauna along with figures of characteristic ammonites on which the scheme is based has not so far been published. It is now possible to pinpoint the exact horizon from which the majority of Buckman's graphoceratids came, based on large new collections, numbering hundreds of specimens, made carefully level by level at the classical locality of Horn Park in southern Dorset. They include perfect matches of the types of almost all of Buckman's nominal species, types whose precise horizons were mostly hitherto unknown and which in some cases remained to be selected from syntype series. These findings allow a revised classification to be presented, based now on accurately collected new material.

In 1990 the known ammonite faunal horizons numbered in total 16 for the Aalenian and 20 for the Lower Bajocian. Of these 36, 14 of the Aalenian and two of the Lower Bajocian can be seen at Horn Park and 15 of them contain Graphoceratidae. Subsequent addition of further newly discovered horizons (Callomon 1995) has not so far necessitated any modification in the Aalenian.

The Inferior Oolite has been quarried at Horn Park intermittently for many years. Previous descriptions were given by Richardson (1928), Bomford (1948), and Senior, Parsons and Torrens (1970), and were summarised by Parsons in Cope (1980). Their bed-numbering is retained here, modified by further subdivision of some of the beds in the lower part of the succession

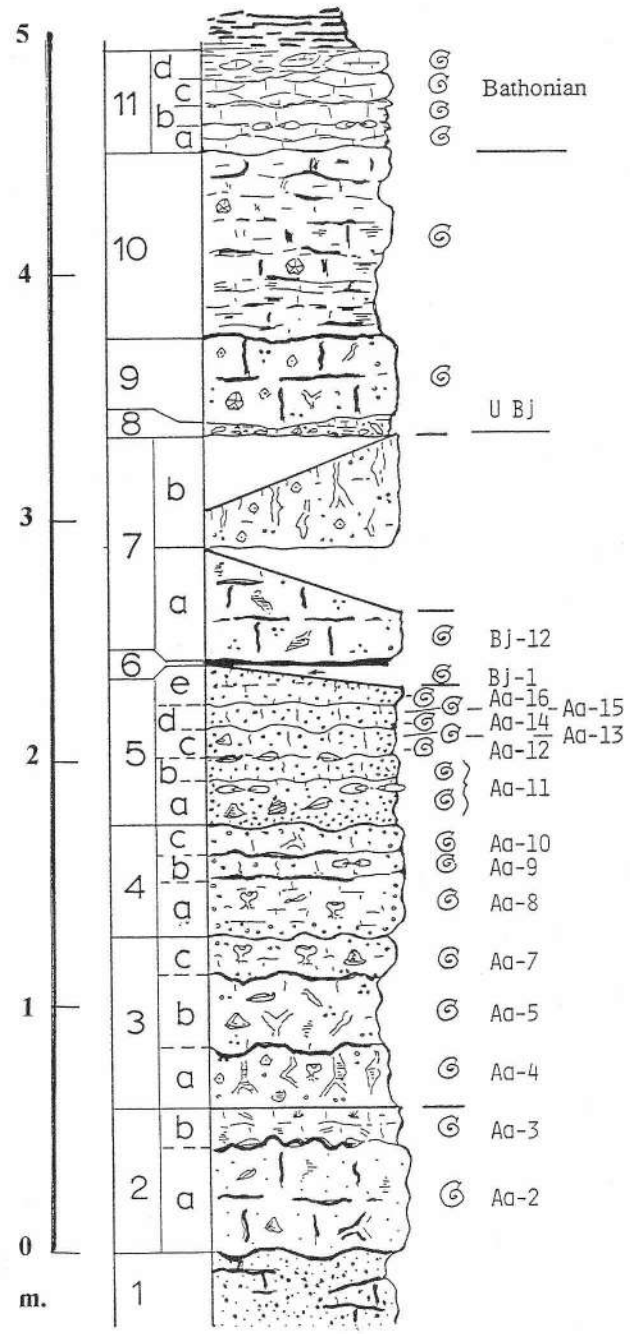


Figure 1: Diagrammatic section through the Inferior Oolite at Horn Park, near Beaminster

(Chandler 1982; Callomon and Chandler 1990). The most recent account of the present quarry (G.R. ST 458022) is that of Callomon (in Callomon and Cope 1995). The standard zonal classification followed here is that of Callomon and Chandler (1990; 1994). A weathering profile of the section is reproduced in Fig.1.

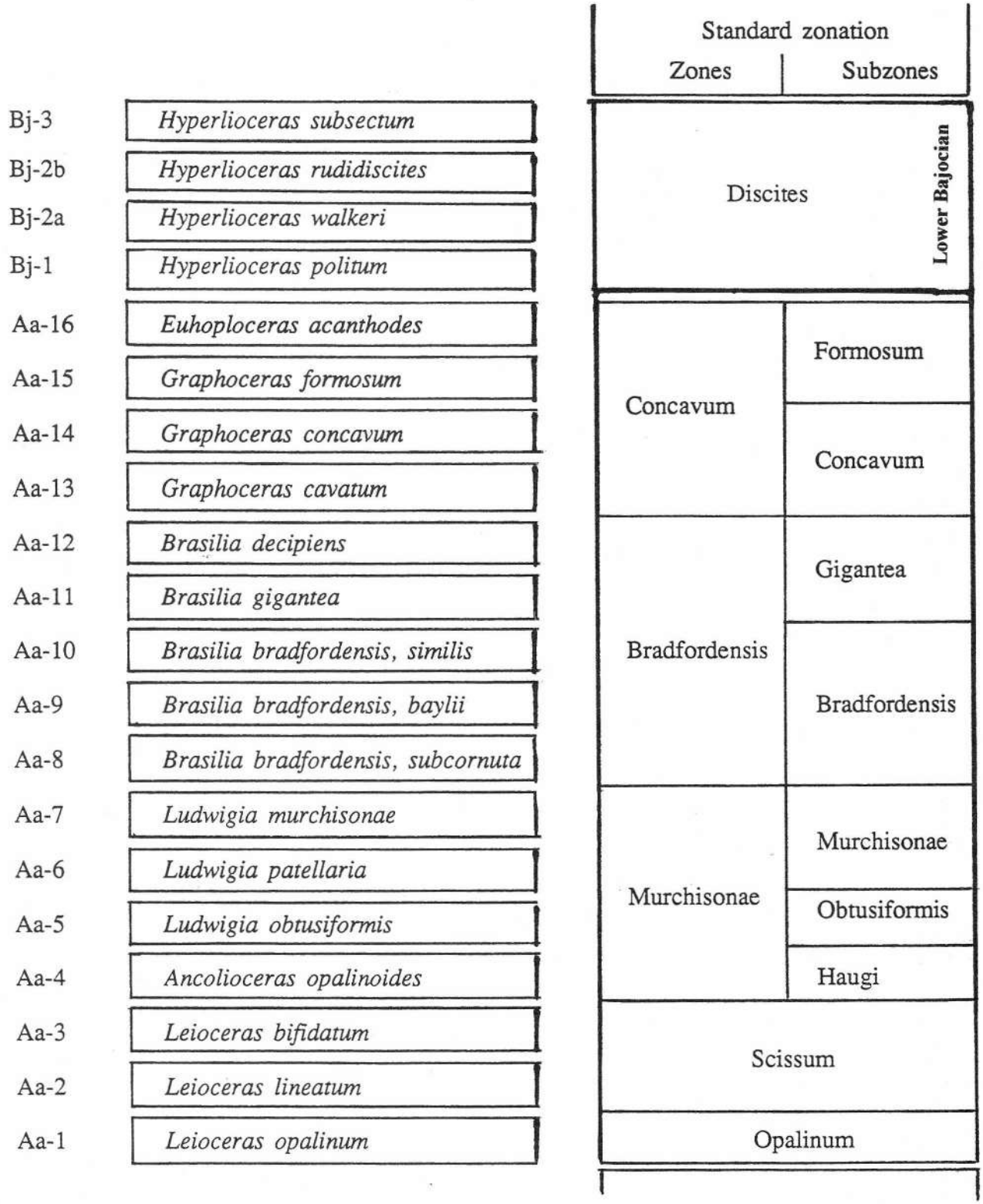
The lowest bed with ammonites at Horn Park, bed 2, forms the base of the quarry and is not worked. It belongs to the Scissum Zone; and because it has yielded rather little material and is much better known elsewhere (e.g. Bridport: Callomon and Chandler 1994), it will not be described here in detail. The main part of the succession consists of beds 3–5 and includes the Horn Park Ironshot (Parsons 1980), which spans the Murchisonae–Concavum Zones. The top is planed off by a slightly unconformable erosion-plane of Bajocian age, Sauzei Zone, but extension of the working has revealed the preservation locally of the lowermost part of the Discites Zone.

The succession will be described in order of distinguishable faunal assemblages. The level of each of these assemblages constitutes a 'faunal horizon' in the sense that has become widely used in recent times (Callomon 1995). The faunal content of a horizon may be regarded for all practical purposes as representing the sampling of an instant in time; horizons are therefore not necessarily contiguous subdivisions of chronostratigraphical Zones or Subzones, and will in general be separated by faunal gaps equivalent to time-durations of unknown extent. Thus, faunal horizons at other localities may well come to be inserted between those at Horn Park. (The time-equivalent of a faunal horizon thus closely resembles one of Buckman's 'hemerae', shorn of all connotations relating to ranges or acmes of any one particular species.) The assemblage of Graphoceratidae from each horizon are listed in a set of faunal tables. As the purpose is to classify English biostratigraphy, no attempt is made to carry out a systematic revision with extensive synonymies, which would in any case be a major undertaking well beyond the scope of the present work. The species listed in the tables therefore include as many of Buckman's nominal (morpho-) species as can be identified in the faunas. Nominal species of other authors are added where no suitable match can be found in Buckman's work, together with a reference to at least one figure and its type status, if any, There may be additional notes as appropriate. Many of Buckman's species are also type-species of nominal genera, and these will be indicated by asterisks. In addition, the following abbreviations are used: *Mon.*: Buckman 1887–94, *Monograph of the Ammonites of the Inferior Oolite Series*; *Supp.*: supplement, *ibid.*, 1898–1907; *T A*: Buckman 1909–30, *Type Ammonites*, vols.III–VII; HT, holotype; HT (mon), *id.*, by monotype; ST, syntype; LT, lectotype; TT, topotype; CT, chorotype (same horizon, different but neighbouring locality). [M], [m]: macro/microconch, respectively. R, O, C,: rare, occurs, common. +: probable horizon from which the type came. Generic names cited in square brackets are those of nominal genera created by Buckman and regarded here as junior synonyms. Names placed in round brackets are retained as subgenera.

Each horizon is labelled with the name of one of its nominal species, preferably one of which it is the type-horizon; and if there are more than one of these, the nomenclaturally senior among them, which would survive if the others were put in synonymy.

For ease of reference, successive horizons will be labelled and numbered according to the practice adopted by Callomon and Chandler (1990), with each horizon bearing a letter code followed by a number (Aa- and Bj- for Aalenian and Bajocian respectively).

In addition to graphoceratid ammonites, many other important species have been recorded from Horn Park. These have been already listed by Callomon and Chandler (1990) and Callomon and Cope (1995) and will not be repeated here.



Note: the labelling of some horizons with additional letters a, b, c... reflects the insertion of further horizons recognised since the first list was drawn up in 1990, so as not to have to change the main framework of numbering introduced in that list. The letters imply no reduction or other inequality of rank and importance

Figure 2: The ammonite faunal horizons of the Aalenian and part of the Lower Bajocian of Dorset-Somerset

The Succession

From below:

AALENIAN

Scissum Zone

Bed 2: Limestone, somewhat sandy, massive, hard; on weathering splits at a parting into two components:

-2a: (Aa-2) massive, white, few fossils, shells with test preserved. ...0·40 m

-2b: (Aa-3) somewhat argillaceous, heavily bioturbated, burrows with ochreous infill weathering into cavernous pockets. Highly fossiliferous: very large bivalves, including *Lima* sp., *Ceratomya* sp., and solitary corals, *Montlivaltia delabechi* Tomes. ...0·15 m

- Sharp boundary; planed erosion surface, base of quarry -

Murchisonae Zone

Bed 3: Limestone, sandy, more or less ferruginous, bioturbated, divisible into three courses separated by irregular clay partings:

Haugi Subzone

-3a: (Aa-4) The *Ancolioceras* Bed, in part of Richardson (1928–30, 41). Limestone, light yellow to grey, variably ferruginous, hard, micro-oolitic in parts, echinodermal, bioturbated and heavily burrowed, the burrows mainly vertical, filled with brown limonitic marl. Many fossils: large bivalves, decalcified; solitary corals; ammonites preserved as internal moulds of bodychambers, inner whorls crushed, replaced by marl. ...0·30 m

The Graphoceratid fauna consists of (i) *Leioceras*, including forms persisting unchanged from below (*Cypholioceras*), fine to moderately strongly ribbed oxycones with a relatively complex suture; (ii) *Cylicoceras*, with stouter whorls and stronger ribbing; (iii) *Staufenia*, similar to the latter but with a simplified suture. As considerable doubt still exists concerning the phylogeny of this group a separate generic name is retained here for it. Finally, (iv) *Ludwigia* appears in abundance.

The macroconchs within each group grade into one another and give the impression of being merely variants of single biospecies. In the Leioceratinae, *Leioceras* and *Cylicoceras* are distinct, recent collecting showing this already to be the case back in the early Aalenian. It confirms Rieber's (1963), Contini's (1969–70) and Callomon and Chandler's (1994) findings that two entirely separate dimorphic groups exist side by side.

Ancolioceras has recently been found elsewhere in south Dorset (Chandler, unpublished field notes) associated with a typical *Leioceras comptum* assemblage. It can be shown probably to have evolved from *Leioceras* (*Cypholioceras*) by strengthening of the ribbing and a decrease in the umbilical diameter. The earliest available name would be *Ancolioceras opalinoides* (Mayer 1864) (LT *Ammonites murchisonae acutus* Quenstedt 1856, pl. 46, fig.4, refigured 1886, pl.59, fig.5; designated. Rieber 1963, 41), for specimens like the lectotype also occur at the centre of variability here; but the precise age of the lectotype is not certain.

Some further species stand apart, and are here placed in the genus *Cylicoceras*, that have strong ribbing and retain a compressed morphology and relatively complex suture. They are presumably close relatives of *Staufenia*, of which the earliest representive *Staufenia sinon* already occurs here but is very rare. A number of *Cylicoceras* bear a striking resemblance to this species (cf. *Cylicoceras crassicostatum* (Rieber 1963)) but lack the characteristic, much simplified suture of the German type specimen of *Staufenia sinon* (Bayle 1878, pl.83, fig. 1, LT designated. Rieber 1963, 40) and of much other central European material. Presumably *Cylicoceras* and *Staufenia* share a common ancestor, the central European population evolving by development of a simple suture and rare examples finding their way into British waters.

Ludwigia is regarded here as the first of the Graphoceratinae and is almost certainly a direct descendant of broad, strongly ribbed *Cylicoceras*, from which *Ludwigia* had already started to differentiate in the upper Scissum Zone (cf. *Ludwigia praecursor* Rieber 1963, p.66 and Chandler unpublished). *Ludwigia* is represented in Aa-4 by ammonites centered on *L.* [*Cosmogyria*] [*] *obtusa* (Buckman, 1899) (*non Amm. murchisonae obtusus* Quenstedt 1846, *nec Amm. obtusus* J. Sowerby 1817); LT Quenstedt, pl.7, fig.12, designated. Rieber 1963 (as 'HT'), lost; = *L. haugi* Douvillé 1885 (LT: Quenstedt 1849, pl. 7, fig.12, designated Géczy 1967, p.190; from Aalen, lost); includes *C. obtusa* Buckman 1899, *Supp.* p.53, pl.4, figs.10–12.

The macroconchs of *Ludwigia* are medium-sized to large, with strong ribbing which is projected forward on the venter. Coarse-ribbed forms tend to have stout quadrate whorl-sections, while smoother ones are Platyconic. Specimens very similar to those from central Europe occur in bed 3a but there are important differences: in particular the absence of very broad, strongly-ribbed forms suggest that the Dorset fauna may represent a slightly different horizon.

- undulating clay parting -

Obtusiformis Subzone

-3b: (Aa-5) Limestone, as below, softer, echinodermal packstone with occasional buff ooliths; olive or khaki-grey but whitish and hard near top. Many large decalcified bivalves; ammonites rarer and preserved as internal moulds. Bioturbated with voids, burrows and limonitic pockets. ...0·30 m

The appearance of large smooth discoidal *Staufenia sehndensis* is cryptogenic in Dorset.The species is very short-ranging, so far only recorded from Aa-5. Exact matches are possible with material from central Europe (Chandler 1982) and records of the species have now been confirmed elsewhere in Dorset (Chandler, unpublished field notes) associated with an otherwise identical fauna.

Murchisonae Subzone

-3c: (Aa-7) Craterospongia Bed: Hard grey limestone with a few ooliths; many large bivalves, echinoderm debris, large sponges (*Craterospongia* sp.) on the upper surface. Heavily bioturbated with burrows filled by red limonitic marl. Ammonites preserved as internal moulds, occasionally calcified. ...0·15 m

The *Ludwigia* fauna is divisible into two groups. In one, the typical *L. murchisonae*, the ribbing abuts the keel at almost 90°. In the other, ancestral prosiradiate ribbing is maintained as in typical *L. haugi*. Intermed-iates do occur but the appearance of this morphological feature is an important tool for the recognition of late forms of the genus. Microconchs are relatively abundant compared with the preceding bed. The earliest available name is *L. murchisonae* (Sowerby 1827) whose holotype is at the centre of the range of variability. First members of the genus *Brasilia* occur here and intergrade with *Ludwigia*: the delimitation of these two morphogenera is to a degree subjective.

- undulating parting -

Bradfordensis Zone, Bradfordensis Subzone

Bed 4: Limestones, hard, biodetrital, divisible into three horizons.

-4a: (Aa-8) Limestone, rather sandy, sparingly ferruginous, *Craterospongia* spp. at the base. Many ammonites, mainly as sandy body-chambers, the inner whorls replaced by limonite. ...0·30 m

The fauna contains *Brasilia* which is now dominant, incorporating some morphotypes that have been ascribed to *Ludwigia* by some authors, e.g. Geczy (1967). This is the type horizon of *Brasilia bradfordensis*, although *Ludwigia* remains common.

-4b: (Aa-9) Limestone, hard, similar to that below, sandy, grading upwards into pale grey densely oolitic limestone. ...0·15 m

Brasilia dominates and shows a marked size increase from the subadjacent horizon. Rare *Ludwigia* persists. Microconchs have similar variability to those below.

-4c: (Aa-10) Pale grey densely oolitic limestone, the buff ooliths non-limonitic Very well-preserved white calcified ammonites with brown shells common near the top, also an abundant bivalve and gastropod fauna. ...0·10–0·20 m

An assemblage of dominant *Brasilia* with a high proportion of fine-ribbed or striate forms and very scarce *Ludwigia*. Microconchs are common and display relatively wide variability of ribbing and inflation. Many fine specimens occur with intact lappets.

This is the first horizon at which the sediment is predominantly calcareous. Accordingly the preservation of the ammonites is now much better. The chambers of the ammonites are hollow and lined with coarse white spar.

-rather flat parting-

Bed 5: The Horn Park Ironshot Bed (Parsons in Cope 1980): Brown to yellow ironshot oolite, in grey, often ferruginous limestone matrix, the ooliths becoming larger towards the top. Strongly bioturbated, with ooliths gathered into clouds or suspended in patches of micrite. Divisible into five parts.

Bradfordensis Zone, Gigantea Subzone

-5a: (Aa-11) Limestone, very hard, heavily bioturbated, reddened in the lower part with small red ooliths, grading upwards into lighter red softer stone with larger ooliths. The bed is divisible into two horizons of almost identical age. ...0·20 m

This level is known locally as the 'Dinner Plate Bed', after the abundant, perfectly preserved, large *Brasilia gigantea* macroconchs which lie almost side by side in it. Most are fairly evolute, showing variability of inflation, ribbing and size. Very large intact *Pleurotomaria* sp. are not uncommon.

-5b: (Aa-11) A bed consisting of much broken shell debris, more coarsely oolitic than below. The ammonite fauna is identical to that of 5a. ....0·05 m

-mud seam-

-5c: Fairly soft yellow bioturbated ironshot stone with abundant large brown ooliths. Divisible into two parts based on fossil content. Many of the fossils are coated by red limonite powder, which also occurs in muddy pockets throughout the lower part of the bed.

-5c(i): (Aa-12) The horizon is characterised by abundant very large *Brasilia decipiens* (up to diameter 0·40 m). *Brasilia* and *Graphoceras* occur in roughly equal proportions. *Brasilia* [*Paquieria*] *floccosa* (Buckman 1904) occurs here with an unmistakable discoidal morphology and fine falcoid ornament. A prominent level of *Ctenostreon* occurs in a rather soft, yellow rotted stone near the base. ...0·05 m

Concavum Zone & Subzone

-5c(ii): (Aa-13) Ironshot oolite as below, harder, containing blue-centered micritic pockets. ...0·10 m

In the early forms of *Graphoceras*, the ancestral falcoid ribbing of *Brasilia* is retained but strengthened. All have a compressed morphology, marked fastigate venter and a rather poorly differentiated keel.

- mud parting-

-5d: Limestones divisible into two horizons, both with abundant ammonites.

-5d(i): (Aa-14) Coarse, hard, blue ironshot oolite, marly and rather yellow in the upper part. ...0·08 m

This is the type horizon of *Graphoceras concavum*. Specimens are compressed, involute and ornamented with sinuous ribs that curve strongly forward on the venter. The whorl-section is keeled and acute on the inner whorls, becoming fastigate on the bodychamber. The umbilicus is circular with a concave umbilical wall. Variants occur that are more evolute, have falcate ribbing, prominent keels and wider venters: they are already suggestive of *Hyperlioceras*.

Concavum Zone, Formosum Subzone

-5d(ii): (Aa 15) Ironshot oolitic limestone, more reddened than below, the ooliths of soft limonite which weather out, leaving holes. ...0·06 m

-rather flat, ?planed surface-

-5e: Hard, reddened, coarsely oolitic limestone, thinning eastwards, heavily bioturbated with fossils at all angles. The upper surface is planed off to produce a spectacular erosion plane.

Locally in parts of the quarry, an upward continuation of the bed can be found (Fig.1). There is no marked stratigraphic break or change in lithology but this upper part sees the first appearence of a fauna containing relatively common *Hyperlioceras* macroconchs. Thus the bed is here divided into two parts:

-5e(i): (Aa-16) Reddened oolitic stone, heavily bioturbated and containing marly burrows at all angles. Ammonites common but difficult to identify because of heavy surface encrustations. ...0·10 m

Graphoceratid ammonites are generally rarer than in the beds below. The majority show a broadening of the venter which has rather rounded shoulders. The keel is now upright and more prominent. Ribbing is fine to coarse, sometimes slightly bunched and strongly falcate. There is a marked increase in the abundance of sonninids (*Euhoploceras acanthodes*).

LOWER BAJOCIAN

Discites Zone

-5e(ii): (Bj-1) Heavily bioturbated, corroded, coarse, reddened oolite with abundant fossils, but many indeterminate and in poor condition. The upper centimetre is a laminated irony crust with ammonites planed through by the erosion surface. In places this surface lies below a thin mud seam ....0·10 m

Here occur the first relatively common members of the genus *Hyperlioceras*. The earliest forms (*Darellia* [M], *Braunsina* [m]) still bear a strong resemblence to *Graphoceras* into which they intergrade, but in the majority of cases they possess a characteristic high prominent keel.

Classification of the Graphoceratidae

A suggested generic organisation of the Graphoceratidae is presented below. Generic names placed in square brackets are nominal genera mostly created by Buckman and regarded here as junior synonyms. The aim is to couple these nominal genera on the basis of their assumed dimorphic associations, [M] = macroconch, [m] = microconch.

Family Graphoceratidae, Buckman 1905

Subfamily Leioceratinae, Spath 1936

Collecting here and elsewhere (Callomon and Chandler 1994; Chandler (unpublished)) supports Rieber's (1963) and Contini's findings (1969–70) that the Leioceratinae comprise at least two distinct groups, both dimorphic and established well before the start of the Murchisonae Zone. The division can be traced back into the Opalinium Zone below, as illustrated by Buckman from his *opaliniforme* hemera, and probably lower into the Toarcian. In bed 3a (Aa-4) three separate lineages are evident: *Leioceras, Cylicoceras* and *Staufenia*.

Genus ***Leioceras*** Hyatt, 1867 [=*Lioceras* Bayle 1878, obj.]

Cypholioceras S.S.B., 1899 [M]: Medium sized, suboxyconic, moderately evolute, smooth or fine-ribbed macroconchs persisting unchanged from the Opalinum Zone.

Ancolioceras S.S.B., 1899 [M] [*Manselia* S.S.B., 1899]. This has stronger ribbing than *Leioceras* (*Cypholioceras*) and is more involute. The whorl section is oxyconic. The entire group retains a suture-line close to that of the ancestral Leioceratids of Aa-1. In Bed 3a the centre of variability for the population is at *A. opalinoides* (*sensu lato*).

As elsewhere in the Graphoceratidae, the retention of the separate generic names for what are almost certainly only successive stages of a single lineage is a matter of historically-determined convention and nomenclatural convenience in labelling significantly differing morphologies. Similar remarks apply to the labelling of dimorphs. The generic names could therefore be subsumed as subgeneric names within senior generic names with which they are coordinate, i.e. *Leioceras* (*L.* s.s.) [m], *L.* (*Cypholioceras*) [M] and *L.* (*Ancolioceras*) [M].

The last members of the Leioceratinae persists as *Ancolioceras* high into the Murchisonae Zone or even the lowest Bradfordensis Zone

Leioceras Hyatt, 1867 [m]: Small finely ribbed forms with lappets. These microconchs range unchanged from Aa-1 into Aa-3.

Subfamily Staufeniinae, Maubeuge 1950

Genus ***Cylicoceras*** S.S.B.1899 [M] [*Hyattina* S.S.B., 1899; *Geyerina* S.S.B., 1913 = *Geyeria* S.S.B., 1899 (obj.) (*non* Buchecker 1880).].

The entire group has rather inflated whorls and is often more evolute than *Ancolioceras*. Its members have relatively complex suture lines and strong ribbing which projects forward on the venter. They stand apart from the other Leioceratids and clearly evolve from an earlier stock, possibly *C. undatum* of the Upper Toarcian. *Hyattina* of the lower Murchisonae Zone has strong similarities and appears to represent last members of the genus *Cylicoceras*.

Canavarella S.S.B., 1904 [m] [*Rhaeboceras* S.S.B, 1889, *non* Meek 1876; *Costiceras* Contini 1969]. Small coarsely-ribbed oxycones with lappets. The type of the genus *Canavarella* is *C. belophora* Buckman 1904, found associated with *Cylicoceras* macroconchs in the Scissum Bed of Bridport; therefore a dimorphic coupling of *Cylicoceras* [M] and *Canavarella* [m] is used here.

Genus ***Staufenia*** Pompeckj 1906. At present the same name is used for both macro- and microconch as no suitable alternative is available.

Staufenia Pompeckj, 1906, *s.s.* [M] [*Costileioceras* Maubeuge, 1950 (**Ludwigia sinon* Bayle, 1878)]

Externally *S. sinon* resembles *Cylicoceras* and probably evolved from it. One consistent feature that sets it apart is a much simplified suture line. The genus evolved into species that are large discoid oxycones with tiny umbilicus and a razor-sharp venter, *S. staufensis* from the Bradfordensis Zone of central Europe. This species has not been recorded from Britain but *S. sehndensis* is reported from the Obtusiformis Subzone of Horn Park (Chandler 1982) and other localities nearby. Members of the genus are extremely rare in Britain.

Staufenia Pompeckj 1906 *pars* [m]. Small, strongly ribbed oxycones inseparable from *Canavarella* other than by their simplified sutures.

Subfamily Graphoceratinae, Buckman 1905

The subfamily Graphoceratinae has its roots in the lower Aalenian. Specimens very close to *Ludwigia* are already present as extreme rarities in faunal horizon Aa-3 of the Scissum Zone (RBC, unpublished), as in Germany (*L. praecursor* Rieber, 1963). By the start of the Murchisonae Zone *Ludwigia* is fully differentiated from *Cylicoceras*, the probable ancestor.

Genus ***Ludwigia*** Bayle 1878

Ludwigia Bayle 1878 *s.s.* [M] [*Cosmogyria* S.S.B. 1899; *Welschia* S.S.B, 1899; *Crickia* S.S.B., 1899; *Hyattia* S.S.B., 1899; *Kiliania* S.S.B., 1899.]

Platycones with square to fastigate whorl-sections. Early members of the group retain on the venter strong prosiradiate ribbing, which persists to the keel. Two distinct faunas, both dimorphic, begin to differentiate soon after the appearance of the genus: the early *L. haugi* and, slightly later, the *L. murchisonae* group with closer strong ribs that fade on the venter. Ribbing in the *L. murchisonae* group abuts the keel at a high angle.

Pseudographoceras S.S.B., 1899 [m] [*Ludwigina* S.S.B., 1899; *Strophogyria* S.S.B., 1899]. Large microconchs with lappets and strong ribbing. Shells are rather evolute and carry a distinct low keel bordered by square shoulders.

Genus ***Brasilia*** S.S.B., 1898

In the latest Murchisonae Zone members of the *Ludwigia murchisonae* group appear with compressed shells and finer ribbing, giving rise to *Brasilia*. The transition from *Ludwigia* to *Brasilia* is gradual and arbitrary (see note under *Leioceras* above) This genus retains a wide diversity of form and size throughout its range. At two levels at Horn Park (Aa-11 and 12) it attains large size and typifies in each case a prominent and easily recognisable horizon. One of them, *B. decipiens*, has also been recognised as a good guide fossil in central Europe (H. Rieber, pers. comm.).

The area of Beaminster, in which Horn Park lies, is the only one with a relatively complete succession of the Bradfordensis Zone in southern Britain.

Brasilia S.S.B., 1898 *s.s.* [M] [*Brasilina* S.S.B., 1899; *Paquieria* S.S.B., 1899; *Wiltshireia* S.S.B., 1899, *Apedogyria* S.S.B., 1899; *Paineia* S.S.B., 1904; *Planifastigites* S.S.B., 1925]. Fastigate platycones, mostly rather evolute ammonites with medium to strong ribbing. The keel is often weak and ill-defined from the sloping shoulders of the venter.

Apedogyria S.S.B., 1899 *pars* [m]: At present no suitable separate name is available for the microconchs of *Brasilia*. Some have been figured by Buckman as *Ludwigella*, but this name is in common usage for the microconchs of *Graphoceras*. *Brasilia* (*Apedogyria*) *subcornuta* is a typical microconch of *Brasilia*. *Apedogyria* is used here although the type of Buckman's genus is a macroconch. This case typifies a common nomenclatural dilemma in dimorphic lineages that have been arbitrarily segmented on purely morphological grounds but in which separate generic taxa are maintained for the dimorphs: the morphological changes in the macroconchs rarely coincide with those — if any — in the microconchs.

Genus ***Graphoceras*** S.S.B. 1898

A trend towards an increasingly oxyconic morphology continues with the change of *Brasilia* into *Graphoceras* in the upper Gigantea Subzone. Evolution proceeds by a gradual shift of morphology evident in the entire population. Rather than speak of, for example, *Graphoceras concavum*, we would do better to speak of 'the *Graphoceras concavum* morphology' at, say , the *Graphoceras limitatum* assemblage level, i.e. Aa-16. Such statements are equally true for the entire family Graphoceratidae.

Graphoceras S.S.B. 1898 [M] [*Lucya* S.S.B., 1902; *Deparoceras* S.S.B., 1904; *Platygraphoceras* S.S.B., 1904]. Compressed oxycones, involute to moderately evolute coiling with fastigate or acute whorl sections. Ribbing is sinuous to falcate and variable in strength.

Ludwigella S.S.B. 1901 [m]. Mostly rather evolute oxycones. The type of the genus was stated to be *Ludwigella arcitenens* by Buckman in 1902; its type specimen is a microconch with lappets. The name *Ludwigella* was however predated by Buckman, 1901 and was applied to a macroconch: *Ludwigella concava* (J. Sowerby) (*Proc. Cotteswold Club*, vol.13, p.226). *Ludwigella* has been widely used for the microconchs of *Graphoceras* by many authors and it is so used here.

Genus ***Hyperlioceras*** S.S.B., 1889

By a broadening and flattening of the venter, the transients of *Graphoceras* in Aa-15/16 evolve into the first *Hyperlioceras*. They still fully intergrade with *Graphoceras;* initially, the macroconchs exactly matching Buckman's genus *Darellia*, and its corresponding microconch *Braunsina*. Only the earliest Discites Zone faunas are recorded from Horn Park.

Hyperlioceras S.S.B 1889 [M] [*Darellia* 1898; *Braunsella* (pro. *Braunsia* S.S.B, 1902 non Kriechbaumer, 1894), *Reynesia* S.S.B, 1902; *Toxolioceras* S.S.B, 1904]. Medium to large shells, often smooth on the

outer whorls. The low keel varies from absent to strongly developed and may be bisulcate.

Braunsina S.S.B., 1902 [m] [*Reynesella* S.S.B., 1902, *Lopadoceras* S.S.B., 1904.]. The microconchs completely intergrade with *Ludwigella*. They are evolute, have round whorl-sections and simple lappets.

The graphoceratid composition of faunal horizon Aa-6

So far, faunal horizon Aa-6 has not been proved at Horn Park. To complete the tally of Buckman's nominal species (in the range Aa-3 to Aa-16), a list is given of Graphoceratidae re-collected from bed 4 of Quarry Hill (Quarr Hill), Chideock (SY 434931). Here Aa-6 is well represented and from it Buckman obtained a number of his type specimens, some of which are types of genera. Important nominal species of other authors are also included.

Leioceratinae Spath, 1936

[M]: *Leioceras* (*Ancolioceras*) * *substriatum* Buckman, 1899, *L.* (*A.*) *subfalcatum* (Buckman 1899), *L.* (*A.*) *costatum* Buckman 1888.

[m]: *Leioceras striatum* Buckman 1899, *L. gracile* Buckman 1899.

Staufeniinae Maubeuge, 1950

[M]: *Cylicoceras* [*Hyattia*] *wilsonum* (Buckman 1899) TTs., *C. aff. uncinatum* (Buckman 1899)., *Staufenia sehndensis* (Hoffman 1913).

[m]: *Cylicoceras* (*Canavarella*) *aff. subcostosum* (Buckman 1899).

Graphoceratinae Buckman, 1905

The species of *Ludwigia* have a very characteristic acute edge to the umbilicus

[M]: *Ludwigia* [*Apedogyria*][*] *patellaria* (Buckman 1899) TTs., *L.* [*Cosmogyria*] *subtabulata* (Buckman 1898) TTs., *L.* [*Welschia*] [*] *obtusiformis* (Buckman 1899) TTs., *L.*[*Hyattia*][*] *pustulifera* (Buckman 1899) TTs., *L* [*Kiliania*][*] *lacinosa* (Buckman 1904) TTs., *L* [*Kiliania*] *armipotens* (Buckman 1904) TTs., *L.* [*Kiliania*] *depilata* (Buckman 1925) TTs., *L. gradata* Buckman 1904, *L. tuberata* Buckman 1904, *L.** *murchisonae* (J de C Sowerby 1827).

[m]: *Ludwigia* (*Pseudographoceras*) *umbilicata* (Buckman 1899), *L.* (*P.*) *patula* (Buckman 1899)., *L.* (*P.*) *tuberculata* Buckman, 1899, *L.* (*P.*) *subtuberculata* Rieber 1963.

Discussion

The Horn Park succession represents what is possibly the most complete portion of the Aalenian and lowest Lower Bajocian in southern England. Fifteen faunal horizons, spanning five standard Zones and seven Subzones, plus the currently undivided parts of the Scissum and Discites Zones are found here. While it is clear that much is missing by erosion or non-deposition, the contents of individual faunal horizons contain samples of evolving biospecies buried over durations which in geological terms are insignificant: they are snapshots in the history of developing lineages.

The preservation of much of the plentiful material is perfect, making comparisons with Buckman's specimens effortless. Furthermore, the complete adult nature of the material permits ontogenic interpretation and the dimorphic status of the specimens to be assessed easily. Table 1 and the accompanying plates are an important source of reference; they act as a guide to the composition of what are probably in all but one or two cases monobiospecific assemblages within each faunal horizon.

Buckman never finished his work on the Graphoceratidae and considered that the space available in his monograph (1887–1907) could not do it justice. By the publication of the Treatise (Arkell 1957), Buckman's genera amounting to almost fifty were reduced to seventeen included in two subfamilies, Graphoceratinae and Leioceratinae.

Evolution within the graphoceratids is gradualistic, the division between genera being arbitrary and the intergradation between them complete. With such large amounts of material it is clear that the overlap between successive faunas is considerable. The generic taxa chosen to be retained have been selected on the basis of convention and convenience. The line of decent for the Graphoceratinae is *Ludwigia, Brasilia, Graphoceras* and *Hyperlioceras. Ludwigia* and *Brasilia* have no more claim to separate existences than, say, *Brasilia* and *Graphoceras* or *Graphoceras* and *Hyperlioceras.* In these cases the generic names are well known and entrenched in the literature, they provide convenient labels for morphotypes within the evolving graphoceratid lineage. In the Leioceratinae, *Leioceras* (*Cypholioceras*) to *Leioceras* (*Ancolioceras*) constitutes one series of transients or chronospecies with *Cylicoceras* and *Staufenia* evolving side by side with it, probably as entirely separate populations. Throughout the entire Aalenian-Lower Bajocian and probably elsewhere, the macroconch populations are the best time-discriminators. Microconchs show repetitive morphology and have restricted ranges of variability in each faunal horizon. The sexual dimorphs constitute breeding pairs in evolving populations. For this reason the microconchs are regarded as subgenera of the retained macroconch genera.

In every case the extreme fine and coarse elements of each assemblage constitute the rarities. Buckman noticed these as unusual and figured a number of them. The plates in his work therefore give a biased impression of the relative abundances of what is to be found. As it is the primary purpose of this work to establish the horizons of types of nominal species, variants of 'horizontal' biospecies, probably monospecific have not be subjected here to reclassification or placed in exhaustive synonymies, which would be beyond the scope of the present work.

Table 1 The range, abundance (rare (R), occurs (O), common (C)) and probable type horizon (+) of the nominal species collected from faunal horizons at Horn Park

KEY: Aa-: Aalenian, Bj-: Bajocian. A reference and type status (if any) is given for each morphospecies. For species or subspecies founded by authors other than Buckman, the plate and figure references relate to the works by the author as listed in the bibliography. Morphospecies are grouped under macro- and microconchs separately. Dimorphs are given separate morphosubgeneric names.

MACROCONCHS	Aa-2	Aa-3	Aa-4	Aa-5	Aa-7	Aa-8	Aa-9	Aa-10	Aa-11	Aa-12	Aa-13	Aa-14	Aa-15	Aa-16	Bj-1	REFERENCE AND TYPE STATUS
Leioceras (*Cypholioceras*) *lineatum* Buckman, 1899	C+															*Supp*.pl. 8, figs.1–3, HT (mon.).
Leioceras (*Cypholioceras*) *comptum* (Reinecke, 1818)	C+	O														Reinecke, 1818, pl. 1, figs.5–6, HT.
L.eioceras (*Cypholioceras*) *bifidatum* Buckman , 1899	O	C+														*Supp*. pl.7, figs. 1–3, ST.
Leioceras (*Cypholioceras*) *capillare* (Buckman, 1928)	O	C+	C+													*T.A*. 786, HT; TTs.
Leioceras (*Cypholioceras*) *opalinoides horni* (Géczy, 1967)		O	C													Géczy, 1967, pl. 40, fig.1, HT.
Leioceras (*Ancolioceras*) * *substriatum* Buckman, 1899	R	R	C+	O	R	R										*Supp*. pl. 6, figs.14–16, HT(mon); CTs.
Leioceras (*Ancolioceras*) *costatum* Buckman, 1888	R	R	C+	C	O	R										*Mon*. pl.7, fig. 7, ST.
Leioceras (*Ancolioceras*) *subfalcatum* (Buckman, 1899)			O	C	R											*Supp*. pl. 11, figs. 25–27, ST.
Leioceras (*Ancolioceras*) *subacutum* (Buckman, 1899)			O	O												*Supp*.pl. 13, figs. 4–6, ST.
Cylicoceras [*Geyerina*] *evertum* (Buckman, 1899)	R	R	R+													*Supp*. pl.11, figs. 10–12, HT(mon.); CT.
Cylicoceras [*Geyerina*] [*] *fasciatum* (Buckman, 1899)	R	R	R+													*Supp*. pl.6, figs.17–19, HT (mon) .
Cylicoceras [*Hyattina*] [*] *brasilum* (Buckman, 1899)			C	C+												*Supp*. pl.13, figs. 7–9a, ST.
Cylicoceras * *undatum* Buckman, 1899	O+	O	R	R												*Supp*. pl.5, figs. 5–6, HT.
Cylicoceras uncinatum (Buckman, 1899)	O	O	R													*Supp*. pl.5, figs.7–11, ST.
Staufenia aff. *sinon* (Bayle, 1878)		R+	R													Bayle, 1878, pl.83, fig.1, LT.
Staufenia sinon citaae (Géczy, 1967)			R													Géczy, 1967, pl. 39, fig. 1, HT.
Staufenia sehndensis (Hoffman, 1913)				R+												Hoffman, 1913, pl. 4, fig. 3, LT.
Ludwigia [*Welschia*] [*] *obtusiformis* (Buckman, 1899)			C	C+	C	O	R	R								*Supp*. pl.12, figs. 1–3a , HT .
Ludwigia haugi Douville', 1885			C	C+	O	R										Quenst., 1846, pl.7, fig. 12 =LT, designated Rieber 1963 (as 'HT').
Ludwigia [*Hyattia*] [*] *pustulifera* (Buckman, 1899)			O	C+	R											*Supp*.pl. 13, figs 1–3a, ST.
Ludwigia crassa Horn, 1909			R	R	R											Horn, 1909, pl.13, figs.2, LT.
Ludwigia [*Kiliania*][*] *lacinosa* (Buckman, 1904)			O	C+	R											*Supp*. pl.15, figs. 4–6, ST.
Ludwigia [*Kiliania*] *armipotens* (Buckman, 1904)			O	O	O											*Supp*. p.65 , fig. 23 (in text), ST.
Ludwigia [*Kiliania*] *depilata* (Buckman, 1925)			R	O	O+											*T.A*. pl. 610, figs. 1–2, HT.
Ludwigia fueloepi Géczy, 1967					R											Géczy, 1967, pl. 45, fig.6, HT.
Ludwigia laevigata Buckman, 1904				O	C+											*Supp*. Pl.11, figs. 13–15, ?=HT (mon); CTS.
Ludwigia murchisonae perrotae Géczy, 1967					C											Géczy, 1967, pl. 45, fig. 3, HT.
Ludwigia murchisonae enayi Géczy, 1967						R										Géczy, 1967, pl. 44, fig.5, HT.
Ludwigia * *murchisonae* (J de C Sow, 1827)				R	C+	C	O	O	R							*Mon*. pl. 2, fig. 1–2, HT refigured.
Ludwigia tuberata Buckman, 1904				R	R											*Supp*. pl. 15, figs. 1–3, HT(mon).
Ludwigia gradata Buckman, 1904				O	C+	O	O	R	R							*Supp*.p.70, fig. 27 (in text), ST.
Ludwigia [*Apedogyria*] [*] *patellaria* (Buckman, 1899)					O	O										*Supp*.pl. 14, figs. 3–5, ST.
Ludwigia [*Crickia*] [*] *reflua* (Buckman, 1899)				O	C+	O	O	O								*Supp*.pl. 11, figs. 16–18, ST; CTs.
Ludwigia vaceki Géczy, 1967						O										Géczy, 1967, pl. 46, fig.5, HT.
Ludwigia obtusiformis buckmani Géczy, 1967					C											Géczy, 1967, pl.43, fig.1, HT.
Brasilia **bradfordensis* (Buckman, 1881)					R	C	C+	C	O							*Mon*..pl.4, figs.5–6, LT designated Rieber 1963
Brasilia [*Brasilina*] *baylii* (Buckman, 1887)							C	C+	R							*Mon*. pl.3, figs.6–7, ST.

MACROCONCHS	Aa-2	Aa-3	Aa-4	Aa-5	Aa-7	Aa-8	Aa-9	Aa-10	Aa-11	Aa-12	Aa-13	Aa-14	Aa-15	Aa-16	Bj-1	REFERENCE AND TYPE STATUS
Brasilia bradfordensis falcatiformis (Géczy, 1967)						C	C									Géczy, 1967, pl. 51, fig.1, HT.
Brasilia bradfordensis elmii (Géczy, 1967)									R							Géczy, 1967, pl. 51, fig.4, HT.
Brasilia [*Apedogyria*] *platychora* (Buckman, 1899)						C	C	C+	C	R						*Mon.*pl.5, figs. 1–2 , ST, CT.
Brasilia [?*Manselia*] *austera* (Buckman, 1923)						O	C+	C	O							*T.A.* pl. 409, figs.1-2, HT.
Brasilia [*Brasilina*] *baylii* (Buckman, 1887)							C+	C	R							*Mon.* pl.3, figs.6–7, ST.
Brasilia effricata Buckman, 1902							R	C+	C	C						*Mon.* pl.7,figs. 3-4, ST.
Brasilia [*Pseudographoceras*] *deleta* (Buckman, 1899)							O	C+	C							*Supp.* pl.11, figs. 22–24, ST.
Brasilia [*Pseudographoceras*] *limatum* (Buckman, 1904)									O	C+	O					*Supp.* p. 92, fig. 54 (in text), HT (mon.).
Brasilia ambigua (Buckman, 1888)								C	C+	O						*Mon.* pl. 7, figs.1–2, HT.
Brasilia similis (Buckman, 1889)								C+	C	C	R					*Mon.* pl. 15, figs.1–2, ST.
Brasilia similis maubeugei Contini, 1969							O	C	O							Maubeugei, 1965, p.78, fig. in text p.79, HT.
Brasilia [*Brasilina*] [*] *tutcheri* (Buckman, 1904)								C	C	C+	O					*Supp.*p. 83, fig. 44–45 (in text), ST.
Brasilia [*Hyattia*] *subcava* (Buckman, 1899)								O+	C	O						*Supp.*p.56, fig.13a–d, HT (mon.).
Brasilia [*Cosmogyria*] *maggsi* (Buckman, 1899)									R	C+	R					*Supp.* pl.10, fig.23–25, HT.
Brasilia [*Brasilina*] *crinalis* (Buckman, 1899)									R	C+	O					*Supp.* pl.10, figs.29–31, ST.
Brasilia decipiens (Buckman, 1888)									C	C+	O	O				*Mon.* pl.12, fig. 8–9, HT.
Brasilia [*Planifastigites*] *platys* (Buckman, 1925)								O	C+	R						*T.A.* pl.579, fig.1–2, HT
Brasilia [*Wiltshireia*] [*] *gigantea* (Buckman, 1888)									C+	O						*Mon.* pl.11, fig.1 & Pl.12, fig. 4, HT; CT .
Brasilia [*Strophogyria*] *pinax* (Buckman, 1899)									C+	R						*Supp.* p.63, fig.21, ST; CT.
Brasilia [*Paineia*] [*] *nitens* (Buckman, 1904)								O	O+	O						*Supp.* p.77, fig. 33, ST.
Brasilia [*Paquieria*] *floccosa* (Buckman, 1899)									O	C+	O					*Supp.*pl.10, figs. 20–22, HT (mon.).
Brasilia pinguis Buckman, 1888										C+	C					*Mon,*pl.12, figs.1–3, HT(mon.).
Graphoceras pulchrum (Buckman, 1902)									O	C	C+					*Mon.*pl. 10, figs.3–4, HT (mon.).
Graphoceras concavum (Sowerby, 1815)										R	O	C+	O	R		*Mon.* pl.2, figs. 6–7, HT, refigured.
Graphoceras decorum Buckman, 1902											R	O	C	C+	C	*Mon.* pl.8, fig. 3–4, HT (mon.).
Graphoceras [*Lucya*] *cavatum* (Buckman,1902)											C+	C				*Mon.*pl. 9, figs. 1–4, HT (mon.).
Graphoceras [*Platygraphoceras*] [*] *apertum* (Buckman, 1888)										O	C+	C	R			*Mon.* pl. 10, figs. 10–11, HT.
Graphoceras stigmosum Buckman, 1902											R	O	C	C+	C	*Mon.* pl.9, figs. 5–6, ST.
Graphoceras **v-scriptum* Buckman, 1888											R	C+	O	O	O	*Mon.* pl.10, figs. 5–6, ST.
Graphoceras [*Lucya*] *marginatum* (Buckman, 1904)											C+	C	C	O		*Supp.* p.75, fig.31 (in text), ST.
Graphoceras [*Lucya*] *magnum* (Buckman, 1902)											C+	C				*Mon.*pl. 6, figs.1–2, HT (mon).
Graphoceras limitatum Buckman, 1902												R	C	C+	C	*Supp.*pl. 10, fig. 7, HT.
Graphoceras [*Deparoceras*] *hamatum* (Buckman, 1904)												R	O	C+	C	*Supp.*p.79, fig.37 (in text), ST.
Graphoceras robustum Buckman, 1904											R	R	C	C+	C	*Supp.* pl.15, figs. 9–11, HT (mon.).
Graphoceras Deparoceras] [*] *fallax* (Buckman, 1888)												R+	R	R	R	*Mon.* pl. 14, figs.10–11, HT.
Graphoceras [*Lucya*] [*] *caduceiferum* (Buckman, 1902)												R+	R	R	R	*Mon.*pl. 21, figs.10–11, HT(mon.).
Graphoceras [*Deparoceras*] *formosum* (Buckman, 1888)												O	C+	C	O	*Mon.* pl. 10, figs.1–2 , HT (mon.).
Graphoceras inclusum Buckman, 1904												R	O	C+	C	*Supp.* pl. 15, figs. 15–17, ST.
Hyperlioceras [*Braunsella*] *lenum* (Buckman, 1902)														R	R	*Mon.* pl. 7, figs.5–6, ST.
Hyperlioceras [*Braunsina*] [*] *contortum* (Buckman, 1904)													R	C+	C	*Supp.*pl. 17, figs.16–18, HT (mon.)
Hypherlioceras [*Braunsella*] [*] *semilenum* (Buckman, 1904)															O	*Supp.*pl. 17, figs.19–21, HT (mon.).
Hyperlioceras [*Darellia*] *politum* (Buckman, 1898)														O	C+	*Mon.*pl. 16, figs. 3–4, HT.
Hyperlioceras [*Reynesia*] *lepidum* (Buckman, 1902)															C+	*Mon.*pl. 11, figs.4–5, HT (mon.).

MACROCONCHS	Aa-2	Aa-3	Aa-4	Aa-5	Aa-7	Aa-8	Aa-9	Aa-10	Aa-11	Aa-12	Aa-13	Aa-14	Aa-15	Aa-16	Bj-1	REFERENCE AND TYPE STATUS
Hyperlioceras [*Reynesia*] [*] *intermedium* (Buckman, 1888)														R	C+	*Mon.*pl. 11, figs. 2–3, HT.
Hyperlioceras [*Reynesia*] *coelum* (Buckman, 1902)														O	C+	*Mon.* pl. 16, figs.10–11, ST.
Hyperlioceras [*Toxolioceras*] *incisum* (Buckman, 1904)														C+	C	*Supp.*pl.21, figs. 31–33, ST.
Hyperlioceras [*Toxolioceras*] *mundum* (Buckman, 1904)														R	O+	*Supp.*pl.18, figs. 4–6, HT (mon.) .
Hyperlioceras aff. *rudidiscites* Buckman, 1902															R	*Mon.* pl. 18, figs. 1–2, HT.
MICROCONCHS																
Leioceras opalinum (Reinecke, 1818)	O	O	R													Reinecke, 1818, pl.1, figs. 1–2. SD: Buckman, 1887.
Leioceras striatum Buckman, 1899	O+	R	R	R												*Mon.* pl. 13, fig.12, LT, designated Rieber, 1963 (as 'HT').
Leioceras partitum Buckman, 1899	O	O	R	R												*Mon.* pl. 13, fig. 11 ?=HT (mon).
Leioceras gracile Buckman, 1899	O	O	R	R												*Supp.* pl. 6, figs. 11–13, HT (mon).
Sylicoceras (*Canavarella*) *subcostosum* (Buckman, 1889)	O	O														*Supp.* pl. 20, figs. 10–12 , LT.
Sylicoceras (*Canavarella*) *cariniferum* (Buckman, 1899)			O+													*Supp.* pl. 11, figs. 7–9, HT (mon).
Sylicoceras (*Canavarella*) *paucicostatum* (Rieber, 1963)			R													Rieber, 1963, pl. 2, figs. 4-5, HT.
Ludwigia (*Pseudographoceras*) *cosmia* (Buckman, 1899)			C	C+												*Supp.*p. 63, fig.20 (in text), ST.
Ludwigia (*Pseudographoceras*) *agria* (Buckman, 1899)			O	C+												*Supp.*p.62, fig.19 (in text), ?=HT (mon.).
Ludwigia (*Pseudographoceras*) *bullifera* (Buckman, 1899)			R	R+												*Supp.* pl.14, figs.1-2, ST.
Ludwigia (*Pseudographoceras*) *umbilicata* (Buckman, 1899)				R	C+	O	O									*Supp.* p. 61, fig.18 (in text), ST.
Ludwigia (*Pseudographoceras*) * *literata* Buckman, 1899					O+											*Supp.* pl. 11,figs.19-21, HT.
Ludwigia (*Pseudographoceras*) *patula* (Buckman,1899)					C+											*Mon.* pl. 3, fig.3, ST.
Ludwigia (*Pseudographoceras*) *tuberculata* Buckman, 1904					C+	O	O	R								*Supp.*pl.3, figs. 4–5, LT.designated Horn, 1909.
Ludwigia (*Pseudographoceras*) *subtuberculata* Rieber, 1963					O+			R								Rieber, 1963, pl. 5, figs. 12-13, HT.
Brasilia (*Apedogyria*) *subcornuta* Buckman, 1899						C+	C	C	O							*Supp.* pl. 14, figs.13–15, ST; CTs.
Brasilia (*Apedogyria*) *glevensis* (Buckman, 1904)						C	C	C								*Supp.* pl. 20, figs.25–27, HT (mon.) .
Brasilia (*Apedogyria*) *carinata* (Buckman, 1904)						O+	O	O	O							*Supp.* pl. 19, figs.40-42,?=ST; CTs.
Brasilia (*Apedogyria*) *rugosa* (Buckman, 1904)								O	C+	O	O	O				*Supp.* pl. 20, figs. 34–36, HT (mon), CT.
Graphoceras (*Ludwigella*) *tenue* Buckman, 1904									R	R	O	O	C	C+		*Supp.*pl. 20, figs.37–39, ST.
Graphoceras (*Ludwigella*) *arcitenens* Buckman, 1902									O	O	O	C+	C			*Mon.* pl. 4, figs.1–2, ST.
Graphoceras (*Ludwigella*) *attenuatum* Buckman, 1904										R	C	O	C+	O		*Supp.*pl. 19, figs. 10–12, ST
Graphoceras (*Ludwigella*) *attractum* Buckman, 1904										C+	C	C	C	O		*Supp.* pl. 19, figs. 31–33, HT(mon),
Graphoceras (*Ludwigella*) *impolitum* Buckman, 1904								R	R	C	C	C	C	O+		*Supp.* pl. 19 ,figs. 25–27, ST.
Graphoceras (*Ludwigella*) *rudis* Buckman, 1889								R	R	R	O	C	O	O		*Mon.* pl. 15, figs. 11–12, HT.
Graphoceras (*Ludwigella*) *cornu* Buckman, 1881											C	C+	O	O		*Supp.*p. 86, figs. 49–50 (in text), HT.
Graphoceras (*Ludwigella*) *castum* Buckman,1904										O	C	C	C	C+		*Supp.*pl. 20, figs. 31–33, ST.
Graphoceras scriptitatum Buckman, 1923												C+	O	O	O	*T.A.* pl. 388, figs. 1–2, HT.
Graphoceras debile Buckman, 1904												R	O	O	O	*Supp.*pl. 20, figs. 22–24, HT (mon.).
Graphoceras (*Ludwigella*) *micrum* Buckman, 1904													C	C+	C	*Supp.*pl. 19, figs. 7–9, ST .
Graphoceras (*Ludwigella*) *vibratum* Buckman, 1904													O	C+	C	*Supp.*pl. 19, figs. 13–15, ST.
Graphoceras (*Ludwigella*) *subrudis* Buckman, 1902													O	C+	O	*Mon.*pl.15, figs. 14–15, ST.
Graphoceras (*Ludwigella*) *latum* (Buckman, 1904)												O	C	C	O	*Supp.* pl. 20, figs. 19–21, ST.
Hyperlioceras (*Braunsina*) *fastigatum* Buckman, 1904														C	C+	*Supp.* pl. 20, figs. 1–3, ST.
Hyperlioceras (*Braunsina*) *cornigerum* Buckman, 1904													O	C+	C	*Supp.* pl. 20, figs. 4–6, HT (mon.).
Hyperlioceras (*Braunsina*) *asperum* Buckman, 1904														O	C+	*Supp.* pl. 17, figs. 13–15, HT (mon.).
Hyperlioceras (*Braunsina*) *rotabilis* (Buckman, 1904)														O	C+	*Supp.*pl. 17, figs. 7–9, HT (mon.).

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BIBLIOGRAPHY

Althoff, W., 1940 'Die Ammonitenzonen der oberen Ludwigienschichten von Bielefeld'. *Palaeontographica* A.**92**, 44 pp, 6 pls, Stuttgart.

Arkell, W. J., 1957 In: *Treatise on Invertebrate Paleontology.* Part L. Mollusca 4 Cephalopoda. Ammonoidea. (Ed. by R.C. Moore). 22 + 490 pp. Kansas & New York.

Bomford, G., 1948 'New sections in the Inferior Oolite'. *Proc. Geol. Assoc.* **59**, 148–50.

Buckman, S.S., 1887–1907 *A Monograph of the Ammonites of the Inferior Oolite Series.* Palaeontographical Society, London : 456 +, 103 pp. (1887–1894) and Supplement (1898–1907): 262 pp, 24 pls.

Buckman, S.S., 1893 'The Bajocian of the Sherborne district: its relation to subjacent and superjacent strata'. *Quart. J. Geol. Soc. London*, **49**, 479–522.

Buckman, S.S., 1909–1930 *Type Ammonites*. London, Wheldon and Wesley. vols. 1–7, 790 pls. Reprint (1972–1976), Historia Naturalis Classica, **93**: no. 1. Cramer Verlag and Wheldon and Wesley, Lehre and Codicote.

Buckman, S.S., 1910 'Certain Jurassic (Lias-Oolite) strata of south Dorset and their correlation'. *Quart. J. Geol. Soc. London* **66**, 52–89.

Callomon, J. H., 1995 'Time from fossils: S.S. Buckman and Jurassic high-resolution geochronology'. In: M. J. Le Bas (ed.) 'Milestones in geology'. *Geological Society, London, Memoirs* **16**, 127–150.

Callomon, J. H. and Chandler, R.B., 1990 'A review of the ammonite horizons of the Aalenian-Lower Bajocian stages in the Middle Jurassic of Southern England'. In: S. Cresta and G. Pavia (eds) 'Atti del meeting sulla stratigrafia del Baiociano'. *Memorie descrittive della carta geologica d' Italia* **40**, 85–111.

Callomon, J. H. and Chandler, R.B., 1994 'Some early Middle Jurassic ammonites of Tethyan affinities from the Aalenian of southern England'. *Palaeopelagos Special Publication* **1**, 17–40, 8 pls.

Callomon, J.H. and Cope, J. C W., 1995 'The Jurassic Geology of Dorset'. In P.D. Taylor (ed.), *Field Geology of the British Jurassic*, Geological Society London, pp.51–103

Chandler, R.B., 1982 'The first record of *Staufenia* (*Staufenia*) *sehndensis* (Hoffmann) in Britain'. *Proc. Geol. Assoc.* **93**, 301–4.

Chandler, R.B. and Sole, D.T.C., 1995 'The Inferior Oolite at East Hill Quarry, Bradford Abbas, Dorset'. *Proceedings of the Dorset Natural History and Archaeological Society* **117**, 101–8.

Contini, D., 1969 'Les Graphoceratidae du Jura franc-comtois'. *Ann. Scient. Univ. Besancon (3), Geol.* **7**, 95 pp, 24 pls.

Contini, D., 1970 'L' Aalenien et le Bajocien du Jura Franc-comtois, étude stratigraphique'. *Ann. Sci. Univ. Besancon, 3 sér., Géologie* **11**, 204 pp.

Cope, J.C.W., 1980 'A correlation of Jurassic rocks in the British Isles, part two : Middle and Upper Jurassic'. *Geol. Soc. London Special Report* **15**, 109 pp.

Donovan, D.T., Callomon, J.H. & Howarth, M.K., 1981 'Classification of the Jurassic Ammonitina'. In: M.R. House and J.R. Senior (eds). *The Ammonoidea*, Syst. Ass. Special. Vol.**18**, 101–55.

Géczy, B., 1967 'Ammonoidés jurassiques de Csernye, Montagne Bakony, Hongrie. Part II, excl. Hammatoceratidae'. *Geol. Hungarica* **35**, 413pp, 65 pls.

Henriques, M.H., 1992 *Biostratigrafia e Paleontologia (Ammonoidea) do Aaleniano em Portugal.* Tesis doctoral, Centro de Geociencias da Universidade de Coimbra.

Henriques, M.H., Gardin, S., Gomes, C.R., Soares, A.F., Rocha, R.B., Marques, J.F., Lapa, M.R. & Montenegro, J.D., 1994 'The Aalenian-Bajocian boundary at Cabo Mondego (Portugal)'. *Miscellanea del Servizio Geologico Nazionale* **5**, 63–77, 2 pls.

Hoffmann, G., 1913 *Stratigraphie und Ammoniten-Fauna des unteren Doggers in Sehnde bei Hannover.* Schweizerbart, Stuttgart, 202 pp., pls.18 pls.

Horn, E., 1909 *Die Harpoceraten der Murchisonae Schiten des Donau Rhein zuges.* Mitt. bad. geol. Landesanst, Heidelberg. **4**, 251–323, 7 pls.

Linares, A. and Sandoval, J., 1990 'The lower boundary of the Bajocian in the Barranco de Agua Larga section (Subbetic Domaine, Southern Spain)'. In: S. Cresta and G. Pavia (eds), Atti del meeting sulla stratigrafia del Baiociano. *Memorie descrittive della carta geologica d' Italia* **40**, 13–22.

Maubeugei, P. L., 1965 'Catalogue des Ammonites du Jurassique inférieur et moyen (Hettangien à Bathonian) du Musée cantonal de Bâle-Campagne'. *Tätigkeitsbericht der Naturforschenden Gesellschaft Baselland* **25**, 43–130.

Morton, N., 1990 'Bearreraig (Isle of Skye, N.W. Scotland) as boundary stratotype for the base of the Bajocian Stage'. In: S. Cresta and G. Pavia (eds), Atti del meeting sulla stratigrafia del Baiociano. *Memorie descrittive della carta geologica d' Italia* **40**, 23–48.

Morton, N., 1994 'Stratigraphical markers in the Aalenian-Bajocian succession at Bearrerraig, Isle of Skye, Scotland'. *Miscellanea del Servizio Geologico Nazionale* **5**, 79–90, 6 figs.

Morton, N. and Chandler, R. B., 1994 'Ammonite biostratigraphy of the Aalenian-Bajocian boundary: comparison of faunal horizons in Dorset/Somerset and Isle of Skye'. *Miscellanea del Servizio Geologico Nazionale* **5**, 91–92.

Morton, N. and Hudson, J. D., 1995 'Field guide to the Jurassic of the Isles of Raasay and Skye, Inner Hebrides, NW Scotland'. In: P.D. Taylor (ed.), *Field Geology of the British Jurassic*, Geological Society, London, 209–80.

Parsons, C., 1980 'Aalenian and Bajocian Correlation Chart' In J.C.W. Cope 1980, 3–21

Quenstedt, F. A., 1845–1849 *Petrefactenkunde Deutschlands. Die Cephalopoden.* Tübingen. 580 pp.-pls. 30–36

Quenstedt, F. A., 1883–1888 *Die Ammononiten des Schwäbischen Jura, II, Der Braune Jura;* Schweizerbart, Stuttgart, Lief 10–15, 441–816, pls 55–90.

Richardson, L., 1928 'The Inferior Oolite and contiguous deposits of the Burton Bradstock-Broadwindsor district, Dorset'. *Proc. Cotteswold Nat. Field Club* **23**, 35–68, pls. 2–6.

Rieber, H., 1963 'Ammoniten und Stratigraphie des Braunjura ß der Schwäbischen Alb'. *Palaeontographica* **A122**, 89 pp., pls.1–8.

Rocha, R.B., Henriques, M.H., Soares, A., Mouterde, R., Caloo B., Ruget, C. and Fernandez-Lopez, S., 1990 'The Cabo Mondego section as a possible Bajocian Boundary stratotype'. *Miscellanea del Servizio Geologico Nazionale* **5**, 63–77, 7 figs., 2 pls.

Sadki, D., 1994 'L' Aalenian supérieur et le Bajocien inférieur du Haut-Atlas marocain: révision biostratigraphique et corrélations'. *Miscellanea del Servizio Geologico Nazionale* **5**, 177–90, 7 figs.

Senior, J.R., Parsons, C.F. and Torrens, H..S., 1970 'New sections in the Inferior Oolite of South Dorset'. *Proceedings of the Dorset Natural History and Archaeological Society* **91**, 114–19.

Spiegler, W., 1966 'Graphoceratidae des Ober-Aalenium (Jura, N W Deutschland)'. *Mitt. geol. Staatsinst. Hamburg* **35**, 5–113, pls.1–9.

Ureta Gill, M.S., 1983 *Bioestratigrafia y paleontologia (Ammonitina) del Aaleniense en el sector noroccidental de la Cordillera Iberica.* Tesis Doctoral. **158/85**. Univ. Complut. Madrid. viii + 452 pp. 34 pls.

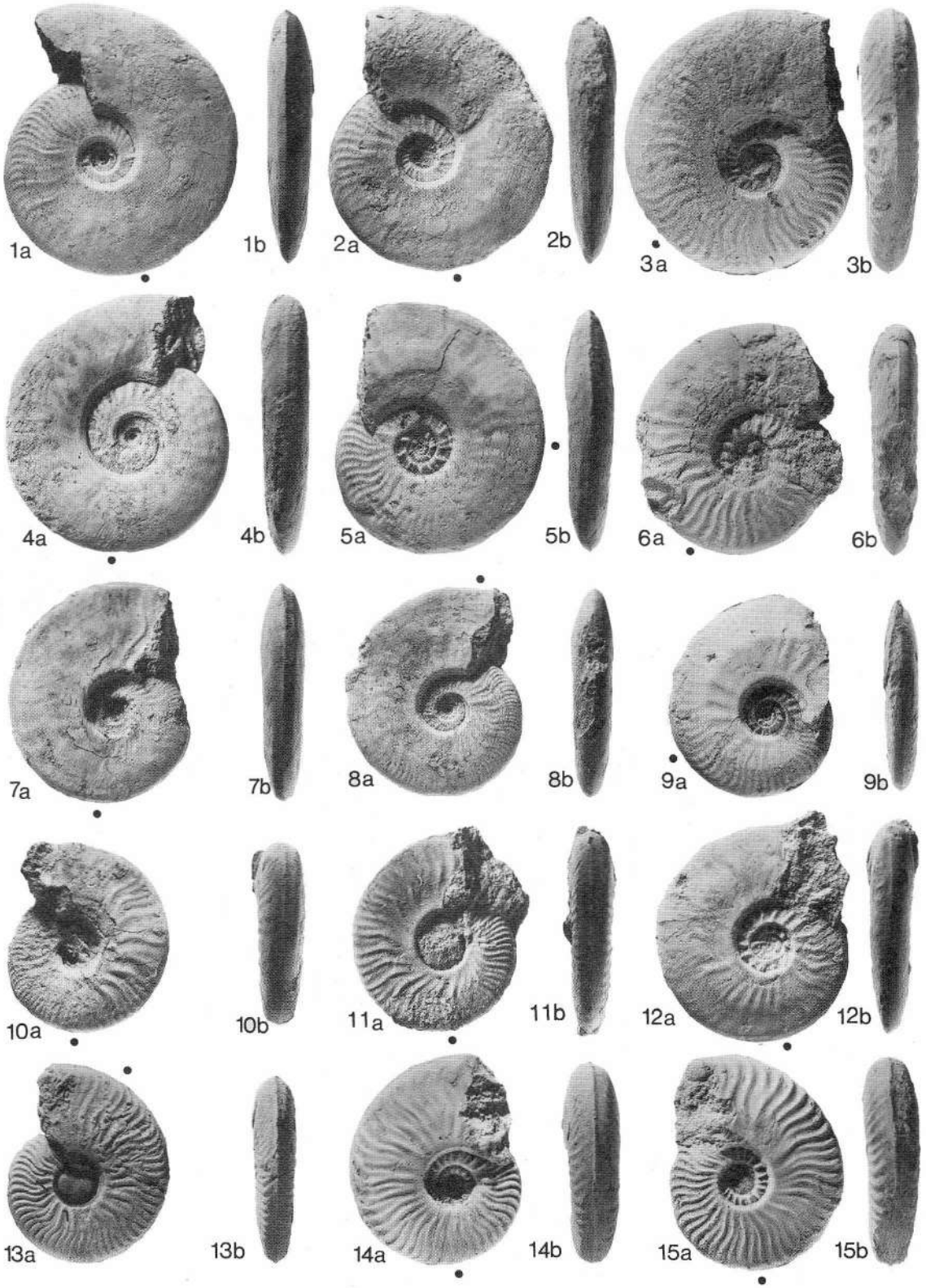

Plate 1: *Bed 3a, (Aa-4) [M]. 1a & b. RBC 29 Leioceras (Ancolioceras) costatum Buckman; 2a & b. RBC 68 Leioceras (Ancolioceras) subacutum (Buckman); 3a & b. RBC 162 Cylicoceras evertum (Buckman); 4a & b. RBC 67 Leioceras (Cypholioceras) opalinoides horni (Géczy); 5a & b. RBC 586 Leioceras (Ancolioceras) aff subacutum (Buckman); 6a & b RBC 584Staufenia sinon (Bayle); 7a & b. RBC 3 Leioceras (Cypholioceras) caplillare (Buckman); 8a & b. RBC 585 Leioceras (Ancolioceras) substriatum Buckman; 9a & b. RBC 65 Leioceras (Ancolioceras) subfalcatum (Buckman); 10a & b. RBC 34 Cylicoceras evertum (Buckman); 11a & b. RBC 159 Cylicoceras fasciatum (Buckman); 12a & b. RBC 30 Staufenia aff sinon citaae (Géczy 1967); 13a & b. RBC 33 Cylicoceras uncinatum (Buckman); 14a & b. RBC 149 Ludwigia obtusiformis (Buckman); 15a & b. RBC 146 Ludwigia lacinosa Buckman).*

Photographs and prints are by the author. Specimens are coated with ammonium chloride. All are in the author's collection and carry specimen-numbers prefixed RBC. All material will be donated to the Sedgwick Museum, Cambridge. Macroconchs [M] are printed at one-third actual size and microconchs [m] at half size. A black dot indicates the position of the last preserved septum.

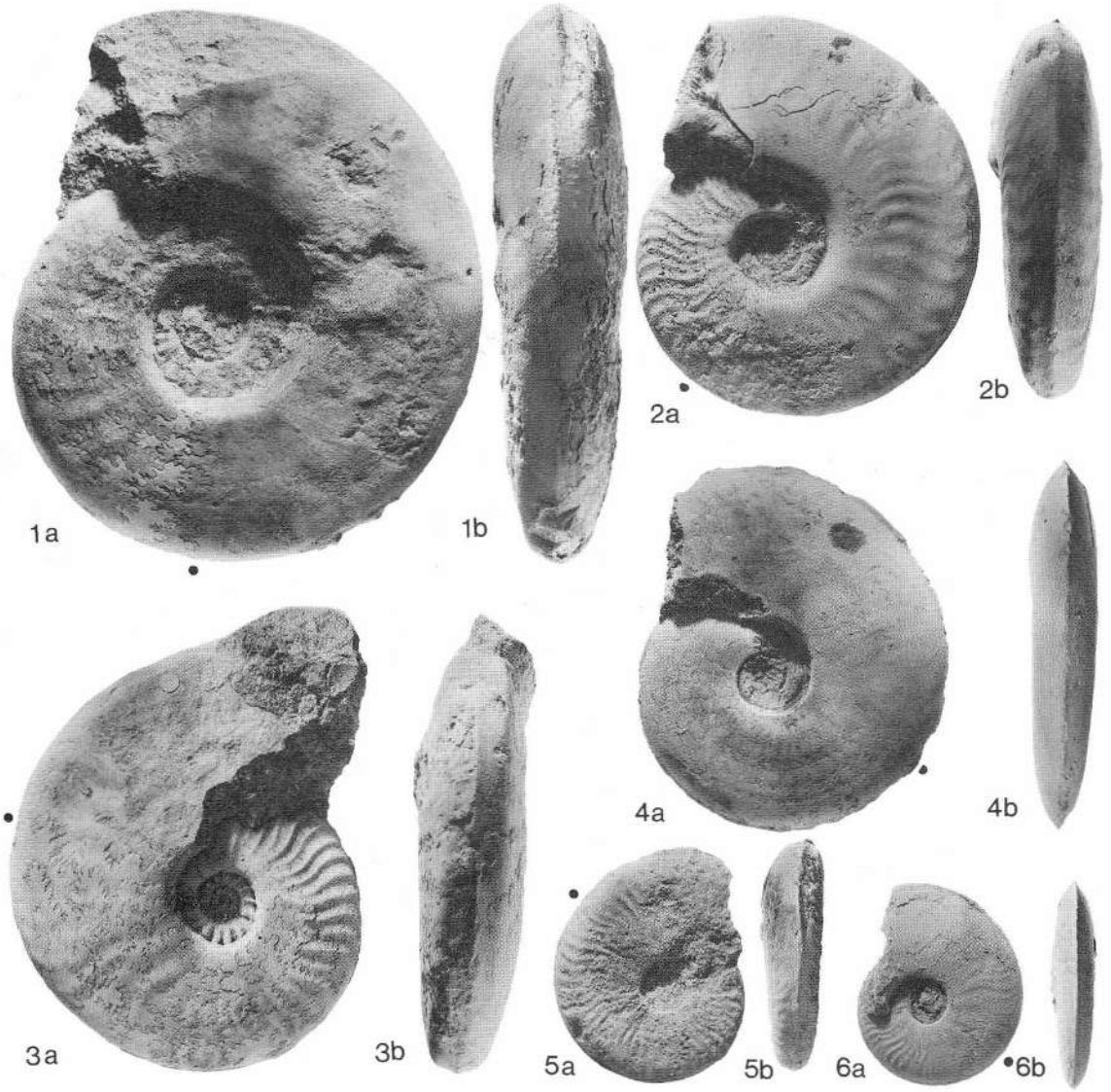

Plate 2: *Bed 3b, (Aa-5) [M]. 1a & b. RBC 173 Ludwigia aff. depilata (Buckman); 2a & b. RBC 73 Ludwigia pustulifera (Buckman); 3a & b. RBC 582 Ludwigia armipotens (Buckman); 4a & b. RBC 15 Staufenia sehndensis (Hoffman); 5a & b. RBC 160 Cylicoceras brasilum (Buckman); 6a & b. RBC 120 Staufenia aff. sehndensis (Hoffman).*

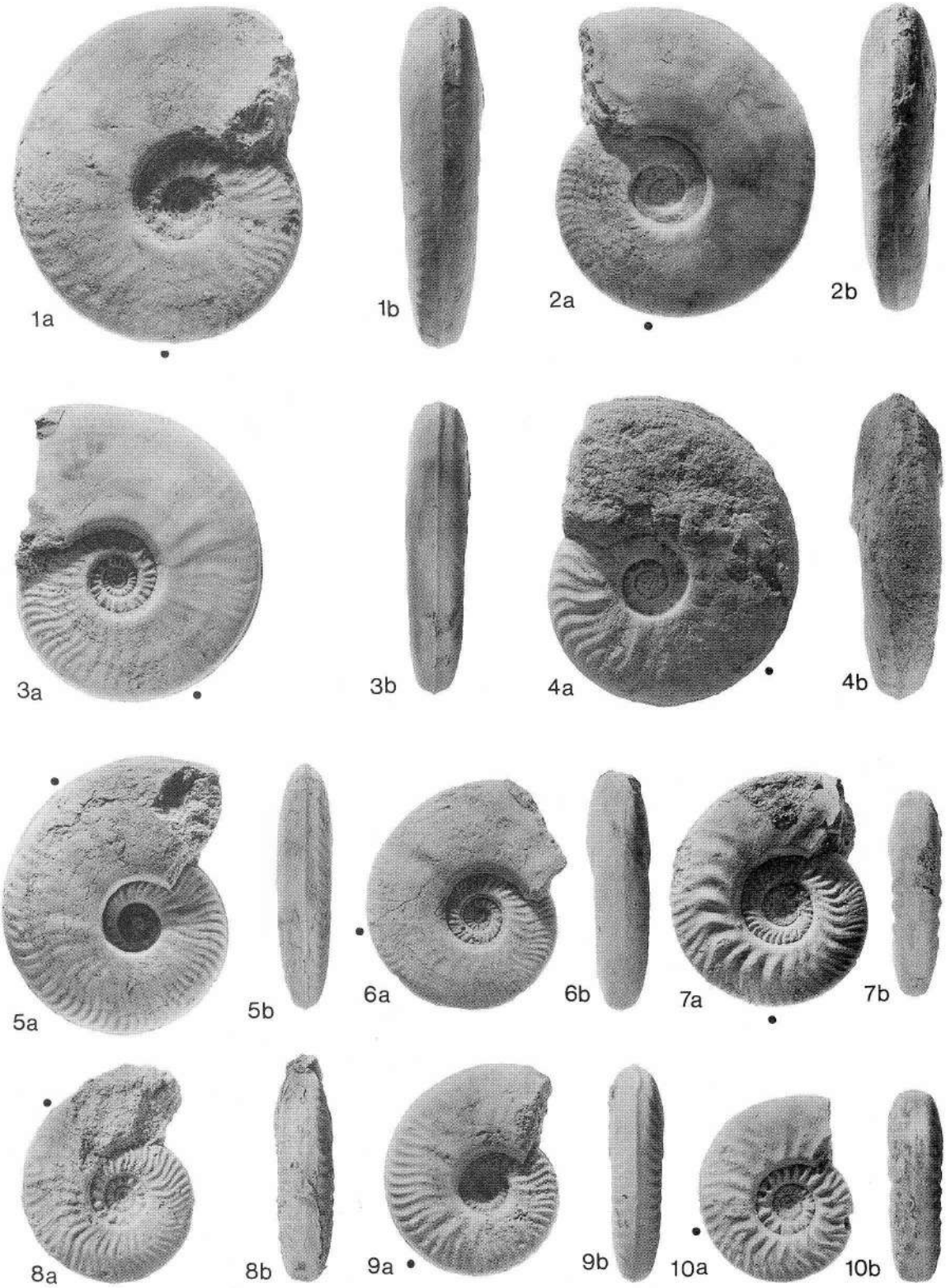

Plate 3: *Bed 3c, (Aa-7) [M]. 1a & b. RBC 79 Ludwigia depilata (Buckman); 2a & b. RBC 150 Ludwigia murchisonae (J. de C. Sowerby); 3a & b. RBC 151 Ludwigia reflua (Buckman); 4a & b. RBC 583 Ludwigia cf crassa Horn; 5a & b. RBC 167 Ludwigia laevigata Buckman; 6a & b. RBC 270 Ludwigia murchisonae (J. de C. Sowerby); 7a & b. RBC 9 Ludwigia fuelopei Géczy; 8a & b. RBC 103 Ludwigia reflua (Buckman); 9a & b. RBC 5 Ludwigia obtusiformis buckmanni Géczy; 10a & b. RBC166 Ludwigia tuberata Buckman.*

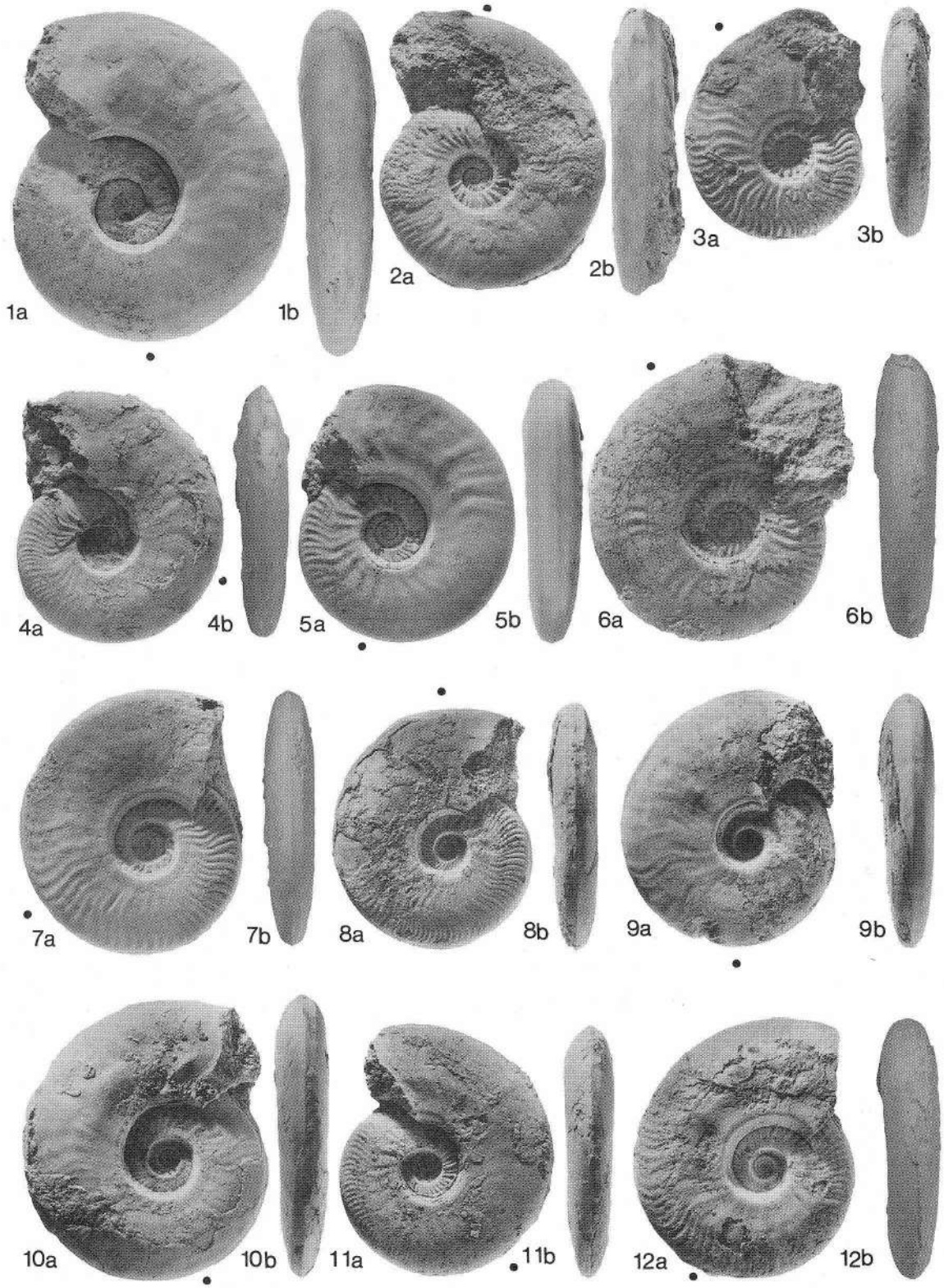

Plate 4: Beds 4a-c, (Aa-8 to Aa-10) [M]. 1a & b. RBC 112 Brasilia platychora. (Buckman) (4a); 2a & b. RBC 164 Ludwigia vaceki Géczy (4a); 3a & b. RBC 28 Brasilia austera (Buckman) (4b); 4a & b. RBC 22 Brasilia bradfordensis (Buckman) (4a); Fig. 5a & b. RBC 63 Ludwigia aff. murchisonae (J. de C. Sowerby) (4a); 6a & b. RBC 26 Brasilia austera (Buckman) (4a); 7a & b. RBC 61 Brasilia aff bradfordensis (Buckman) (4a); 8a & b. RBC 305 Brasilia baylli (Buckman) (4c); 9a & b. RBC 105 Brasilia effricata Buckman (4c); 10a & b. RBC 111 Brasilia platychora (Buckman)(4c); 11a & b. RBC 46 Brasilia bradfordensis (Buckman) (4c); 12a & b. RBC 300 Brasilia subcava (Buckman) (4c).

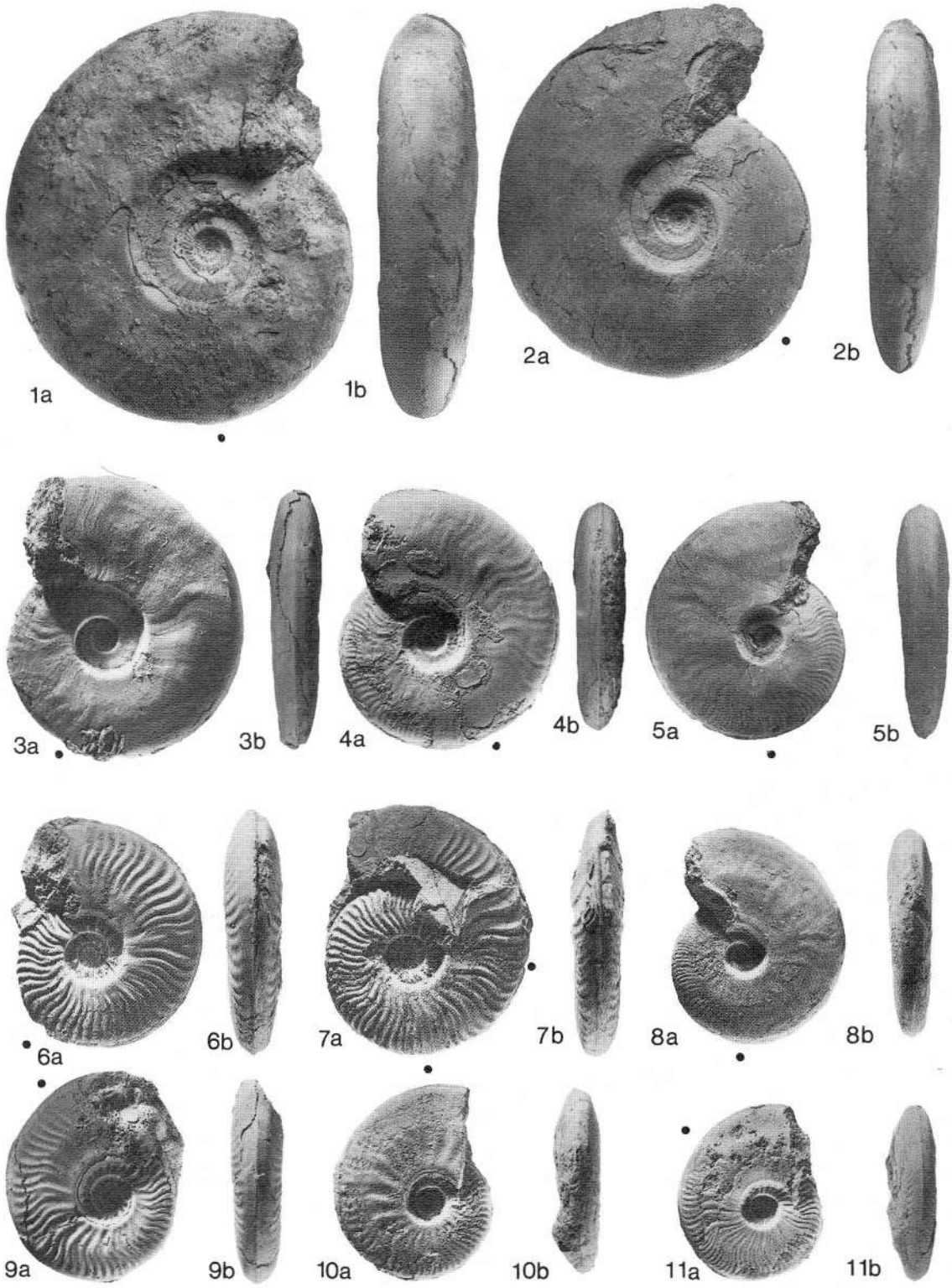

Plate 5: Beds 4c-5a, (Aa-10 to Aa-11) [M].1a & b. RBC 308 Brasilia gigantea (Buckman) (5a); 2a & b. RBC 309 Brasilia platychora (Buckman) (5a); 3a & b. RBC 8 Brasilia effricata (Buckman) (5a); 4a & b. RBC 320 Brasilia bradfordensis (Buckman) (5a); 5a & b. RBC 314 Brasilia aff ambigua (Buckman) trans. similis (Buckman) (5a); 6a & b. RBC 104 Brasilia similis maubergei Contini (4c); 7a & b. RBC 60 Ludwigia obtusiformis (Buckman) (4c); 8a & b. RBC 281 Brasilia similis (Buckman) (4c); 9a & b. RBC 47 Ludwigia gradata Buckman (4c); 10a & b. RBC 107 Brasilia bradfordensis (Buckman) (4c); 11a & b. RBC 51 Brasilia tutcheri (Buckman) (4c).

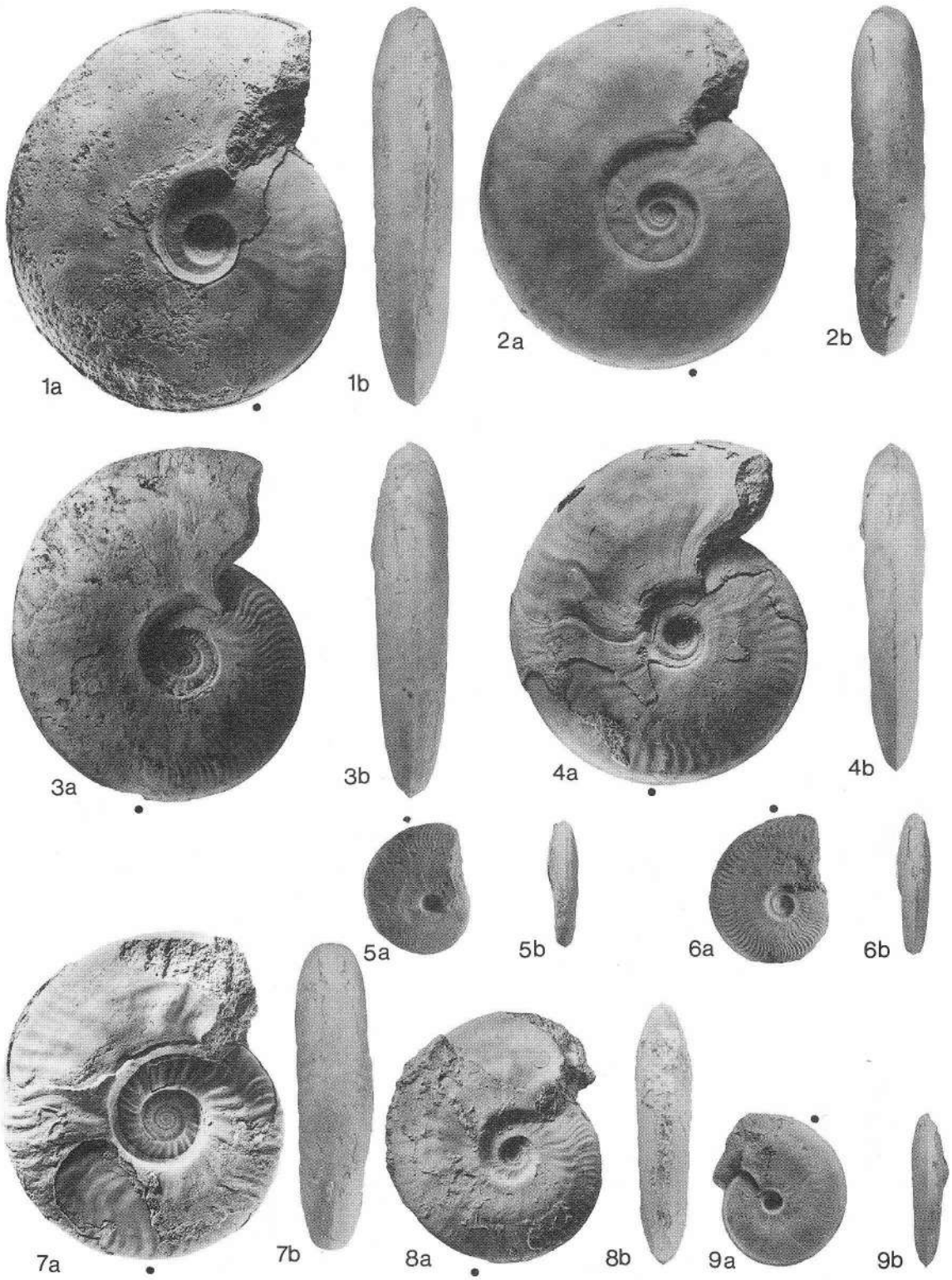

Plate 6: Beds 5a & 5c, (Aa-11 to Aa-13) [M]; 1a & b. RBC 310 Brasilia decipiens (Buckman) (5ci); 2a & b. RBC 312 Brasilia effricata Buckman (5a); 3a & b. RBC 16 Brasilia similis aff maubergei Contini (5a); 4a & b. RBC 86 Graphoceras cavatum (Buckman) (5cii); 5a & b. RBC 222 Graphoceras decorum Buckman (5cii); 6a & b. RBC 387 Brasilia tutcheri (Buckman) (5ci); 7a & b. RBC 306 Brasilia nitens (Buckman) (5a); 8a & b. RBC 115 Brasilia subcava (Buckman) (5a); 9a & b. RBC 7 Brasilia crinalis (Buckman) (5ci).

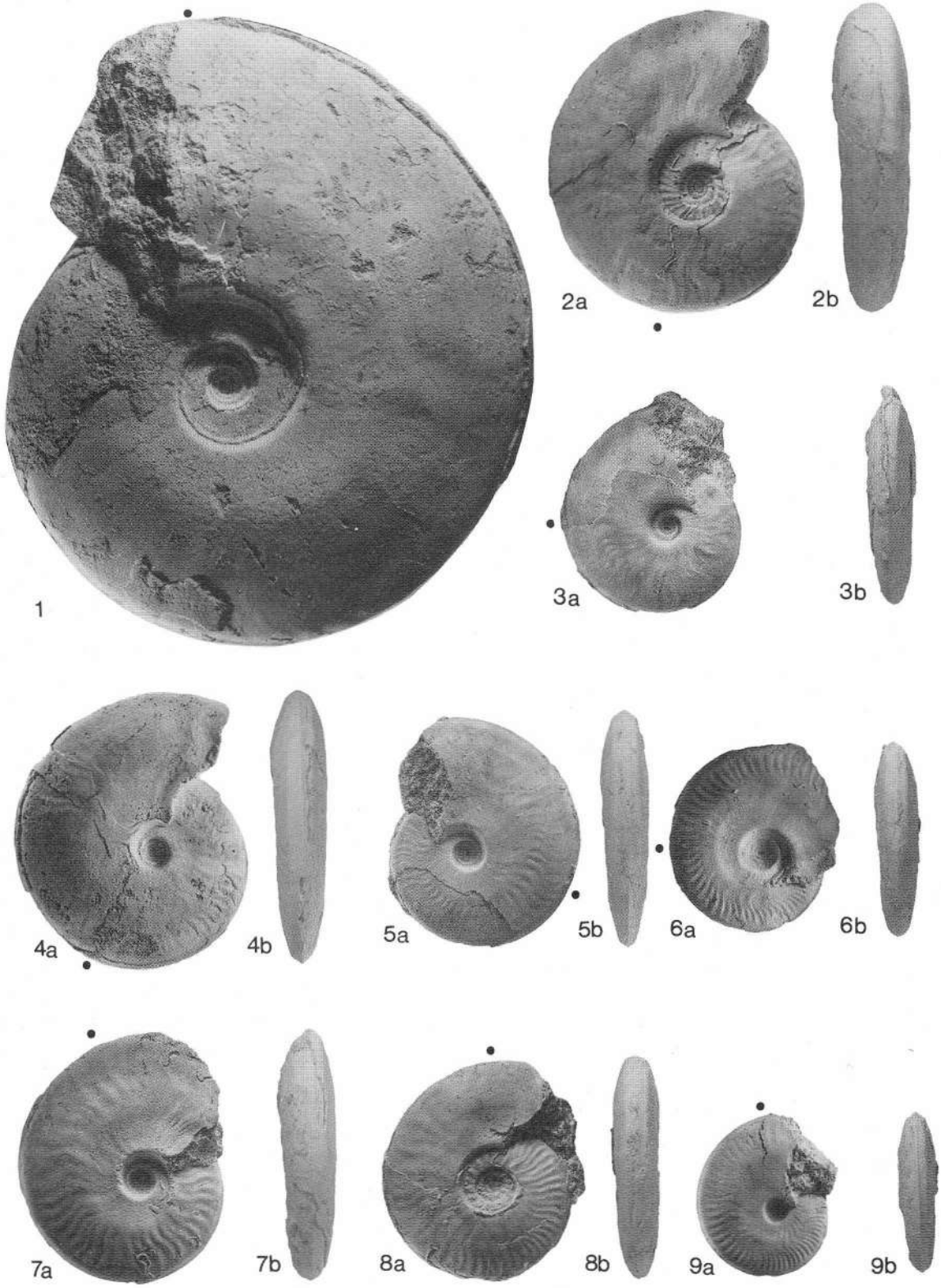

Plate 7: *Beds 5a-c, (Aa-11 to Aa-13) [M]. 1. RBC 269 Brasilia decipiens (Buckman) (5ci); 2a & b. RBC 41 Brasilia nitens (Buckman) (5a); 3a & b. RBC 92 Brasilia floccosa (Buckman) (5ci); 4a & b. RBC 87 Graphoceras magnum (Buckman) (5cii); 5a & b. RBC 384 Graphoceras concavum (Sowerby) (5cii); 6a & b. RBC 93 Graphoceras v-scriptum Buckman (5cii); 7a & b. RBC 89 Graphoceras magnum (Buckman) (5cii); 8a & b. RBC 213 Graphoceras apertum (Buckman) (5cii); 9a & b. RBC 219 Graphoceras decorum Buckman (5cii).*

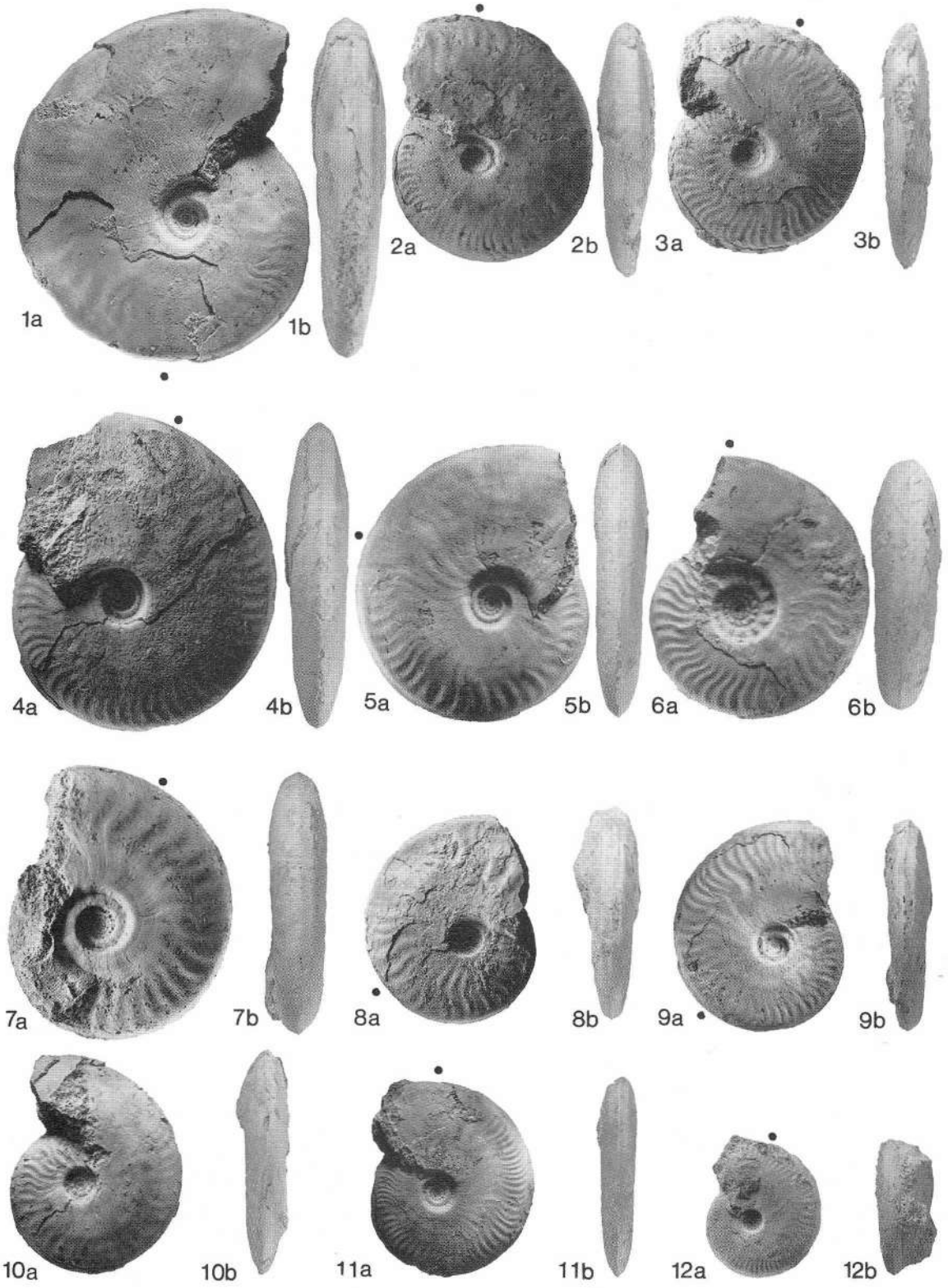

Plate 8: *Bed 5d, (Aa-14 to Aa-15) [M]. 1a & b. RBC 356 Graphoceras aff. cavatum (Buckman) (5di); 2a & b. RBC 215 Graphoceras concavum (Sowerby) (5dii); 3a & b. RBC 386 Graphoceras concavum (Sowerby) (5di); 4a & b. RBC 360 Graphoceras aff. formosum (Buckman) (5dii); 5a & b. RBC 88 Graphoceras formosum (Buckman) (5dii); 6a & b. RBC 42 Graphoceras caduceiferum (Buckman) (5dii); 7a & b. RBC 361 Graphoceras fallax (Buckman) (5di); 8a & b. RBC 383 Graphoceras stigmosum Buckman (5dii); 9a & b. RBC 202 Graphoceras concavum (Sowerby) (5dii); 10a & b. RBC 382 Graphoceras stigmosum Buckman trans. Hyperlioceras (5dii); 11a & b. RBC 218 Graphoceras aff, concavum (Sowerby) (5di); 12a & b. RBC 220 Graphoceras limitatum Buckman (5dii).*

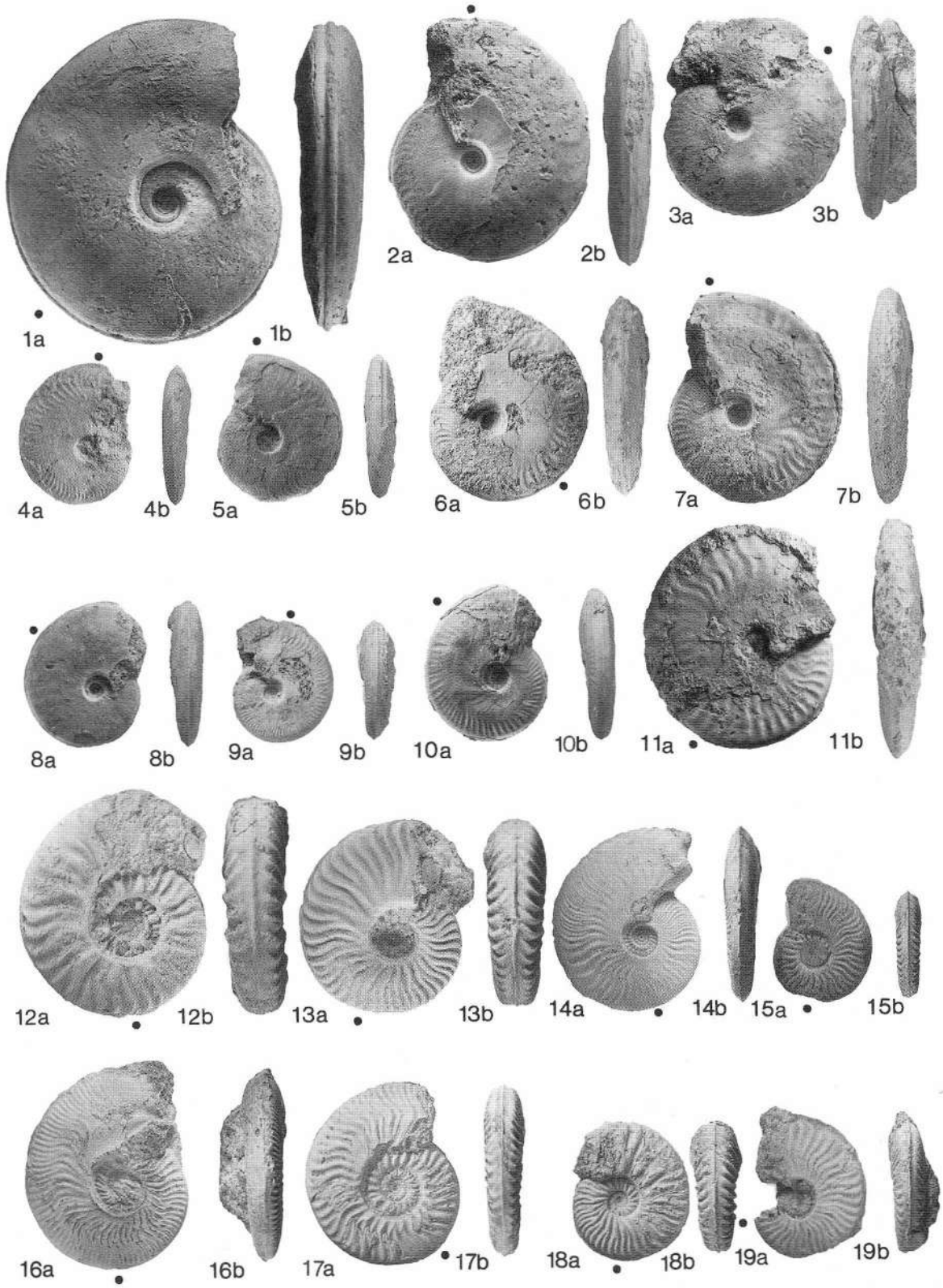

Plate 9: *Bed 5e, (Aa-16 to Bj-1) [M]. 1a & b. RBC 85 Hyperlioceras politum (Buckman) trans. rudidiscites Buckman (5eii); 2a & b. RBC 98 Hyperlioceras intermedium (Buckman) (5eii); 3a & b. RBC 357 Hyperlioceras intermedium (Buckman) (5eii); 4a & b. RBC 437 Graphoceras decorum Buckman (5eii); 5a & b. RBC 260 Hyperlioceras mundum (Buckman) (5eii); 6a & b. RBC 412 Graphoceras decorum Buckman (5ei); 7a & b. RBC 405 Graphoceras concavum (Sowerby) (5ei); 8a & b. RBC 410 Hyperlioceras coelum (Buckman) (5ei); 9a & b. RBC 428 Graphoceras decorum Buckman (5ei); 10a & b RBC 404 Graphoceras limitatum Buckman (5ei); 11a & b. RBC 414 Graphoceras stigmosum Buckman (5ei); Bed 3 & 4, (Aa-4 to Aa-9) [m]. 12a & b. RBC 145 Ludwigia (Pseudographoceras) agria (Buckman) (3a); 13a & b. RBC 75 Ludwigia (Pseudographoceras) cosmia (Buckman) (3a); 14a & b. RBC 280 Leioceras striatum Buckman (3a); 15a & b. RBC 2 Leioceras gracile Buckman (3a); 16a & b. RBC 53 Brasilia (Apedogyria) aff. subcornuta Buckman (4a); 17a & b. RBC 296 Brasilia (Apedogyria) carinata (Buckman) (4b); 18a & b. RBC 458 Ludwigia (Pseudographoceras) literata Buckman (4a); 19a & b. RBC 457 Cylicoceras (Canavarella) cf. subcostosum (Buckman) (3a).*

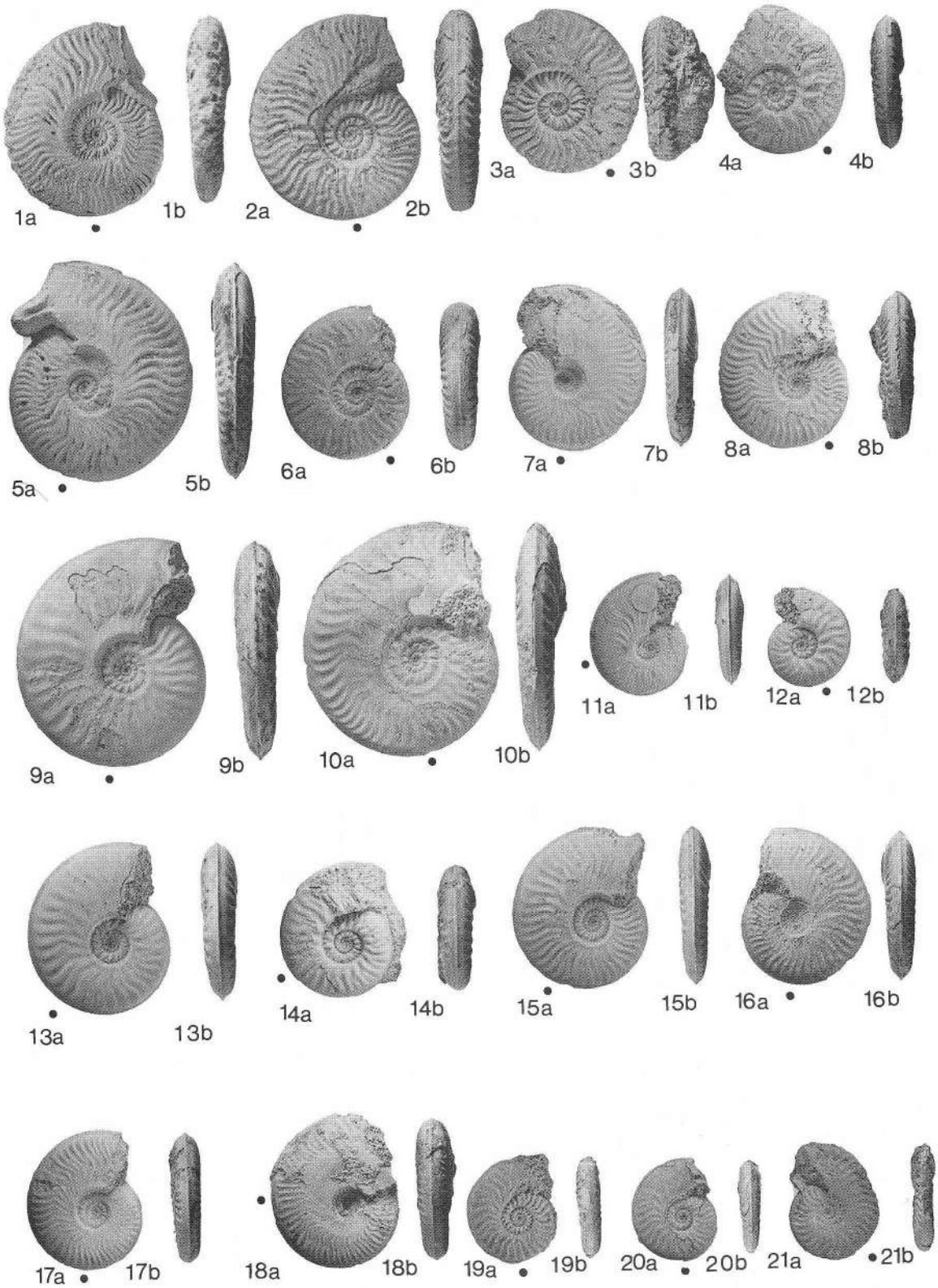

Plate 10: *Bed 4 & 5, (Aa-10 to Bj-1) [m]. 1a & b. RBC 43 Brasilia (Apedogyria) subcornuta Buckman (4c); 2a & b. RBC 299 Brasilia (Apedogyria) aff. subcornuta Buckman (4c); 3a & b. RBC 304 Ludwigia (Pseudographoceras) umbilicata Buckman (4c); 4a & b. RBC 4 Brasilia (Apedogyria) aff. glevensis (Buckman) (4c); 5a & b. RBC 277 Brasilia (Apedogyria) aff. glevensis (Buckman) (5a); 6a & b. RBC 343 Brasilia (Apedogyria) aff. rugosa (Buckman) (5ai); 7a & b. RBC 460 Graphoceras (Ludwigella) cf.castum Buckman (5cii); 8a & b. RBC 367 Graphoceras (Ludwigella) castum Buckman (5c); 9a & b. RBC 90 Graphoceras (Ludwigella) cornu Buckman (5dii); 10a & b. RBC 91 Graphoceras (Ludwigella) arcitenens Buckman (5dii); 11a & b. RBC 6 Brasilia (Apedogyria) sp. (5c); 12a & b. RBC 375 Graphoceras (Ludwigella) cf. impolitum Buckman (5ci); 13a & b. RBC 463 Hyperlioceras (Braunsina) cornigerum Buckman (5dii); 14a & b. RBC 380 Graphoceras (Ludwigella) latum (Buckman) (5di); 15a & b. RBC 464 Graphoceras (Ludwigella) attenuatum Buckman 5dii); 16a & b. RBC 94 Graphoceras (Ludwigella) aff. castum Buckman (5di); 17a & b. RBC 470 Hyperlioceras (Braunsina) fastigatum Buckman (5eii); 18a & b. RBC 409 Graphoceras (Ludwigella) castum Buckman (5ei); 19a & b. RBC 422 Graphoceras (Ludwigella) micrum Buckman (5ei); 20a & b. RBC 392 Hyperlioceras (Braunsina) asperum Buckman (5ei); 21a & b. RBC 435 Hyperlioceras (Braunsina) fastigatum*