«ANNALES DU MUSÉUM D'HISTOIRE NATURELLE DE NICE - TOME IV - 1976»

THE MID-CRETACEOUS OF THE UNITED KINGDOM

W. J. KENNEDY
Department of Geology and Mineralogy
Parks Road,
Oxford

J. M. HANCOCK
Department of Geology,
King's College,
Strand
London
WC2R 2LS

INTRODUCTION

The mid-Cretaceous sediments of the United Kingdom and the south western margins of the Paris basin (Text-figs. 1, 2) encompass what are historically the most widely documented and discussed faunas and sequences of this date. Many of the lithostratigraphic units stem from William Smith and his contemporaries in England, whilst the Cretaceous takes its name from the widespread occurrence of coccolith micrites - chalks (Latin *Creta*) in this area during the Cenomanian to Maastrichtian interval. The area also includes the type regions of two of the stages under review in the current volume, the Cenomanian, named from the environs of Le Mans (Roman Cenomanum) and the Turonian, named after Touraine in the southern part of the area. The bulk of stratigraphically significant macroinvertebrates, in particular ammonites, echinoids, brachiopods and bivalves were first described on the basis of material from this region. In part because of this long familiarity, there have been relatively few comprehensive faunal and biostratigraphic revisions of these areas until the last few years. Thus the definitive accounts of the English Mid and Upper Cretaceous stem from the first decades of this century, whilst the revision of the classic ammonite faunas of the Cenomanian and Turonian of the whole area are still in progress - indeed, type material of many of the important species of Sharpe and Mantell and d'Orbigny, including widely quoted indices such as *Collignoniceras woollgari* (Mantell) and *Romaniceras deverianum* (d'Orbigny) have never been adequately refigured, or indeed never figured at all (e.g. *Pseudotissotia galliennei* (d'Orbigny), *"Ammonites" turonensis* d'Orbigny, *Lewesiceras peramplum* (Mantell), whilst the origin of others has been in dispute (e.g. *Euomphaloceras euomphalum* (Sharpe), *Metoicoceras geslinianum* (d'Orbigny)).

Recent publications have provided new insight into certain aspects of the regional setting, palaeogeography and biostratigraphy of the Aptian, Albian and Cenomanian stages, but our knowledge of the Turonian and Coniacian is fragmentary. Some progress has been made on systematic revisions of the ammonite faunas of the region, and the echinoids, important in the correlation of chalk facies, are also relatively well-known. Published work on other important groups, notably inoceramid bivalves and Foraminiferida, is insufficient for there to be any useful discussion of their distribution, and as a result they figure little in the subsequent account.

REGIONAL SETTING

During the Mid-Cretaceous, the area of western Europe under study lay between 30° and 40° N (Smith, Briden and Drewry 1973). To the south lay the now vanished oceanic area of Tethys, whilst to the west, the proto-north Atlantic was opening. During the late Jurassic and early Cretaceous, the whole region comprised a more or less land-locked epeiric sea (Hallam 1969), the eastern shores of which were the Precambrian and Palaeozoic massifs of central Europe, whilst the western shores were the shield areas and Greenland. Sea floor spreading in the North Atlantic may have begun as early as the late Jurassic (e.g. Laughton 1972, 1975), heralded perhaps by the Triassic and early Jurassic fault graben of the eastern seaboard of North America. Between a period of 150 to 80 million years ago, there was, however, both breakup of the North Atlantic continents and rotation of the Iberian Peninsula, with consequent opening of the Bay of Biscay (see Wilson, 1975, with bibliographic references). Current reconstructions show, however, that even during Campanian times, the west of Ireland was situated only a short distance (of the order of 900 km) east of Newfoundland (Laughton 1972, 1975).

The renewal of rapid spreading, leading to the development of the present seaway, is thus a late Cretaceous and early Tertiary event, as evidenced by both direct sea floor spreading data and by the widespread latest Cretaceous and Tertiary basic vulcanicity in Ireland, Scotland, Greenland, Iceland and the North Sea (Spencer 1974). The mid-Cretaceous history recorded in the land based outcrops of western Europe are thus a key not only to that of the North Sea area, but also to the eastern seaboard of the United States and Canada.

From Albian times onwards the Cretaceous was a period of tectonic quiescence in western Europe, and the history and patterns of sedimentation in the region can be interpreted in terms of a simple model involving the interaction of two groups of factors, the *tectonic framework* and the *transgressive history*.

TECTONIC FRAMEWORK

The tectonic framework of the western European shelf seas during the Cretaceous reflected, as it does now, a history extending back to the Precambrian, as demonstrated by Sutton (1968) ; the disposition of massif and basin areas in many cases being inherited from early Mesozoic and pre-Mesozoic structures.

A limited number of basic elements are recognised (Text-fig. 3) as follows :

Massifs are areas of Palaeozoic and Precambrian rocks built during the Variscan and earlier orogenies (Hancock 1975). Such massifs include the Fennoscandian Shield, a central-west European area including the Anglo-Brabant Massif (the London Landmass, London Platform or London-Belgium ridge of authors), Ardennes, Rhenish, Vosges, Hartz and Bohemian Massifs, with the Massif Central to the south linked to the north-west to the massif of Armorica (Massif de Morvan), and Devon-Cornwall (Cornubia). Several poorly known regions in the North Sea also display massif-like characters, e.g. the Ringkøbing-Fyn High and the Mid North Sea High (Heybroek et al. 1967, Kent 1975, Hancock and Scholle 1975). To the west and north, the sites of the Caledonides in Scotland (extending offshore as the Shetland platform) western and northern England, Wales and Ireland were a further complex of massifs (whose Cretaceous history is poorly understood, for their Mesozoic cover was largely removed during the Tertiary), whilst still further west lay Greenland, the Canadian Shield and the extension of the Appalachians into Newfoundland and the Grand Banks. The role of now foundered scraps of continental crust such as the Rockall Plateau, Porcupine Bank, Orphan Knoll, Flemish Cap and the Galicia Bank during the late Cretaceous is not fully known.

These massifs dominated Mid- to Late Cretaceous sedimentation in several ways. Many were islands, standing above the Cretaceous sea for the whole period; yet others were encroached on and submerged during transgression, with resultant cutoff of terriginous debris, only to be rejuvenated during regression. Some, such as the Anglo-Brabant Massif, influence sedimentation long after submergence and relatively deep burial.

Approaches to Massif areas are generally marked by facies changes (discussed further below), with a passage towards terrigenous clastic sequences, or calcarenitic and biohermal shallow water limestones, the latter even developing over wholly submerged massifs. Successions may also thin (Text-fig. 4) ; over massifs Upper Cretaceous sequences are thus of the order of 100-200 m in thickness, and may be interrupted by condensed beds, nonsequences and disconformities, even though the massifs themselves were, in general, tectonically passive.

Between these island-massif areas were basinal regions, permanently submerged, and often subsiding, so that sedimentary successions are in general complete and of the order of 400-500 m thickness. In some cases, subsidence exceeded rate of sediment supply, and overall deepening occurred ; basinal areas are also only superficially affected by overall regressive-transgressive phases.

There are two major basinal areas in the region of study, the North Sea Basin, bounding an area of continued subsidence since the Triassic, and regarded by some as a failed rift system, and the Anglo Paris (or more correctly, Wessex-Paris) Basin to the south.

Of more local effect, but nevertheless important, are deep furrows within basins, generally marginal to up-domed blocks ; these are the compensatory troughs (randtröge) of Voigt (1963), where Late Cretaceous sequences range up to 2000 m in thickness. These troughs are largely limited to a broad belt running across the North Sea and North German Plain into Poland.

In basins, and on the sumerged flanks of massifs there are minor variations in thickness, which can be related to basement "highs", salt, posthumous movements along the pre-Mesozoic faults and fold axes (e.g. Owen 1963, 1971a; Drummond 1970; Hart 1971). These areas of sedimentary thinning, non-sequence and local development of shallow water facies are known by a variety of names, of which "swell" is currently prevalent (Allen 1967 gives "axis", "cill", "sill", "seuil", "swell", "schwelle", "rise", "ridge", "saddle", "platform" and "positive area" as other terms for these areas).

Finally, one must mention the widespread occurrence of salt domes and walls extending across the North Sea area, North German Plain and into Poland (Brunstrom and Walmsley 1969 ; Heybroek et al. 1967 ; Sorgenfrei 1969 with bibliography, Taylor and Colter 1975). In Germany, salt movements occurred chiefly in the post-early Jurassic to pre early Cretaceous times, with renewed activity in the pre-Miocene and Pleistocene (Richter-Bernburg and Schott 1959). In the British parts of the North Sea, Kent (1967) suggested that salt movement was initiated during the Keuper, and continued intermittantly through the Jurassic, Cretaceous and Tertiary. Halokinetic movements may thus have been a factor influencing basin and swell areas in some parts of the area of study, and be the origin of anomalous features of the Norfolk Upper Cretaceous (Peake and Hancock 1961) and the Cenomanian-Turonian of south-west England (Lees and Tait 1946 ; Falcon and Kent 1960).

The basin-massif transition is somewhat variable. The Massif Central and Armorican Massif are thus linked by a shallow sill below the Straits of Poitou, whilst, in striking contrast, the northern boundary of the Hartz Massif is fault-bounded (Hancock 1975), as is the southern boundary of the Mons Basin. The basin-massif boundary is generally reflected in sedimentation patterns long after submergence, and is often very constant. Thus the margins of the Anglo-Brabant Massif, submerged during the late Albian, is delineated by sedimentary thinning, non sequences and condensation until at least the Santonian. Similarly the facies changes at the western margin of the Wessex Basin in south-west England occured along the same line from Jurassic to late Cretaceous times in an area submerged since the late Triassic.

TECTONIC ACTIVITY

During the late Cretaceous, north-western Europe as a whole was characterised by an extremely low level of tectonic activity, and what is recognised may be halokinetic in origin. As a result, such movements as did occur, although involving movements of hundreds of metres at maximum, produce spectacular results. In the northern Hartz, there are Santonian conglomerates which are the result of the rejuvenation of relief by fault uplifting (Hancock 1975). In Northern Ireland block uplift of small areas of Palaeozoic basement led to the stripping of a Cenomanian to Turonian cover and its incorporation as intraclasts in neighbouring Santonian sediments (Hancock 1961). Northeast of the Münster Basin, uplift of the Lippisch Swell during Coniacian times led to mass movement of Cenomanian to Coniacian sediments into the Münster Basin as a spectacular complex of slide conglomerates (Voigt 1962). Movements on this swell during Turonian times led to the sporadic emplacement of turbidites into the Plänerkalk of the southwest slope of the Osningen Hills. Less spectacular slump deposits occur in the Campanian of Beckum, whilst small scale movements in Norfolk and south-west England have already been referred to.

REGRESSIVE-TRANSGRESSIVE HISTORY

Recognition of widespread transgression during the late Cretaceous dates from the publications of Suess (1885-1909). In fact, his "Cenomanian Transgression" commenced in the Barremian and proceeded most rapidly during Albian and Cenomanian in north western Europe at least, with overall transgression extended at least into the late Campanian. Text-fig. 5 is a plot of the relative magnitudes of regression and transgression in the area from the Albian to Maastrichtian, based on data given by Hancock (1975) plotted on the late Cretaceous time scale given by Obradovich and Cobban (1975).

Actual rates of transgression and regression are difficult to assess, but lateral migration of facies belts provides an indication of movement. Regressive facies are curiously scarce in north-western Europe, save for the Turonian-Coniacian successions of the southern Paris Basin (Kennedy and Juignet 1974). Regression can be inferred, however, from the presence of stratigraphic breaks in marginal areas, and the widespread development of phosphatic nodule beds or hardground complexes in more basinal facies.

The cumulative rise in sea level is difficult to assess, but may be approached by a summation of the maximum thickness of facies over massif areas which are assumed to have remained stable, and the presumed water depth. For the Upper Cretaceous as a whole, one reaches a figure of (400 + 2-300 m) = 600-700 m. sea level rise during the Cenomanian to Maastrichtian interval. This transgression is believed to have been the result of eustatic sea level changes related to a surge in rates of Cretaceous sea floor spreading, a mechanism first proposed by Hallam in 1963. In 1973, Hays and Pitman marshalled evidence for a surge between 80 and 110 million years ago, which they correlated with the late Cretaceous transgression documented here. The problem of this approach is that calculation of rates of spreading depend on the time scale used, as discussed by Baldwin et al. (1974). Since estimates of spreading rate are based upon rather arbitrary subdivision of the Cretaceous into stages of equal duration (Harland et al. 1964) it is probably unsafe to make too detailed a comparison. It is, however, of some interest that Hays and Pitman suggested a figure of 600 m for the overall rise in late Cretaceous sea level, a closely comparable figure to that deduced by Hancock (1975) and cited here. Explanation of the overall pattern of regression and transgression appears to be linked to plate movements and variation in spreading rates, but precise correlation must be taken as "not proven" at present.

REGIONAL FACIES RELATIONSHIPS

One of the more striking features of the Upper Cretaceous sequences throughout western Europe is the frequent reappearance, at widely separated points in space and time, of a near identical facies. The English or French geologist thus recognises the identical lithology, diagenesis, trace-fossils and benthonic palaeocommunities in the Cenomanian Chalk Marl of southern England and its equivalent in the Boulonnais and the Turonian Teplice Formation of Bohemia, or the bulk of the rhythmically bedded Mid Cretaceous sequences of the Vocontian Trough and Basses-Alpes. From this widespread occurrence of a limited number of facies, often in a similar lateral and vertical relationship to each other, one can generate a relatively simple model of sedimentation, as illustrated schematically in Text-fig. 6.

Precisely what facies are recognised and their limits of definition (inherently gradational in many cases) is infinitely disputable. Kauffman (1967, 1969, 1970) recognised no less than 12 different facies and 52 different lithologies in a similar exercise on the Upper Cretaceous successions of the U.S. Western Interior, whilst Hancock (1975) recognises seventeen major facies in western Europe. Table I summarises the faunal, sedimentological and lithological features of the facies we would recognise in the area of study, together with lists of some of the better known examples. Fuller descriptions of the facies in various areas within and without those of our immediate study are : in Britain : Jukes-Browne & Hill (1900-1904), Casey (1961), Hancock (1961, 1969), Allen and Narayan (1964), Kennedy (1969, 1970a, 1970b). Drummond (1970), and Owen (1971) ; in northern France : Cayeux (1897, 1935, 1939-50), Dangeard (1951), Juignet (1968, 1970, 1971), Kennedy & Juignet (1974) ; in Belgium : Marlière (1939, 1954), Calembert (1956) ; in the Netherlands : Umbgrove (1926), Romein (1962), and Felder (1974) ; in the Germanies : Kahrs (1927), Voigt (1929, 1963), Arnold (1964), Tröger (1963, 1969), Tillman (1964), Kemper (1968), and Diener (1967a, 1967b) ; in Poland : Cieśliński (1960), Pożaryski (1960), Jaskowiak (1966), Marcinowski (1970, 1974), and Marcinowski & Szulczewski (1972) ; in Czechoslavakia : Klein & Soukup (1966) ; in Denmark : Håkansson et al. (1974) and Surlyk & Birkelund (in press) ; in Sweden : Brotzen (1966), Christensen (1975) and Bruun-Peterson (1975). Although completely outside our region, the work of Bushinskii (1954) in the Soviet Union is too important not to be mentioned.

A number of generalisations con be made about facies distributions (Hancock 1975) :

1. Individual facies migrated laterally and upwards stratigraphically as massifs were submerged during transgression. The glauconitic and nodular phosphate facies at the base of the chalk sequence in southern England (Kennedy and Garrison 1975) is Lower Cenomanian; in south-west England it is Upper Cenomanian (Hancock 1969, Kennedy (1970).

Although individual facies are of universal occurrence, many dominate at certain times and in certain areas. Cross-bedded quartz sand facies are particularly widespread in the Albian and Cenomanian, and dominate the succession in Saxony and northern Bohemia. Chalks nowhere appear before the Early Cenomanian, although the facies sequence illustrated in Text-fig. 6 commenced during the Albian.

2. Some facies are typically basinal, e.g. marine clays, whilst others typically formed over the submerged flanks of massifs, as with burrowed calcarenites and calcarenitic sandstones, although cross-bedded quartz sand facies occur in either context.

3. In all settings, the ultimate facies is chalk. Chalks can transgress all other facies, and rest on pre-Cretaceous rocks down to Precambrian basement. In most regions where this has occurred, subsequent Tertiary erosion has stripped away the evidence, but remanié flint gravels may be left as clues, as may pockets of chalk in solution collapse cavities (in Kerry, see Walsh 1966) or as blocks in volcanic vents (in Arran, see Peach et al. 1901). The very local and chance preservation of these occurrences suggests a very widespread chalk facies.

4. The sequence of facies is predominantly transgressive. Regressive sequences are generally insignificant (e.g. the temporary appearance of calcareous sandstones above glauconitic nodular phosphate facies and chalks in Sarthe), except for two areas. (a) The Turonian to early Coniacian of Touraine, where chalks grade up into tuffeau and then calcarenitic skeletal glauconitic limestone ; (b) in the Münster Basin, where post Turonian earth movements complicate the sequence.

The Maastrichtian of western Europe is in a regressive facies almost everywhere, however, and where transgressive, as on the Cotentin Peninsula, is a tuffeau or calcarenite rather than chalk.

BIOSTRATIGRAPHIC SUBDIVISIONS

Current biostratigraphic subdivisions of the Albian and Cenomanian stages in England and northern France are based almost exclusively on ammonites. Although there has been extensive work on microfaunas and inoceramid bivalves, little has been published on these groups, and discussions below are therefore largely limited to the ammonite succession. For the Turonian, a variety of organisms has been used, largely as a result of the rarity or absence of ammonites (and indeed virtually all other originally aragonitic fossils) in the chalk facies which dominates during this interval. Only in Sarthe and Touraine, and at local horizons elsewhere (e.g. the English Chalk Rock) are ammonites a significant element of faunas. In consequence echinoids, brachiopods and inoceramid bivalves have been used since the first tentative subdivision of the Chalk sequence, and their correlation with standard ammonite successions is for the most part, unclear, as reviewed below.

As well as a lack of originally aragonitic fossils in chalks (by ecological exclusion and pre-burial dissolution of their remains ; see Jefferies 1962, 1963, Hudson 1967, Kennedy 1969, 1971) there are certain other problems associated with inter and intra-regional correlation which affect faunas in all facies.

The first of these factors is that throughout the mid-Cretaceous, north-western Europe fell within the Boreal Realm, characterised by an absence or rarity of many important invertebrate groups, including many ammonite families, larger Foraminiferida and rudistid bivalves. Although this Boreal Realm, has long been recognised in the Jurassic (Neumayr 1883, Uhlig 1911, Arkell 1956), the causal factors have been uncertain. Hallam (1969, 1971, 1972) under prodding from Reid (1973), has now rejected previous simplistic arguments suggesting temperature and salinity as controls on faunal distribution, invoking rather the concepts of environmental stability and predictability (Sanders 1968 ; Bretsky and Lorenz 1969, Woodwell and Smith 1969, Valentine 1971, 1973). The Boreal Realm is regarded as a region of high stress, due to fluctuating temperature, salinity, environmental energy, seasonal illumination and the like, in contrast to the stable environment of the Tethyan Realm. The known palaeogeography of the Jurassic, together with observed faunal density/diversity changes fully support this conclusion. A similar division into distinct realms can be traced through into the early Cretaceous, and biogeographic distributions during this interval are fully reviewed by various authors in Hallam's (1973) *Atlas of Palaeobiogeography* and the *Boreal Lower Cretaceous* (edited by R. Casey and P.F. Rawson 1974). The continuance of these faunal realms during the early Cretaceous results in the standard ammonite zonation of the Albian being based largely on hoplitid ammonites, of rather limited geographic distribution (Owen 1971b, 1974), but during the late Albian to Cenomanian, faunas take on a more cosmopolitan aspect, presumably as a result of the declining geographic identity of the Boreal area and increasing oceanic influences as the North Atlantic opens. Even in the Cenomanian, however, up to 95% of ammonites in some collections from the area of study are dominated by the boreal genus *Schloenbachia*.

Within the Lower Cretaceous of the Boreal Realm, provinces can also be recognised, affecting many groups, as discussed by Jeletzky (1971), Owen 1974), Casey and Rawson (1974) and others ; in the Upper Cretaceous of the immediate are of study, two broad sub provinces can also be recognised (Wright *in* Kermack 1954, Peake and Hancock 1961, Stokes 1975) characterised as follows (C.J. Wood, personal communication) :

1. A southern subprovince, including the chalk areas of the Anglo-Paris Basin, in which echinoderms are common but inoceramid bivalves and belemnites are a subordinate element and ammonites (perhaps merely because of non-preservation) scarce.

2. A northern subprovince extending from northern England through Germany and Poland into European Russia in which the macrofauna contains rich belemnite and inoceramid assemblages with infrequent ammonites.

In the Anglo-Paris Basin, a macrofaunal zonal scheme based on brachiopods, echinoids, belemnites and like was initiated by Hébert (on the basis of sucessions in northern France), and subsequently extended to England by Barrois (1875, 1876), Evans (1870), Rowe (1900-1908) and others.

There are been attempts to devise ammonite zonations for this interval, but early work by Spath (1923b, 1926) still widely cited in the literature (e.g. Muller and Schenk 1943, Jeletzky 1968, etc.) represents a combination of inspired guesswork and intuition ; it relates to no real successions, as is discussed below. Hancock (1959, 1969), Jefferies (1962, 1963) and Kennedy (1969, 1970, 1971) have proposed ammonite zonations for the Cenomanian which, with modification, appear widely applicable ; ammonites are so rare in much of the Turonian chalk facies that only broad assemblages are recognised to date.

ALBIAN

The current ammonite zones and subzones of the Albian stage in England and northern France are summarised in table 2. The basis of this refined zonation in England is the work of L.F. Spath (1923a-1943, 1923b, 1923c, 1925) modified by Casey (1950, 1957, 1959, 1961, *in* Smart et al., 1966, *in* Worssam and Taylor 1969), Owen (1958, 1960, 1963, 1971b) and Hancock (1965). In France, important contributions and discussions are [illegible] Breistroffer (1947, 1965), Cayeux (1960), [illegible] (1965a-b), P. Destombes (1970), J.P. and P. D[illegible] (1938a-b, 1963) and P. Destombes and J.P. D[illegible] (1965).

The base of the Albian is thus drawn below [illegible]*meriella tardefurcata* Zone ; Breistroffer (1947) a[illegible] (1961) provide full discussions on the relegati[illegible] "*nodosocostatum*" Zone or Clansayesian to th[illegible] rather than the Albian.

It should be noted that the *mammillatum* [illegible] currently used is equivalent to the lower half [illegible] Spath's *mammillatum* Zone (his *monile* Subzon[illegible] 1961, p. 498) and that the index fossil of [illegible] *puzosianus* Subzone, does not range to the ba[illegible] *eodentatus* Subzone in the expanded sequences of [illegible] de Bray and Aube (Owen 1971b). Much of the Bri[illegible] *millatum* Zone is condensed, and the placement o[illegible] the rarer species, known only from the main *mam*[illegible] Zone nodule bed, in individual subzones is uncerta[illegible]

Casey (1961, p. 498) has discussed the repla[illegible] *D. inaequinodatum* by *Hoplites (Isohoplites) eode*[illegible] a subzonal index on the basis of the latter's narro[illegible] range and wider geographic distribution. The [illegible] subzones of the remainder of the Middle Al[illegible] exhaustively discussed by Owen (1971b, pp. 118[illegible] are arguments for reference of the *cristatum* Subz[illegible] base of the Upper Albian, a view tentatively followe[illegible] subzone of *Mortoniceras (Mortoniceras) aequat*[illegible] the top of the *inflatum* Zone has been recogni[illegible] Spath's work, but as noted by Casey (*in* Wor[illegible] Taylor 1969, p. 28) records of the species from B[illegible] based on misidentifications. *Mortoniceras (Mort*[illegible] *altonense* Breistroffer has been suggested as a [illegible] name-bearer for the Subzone, but Owen (1976) [illegible] that it cannot be separated from the *auritus* Sub[illegible] authors to date have recognised two division[illegible] *Stoliczkaia dispar* Zone. An appraisal of know[illegible] suggests that the fauna of the lower, *substuderi* S[illegible] Spath (e.g. 1923-1943) and others is no more tha[illegible] poverished assemblage of forms better known [illegible] higher parts of the Zone, and subzonal division ap[illegible] wise at this time. Very recently Owen (1976) has re[illegible] subzones of the Upper Albian, particularly on the [illegible] sucessions in the Weald and Oxfordshire. He als[illegible] against attempts to recognise a *substuderi* Subzon[illegible] theless, he distinguishes a Subzone of *Mor*[illegible] *rostratum* between the *auritus* and *perinflatum* S[illegible] which he places within the dispar Zone. Use of [illegible] Vraconian for the *dispar* Zone (e.g. Drummond 19[illegible] be discouraged.

UPPER APTIAN

Hypacanthoplites jacobi Zone (undivided[illegible]

Hypacanthoplites jacobi (Collet)
H. anglicus Casey
H. anglicus cauvillensis Destombes et al.
H. anglicus audax Casey
H. aff. *bigoureti* (Seunes)
H. sigmoidalis Casey
H. rubricosus Casey
H. rubricosus tenuiformis Casey
H. rubricosus papillosus Casey
H. elegans (Frietel)
H. cf. *hanovrensis* (Collet)
H. pricei Casey
H. cf. *spathi* (Dutertre)
H. newingtoni Casey
H. simmsi (Forbes)
H. clavatus (Fritel)
H. clavatus monocostatus Casey
H. cf. *sarasini* (Collet)
H. propinquus Casey
H. cf. *shepherdi* Casey
Nolaniceras aff. *nolani* (Seunes)

Bucaillella cayeuxi Destombes et al.
B. cayeuxi moricei Destombes et al.
B. cayeuxi wattei Destombes et al.

LOWER ALBIAN

Leymeriella tardefurcata Zone
Farnhamia farnhamensis Subzone

Hypacanthoplites anglicus Casey
H. milletioides Casey
H. corrugatus Casey
Farnhamia farnhamensis Casey
F. crassa Casey
F. discoidalis Casey
F. fallax Casey
Anadesmoceras sp.

Hypacanthoplites milletioides Subzone

H. milletioides Casey

Leymeriella regularis Subzone

Pictetia depressa (Pictet and Campiche)
Eogaudryceras (Eogaudryceras) sp.
Aconeceras neonisoides Casey
Douvilleiceras leightonense Casey
D. leightonense pringlei Casey
D. pustulosum Casey
Hypacanthoplites cf. *milletianus* (d'Orbigny)
Leymeriella (Leymeriella) tardefurcata (d'Orbigny)
L. (L.) tardefurcata intermedia Spath
L. (L.) tardefurcata densicostata Spath
L. (L.) regularis (Bruguière) d'Orbigny sp.
L. (L.) consueta Casey
L. (L.) consueta magna Casey
L. (L.) pseudoregularis Seitz
L. (L.) diabolus Casey
L. (L.) rudis Casey
L. (L.) renascens Seitz
L. (L.) cf. *revili* (Jacob)
L. (Epileymeriella) cf. *hitzeli* (Jacob)
Cleoniceras (Cleoniceras) antiquum Casey
C. (C.) morgani Spath
Anadesmoceras strangulatum Casey
A. subbaylei (Spath)
A. costatum Casey
A. tenue Casey
A. nudum Casey

Douvilleiceras mammillatum Zone
Sonneratia kitchini Subzone

Hamites pseudattenuatus Casey
Beudanticeras newtoni Casey
B. dupinianum (d'Orbigny)
B. dupinianum evolutum Casey
B. arduennense Breistroffer
Douvilleiceras sp. juv. cf. *mammillatum* (Schlotheim)
D. cf. *mammillatum* (Schlotheim)
D. mammillatum praecox Casey
D. mammillatum aequinodum (Quenstedt)
D. leightonense Casey
D. leightonense pringlei Casey
D. pustulosum Casey
Sonneratia kitchini Spath
S. kitchini chalensis Casey
S. kitchini ovalis Casey
S. rotator Casey
S. rotator leightonensis Casey
? *S. perinflata* Breistroffer
S. elegans Casey
S. subglabra Casey
S. parenti Jacob
? *S. caperata* Casey
Cleoniceras (Cleoniceras) morgani Spath
C. (C.) strigosum Casey
Anadesmoceras baylei (Jacob)

(?) : uncertain horizon, not *uncertain identification*

Cleoniceras floridum Subzone

Protanisoceras (Protanisoceras) cantianum Spath
P. (P.) blancheti (Pictet and Campiche)
P. (P.) vaucherianum (Pictet)
P. (P.) acteon (d'Orbigny)
P. (P.) hengesti Casey
P. (Torquistylus) anglicum (Spath)
? *Rossalites oweni* Casey
Beudanticeras newtoni Casey
Beudanticeras dupinianum (d'Orbigny)
B. dupinianum evolutum Casey
? *B. bulbosum* Casey
B. arduennense Breistroffer
? *Uhligella subornata* Casey
? *Cymahoplites* sp. nov. cf. *kerenskianus* (Bogoslowsky)
Douvilleiceras mammillatum (Schlotheim)
D. mammillatum aequinodum (Quenstedt)
D. mammillatum praecox Casey
D. leightonense pringlei Casey
D. orbignyi Hyatt
D. alternans Casey
D. magnodosum Casey
D. monile (J. Sowerby)
D. pustulosum Casey
Sonneratia flava Casey
S. extremis Casey
S. parenti Jacob
Anahoplitoides cf. *gigas* (Sinzow)
Cleoniceras (Cleoniceras) cleon (d'Orbingy)
C. (C.) sublaeve Casey
C. (C.) janneli (Parent)
C. (C.) seunesi Bonarelli
C. (C.) floridum Casey
C. (C.) dimorphum Casey
C. (C.) imitator Casey
C. (Neosaynella) inornatum Casey
C. (N.) cantianum Casey
? *Tegoceras gladiator* (Bayle)
? *T. mosense* (d'Orbigny)
? *Oxytropidoceras alticarinatum* Spath
? *Parengonoceras ebrayi* (de Loriol)

Otohoplites raulinianus Subzone

Hamites praegibbosus Spath
Hamites dixoni Casey
Hamites hybridus Casey
Protanisoceras (Protanisoceras) raulinianum (d'Orbigny)
P. (P.) lardyi (Pictet and Renevier)
P. (P.) ventrosum Casey
P. (P.) cantianum Spath
P. (P.) coptense Casey
P. (P.) subquadratum Casey
P. (P.) cf. *halleri* (Pictet and Campiche)
P. (Torquistylus) anglicum (Spath)
? *Rossalites oweni* Casey
Beudanticeras newtoni Casey
B. dupinianum (d'Orbigny)
B. dupinianum evolutum Casey
B. bulbosum Casey
B. arduennense Breistroffer
? *Uhligella subornata* Casey
? *Cymahoplites* sp. nov. cf. *kerenskianus* (Bogoslowsky)
D. mammillatum (Schlotheim)
D. mammillatum aequinodum (Quenstedt)
D. mammillatum praecox Casey
D. scabrosum Casey
D. orbignyi Hyatt
D. alternans Casey
D. monile (J. Sowerby)
Otohoplites raulinianus (d'Orbigny)
O. elegans (Spath)
O. polygonalis Casey
O. waltoni Casey
O. waltoni niger Casey
? *O. icarus* Casey
O. auritiformis (Spath)

O. auritiformis planidorsatus Casey
O. glyphus Casey
O. subguersanti Casey
Sonneratia trigonalis Casey
S. parenti Jacob
Pseudosonneratia occidentalis Casey
P. occidentalis pluricostata Casey
P. crassa Casey
? Cleoniceras (Cleoniceras) cleon (d'Orbigny)
C. (C.) quercifolium (d'Orbigny)
? Tegoceras gladiator (Bayle)
? T. mosense (d'Orbigny)
? Oxytropidoceras alticarinatum Spath
? Parengonoceras ebrayi (de Loriol)

Protohoplites (Hemisonneratia) puzosianus Subzone

Protanisoceras (Protanisoceras) raulinianum (d'Orbigny)
P. (P.) cantianum Spath
P. (P.) vaucherianum (Pictet)
? P. (P.) hengesti Casey
Beudanticeras newtoni Casey
B. dupinianum (d'Orbigny)
B. dupinianum evolutum Casey
B. arduennense Breistroffer
B. laevigatum (J. de C. Sowerby)
D. mammillatum (Schlotheim)
D. mammillatum aequinodum (Quenstedt)
D. mammillatum praecox Casey
D. scabrosum Casey
D. orbignyi Hyatt
D. alternans Casey
Tetrahoplites cf. *subquadratus* (Sinzow)
Tetrahoplites dragunovi Saveliev
Protohoplites (sensu lato) spp.
Protohoplites (Protohoplites) archiacianus (d'Orbigny)
P. (P.) latisulcatus (Sinzow)
P. (P.) michelinianus (d'Orbigny)
P. (P.) michelinianus costatus Casey
P. (Hemisonneratia) puzosianus (d'Orbigny)
P. (H.) cantianus Casey
P. (H.) gallicus (Breistroffer)
Otohoplites raulinianus (d'Orbigny)
O. elegans (Spath)
O. polygonalis Casey
O. waltoni Casey
O. waltoni niger Casey
O. destombesi Casey
O. simplex Casey
O. guersanti (d'Orbigny)
O. guersanti semiglabrus Casey
O. oweni Casey
O. involutus Casey
O. auritiformis (Spath)
O. auritiformis planidorsatus Casey
O. subchloris Casey
Sonneratia dutempleana (d'Orbigny)
Pseudosonneratia occidentalis Casey
P. occidentalis pluricostata Casey
P. jacobi Casey
P. praedentata Casey
P. crassa Casey
P. acuta Casey
? Cleoniceras (Cleoniceras) cleon (d'Orbigny)
C. (C.) quercifolium (d'Orbigny)

MIDDLE ALBIAN

Hoplites (Hoplites), dentatus Zone
Hoplites ('Isohoplites') eodentatus Subzone

Protanisoceras spp.
Beudanticeras laevigatum (J. de C. Sowerby)
B. aff. *dupinianum* (d'Orbigny)
B. sanctaecrucis Bonarelli
B. albense Breistroffer
Douvilleiceras inaequinodum (Quenstedt)
Cleoniceras (Cleoniceras) devisense Spath
Otohoplites spp.
Otohoplites ? cunningtoni Spath
O. normanniae Destombes et al.
Anahoplitoides mimeticus (Spath)
Hoplites (Isohoplites) steinmanni (Jacob)
H. (I.) eodentatus Casey
H. (I.) spp.
Hoplites (Hoplites) caletanus Destombes et al.
H. (H.) spp.
Lyelliceras camatteanum (d'Orbigny)
L. pseudolyelli (Parona and Bonarelli)
L. hirsutum (Parona and Bonarelli)
L. huberianum (Pictet)
L. vaasti Destombes et al.
Brancoceras (Brancoceras) spp.

Lyelliceras lyelli Subzone

Hypophylloceras sp.
Protanisoceras (Protanisoceras) alternotuberculatum (Leymerie)
P. (P.) barrense (Buvignier)
P. (P.) nodoneum (Buvignier)
P. (P.) moreanum (Buvignier)
P. (P.) spp.
Metahamites sp.
Pseudohelicoceras argonnensis (Buvignier)
Beudanticeras laevigatum (J. de C. Sowerby)
B. sanctaecrucis Bonarelli
B. albense Breistroffer
Douvilleiceras clementinum (d'Orbigny)
Cleoniceras (Cleoniceras) devisense Spath
Hoplites (Hoplites) dentatus (J. Sowerby)
H. (H.) dentatus robusta Spath
H. (H.) dentatus densicostata Spath
H. (H.) dentatus sulcata Seitz
H. (H.) baylei Spath
H. (H.) bullatus Spath
H. (H.) bennetianus (J. de C. Sowerby)
H. (H.) spp.
Lyelliceras pseudolyelli (Parona and Bonarelli)
L. huberianum (Pictet)
L. lyelli (d'Orbigny)
L. lyelli ornatissima Ciry
L. raderaci (Pervinquière)
L. cotteri Spath
L. hirsutum (Parona and Bonarelli)
L. gevreyi (Jacob)
Brancoceras (Brancoceras) senequieri (d'Orbigny)
B. (B.) versicostatum (Michelin)
B. (B.) spp.
Eubrancoceras (Eubrancoceras) aegoceratoides (Steinma
E. (E.) spp.
Oxytropidoceras evansi Spath
O. spp.

Hoplites (Hoplites) spathi Subzone

Pictetia astieriana (d'Orbigny)
Hamites (Hamites) attenuatus J. Sowerby
H. (H.) rotundus J. Sowerby
Protanisoceras (Protanisoceras) spp.
Metahamites sablieri (d'Orbigny)
M. spp.
Hoplites (Hoplites) dentatus (J. Sowerby)
H. (H.) dentatus robusta Spath
H. (H.) dentatus densicostata Spath
H. (H.) dentatus sulcata Spath
H. (H.) spathi Breistroffer
H. (H.) persulcatus Spath
H. (H.) paronai Spath
H. (H.) maritimus Owen
H. (H.) mirabiliformis Spath
H. (H.) obtusus Spath
H. (H.) pringlei Spath
H. (H.) similis Spath
H. (H.) mirabilis Parona and Bonarelli
H. (H.) vectensis Spath
H. (H.) latesulcatus Spath
H. (H.) escragnollensis Spath

H. (H.) rudis Parona and Bonarelli
H. (H.) dorsetensis Spath
H. (H.) canavarii Parona and Bonarelli
H. (H.) canavariformis Spath
H. (H.) spp.
Anahoplites osmingtonensis Owen
A. grimsdalei Owen
A. evolutus Spath
A. mimeticus Spath
A. intermedius Spath
Eubrancoceras spp.
Oxytropidoceras roissyanum (d'Orbigny)
O. mirapelianum (d'Orbigny)
O. cf. carbonarium (Gabb)
O. spp.
Mojsisovicsia delaruei (d'Orbigny)
M. compressa Spath
M. subdelaruei Spath
Falloticeras proteus (d'Orbigny)

Euhoplites loricatus Zone
Anahoplites intermedius Subzone

Tetragonites kitchini (Krenkel)
Hamites (Hamites) attenuatus J. Sowerby
H. (H.) rotundus J. Sowerby
H. (H.) tenuicostatus Spath
H. (H.) compressus Spath
H. (H.) compressus gracilis Spath
H. (H.) gibbosus Spath
Protanisoceras (Heteroclinus) nodosum (J. Sowerby)
P. (H.) flexuosum (d'Orbigny)
Pseudohelicoceras subcatenatum Spath
Falciferella milbournei Casey
Puzosia (Anapuzosia) provincialis (Parona and Bonarelli)
Uhligella derancei Casey
U. derancei erugata Casey
Desmoceras (Desmoceras) latidorsatum (Michelin)
Hoplites (Hoplites) canavariformis Spath ?
H. (H.) pretethydis Spath
H. (H.) dentatiformis Spath
H. spp.
Anahoplites osmingtonensis Owen
A. grimsdalei Owen
A. evolutus Spath
A. mimeticus Spath
A. intermedius Spath
A. mantelli Spath
A. praecox Spath
A. alternatus (Woodward)
A. planus (Mantell)
A. planus compressa Spath
A. planus inflata Spath
A. planus discoidea Spath
A. splendens (J. Sowerby)
Dimorphoplites niobe Spath
Euhoplites subtabulatus Spath
E. pricei Spath
E. loricatus Spath
E. subtuberculatus Spath
E. aspasia Spath
E. microceras Spath
Eubrancoceras (Eubrancoceras) cricki Spath
E. (E.) spp.

Dimorphoplites niobe Subzone

Hamites (Hamites) attenuatus J. Sowerby
H. (H.) rotundus J. Sowerby
H. (H.) tenuicostatus Spath
H. (H.) compressus J. Sowerby
H. (H.) compressus gracilis Spath
H. (H.) gibbosus J. Sowerby
Falciferella milbournei Casey
Engonoceras iris Spath
Hoplites spp.
Anahoplites planus (Mantell)
A. planus compressa Spath
A. planus inflata Spath
A. planus discoidea Spath
A. splendens (J. Sowerby)
Dimorphoplites niobe Spath
Euhoplites pricei Spath
E. loricatus Spath
E. subtuberculatus Spath
E. aspasia Spath
E. microceras Spath
Eubrancoceras (Eubrancoceras) cricki Spath
E. (E.) sp.

Mojsisovicsia subdelaruei Subzone

Hamites (Hamites) attenuatus J. Sowerby
H. (H.) rotundus (J. Sowerby)
H. (H.) tenuicostatus Spath
H. (H.) compressus J. Sowerby
H. (H.) compressus gracilis Spath
H. (H.) gibbosus J. Sowerby
H. (H.) subrotundus Spath
Hoplites spp.
Anahoplites planus (Mantell)
A. planus compressa Spath
A. planus inflata Spath
A. planus discoidea Spath
A. planus sulcata Spath
A. splendens (J. Sowerby)
Dimorphoplites niobe Spath
D. doris Spath
D. pinax Spath
D. biplicatus (Mantell)
Euhoplites pricei Spath
E. loricatus Spath
E. subtuberculatus Spath
E. aspasia Spath
E. microceras Spath
Mojsisovicsia subdelaruei Spath
M. remota Spath
M. spinulosa Spath

Euhoplites meandrinus Subzone

Hamites (Hamites) attenuatus J. Sowerby
H. (H.) rotundus J. Sowerby
H. (H.) tenuiscostatus Spath
H. (H.) compressus J. Sowerby
H. (H.) compressus gracilis Spath
H. (H.) gibbosus J. Sowerby
H. (H.) subrotundus Spath
Hoplites spp.
Anahoplites planus (Mantell)
A. planus compressa Spath
A. planus inflata Spath
A. planus discoidea Spath
A. splendens (J. Sowerby)
A. pleurophorus Spath
Dimorphoplites niobe Spath
D. pinax Spath
D. pinax elegans Spath
D. doris Spath
D. biplicatus (Mantell)
D. hilli Spath
D. perelegans Spath
D. crassa Spath ?
D. parkinsoni Spath

Euhoplites lautus Zone
Euhoplites nitidus Subzone

Hamites (Hamites) rotundus J. Sowerby
H. (H.) compressus J. Sowerby
H. (H.) compressus gracilis Spath
H. (H.) gibbosus J. Sowerby
H. (H.) subrotundus Spath
H. (H.) maximus J. Sowerby
H. (H.) tenuis J. Sowerby

H. (H.) tenuis subacuaria Spath
Proturrilitoides densicostatus (Passendorfer)
Anahoplites planus (Mantell)
A. planus compressa Spath
A. planus inflata Spath
A. planus discoidea Spath
A. planus gracilis Spath
A. splendens (J. Sowerby)
Dimorphoplites biplicatus (Mantell)
D. parkinsoni Spath
D. tethydis (Bayle)
D. tethydis Spath (non Bayle)
D. glaber Spath
D. chloris Spath
Euhoplites truncatus Spath
E. truncatus quadrata Spath
E. lautus (J. Sowerby)
E. lautus duntonensis Spath
E. nitidus Spath
E. opalinus Spath
E. proboscideus (J. Sowerby)
E. proboscideus intermedia Spath
E. bucklandi Spath
Mojsisovicsia equicostata Spath
Dipoloceras cornutum (Pictet)

Anahoplites daviesi Subzone

Hamites (Hamites) compressus J. Sowerby
H. (H.) compressus gracilis Spath
H. (H.) gibbosus J. Sowerby
H. (H.) subrotundus Spath
H. (H.) maximus J. Sowerby
H. (H.) tenuis J. Sowerby
H. (H.) tenuis subacuaria Spath
Anahoplites planus (Mantell)
A. planus compressa Spath
A. planus inflata Spath
A. planus discoidea Spath
A. planus gracilis Spath
A. splendens (J. Sowerby)
A. daviesi Spath
A. daviesi ornata Spath
A. daviesi elegans Spath
Dimorphoplites biplicatus (Mantell)
D. parkinsoni Spath
D. tethydis (Bayle)
D. tethydis Spath (non Bayle)
D. glaber Spath
D. chloris Spath
Euhoplites truncatus Spath
E. truncatus quadrata Spath
E. lautus (J. Sowerby)
E. lautus duntonensis Spath
E. nitidus Spath
E. opalinus Spath
E. probiscideus Spath
E. proboscideus intermedia Spath
E. bucklandi Spath
Dipoloceras cornutum (Pictet)

UPPER ALBIAN

Mortoniceras inflatum Zone
Dipoloceras cristatum Subzone

Phylloceras (Hypophylloceras) subalpinum (d'Orbigny)
Beudanticeras beudanti (Brongniart)
B. subparandieri Spath
Anahoplites planus (Mantell) and vars.
Dimorphoplites glaber Spath
D. chloris Spath
D. tethydis (Bayle)
D. biplicatus (Mantell)
D. parkinsoni Spath
D. ? silenus Spath
Metaclavites metamorphicus (Spath)
M. compressus (Parona & Bonarelli)
M. trifidus (Spath)
Euhoplites truncatus Spath
E. lautus (J. Sowerby)
? E. loricatus Spath
E. opalinus Spath
E. bucklandi Spath
E. proboscideus (J. Sowerby)
E. armatus Spath
E. trapezoidalis Spath
E. serotinus Spath
E. solenotus (Seeley)
E. ochenotus (Seeley)
E. sublautus Spath
Gastroplites cantianus Spath
Neophlycticeras (Protissotia) iterianum (d'Orbigny)
N. (P.) orion Casey
N. (Eotropitoides) jayeti Breistroffer
Oxytropidoceras cantianum Spath
Mojsisovicsia (Dipoloceratoides) cornuta (Pictet)
Dipoloceras cristatum (Brongniart)
D. corbulatum Spath
D. multispinosum Spath
D. fredricksburgense Scott *britannicum* Breistroffer
D. pseudaon Spath
D. moniliforme Spath
D. bouchardianum (d'Orbigny) and vars.
Mortoniceras (Mortoniceras) rigidum Spath
Hysteroceras orbignyi Spath
H. capricornu Spath
H. pseudocornutum Spath
H. (Dipoloceras ?) symmetricum (J. de C. Sowerby)
H. simplicosta Spath
H. serpentinum Spath
Pseudhelicoceras pseudoelegans Spath
Hamitoides ? rusticus Spath
Hamites (Hamites) compressus J. Sowerby
H. (H.) compressus gracilis Spath
H. (H.) incurvatus Brown
H. (H.) maximus J. Sowerby
H. (H.) maximus rectus Brown
H. (H.) gibbosus J. Sowerby
H. (H.) tenuis J. Sowerby

Hysteroceras orbignyi Subzone

Beudanticeras beudanti (Brongiart) & vars.
B. subparandieri Spath
B. sphaerotum (Seeley)
Anahoplites planus (Mantell) & vars.
A. picteti Spath
Metaclavites compressus (Parona & Bonarelli)
M. trifidus (Spath)
Euhoplites truncatus Spath
E. opalinus Spath
E. proboscideus (J. Sowerby)
E. armatus Spath
E. trapezoidalis Spath
E. serotinus Spath
E. solenotus (Seeley)
E. ochenotus (Seeley)
E. sublautus Spath
E. sublautus monacanthus Spath
E. subcrenatus Spath
E. inornatus Spath
E. vulgaris Spath
E. boloniensis Spath
Neophlycticeras (Neophlycticeras) brottianum (d'Orbi
N. (N.) gibbosum Spath
N. (Eotropitoides) jayeti Breistroffer
Dipoloceras pseudaon Spath
D. pseudaon moniliforme Spath
D. bouchardianum (d'Orbigny)
Mortoniceras (Mortoniceras) pricei Spath
M. (M.) pricei intermedium Spath
M. (Deiradoceras) cunningtoni Spath
M. (D.) cunningtoni flexuosum Spath
M. (D.) bipunctatum Spath
M. (D.) devonense Spath

M. (D.) albense Spath
M. (D.) albense transitorium Spath
Prohysteroceras (Goodhallites) goodhalli (J. Sowerby) & vars.
Hysteroceras varicosum (J. de C. Sowerby)
H. varicosum binodosum (Stieler)
H. binum (J. Sowerby)
H. subbinum Spath
H. carinatum Spath
H. carinatum ascendens Spath
H. orbignyi (Spath)
H. aff. *choffati* Spath
H. capricornu Spath
Pseudhelicoceras robertianum (d'Orbigny) & vars.
Idiohamites tuberculatus (J. Sowerby)
I. spiniger (J. Sowerby)
I. subspiniger Spath
Hamites (Hamites) incurvatus Brown
H. (H.) maximus J. Sowerby
H. (H.) maximus rectus Brown
H. (H.) intermedius J. Sowerby
H. (H.) intermedius opalinus Spath
H. (H.) intermedius distinctus Spath

Hysteroceras varicosum Subzone

Puzosia (Puzosia) spathi Breistroffer
Beudanticeras beudanti (Brongniart)
B. subparandieri Spath
Anahoplites planus (Mantell) & vars.
Metaclavites trifidus (Spath)
M. compressus (Spath)
Epihoplites denarius (J. de C. Sowerby)
E. deluci (Brongniart)
E. glyptus Spath
E. gibbosus Spath
Semenovites gracilis (Spath)
S. iphitus (Spath)
Euhoplites alphalautus Spath
E. proboscideus Spath
E. proboscideus ultimus Spath
E. armatus Spath
E. vulgaris Spath
E. boloniensis Spath
Mortoniceras (Mortoniceras) pricei Spath
M. (M.) inflatum (J. Sowerby)
M. (M.) pricei geometricum Spath
M. (Deiradoceras) cunningtoni Spath
M. (D.) cunningtoni flexuosum Spath
M. (D.) bipunctatum Spath
M. (D.) devonense Spath
M. (D.) albense Spath
M. (D.) albense transitorium Spath
Prohysteroceras (Goodhallites) goodhalli (J. Sowerby) & vars.
P. (G.) delabechei Spath
P. (G.) delabechei robustum Spath
Hysteroceras varicosum (J. de C. Sowerby)
H. varicosum binodosum (Stieler)
H. binum (J. Sowerby)
H. subbinum Spath
H. carinatum Spath
H. carinatum ascendens Spath
H. orbignyi (Spath)
Eoscaphites circularis (J. de C. Sowerby) & vars.
E. subcircularis (Spath)
Pseudhelicoceras (Pseudhelicoceras) robertianum (d'Orbigny) & vars
P. ? gaultinum Spath
Anisoceras (Anisoceras) subarcuatum Spath
Idiohamites tuberculatus (J. Sowerby)
I. spiniger (J. Sowerby)
I. turgidus (J. Sowerby) & vars.
I. spinulosus (J. Sowerby)
I. favrinus (Pictet)
"I." ellipticoides Spath
I. ? incertus Spath & vars.
Hamites (Psilohamites) bouchardianus d'Orbigny
Ptychoceras (Mastigoceras) adpressum (J. Sowerby)

Callihoplites auritus Subzone

Anahoplites planus (Mantell) & vars.
A. picteti Spath
A. sp. nov.
Epihoplites gibbosus Spath
Callihoplites catillus (J. de C. Sowerby)
C. potternensis Spath
C. patella Spath
C. strigosus Spath
C. formusus Spath
C. auritus (J. Sowerby)
C. variabilis Spath
Euhoplites alphalautus Spath
E. trapezoidalis Spath
E. vulgaris Spath
Mortoniceras (Mortoniceras) inflatum (J. Sowerby) & vars.
M. (M.) pricei Spath & vars.
M. (M.) fissicostatum Spath & vars.
M. (M.) commune Spath
M. (M.) potternense Spath
M. (M.) evolutum Spath
M. (M.) quadrinodosum Spath
M. (Deiradoceras) cunningtoni Spath & vars.
"Elobiceras" pseudelobiense (Spath)
Prohysteroceras (Goodhallites) goodhali (J. Sowerby) & vars.
P. (Neoharpoceras) coptense Spath
P. (N.) hugardianum (d'Orbigny)
Hysteroceras subbinum Spath
H. carinatum Spath & vars.
H. orbignyi (Spath)
H. bucklandi Spath
Hengestites applanatus Casey
Eoscaphites subcircularis (Spath)
Scaphites simplex Jukes-Browne
Mariella (Mariella) cf. *escheriana* (Pictet)
Pseudhelicoceras (Pseudhelicoceras) robertianum (d'Orbigny) & vars.
Anisoceras (Anisoceras) saussureanum (Pictet)
A. (A.) subarcuatum Spath
Idiohamites tuberculatus J. Sowerby
I. spiniger (J. Sowerby)
I. turgidus (J. Sowerby) & vars.
I. spinulosus (J. Sowerby)
I. favrinus (Pictet)
I. ? incertus Spath & vars.
Hamites (Stomohamites) cf. *parkinsoni* (Fleming)
Lechites gaudini (Pictet & Campiche)

Mortoniceras altonense Subzone

Anahoplites planus (Mantell)
Callihoplites strigosus Spath
? C. horridus Spath
? C. potternense Spath
C. glossonotus (Seeley)
? C. robustus Spath
C. leptus Spath
? C. pulcher Spath
Discohoplites coelonotus (Seeley)
Lepthoplites ornatus Spath
Mortoniceras (Mortoniceras) inflatum (J. Sowerby)
M. (M.) fissicostatum Spath
M. (M.) nanum Spath
M. (M.) altonense Breistroffer
Cantabrigites cantabrigense (Spath)
Prohysteroceras (Goodhallites) candollianum Spath non Pictet
Hysteroceras carinatum Spath & vars.
Scaphites simplex Jukes-Browne
Anisoceras (Anisoceras) armatum (J. Sowerby)
A. (A.) saussureanum (Pictet)
Lechites gaudini (Pictet & Campiche)

Stoliczkaia dispar Zone

Phylloceras (Hypophylloceras) seresitense Pervinquière
Gaudryceras aff. *madraspatanum* (Stoliczka)
Tetragonites sp.
Scaphites (Scaphites) hugardianus d'Orbigny
S. (S.) simplex Jukes-Browne
Mariella (Mariella) bergeri (Brongniart)
M. (M.) miliaris (Pictet & Campiche)
M. (M.) gresslyi (Pictet & Campiche)
M. (M.) cantabrigiensis (Jukes-Browne)
M. (M.) nobilis (Jukes-Browne)
Ostlingoceras (Ostlingoceras) puzosianum (d'Orbigny)
Turrilitoides (Turrilitoides) hugardianus (d'Orbigny)
T. (T.) toucasi (Hébert & Munier-Chalmas)
Anisoceras (Anisoceras) armatum (J. Sowerby)
A. (A.) perarmatum Pictet & Campiche
A. (A.) saussureanum (Pictet)
A. (A.) exoticum Spath
A. (A.) jacobi Breistroffer (*picteti* Spath)
A. (A.) pseudoelegans Pictet & Campiche
Idiohamites dorsetensis Spath
I. elegantulus Spath
Hamites (Stomohamites) virgulatus Brongniart
H. (S.) venetzianus Pictet
H. (S.) duplicatus Pictet & Campiche
H. (S.) charpentieri Pictet
H. (S.) subvirgulatus Spath
H. (S.) ibex Spath
H. (S.) ptychoceratoides Spath
Lytohamites similis Casey
Lechites gaudini (Pictet & Campiche)
L. moreti Breistroffer
L. communis Spath
Desmoceras (Desmoceras) latidorsatum (Michelin) & vars.
Puzosia (Puzosia) provincialis (Parona & Bonarelli)
sharpei Spath
P. (P.) communis Spath
Callihoplites tetragonoides Spath
C. seeleyi (Spath) & vars.
C. vraconensis (Pictet & Campiche) & vars.
C. tetragonus (Seeley) & vars.
C. gymnus Spath & vars.
C. advena Spath & vars.
C. acanthonotus (Seeley) & vars.
C. atavus Spath
C. paradoxus Spath & vars.
C. multifidus Breistroffer
C. robustus Spath
C. cratus (Seeley)
C. glossonotus (Seeley) & vars.
C. leptus (Seeley) & vars
C. pulcher Spath & vars.
C. fuscus Spath
C. senilis Spath & vars.
C. semiglaber Spath
Lepthoplites falcoides Spath
L. cantabrigiensis Spath
L. proximus Spath
L. pseudoplanus Spath
Pleurohoplites renauxianus (d'Orbigny)
P. subvarians Spath
P. epigonus Spath
P. serpentinus Spath & vars.
Arrhaphoceras studeri (Pictet & Campiche) & vars.
A. precoupei Spath
A. transitorium Spath
A. substuderi Spath
A. woodwardi (Seeley)
Discohoplites caelonotus (Seeley)
D. simplex Wright & Wright
D. subfalcatus Semenow)
D. valbonnensis (Hébert & Munier-Chalmas)
D. valbonnensis (Hébert & Munier-Chalmas) *dorsetensis* Wright & Wright
D. daedalius Wright & Wright
D. varicosus Spath
D. subfalcatus (Semenow)
D. anomalus Spath
Hyphoplites costosus Wright & Wright
H. campichei Spath
H. falcatus aurora Wright & Wright
Neophlycticeras (Neophlycticeras) sexangulatum (Seeley
Stoliczkaia (Stoliczkaia) dispar (d'Orbigny)
S. (S.) rhamnonotus (Seeley)
S. (S.) notha (Seeley) & vars.
S. (S.) dorsetensis Spath & vars.
S. (Villoutreysia) sp.
Paradolphia prisca Casey
Engonoceras grimsdalei Spath
Mortoniceras (Mortoniceras) rostratum (J. Sowerby)
M. (M.) fallax Breistroffer
M. (M.) pachys (Seeley)
M. (M.) kiliani (Lasswitz)
M. (Durnovarites) perinflatum (Spath)
M. (D.) quadratum (Spath)
M. (D.) postinflatum Spath
M. (D.) subquadratum Spath & vars.
M. (Cantabrigites) cantabrigense Spath & vars
M. (C.) subsimplex Spath
M. (C.) minor Spath & vars.

Work on other groups of Albian macrofossils i inadequate for the erection of comparable zonal scheme The following notes summarise what is known of the mo important groups ; fuller faunal lists for the Lower Albia are given by Casey (1961) ; the fullest faunal lists f higher parts of the stage remain those of Jukes-Brow and Hill (1900) although Casey (in Smart et al., 1966) h reviewed the faunas of the Gault at Folkestone (Ken

Bivalvia. Inoceramids (see Kauffman, elsewhere th volume) appear to be the most promising bivalve group f correlation purposes. Published information show '*Inoceramus*' *coptensis* Casey occuring in the *tardefurca* and *mammillatum* Zones; '*I.*' *salomoni* (d'Orbigny) restri ted to the *mammillatum* Zone, '*I.*' *concentricus* Parkins ranging from the base of the *dentatus* Zone to the top of t *inflatum* Zone. *Actinoceramus sulcatus* (Parkinson) is co fined to the *cristatum* and *orbignyi* Subzones, where it accompanied by *A.* (?) *subsulcatus* Wiltshire.

The higher parts of the *inflatum* Zone and the *disp* Zone yield inoceramids referred to '*I*'. *anglicus* Woods, '*I. tenuis* Mantell and *I. crippsi* Mantell. No work has be published on these forms since Woods' Monograph (189 1913), nor on the oysters, of considerable potential in sa dier facies.

Coleoidea. Swinnerton (1955) monographed the A bian belemnites, whilst Casey (1961), Milbourne (Hancock 1965) and Spaeth (1974) provide further i formation. Virtually all the belemnites from the Albian our area belong to the genus *Neohibolites*. Milbourne (Hancock 1965) suggested that the varieties recognised Swinnerton should be elevated to specific level, and outli certain changes in gross morphology ; no work multivariate analysis or intraspecific variation has be published to confirm this however. The current state knowledge thus indicates that *Neohibolites minim* (Miller) ranges from the *tardefurcata* Zone up into t Cenomanian, whilst *N. ernsti* Spaeth ranges from *cristatu* to ? *altonense* Subzones.

Arthropoda ; Decapoda and *Cirripedia*. Early work decapods and cirripedes includes monographs by B (1852-1862), Woods (1921-1931), Darwin (1851) a Withers (1935). Collins (in Hancock 1965), Wright a Collins (1973) and Collins (1974) have revised knowledge of these groups ; cirripedes are of li stratigraphic value, but evolutionary changes in the c *Notopocorystes* indicate a limited stratigraphic val although these are rather rare fossils.

Ostracoda. Work on this group has been effectiv restricted to the Middle and Upper Albian Gault C facies. Early work by Jones (1849, 1870), Jones and Hinde (1890) and Chapman and Sherborn (1893) has been revised by Kaye (1964, 1965) ; Hart (1974b) has provided a provisional zonal scheme and summarised the stratigraphic distribution of some commoner taxa, as shown in Text-fig. 7, and summarised below.

Ostracoda are found in large numbers throughout the Gault Clay and at several levels they are even more abundant than the Foraminiferida. The twenty-one species included in Text-fig. 7 are the most abundant. The majority are long-ranging forms (*Cythereis corrigenda* Kaye, *Cythereis reticulata* Jones and Hinde, *Cythereis thorenensis* Triebel, *Cytherella ovata* (Roemer), *Cytherella parallela* Reuss, *Neocythere (Centrocythere) denticulata* Mertens, *Neocythere (Neocythere) vanveeni* Mertens, *Platcythereis gaultina* (Jones), *Protocythere consobrina* Triebel, *Protocythere lineata* (Chapman and Sherborn), *Schuleridea jonesiana* (Bosquet), *Veenia harrisiana* (Jones) and do not allow any very fine subdivision. Five broad zones are recognised.

Zone A. *eodentatus* to *intermedius* Subzones

The Zone is characterised by a fauna dominated by the small species *Schuleridea brevis* (Cornuel), together with the much larger *S. jonesiana*.

Zone B. Upper *intermedius-daviesi* Subzones.

The appearance of *Dolocytheridea bosquetiana* (Jones and Hinde), followed closely by *C. thorenensis* and *Monoceratina umbonata* (Williamson); together with the disappearance of *S. brevis*, marks the base of this Zone.

Zone C. *cristatum* lower *auritus* Subzones

Four species appear at about this level; the more reliable appear to be *Cytherelloidea stricta* (Jones and Hinde), and *Cythereis lurmannae* Triebel, which together with *Macrocypris simplex* Chapman are extremely abundant in the Zone.

Zone D. *auritus* Subzone

The fauna of Zone C continues with little change throughout this Zone, but there is a noticeable difference in that the long ranging species *Bairdia pseudoseptentrionalis* (Mertens) appears in considerable numbers.

Zone E. *dispar* Zone

This Zone is recognised by the reduction of *Cytherelloidea chapmani* (Jones and Hinde) while at the same time there appears to be a corresponding increase in the numbers of *C. stricta*. There is also a marked reduction in numbers of *Cythereis folkestoneiensis* Kaye.

Foraminiferida. Foraminiferida from the English Albian were first monographed by Chapman (1891-1898), since when the only relevant work has been by Khan (1950a-b, 1952) and Bruckshaw et al. (1961) until Hart (1974b) provided a complete zonal scheme for the Middle and Upper Albian, and a statistical basis for correlation on the basis of superfamilial dominance. It is unfortunate that the planktonic foraminiferids are unsuitable for zonal subdivision, only Bandy's (1967) Lower Cretaceous 'primitive planktonic fauna' with forms such as *Hedbergella delrioensis* (Carsey), *H.planispira* (Tappan) and *H. infracretacea* (Glaessner) (=*Globigerina cretacea* Chapman (non d'Orbigny) occurring. Species of *Planomalina* and *Ticinella*, critical for correlation with standard successions, are absent, and Hart's scheme (summarised below and in Text-fig. 8) is thus of Boreal application only.

Zone 3. *eodentatus-niobe* Subzones

Subzone 3i - lower *eodentatus-spathi* Subzones

The fauna of this subzone is essentially that of the forerunners of the basic groups that continue throughout the Gault Clay. The *Arenobulimina* group is represented by *A. macfadyeni*, while the *Gavelinella/Lingulogavelinella* group is represented by *G.intermedia* and *G. tormarpensis*. Although *Epistomina spinulifera* (Reuss) *(Pulvinulina spinulifera* (Reuss) Chapman 1896 pl. 2, fig. 1a-c), *Hoeglundina carpenteri* (Reuss) *(Pulvinulina carpenteri* (Reuss) Chapman 1898, pl. 1, fig. 11a-c) and *Conorboides lamplughi* (Sherlock) are found at this level they are not important elements of the fauna and the Subzone is dominated by the agglutinated species (which also include *Labrospira latidorsata* (Borneman) *(Haplophragmium latidorsatum* (Borneman) (Chapman 1892, pl.5, fig. 12a-b) and *Labrospira nonionoides* (Reuss) *(Haplophragmium nonionoides* Reuss: Chapman 1892, pl. 5, fig. 9a-b) of which *A. macfadyeni* is the most important.

Subzone 3ii - *intermedius-niobe* subzones

While the above fauna continues unchanged, *E. spinulifera* and *Hoeglundina chapmani* (Ten Dam) *(Pulvinulina carcolla* (Roemer) Chapman 1898, pl. 1, fig. 9, and *Pulvinulina elegans* (d'Orbigny) Chapman 1898, pl. 1, fig. 8), together with *H. carpenteri*, are more abundant. *H. delrioensis* and *H. planispira* also appear at this level together with *Quinqueloculina antiqua* Franke *(Miliolina venusta* Karrer: Chapman, 1891, pl. 9, figs. 5-6 and *Miliolina ferussaci* (d'Orbigny) Chapman 1891, pl. 9, fig. 8). *'Siphouvigerina' asperula* (Chapman) *(Sagrina asperula* Chapman 1896, pl. 12, fig. 1) is commonly found in the lower levels of this subzone.

Zone 4. *subdelaruei-cristatum* Subzones

The base of the zone is marked by the appearance of *Nodobacularia nodulosa* (Chapman) *(Nubecularia nodulosa* Chapman 1891, pl. 9, fig. 2) with *Dorothia filiformis* (Berthelin) *(Gaudryina filiformis* Berthelin : Chapman 1892, pl. 11, fig. 7), and the loss of *C. lamplughi*. The fauna of the greater part of this Zone is dominated by large, highly ornamented specimens of *E. spinulifera*.

Transitional Zone 4a. Upper *cristatum* - lower *orbignyi* Subzones

At the base of transitional zone 4a (the level of the *cristatum* phosphate bed in the Folkestone Gault), there is an important faunal turnover with the appearance of a typically Upper Albian fauna which includes *A. chapmani*, *Citharinella pinnaeformis* (Chapman) *(Frondicularia pinnaeformis* Chapman 1894, pl. 3, figs. 9-11), *Spiroloculina papyracea* Burrows, Sherborn and Bailey, *Vaginulina mediocarinata* Tem Dam *(Vaginulina strigillata* Reuss : Chapman 1894, pl. 8, figs. 3-4), *G. cenomanica*, and *H. infracretacea*. At the same level the *A. macfadyeni* fauna is severely reduced while *H. chapmani* disappears. Although *E. spinulifera* dies out within Zone 4a, derived, corroded specimens can be found above this level.

Zone 5. Upper *orbignyi*-lower *auritus* Subzones

With the marked reduction of the robertinacean fauna, and the loss of *E. spinulifera*, the fauna from this Zone becomes more typically Upper Albian. *A. chapmani* remains the dominant species with *C. pinnaeformis*, *G. reussi*, *Tritaxia pyramidata* Reuss *(Verneuillina triquetra* Chapman (non Munster) 1892, pl. 6, fig. 24a-b and *Tritaxia tricarinata* Chapman (non Reuss) 1892, pl. 1, fig. 1a) and *Dorothia gradata* (Berthelin) *(Gaudryina pupoides* Chapman (non d'Orbigny) 1892, pl. 11, fig. 8a-b and *Gaudryina rugosa* Chapman (non d'Orbigny) 1892, pl. 11, fig. 9a-b) being less important elements of the fauna.

Transitional Zone 5a - Middle *auritus* subzone

As in the case of Zone 4, there follows a transitional Zone, marked by the appearance of three very distinctive species, *A. sabulosa*, *L. jarzevae*, and *Marssonella ozawai* Cushman. With the appearance of *Citharinella laffittei* Marie in the centre of this transitional Zone the fauna almost becomes that which characterises the remainder of the Upper Gault Clay succession.

Zone 6. Upper *auritus* Subzone and *dispar* Zone

The appearance of *A. frankei* and the planktonic species *G. bentonensis*, *Guembilitria harrisi* Tappan, and *Heterohelix moremani* (Cushman), with a complementary reduction in the numbers of *C. pinnaeformis*, identifies this final zone of the Gault Clay. Although the fauna is essentially continuous throughout this interval, two subzones can be recognised and used for correlative purposes.

Subzone 6i - upper *auritus* Subzone

This subzone contains a fauna rich in large specimens of *G. bentonenesis*.

Subzone 6ii - *dipar* Zone

A. sabulosa and *A. chapmani* occur in almost equal numbers in this subzone. *A. frankei* and *C. laffittei* are also more frequently encountered, as are specimens belonging to the Family Polymorphinidae (e.g. *Globulina* spp.), with fistulose variants being concentrated at particular intervals.

Although this completes the succession as found at the surface at Folkestone there is an added complication : in some of the boreholes from the English Channel another cycle of sedimentation has been found between Subzone 6ii and the base of the overlying Cenomanian Glauconitic Marl, which forms the base of the Lower Chalk.

Subzone 6a (macrofaunal equivalent unknown)

This Subzone is difficult to place in either the Albian or the Cenomanian.

The fauna contains the following indicators :

typically Albian species in Britain: *A. chapmani, A. sabulosa, A. frankei.*
typically Cenomanian species in Britain: *Arenobulimina advena* (Cushman), *Plectina mariae* (Franke), *Flourensina intermedia* Ten Dam, *Gaudryina austinana* Cushman.

As keeled planktonic species belonging to the genus *Praeglobotruncana* Bermudez appear in the overlying Glauconitic Marl it would seem more correct (Bandy 1967) to place this subzone in the Upper Albian, even though some of the more important Cenomanian benthonic species are present. This problem is made more difficult by the fact that the majority of the species under discussion are evolutionary derivatives of one another. At Folkestone it has been possible to demonstrate that *A. advena* developed from *A. chapmani* with the appearance of the internal partitions which normally characterize the Cenomanian species. In the same interval the triserial *F. intermedia* appears to develop from the quadriserial *A. sabulosa* by the reduction of the number of chambers in each whorl. the fauna of subzone 6a is therefore one of a complete transition. Where this subzone is lacking there is no problem in the identification of the Albian-Cenomanian boundary since the transitional forms of these tawo evolutionary sequences are not recorded.

In northern France, Marie (1965, with references) has similarly documented the distribution of Albian Foraminiferida, and reviewed earlier literature.

Nannofossils. Gault coccoliths were first recognised by Murray and Blackman (1898) and a complete monograph of the flora of the British Gault has been published by Black (1972-1975 with bibliography). Most taxa are very long ranging, and no stratigraphic summary or zonal conclusions are available other than those tentatively proposed by Thierstein (1971). Work on non-calcareous microplankton is also somewhat limited, although some systematic and stratigraphic discussions are given by Cookson and Hughes (1964) and Davey (1969, 1970).

CENOMANIAN. Zonal subdivision of the Cenomanian of England and the western parts of the Paris Basin began with the work of Hébert (1863, 1864, 1866, 1875) w suggested the following succession :

Turonien (Craie marneuse)	Craie à *Inoceramus labiatus* et *Ammonites nodosoides*
	Craie à *Turrilites costatus*
Cénomanien (Craie glauconieuse)	Craie à *Turrilites tuberculatus*
	Glauconie à *Turrilites bergeri* et *Ammonites inflatus*

In 1874, Hébert produced an account of the successio in both southern England and northern France, noting t close similarities ; his work was extended by Cha Barrois (1875, 1876) who, for the first time produced correlation of d'Orbigny's stages with divisions recogni by British geologists e.g. Mantell (1818, 1822). Phill (1821) and Evans (1870). Barrois'succession was as follo

Turonien	Zone à *Inoceramus labiatus*
	Zone à *Belemnites plenus*
Cénomanien	Zone à *Holaster subglobosus*
	Zone à *Pecten asper*
	Zone à *Ammonites inflatus*

Subsequently, Jukes-Browne and Hill (1896, 19 refined Barrois' work, and used two divisions in Cenomanian :

Holaster subglobosus Zone
Schloenbachia varians Zone

These authors noted that *Holaster subglobosus* had somewhat different distribution in Yorkshire and L colnshire and proposed a Zone of *Offaster sphaericus* as alternative in this region.

These authors recognised a horizon characterised *Belemnites plenus* at the top of their *subglobo sphaericus* Zone, and this 3-fold division survived in literature until today (although the position of the *ple* Zone or Subzone has been disputed).

In France, the work of Lennier (1867, 1882) in Ha Normandie, and Guéranger (1867), Triger (1869), B (1881) and Guillier (1886) in Sarthe and Maine led e tually to the proposition of a two fold division based on monites (de Grossouvre 1901) :

Turonien	Zone à *Mammites nodosoides*
Cénomanien	Zone à *Acanthoceras rhotomag*
	Zone à *Acanthoceras mantelli*
Albien Supérieur	Zone à *Stoliczkaia dispar*

This subdivision is basically satisfactory and remaine use in France until very recently. In contrast, the Eng zonation is far from satisfactory. *Holaster suglobosus* different ranges in northern and southern England, wh Wright (in Peake and Hancock 1961) has recorded species from the top Albian *dispar* Zone. *Schloenba varians* is an equally unsatisfactory index fossil (comp Peake and Hancock 1961, p. 299). As interpreted Jukes-Browne and Hill, it was used for all species of genus *Schloenbachia*, which ranges throughout most of Cenomanian stage. Interpreted in terms of the lecto (BMNH C43962b), *S. varians* is a Lower Cenoma species.

The work of L.F. Spath (1923c, 1926) appeared major advance in the subdivision and correlation of Cenomanian. His 1923c scheme is as follows :

Upper Cenomanian (Acanthoceratan) *subglobosus* Zone of authors	*Metoicoceras pontieri*
	Acanthoceras cenomanense
	Calycoceras baylei
Lower Cenomanian Schloenbachian) *varians* Zone of authors	*Euomphaloceras euomphalum*
	Hyphophites falcatus
	Mantelliceras martimpreyi

with a provisional subdivision of the *euomphalum falcatus* Zones as follows :

Protacanthoceras compressum (Jukes-Browne)
Schloenbachia costata (Sharpe)
Forbesiceras sp. (aff. *complanatum* Mantell)
Calycoceras naviculare (Sharpe) *non* Mantell
Mantelliceras sp. aff. *feraudianum* Sharpe, *non* d'Orbigny
Mantelliceras mantelli (J. Sowerby)

From the remainder of the part of this paper dealing with the Cenomanian it is clear that Spath's ideas on Cenomanian ammonite successions were still developing, and in 1926 he produced a very comprehensive zonal scheme :

	Subzones	Old Zones
Turonian (Mammitan)	*whitei* *pontieri*	plenus
Upper Cenomanian (Acanthoceratan)	*vicinaie* *subflexuosum*	subglobosus
	rhotomagense *diadema* *vectense*	upper *varians* (=*euomphalus*)
Lower Cenomanian (Mantelliceratan)	*costatum* *cantianum*	lower *varians* (= *falcatus*)
	martimpreyi *Stauronema carteri* and *Pecten asper* pre-*martimpreyi*	
Upper Albian (Pleurohoplitan)	*dispar* *substuderi*	*Pecten asper* (pars.)

This scheme is a combination of intuition and guesswork, based, like many of Spath's schemes, on museum work and little field collecting. This succession has been the basis of widespread discussion, in the mistaken belief that it corresponded to established successions (Dubourdieu 1953, 1956 ; Muller and Schenk 1943 ; Thomel 1965 ; Jeletzky 1968) and terms such as *martimpreyi* Zone are still in use. Kennedy (1969, 1971) and Kennedy & Hancock (1971) have discussed the flaws in this zonation, which may be summarised as follows.

1. The pre-*martimpreyi* Subzone

"Apart, possibly from certain undescribed Warminster ammonites of the genera *Submantelliceras* and *Euhystrichoceras*, the exact horizon of which is unknown, the only British forms that can be ascribed to the (provisional) pre-*martimpreyi* Zone belong to a curious fauna of uncoiled types - Anisoceratids, etc., known only from Gore Cliff, Isle of Wight. These comprise undescribed Algeritids, notably *Idiohamites*, distinguished from *Anisoceras* by ornamentation and simple suture line, with bifid dorsal lobe. They are partly derivatives of *Idiohamites dorsetensis* nov., referred to below, and developments of forms like *Anisoceras picteti* nov. and *A. campichei* nov., all from the earlier *dispar* Zone" (Spath 1926, p. 424).

This is indeed the earliest extensive Cenomanian fauna found in England, and indeed western Europe, and although Spath recorded it only from Gore Cliff, this, the *carcitanensis* assemblage fauna, also occurs elsewhere in the Isle of Wight, around Lewes (Sussex), Selborne (Hants.), in South-west England, Haute Normandie, Sarthe and elsewhere (Juignet and Kennedy 1976 ; Hancock, Kennedy and Klaumann 1972).

2. The *martimpreyi* Subzone

"*Mantelliceras martimpreyi* is easily confused with the flattened forms of the (probably later) *couloni* type ; and Pervinquière identified with it some Tunisian forms that are here referred to *Mantelliceras batheri* nov., and *Eucalycoceras lymense* nov. Since at Berrouaghia in Algeria, *Mantelliceras martimpreyi* occurs in the lowest ('*Algerites*') and highest beds (above *Eucalycoceras constrictum* nov., which cannot be very low in the Cenomanian), it is, perhaps a somewhat doubtful fossil, but *Mantelliceras saxbii* (Sharpe) is a closely allied British species " (Spath 1926, p. 424).

Kennedy and Hancock (1971) have now shown that the original *martimpreyi* Zone of Spath is well above the base of the Cenomanian stage, and since Spath gave Ventnor (Isle of Wight) and Warminster (Wilts.) as localities for the Zone, there seems no doubt that, as originally conceived, the *martimpreyi* Zone fauna corresponds to the *saxbii* Zone fauna listed below.

3. *costatum* and *cantianum* Subzones

These divisions are not supported by field evidence : both species range down to the base of the Lower Cenomanian. Of more interest is the equation of this part of the Cenomanian with a '*falcatus*' Zone, for *Hyphoplites* is abundant above *saxbii* Zone faunas in the Isle of Wight, Hampshire and elsewhere. Spath's suggestion that *Hyphoplites* ranges into beds with '*Protacanthoceras* of the *hippocastanum* group' is based on remanié specimens from Middle Cenomanian Chalk Basement Beds of south-west England.

4. The *euomphalum* Zone

Use of *E. euomphalum* as a zonal index for such a low level in the Cenomanian is puzzling, since this is in fact a very late Cenomanian species. Two explanations seem possible ; firstly Spath may have considered *E. cunningtoni* to be a synonym of *E. euomphalum* (as have some subsequent workers), or he may have been misled by specimens of *E. euomphalum* in the British Museum and Geological Survey Collections which are mis-labelled, and said to come from Middle Cenomanian Basement Beds at Evershot (Dorset) and Chardstock (Devon) (which they certainly do not), or the type, which is also mislocalized (Wright and Wright 1951).

Spath's subdivisions of the Upper Cenomanian are not valid. *Acanthoceras vectense* (= *A. sussexiense*), *A. rhotomagnense* (Spath non Brongniart ?), and *A. subflexuosum* being variants of a single contemporaneous species (Kennedy and Hancock 1970).

5. *vicinale* Subzone

Casey (1960) and Matsumoto, Sastry and Sarkar (1966) successfully demonstrated the unsatisfactory nature of *Ammonites vicinalis* as an index for the top of the Cenomanian ; it is, in fact, a Lower Cenomanian form. Wright's (1956) Upper Cenomanian *Utaturiceras* are *Thomelites* (Wright and Kennedy in Juignet et al., 1973).

The first satisfactory ammonite zonation of the Cenomanian of England and northern France was published by Hancock (1959) and was based upon the unpuplished work of C.W. Wright in England, and a revision of the ammonites of the Cenomanian in the type area around Le Mans. The division was as follows :

Upper Cenomanian	*Calycoceras naviculare* Zone
Middle Cenomanian	*Acanthoceras rhotomagense* Zone
Lower Cenomanian	*Mantelliceras mantelli* Zone

This broad zonal division has found general acceptance and can be applied over the whole of western Europe (Christensen 1975, Marcinowski 1974) and beyond.

Subsequent detailed work on the English Lower Chalk (Kennedy 1969, 1970) and systematic revisions of the ammonite fauna (Kennedy and Hancock 1970, 1971 ; Kennedy 1971) led to tentative divisions of the lower two zones into a series of 'assemblages'. These assemblages have now been recognised in northern France (Kennedy and Juignet 1976) ; the lowest has been found in western Germany (Hancock, Kennedy and Klaumann 1972), and there is some hope of their recognition in Poland (Marcinowski 1974). Cooper (this volume) has been able to distinguish them in Angola, and we have been able to recognise some of them in north Africa, South Africa and Texas.

During the same period, R.P.S. Jefferies published his extensive work on the faunas of the *plenus* 'Subzone' (1962, 1963). The unit was originally regarded as Cenomanian by Jukes-Browne and Hill (1896, 1903) and subsequent authors, until Spath (1926) referred it to the Turonian on the basis of the Turonian aspect of the ammonite fauna, and since this time, there have been widely divergent views as to the precise position of the Cenomanian-Turonian boundary, as is discussed below under the Turonian stage. Our current view is to regard Jefferies '*Metoicoceras geslinianum*' and '*gourdoni*' Zones, together with a part of the succeeding Middle Chalk / Craie Marneuse as Cenomanian, giving the following zonation :

Upper Cenomanian	*Sciponoceras gracile* Zone *Eucalycoceras pentagonum* / *Calycoceras naviculare* Zone
Middle Cenomanian	*Acanthoceras jukesbrownei* Zone *Turrilites acutus* Zone *Turrilites costatus* Zone
Lower Cenomanian	*Mantelliceras* gr. *dixoni* Zone *Mantelliceras saxbii* Zone *Hypoturrilites carcitanensis* Zone

This basic succession is well established, and although certain revisions of earlier zonal nomenclature have been made as discussed below, the sequence of faunas is not in dispute.

The base of the Cenomanian stage in north-western Europe is thus characterised by the appearance of diverse acanthoceratids including *Mantelliceras, Sharpeiceras, Paracalycoceras and Acompsoceras*, together with an abundance of *Schloenbachia* and the heteromorph *Hypoturrilites*. There have been a number of records of the precocious appearance of several of these genera associated with *dispar* Zone ammonites, and whilst the existence of intermediate faunas is to be expected, a re-examination of several of these records suggests that all require reinvestigation. Over much of western Europe the base of the Cenomanian is marked by a sharp omission surface, and Cenomanian sediments and faunas occur let down into Albian sediments in burrow infills. Wright's (1947) and Spath's (1938) records of *Schloenbachia* from the *dispar* Zone of the Dorset coast represent occurrences of this type (Wright 1959, p. 766, see also Smart 1955), whilst Kennedy (1971, p. 45) has noted occurrences of this type elsewhere in England. Thomel's (1961) record of *Schloenbachia* from the Upper Albian of the Alpes Maritimes may be a similar occurrence (Thomel 1965, p. 136) ; we have been unable to reinvestigate Breistroffer's records of Albian *Schloenbachia* from La Fauge (Vercours) and Follet's (1954) record from Saint-Armand-des-Hautes-Terres (Eure) also merits reappraisal. *Schloenbachia* evolves from several of the *dispar* Zone species of the 'genera' *Arrhaphoceras, Lepthoplites, Pleurohoplites* and *Callihoplites* (which probably represent a single variable species only) by accentuation of the keel and minor changes in sculpture. Some individuals in our collections from the *dispar* Zone show intermediate features, and Scholz' (1973) subgenus *Schloenbachia (Praeschloenbachia)* appears to be based on just such variants. Records of true *Mantelliceras* from the *dispar* Zone also appear unsubstantiated. Specimens of *Stoliczkaia* from this level sometimes develop nuclei with 'submantellicerine' ornament (Kennedy 1971, pl. 17, figs. 3a-b - 7a-b ; Kennedy and Hancock 1971, pl. 81, figs. 11-13) and Albian *Mantelliceras* or *Submantelliceras*' recorded by Thomel (1968) are based upon such material. Larger '*Submantelliceras*' *saxbii* from Provence recorded and figured by Thomel 1972, pl. 1, figs. 10-12 are, in our view, crushed *Stoliczkaia* of the *dorsetensis* group. Re-examination of the supposed Albian *Hypoturrilites, H. primitivus* Clark (1965, p. 51, pl. 19, figs. 1-3) reveals it to be a pathological *Mariella*.

A final comment is to note that *Stoliczkaia* (as a new, unnamed subgenus) survives into the Lower Cenomania[n] both England and northern France (Hancock 1959).

The ammonite fauna of the currently recognised zon[es] the Cenomanian are as follows :

LOWER CENOMANIAN

Hypoturrilites carcitanensis assemblage Zone

Schloenbachia varians and its varieties are the [...] frequent ammonites, accompanied by inflated *M[an]telliceras* such as *Mantelliceras mantelli* (J. Sowerby), *tuberculatum* (Mantell) and *M. cantianum* Spath (per[haps] no more than variants of a single species). *Hypoturri[lites] carcitanensis* (Matheron) with, less frequently *Idiohan[...]* *collignoni* Spath, *I. alternatus* (Mantell) and varie[...] *Anisoceras armatum* (J. Sowerby), *A. auberti* ([Per]vinquière) and *A. jacobi* Breistroffer are typical. The [com]plete fauna is as follows :

Anisoceras (Anisoceras) armatum (J. Sowerby)
A. (A.) aff. *jacobi* Breistroffer
A. auberti Pervinquière
Acompsoceras spp.
Austiniceras austeni (Sharpe)
Desmoceras latidorsatum (Michelin)
Euhystrichoceras nicasei (Coquand)
E. simplex Spath
E. constrictum Spath
Forbesiceras largilliertianum (d'Orbigny)
F. obtectum (Sharpe)
F. beaumontianum (d'Orbigny)
Hyphoplites arausionensis arausionensis (Hébert and Munier-Chalmas)
H. arausionensis horridus Wright and Wright, and transition forms
H. campichei (Spath)
H. cf. *falcatus* (Mantell)
H. pseudofalcatus (Semenow)
Hypoturrilites gravesianus (d'Orbigny)
H. tuberculatus (Bosc)
H. carcitanensis (Matheron)
H. mantelli (Sharpe)
Idiohamites alternatus (Mantell)
I. alternatus vectensis Spath
I. ellipticus (Mantell)
I. ellipticus radiatus Spath
I. collignoni Spath
I. spp.
Lechites ? sp.
Mesogaudryceras leptonema (Sharpe)
Mariella (Mariella) cenomanensis (Schlüter)
M. (M.) essenensis (Geinitz)
M. (M.) lewesiensis (Spath)
M. (M.) spp. nov.
Mantelliceras costatum (Mantell)
M. cantianum Spath
M. aff. *saxbii* (Sharpe)
M. aff. *ventnorense* (Diener)
M. mantelli (J. Sowerby)
Puzosia spp.
Scaphites sp. (*? hilli* Adkins and Winton)
Schloenbachia varians (J. Sowerby) and varieties
Sciponoceras roto Cieśliński
S. sp. nov.
Stomohamites duplicatus (Pictet and Campiche)
Sharpeiceras laticlavium (Sharpe)
S. schlueteri Hyatt
S. cf. *florencae* Spath
Ostlingoceras bechii (Sharpe)
O. puzosiforme Spath
O. gallienii (Boule, Lemoine and Thévenin)
Turrilites (Mesoturrilites) sp.

Mantelliceras saxbii Assemblage Zone

Schloenbachia remains the dominant genus, althou[gh in]flated forms are less frequent than below. Compr[...]

Mantelliceras of the *saxbii* group - *M. saxbii* (Sharpe), *M. ventnorense* (Diener) and *M. tenue* Spath - are more frequent, although inflated forms like *M. mantelli* survive. The species of *Idiohamites* and *Anisoceras*, characteristic of the *carcitanensis* Zone have virtually disappeared. *Hyphoplites falcatus* (Mantell) and related forms are locally common.

The fauna is as follows :

Acompsoceras sarthense (Guéranger)
A. renevieri (Sharpe)
A. sp..
Austiniceras austeni (Sharpe)
Desmoceras spp.
Forbesiceras spp.
Hyphoplites campichei Spath
H. falcatus falcatus (Mantell)
H. falcatus interpolatus Wright and Wright
H. curvatus (Mantell)
H. arausionensis (Hébert and Munier-Chalmas)
Hypoturrilites aff. *carcitanensis* (Matheron)
H. mantelli (Sharpe)
H. gravesianus (d'Orbigny)
H. tuberculatus (Bosc)
Mantelliceras mantelli (J. Sowerby)
M. costatum (Mantell)
M. cantinaum Spath
M. saxbii (Sharpe)
M. ventnorense (Diener)
M. tenue (Spath)
Phylloceras (Hypophylloceras) cf. *seresitense* Pervinquière
Puzosia octosulcata (Sharpe)
Scaphites obliquus J. Sowerby
S. aff. *equalis* J. Sowerby
Sciponoceras spp.
Stomohamites sp.
Schloenbachia varians (J. Sowerby) and varieties
Sharpeiceras laticlavium (Sharpe)

Mantelliceras dixoni Assemblage Zone

Relatively compressed *Schloenbachia* are the commonest ammonites. They are accompanied by the youngest representatives of the genus *Mantelliceras*, generally characterised by strong ribs, and, in inflated forms, show a superficial homoeomorphy with *calycoceras*, although they lack siphonal tubercles even when juvenile. *M. dixoni* has been selected as zonal index until the fauna has been fully documented ; a more satisfactory species may be *M. orbignyi* (Collignon).

The fauna is :

Hypoturrilites tenouklensis (Pervinquière)
H. sp..
Austiniceras austeni (Sharpe)
Acompsoceras aff. *essendiense* (Schlüter)
Mantelliceras gr. *dixoni* Spath
M. aff. *souaillonense* (Renz)
M. orbignyi (Collignon)
M. lymense (Spath)
M. cf. *mantelli* (J. Sowerby)
Paracalycoceras spp.
Schloenbachia varians (J. Sowerby) and varieties
Scaphites obliquus J. Sowerby
S. spp.
Turrilites costatus Lamarck
T. spp.

MIDDLE CENOMANIAN

In all sections we have studied there are no transitional faunas between the *Mantelliceras*-dominated acanthoceratid assemblages of the Lower Cenomanian and the *Acanthoceras-Calycoceras* dominated assemblages of Middle Cenomanian age. There is either a relatively barren gap in the sequence, or, as in Normandy and Maine, a regional non-sequence. In the lowest zone, that of *Turrilites costatus*, *Schloenbachia varians* is replaced by *Schloenbachia coupei* (Brongniart) and varieties as the commonest ammonite, whilst the first *Acanthoceras* of the *rhotomagense* (Brongniart) and *Calycoceras* of the *gentoni* (Brongniart) group appear. *Turrilites costatus* Lamarck is abundant, and floods of *Sciponoceras baculoide* (Mantell) appear towards the top of the zone.

The fauna is :

Acanthoceras rhotomagense rhotomagense (Brongniart)
A. rhotomagense subflexuosum Spath
A. rhotomagense sussexiense (Mantell)
A. rhotomagense clavatum Kennedy and Hancock
A. rhotomagense confusum (Guéranger)
A. bassae Kennedy and Hancock
Austiniceras austeni (Sharpe)
Puzosia spp.
Acompsoceras essendiense (Schlüter)
A. sarthense (Guéranger)
A. spp.
Desmoceras latidorsatum (Michelin)
Anagaudryceras involvulum (Stoliczka) (Normandy)
Borissiakoceras mirabile (Archanguelsky) (Normandy)
Anisoceras plicatile (J. Sowerby)
A. spp.
Forbesiceras largilliertianum (d'Orbigny)
F. obtectum (Sharpe)
Hypoturrilites gravesianus (d'Orbigny)
Scaphites obliquus J. Sowerby
S. equalis J. Sowerby
Calycoceras gentoni (Brongniart) and varieties
Euomphaloceras inerme (Pervinquière)
Sciponoceras baculoide (Mantell)
Hamites (Stomohamites) simplex d'Orbigny
Turrilites costatus Lamarck
T. scheuchzerianus Bosc
T. acutus Passy
Schloenbachia coupei (Brongniart) and varieties

Turrilites acutus Assemblage Zone

Turrilites acutus Passy replaces *T. costatus* Lamarck as the dominant *Turrilites*. *Scaphites equalis* J. Sowerby is more frequent than below, as are diverse *Calycoceras*.

The fauna includes :

Acanthoceras rhotomagense rhotomagense (Brongniart) and varieties)
A. latum Crick
Austiniceras austeni (Sharpe)
Anisoceras plicatile (J. Sowerby)
A. spp.
Acompsoceras spp.
Calycoceras newboldi newboldi (Kossmat)
C. newboldi spinosum (Kossmat)
C. newboldi planecostata (Kossmat)
C. gentoni (Brongniart) and varieties
Euomphaloceras group of *inerme* (Pervinquière)
E. cunningtoni (Sharpe)
Forbesiceras obtectum (Sharpe)
F. largilliertianum (d'Orbigny)
F. spp.
Protacanthoceras spp. nov.
Eucalycoceras ? spp.
Puzosia subplanulata (Schlüter)
P. aff. *crebrisulcata* (Kossmat)
P. spp.
Schloenbachia coupei (Brongniart) and varieties
Scaphites equalis J. Sowerby
S. obliquus J. Sowerby
Sciponoceras aff. *baculoide* (Mantell)
S. spp.
Hamites (Stomohamites) simplex d'Orbigny
Turrilites acutus Passy
T. costatus Lamarck
T. scheuchzerianus Bosc.
Worthoceras sp.

Acanthoceras jukesbrownei Assemblage Zone

This zone is characterised by the appearance of large *Acanthoceras* characterised by coarse, distant alternately long and short ribs - *Acanthoceras jukesbrownei* Spath and *A. whitei* Matsumoto.

Acanthoceras jukesbrownei Spath
A. whitei Matsumoto
A. spp.
Austiniceras austeni (Sharpe)
Acompsoceras sarthense (Guéranger)
Calycoceras choffati (Kossmat)
C. cenomanense (d'Archiac)
C. boulei Collignon
C. aff. *gentoni* (Brongniart)
C. ex. gr. *newboldi* (Kossmat)
C. (Lotzeites) sp.
Protacanthoceras spp. nov.
Scaphites equalis J. Sowerby
S. obliquus J. Sowerby
Eucalycoceras gothicum (Kossmat)
Hamites (Stomohamites) simplex d'Orbigny
Turrilites acutus Passy
T. costatus Lamarck
T. scheuchzerianus Bosc
Sciponoceras sp

UPPER CENOMANIAN

Calycoceras naviculare was used by Hancock (1959) as an index for a zone broadly equivalent to the whole of the Upper Cenomanian substage. Jefferies (1962, 1963) introduced Zones of *Metoicoceras geslinianum* (below) and *Metoicoceras gourdoni* (above) within his '*plenus* Subzone'. Subsequently Kennedy and Juignet (1973) and Juignet et al (1973) pointed out that there was an unnamed interval, which should be included in the Cenomanian, above the *plenus* Zone and below the first appearance of typically Turonian ammonites such as *Mammites*, *Fagesia* and *Metasigaloceras*. This led to the following zonation of the Upper Cenomanian:

un-named interval ('Horizon A')
Metoicoceras gourdoni Zone
Metoicoceras geslinianum Zone
Calycoceras naviculare Zone

Thomel (1972, 1973) has pointed out that, in southern France, *Calycoceras naviculare* is commonest in the *plenus* Zone; indeed, he has used the term *naviculare* Zone for this latter interval.

In view of these two different usages of the term *naviculare* Zone, Juignet and Kennedy (1977) have proposed a *Eucalycoceras pentagonum* assemblage Zone as a replacement for the *naviculare* Zone as used by Kennedy (1969-71) and Juignet e t al (1973) in the Anglo-Paris Basin. Although *E. pentagonum* (Jukes-Browne) is a somewhat uncommon species and restricted to the upper part of its zone, it appears to be a suitable index for this assemblage zone in that it is: 1. readily recognisable; 2. its stratigraphic horizon is well known 3. the species is geographically widespread. However, the two authors of this paper disagree on the name for this zone : J.M.H. wishes to retain a *naviculare* Zone, W.J.K. wishes to use a *pentagonum* Zone.

The subdivisions of the *plenus* Zone on an international scale into Zones of *M. geslinianum* below and *M. gourdoni* above cannot be maintained. To avoid confusion we therefore propose *Sciponoceras gracile* (Shumard) as an index for a broad zone which includes not only the *geslinianum* and *gourdoni* Zones (of Jefferies 1962, 1963, and others), but also Horizon A of Juignet et al (1973) into which *S. gracile* ranges. This zone is believed to correspond to the Zone of *S. gracile* used in North America.

The *pentagonum/naviculare* and *gracile* assemblage Zones compare in status to the classic *mantelli* and *rhotomagense* Zones, and with them, will probably serv standards for broad global zonation of the Cenoman stage. Definition of finer, more restricted, north-w European divisions of the *pentagonum/naviculare* *gracile* assemblage Zones, corresponding in other word the local zonations (e. g. *carcitanensis*, *saxbii*, *dix* *costatus*, *acutus* and *jukesbrownei* assemblage Zones England and northern France) must await further study faunas from both southern England and Sarthe.

Eucalycoceras pentagonum/Calycoceras naviculare

assemblage Zone

This zone is characterised by the frequent occurrenc *Calycoceras* sensu stricto, e. g. the *naviculare* group, rarity of *Acanthoceras* other than *A. hippocastanum* (J C. Sowerby) and the presence of *Schloenbachia lyme* Spath, *Eucalycoceras pentagonum* (Jukes-Brown *Protacanthoceras* of the *compressum* (Jukes-Brow group and diverse *Thomelites*. *Calycoceras navicu* (Mantell) is not infrequent in the higher parts of this Z in southern England, but in northern France, is comme in the lower part of the suceeding zone. The fauna includ

Acanthoceras hippocastanum (J. de C. Sowerby)
Austiniceras austeni (Sharpe)
Calycoceras naviculare (Mantell)
C. bruni (Fabre)
C. guerangeri (Spath)
C. aff. *newboldi* (Kossmat) and vars.
C. (Lotzeites) aberrans (Kossmat)
C. (L.). spp.
Euomphaloceras euomphalum (Sharpe)
Protacanthoceras compressum (Jukes-Browne)
P. bunburianum (Sharpe)
P. spp.
Pseudocalycoceras cf. *lattense* (Thomel)
Pseudocalycoceras spp.
Thomelites sornayi (Thomel)
T. prerusticum (Thomel)
T. spp. nov.
Forbesiceras spp. nov.
Schloenbachia lymense Spath
Scaphites equalis J. Sowerby
S. obliquus J. Sowerby
Hamites (Stomohamites) spp.
Sciponoceras spp.

Sciponoceras gracile assemblage Zone

The fauna of this zone is characterised by the occurr of *Sciponoceras gracile*, *Kanabiceras septemseriatum* *Allocrioceras*, with *Metoicoceras* as the most frequent of normally coiled ammonites; current revision of diverse *Metoicoceras* species described suggests tha *gourdoni* (de Grossouvre), *M. bureaui* (de Grossouvre *petraschecki* (de Grossouvre), *M. dumasi* (de Grosso and *M. pontieri* Leriche are all variants, and all syno of *Metoicoceras geslinianum* (d'Orbigny), *Metoicoceras whitei* Hyatt and many other New Worl ms.

The fauna includes :

Sciponoceras gracile (Shumard)
Metoicoceras geslinianum (d'Orbigny)
Kanabiceras septemseriatum (Cragin)
Allocrioceras annulatum (Shumard)
Calycoceras naviculare (Mantell) (acme low in Zone)
Austiniceras austeni (Sharpe)
Vascoceras diartianum (d'Orbigny) (low in zone)
Lytodiscoides sp
Hamites (Stomohamites ?) sp
Sumitomoceras faustum Matsumoto & Muramoto
Worthoceras sp?
Scaphites sp
Damesites ? sp

Barnes (1959), Bukry (1969), Caratini (1963), Noël (1959) and Stover (1966) whilst other groups are described by Aubry (1970, 1972) and Bignot and Lezard (1974). Little progress has been made in the application of these groups as biostratigraphic indices.

TURONIAN. Zonal subdivision of the Turonian of England and the western part of the Paris Basin again began with the work of Hébert (1863, 1864, 1866, 1874, 1875), but it was Barrois (1875, 1876) who proposed the system which still finds widespread use today.

Senonian	Zone à *Micraster cortestudinarium*
	Zone à *Holaster planus*
Turonian	Zone à *Terebratulina gracilis*
	Zone à *Inoceramus labiatus*
Cenomanian	Zone à *Belemnites plenus*

This threefold division was applied and extended in England by the Geological Survey, and was used by Jukes-Browne and Hill (1903) and Rowe (1900-1908). *Orbirhynchia (Rhynchonella) cuvieri* has been used as an alternative index for the *labiatus* Zone, whilst *Terebratulina 'gracilis'* has been replaced by *T. lata* as a zonal index, the true *T. gracilis* being restricted to the late Campanian.

These zonal divisions survive to the present. Lack of work on inoceramids, echinoids, brachiopods, together with a scarcity of ammonites, result in a scheme which is far less satisfactory than the ammonite zonations of the Albian and Cenomanian previously outlined.

The Turonian stage was introduced by d'Orbigny in 1842, but in 1847 he made the lower part of this the Cenomanian stage, and thus limited the Turonian to the upper part of his original stage. He listed fossils from the Turonian in 1850, and in 1852 designated the type area as lying between Saumur (on the River Loire) and Montrichard (on the River Cher). The geographical limitation of the type area has been ignored by most subsequent geologists. In 1959, Lecointre, in a paper specifically on the type Turonian, laid emphasis on the Cher valley as far east as Fretevou, which has led Butt (1966) and Bellier (1971) to refer to the Cher valley as the type area, and to include sections outside d'Orbigny's definition. To confuse matters further, many geologists have placed two members - the Sables de Bousse and the Craie à *Terebratella carantonensis* - within the basal part of the Turonian e. g. Triger, 1869 ; Guillier 1886 ; Delaunay 1934 ; Lecointre 1959 (but not 1947, nor in Sornay 1957) ; the Sables de Bousse does not occur in Touraine ; the Craie à *Terebratella carantonensis* (which , as originally defined by Triger in 1869 included the Sables de Bousse) is a name for the basement bed of the Chalk used locally in the Sarthe, where it is sometimes rich in brachiopods ; no such brachiopod rich basement bed to the Chalk has been recorde d from Touraine.

The lowest formation of the type Turonian that falls within the definitions of d'Orbigny, and as mapped by Alcaydé (1968, 1970, 1971), is the Craie Marneuse. Amongs the few ammonites recorded from this are *Mammites nodosoides* (Schlotheim) and *Lewesiceras peramplum* auct. (Lecointre, 1947), but more common is *Inoceramus labiatus* (Schlotheim). These fossils show that the formation falls into the widely used Zone of *Inoceramus labiatus*, whose base is known to coincide elsewhere with the base of the Zone of *Mammites nodosoides* (Kennedy and Juignet, 1973 ; Juignet, Kennedy and Wright, 1973).

Defining the base of the Turonian on the appearance in abundance of the *Inoceramus labiatus* and *Mammites* lineages seems to the most satisfactory, as it is :

I) Adequately defined on the basis of several stratigraphically important groups.

II) A level of significant macrofaunal turnover.

III) Traceable as far afield as Europe, North and S[...] America, Madagascar and Japan.

This definition is adopted here, since the correlation[...] have made are based essentially upon macrofaunas[...] jections to this procedure may be forthcoming[...] philosophical or other grounds and a discusison of the[...] ficulties is presented elsewhere.

The characterisation of the Cenomanian - Turo[...] boundary in the type areas for the stages on the globo[...] canid (planktonic foraminifera) scale is still subject to [...] uncertainties, despite the recent work of Butt (19[...] Marks (1967) and Bellier (1971). It is well establi[...] among micropalaeontologists that a sequence of [...] botruncanid species can be recognised about the leve[...] the Cenomanian-Turonian boundary in most regions of[...] World in the circum-global belt representing present [...] latitudes up to 50°. This sequence includes two m[...] elements of stratigraphical value :

(I) the upper part of the range of the genus *Rotalipo[...]*

(II) the basal part of the range of the earliest "twin-[...] led" *Globotrucana*. These have recently been g[...] ped under the new subgenus *Praeglobotrun[...] (Dicarinella)*

There is some overlap of these two elements in [...] which takes place in Britain in the Plenus Marls (F[...] Dilley, personal communication). The overlap [...] however, yet to be noted in the type areas. The Fret[...] Chalk contains species of "*Dicarinella*", (Butt 1[...] Bellier, 1971) but *Rotalipora* has not been recorded wi[...] the type sections of either the Cenomanian or Turon[...] Marks (1967) has recorded *Rotalipora cushmani* from [...] Middle Cenomanian of Sarthe, presumably some [...] below its extinction level. Overall, the evidence is at pre[...] inadequate for precise placing of the basal part of [...] Fretevou Chalk in the globotruncanid scale but on nega[...] evidence would appear tq be at a level younger than the [...] tinction of *Rotalipora cushmani* and older than the earl[...] occurrence of *Globotruncana helvetica*, a world[...] Turonian index form in Tethyan sequences which has b[...] reliably reported from the Low Countries (Moork[...] 1967) and also in southern Britain (F.C. Dilley, in litt.[...]

Additional difficulties arise in considering the seque[...] relationships of globotruncanid taxa about [...] Cenomanian-Turonian boundary in the fuller devel[...] planktonic foraminiferal faunas of southern France. [...] thault (in Porthault et al. 1966) tabulated [...] stratigraphical distribution of planktonic foraminife[...] the Fosse Vocontienne, against an ammonite-based [...] stratigraphy developed by Thomel (1962, 1965, in [...] thault et al. 1966). It is not clear how precisely the[...] studies are integrated in terms of the actual field secti[...] but the overlap of "*Dicarinella*" and the last *Rotalipo[...]* demonstrated as low as the *'geslinianum'* Zone [...] possibly slightly below this. Later, unpublished wor[...] Porthault, kindly made available to us by him, ext[...] the range of "*Dicarinella*" as low as the *'naviculare'* [...] in this region and also extends the lower limit of [...] *helvetica* to overlap with the last *Rotalipora* in [...] *'geslinianum'* Zone. If these findings are confirmed, [...] analysis of sequences in northern Europe generally [...] present additional problems.

In Britain the base of the Turonian has been drawn [...]

1) The base of the Zone of *Sciponoceras gracile* as [...] in this paper (Spath 1926, Wright and W[...] 1951, Jefferies 1962, 1963, and current practice o[...] Institute of Geological Sciences), although this hor[...] has been variously called the base of the *Metoicoc[...] whitei, pontieri* or *geslinianum* Zone. Several aut[...] have included the 'Subzone' of *Actinocamax pl[...]* within their Zone of *Inoceramus labiatus*, e.g. Jef[...] 1962.

2) Between beds 4 and 5 of Jefferies (1962) in the m[...]

Neocardioceras juddi (Barrois & Guerne (at top of zone)
Watinoceras? sp (high in zone)

Work on other groups of Cenomanian macrofossils is inadequate for erection of zonal schemes comparable to that outlined above, whilst microfaunal work is largely unpublished and unavailable. The following notes summarise what is known of the more important groups. Jukes-Browne & Hill (1903, 1904) provide the most complete faunal lists, now sadly outdated; other general sources are: Jefferies (1962, 1963), Kennedy (1969, 1970), Peake and Hancock (1961), Smart, Bisson and Worssam (1966), Wright and Wright (1942) and Juignet (1974).

Bivalvia. As with the Albian, inoceramid bivalves are of great stratigraphic potential. E.G. Kauffman is currently studying Cenomanian inoceramids from the region, and his work is summarised elsewhere in this volume.

No satisfactory information is available on other bivalve groups although oysters of the *Pycnodonte (Phygraea) vesicularis* (Lamarck) and *Rhynchostreon columba* (Lamarck) groups have great potential.

Coleoidea. Belemenites are rare throughout most of the Cenomanian of the area. *Neohibolites minimus* (Miller) occurs rarely in the *H. carcitanensis* assemblage Zone ; *Actinocamax primus* Archangelsky is also rare, but ranges from the Lower to Middle Cenomanian, being most frequently found in the *costatus* Zone. *Actinocamax plenus* (Blainville) is restricted to the middle of the *gracile* Zone. Unfortunately separation of *plenus* and *primus* is difficult with fragmentary material or small numbers of individuals (Christensen, 1970).

The remaining Cenomanian belemnite, *Belemnocamax boweri* Crick is probably of Middle Cenomanian age.

Brachiopoda. Monographs by Sahni (1929) on terebratulides, Pettitt (1950, 1954) on rhynchonellides, Owen (1062, 1968, 1970) on *Cyclothyris*, rhynchonellides and Kingenids are the more important contemporary studies on Cenomanian brachiopods in the area. The group's stratigraphic distribution remains poorly known, and apart from Owen's work, is badly in need of revision. The most important stratigraphic occurrences seem to be those of the genus *Orbirhynchia;* over the whole area, *Orbirhynchia mantelliana* (J. de C. Sowerby) is abundant towards the top of the *costatus* Zone, and *O. wiesti* (Quenstedt) and *O. praedispansa* Pettitt are moderately common and widespread in the *gracile* Zone. Jeans (1968) gives further details.

Echinodermata. Echinoids are diverse and often common in marginal facies of the Cenomanian, but occurrences are generally facies linked and thus of limited stratigraphic value. Holasteroids, spatangoids and cassiduloids appear to be of somewhat greater value, notably in chalk facies. Thus in England, *Holaster altus* Jukes-Browne and *H. laevis* de Luc are typically Lower Cenomanian forms, accompanied in the higher parts of the substage, by *H. altus bischoffi* Renevier and *H. coravium* Lamarck. *H. subglobosus* (Leske) is the dominant Middle Cenomanian member of the genus, whilst *H. trecensis* Leymerie ranges from Lower to Upper Cenomanian. *Catopygus columbarius* (Lamarck) is typically Lower Cenomanian. *C. obtusus* Desor typically occurs at the top of the Upper Cenomanian. In Normandy, Cayeux (1963, 1965 and Cayeux and Villoureys 1964) have summarised distributions in the Pays de Caux area. The distribution of forms in Sarthe is summarised by Cotteau and Triger (1855-1869), Delaunay (1934) and Juignet (1974) and in Touraine by Lecointre (1947). There is no contemporary work on asteroids, marginals of which are ubiquitous in many facies.

Arthropoda. There is no recent work on Ostracoda. A complete monograph of the English Cenomanian crabs is given by Wright and Collins (1973).

Foraminiferida. There is extensive unpublished information on Cenomanian Foraminiferida in the area of study, in large part based on work associated with the Channel Tunnel project. Some twelve divisions are recongised by Carter (*in* Bruckshaw, Goguel, Harding and Malcor 1961) and Hart (1970: Unpublished Ph. D. Thesis, London University) and have been the basis of certain discussions on the correlation of the Cenomanian (Carter and Hart in discussion of Kennedy 1969, Hart 1971, 1973 a-c, in preparation), as has work on benthonic/planktonic ratios (e.g. Hart 1973 b-c). No details are published to date. The base of the Cenomanian is marked by the appearance of elements of the *Praeglobotruncana delrioensis* (Plummer)/ *Rotalipora evoluta* Sigal fauna of Pessagno (1967). Hart (1973b) suggests *Hedbergella amabilis* Loeblich and Tappan, *Praeglobotruncana delrioensis* (Plummer), *Hedbergella delrioensis* and *Rotalipora evoluta* Sigal as typical planktonic markers, and *Arenobulimina anglica* Cushman, *Flouresina intermedia* Ten Dam, *Gaudryina austiniana* Cushman, *Gavelinella baltica* Brotzen, *G. cenomanica* (Brotzen) and *Plectina pariae* Franke as typical benthonic forms. Above, no recent faunal lists or ranges are available, although much information of the English faunas is given by Jefferies (1962) and Burnaby (1962). In northern France, the work of Marks (1967a-b, 1968) and Magné and Polvêche (1961) are particularly relevant.

Larger benthonic Foraminiferida have also received some attention, notably in reviews by Douglass (1960) and Hofker (1963). Hart (1971, 1973a) has discussed the scattered British records of forms referred to *O. concava* (Lamarck, known from Wilmington, Dunscombe, Wolborough, Babcombe (Devon) and Antrim (Ireland). The Marnes à *Orbitolites* de Ballon (Sarthe) are, of course the source of the first described material of the group, which occur widely in northern France. Hart regards all occurrences as indicative of an early Cenomanian date.

Nannofossils, Cenomanian non-calcareous microplankton from England and northern France has been discussed by Cookson and Hughes (1964), Clarke and Verdier (1967), Davey, Downie, Sarjeant and Williams (1966) and Davey (1969, 1970). Chalks generally yield diverse, well preserved microfloral assemblages, although marginal facies are often barren. The predominant species, usually comprising up to 75% of samples, are *Palaeohystrichophora infusorioides, Claistosphaeridium huguonioti, Mierhystridium* species (predominantly *M. inconspicuum*) and the *Hystrichosphaera ramosa* group.

Correlations have been attempted on the basis of proportional abundances of various taxa (Davey 1970, pp. 384-391), whilst the whole of the Cenomanian has been referred to a single Zone of *Litosphaeridium (Hystrichosphaeridium) siphoniphorum*, the base of the zone characterised by the appearance of *Palaeohystrichophora infusorioides*. Clarke and Verdier (1967, p. 82) recognise three subzones:

Ia. Subzone of *Dinopterygium perforatum*, the base marked by the first appearance of *P. infusorioides*, the top by the last appearance of *D. perforatum* and *C. reticulata*, whilst *H. cingulata* var. *granulata* and *M. irregulare* make their first appearance at the top of the subzone. Davey (1969, 1970) failed to recognise this unit in subsequent studies.

Ib. Subzone of *Palaeoperidinium spinosum*; according to Davey the base of the subzone is characterised by the appearance of *Hystrichosphaera crassimurata* and the top by the last appearance of *Epelidosphaeridium spinosum*.

Ic. Subzone of *Cleistophaeridium huguonioti*, the base being marked by the disappearance of *E. spinosum*, the top by the disappearance of six distinctive species, of which *C. huguonioti*, *L. siphonophorum* and *setosum* are the most important.

Calcareous nannofossils, notably coccoliths and rhabdoliths have been described by Black (1967), Black and of the Plenus Marls, which corresponds with the disappearance of *Rotalipora cushmani* (Wood 1965, Hart in Stinton 1971 ; see also Magné and Polveche 1961). This horizon lies within Jefferie's Zone of *Metoicoceras gourdoni.*

3) The base of the Middle Chalk = the base of the Melbourn Rock (Jukes-Browne and Hill 1903, with references). It has been commonly assumed that this coincides with the base of the Zone of *Inoceramus labiatus.*

Not only have different meanings been given to the base of the *labiatus* Zone, but it is now known from the work of Kauffman (this volume) that *I. labiatus* (s.l.) does not become common until some way above the top of the Plenus Marls, within the Melbourn Rock. The lithic change does not coincide with the zonal boundary.

The base of the Coniacian is widely taken as the base of de Grossouvre's (1901) *Barroisiceras haberfellneri* Zone, defined by the occurrence of such ammonites as *Peroniceras subtricarinatum, P. westphalicum, B. haberfellneri, Peroniceras westphalicum, Scaphites meslei, S. lamberti* and like. Because these forms are absent in the chalks of northern France and England, correlation has always been difficult.

De Grossouvre (1901) considered that the stratotype Coniacian was the equivalent of the Craie (Zone) à *Micraster decipiens* and the lower part of the Craie (Zone) à *Micraster coranguinum* in the northern part of the Paris Basin. Since in England *M. decipiens* does not become common until several metres above the base of the classic *Micraster cortestudinarium* Zone, it is probable that the base of the Coniacian is around the level of the boundary between the Zones of *Micraster normanniae* and *M. decipiens* as used by Stokes (1975). The base of Coniacian would fall within the *M. cortestudinarium* Zone, rather than at the base where it has been traditionally placed by English geologists.

Further confusion arises when the German succession is considered, for here the base of the Coniacian is taken at the base of a Zone of *Inoceramus koeneni,* which can be correlated with the base of the English *Micraster coranguinum* Zone (e.g. Stokes 1975, fig. 19), generally regarded as Santonian by English geologists : French, English and German divisions can be correlated as shown in Table 4.

It must be stressed that the ***labiatus/cuvieri, lata*** and *planus* Zones so widely applied in the chalk facies in the area of study are broadly conceived units, and hard to apply with any consistency in the field, and bear no comparison with the ammonite zonations applied to the Albian and Cenomanian stages.

Ammonoidea. International macrofaunal correlation of the Turonian stems from the work of de Grossouvre (1901) on the ammonites of the type area and elsewhere in France:

	Upper	*Romaniceras deveriai* Zone
Turonian	Middle	*Romaniceras ornatissimum* and *R. bizeti* Zones
	Lower	*Mammites nodosoides* Zone

Romaniceras is, however, rather rare over most of the Anglo Paris Basin, and presents certain nomenclatoral difficulties (Wright, 1959, p. 768) and in consequence, a simple division into three assemblage Zones has been proposed which can be applied to the chalk sequences discussed here:

3. *Subprionocyclus neptuni* assemblage Zone
2. *Collignoniceras woollgari* assemblage Zone
1. *Mammites nodosoides* assemblage Zone

The *nodosoides* assemblage Zone is well represented in the English *labiatus* Zone. *Watinoceras coloradoense* (Henderson) and *Neocardioceras ?* occur at the base, whilst some way above the base of the assemblage zone one finds :

Mammites nodosoides (Schlotheim)
Plesiovascoceras catinum (Mantell)
Fagesia pachydiscoides Spath
Metasigaloceras rusticum (J. Sowerby)
Lewesiceras lewesiense (Mantell)
Austiniceras austeni (Sharpe)

The *woollgari* Zone is equivalent to the bulk of the English *lata* Zone ; ammonites include :

Collignoniceras woollgari (Mantell)
C. sp.
Lewesiceras lewesiense (Mantell)
Austiniceras austeni (Sharpe)

The *neptuni* Zone spans the higher parts of the *lata* Zone and the *planus* Zone, including the rich ammonite assemblage known from the Chalk Rock (the so-called *reussianum* fauna).

The ammonites from these levels include :

Subprionocyclus neptuni (Geinitz)
S. cristatus Billinghurst
S. normalis (Anderson)
Hyphantoceras reussianum (d'Orbigny)
Bostrychoceras woodsi (Kitchin)
Scaphites geinitzi d'Orbigny
S. pseudoaequalis Yabe
Otoscaphites bladenensis (Schlüter)
Metaptychoceras smithi (Woods)
Sciponoceras bohemicum (Fritsch)
Pseudopuzosia marlowensis (Noble)
Pseudojacobites farmeryi (Crick)
Austiniceras curvatisulcatum (Chatwin and Withers)
Lewesiceras mantelli Wright and Wright
L. sharpei Spath

Romaniceras deverianum (d'Orbigny) occurs as a great rarity at the top of the *lata* Zone. No ammonites are known from the *normanniae* Zone. The three faunas recognised above can be traced into Normandy and into the chalk succession of the Paris Basin. In Sarthe and Touraine, however, where de Grossouvre first drew up his zonal subdivisions of the Turonian, ammonites are locally very common. There are very few Lower Turonian records, although Lecointre (1947, 1949) and others have recorded *Lewesiceras* and *Mammites* species from the Craie de Fretevou of Butt (1966). The base of this unit is, however, of Cenomanian age, yielding *Sciponoceras gracile* (Shumard). Of more interest is the richer assemblage known from the Tuffeau de Bourré ; we have found the following species associated together in the same shell bed in the Saumur region :

Lewesiceras lewesiense (Mantell)
Neoptychites cephalotus (Courtiller)
N. spp.
Kamerunoceras salmuriense (Courtiller)
Selwynoceras ? papale (d'Orbigny)
(= *'Mammites' vielbancii* (d'Orbigny)
Jeanrogericeras reveliereanum (Courtiller)
Romaniceras sp. (? = *Acanthoceras kallesi* Zazvorka)
Selwynoceras carolinum (d'Orbigny)

In other areas, the Tuffeau de Bourré yields what appears to be a somewhat different, younger fauna, including :

Lewesiceras lewesiense (Mantell)
Romaniceras deverioide (de Grossouvre) ; varieties
(*R. ornatissimum* (Stoliczka) may have priority)
Pseudotissotia galliennei (d'Orbigny)
S. ? papale (d'Orbigny)
'Prionotropis' canthus Sornay
'P.' turoniensis Sornay

The highest fauna known in this area, coming from the Tuffeau de Touraine, includes *Coilopoceras requienianum* (d'Orbigny) and *Romaniceras deverianum* (d'Orbigny) (of which *R. uchauxiense* Collignon is probably a synonym).

Correlation of these faunas with the sections in chalk facies is difficult since there are so few species common to the two.

Coleiodea. This group is virtually unknown from the Turonian of the region.

Bivalvia. As with the Cenomanian, inoceramid bivalves appear very promising potential stratigraphic indicators, but unfortunately no detailed work has been published to date. Dr. E.G. Kauffman's preliminary observations are published elsewhere in this volume.

Data on other bivalve groups suggests a limited stratigraphic value, although the oysters, notably pycnodontids and the *Rhynchostreon* so abundant in Tuffeau facies, have great potential.

Brachiopoda. The chief sources of information remain Sahni (1929) and Pettitt (1950, 1954). both rhynchonellids and terebratulids are common at many levels, as is *Terebratulina*. Ranges given in the literature are for the most part meaningless and taxonomic revision is urgently needed.

Echinodermata. Echinoids are frequently common in chalk facies. *Conulus* may have some stratigraphic potential (e.g. Popiel-Barczyk 1958) as may *Holaster* species, although *Holaster (Sternotaxis) planus* (Mantell) ranges throughout the stage. The *Micraster* present the most satisfactory group for stratigraphic subdivision, and Stokes has recently provided revised determinations on ranges. The *Micraster* recorded by Rowe (1899) and Kermack (1954) are referred to the genus *Epiaster* by Stokes ; the typical *lata* Zone species is a small form of *Micraster corbovis* Forbes. A large form of this species occurs low in the *planus* Zone, accompanied by transitions between *M. leskei* des Moulins and *Epiaster michelini*. Large forms of *leskei* extend throughout the *planus* Zone, with transitions to *M. normanniae* at the top of the Zone ; *M. normanniae* itself is common in its Zone. Early forms of *M. decipiens* (Bayle) occur in the *normanniae* Zone, but are narrower than typical Coniacian individuals.

There is no recent work on the ubiquitous asteroid marginals.

Arthropoda. There is no recent work on Ostracoda. Other groups are too rare to be of value.

Foraminiferida. Although the Foraminiferida of the type Turonian have been revised by Butt (1966) and Bellier (1971), there is no published account of British Turonian sequences as such. *Globotruncana helvetica* is recorded from low in the English Middle Chalk, whilst Curry (1965) records *Globotruncana sigali* and *G. lapparenti* from off the Scilly Isles.

Nannofossils. There is no comprehensive account of Turonian nannofossils, although some are mentioned in the work of Black and others noted above. Clarke and Verdier (1967) recognise two non-calcareous microplankton zones in the Turonian. The base of the lower *Scriniodinium camppanula* Zone is drawn immediately above the last appearance of *C. obliquicostatum, G. extensa, H. huguoniot, H. siphoniphorum, H. cingulata* var. *polygonalis* and *M. echinatum*; the top marked by the last appearance of *S. campanula*. This Zone corresponds to the lower part of the *labiatus* Zone. The *Cyclonephelium membraniphorum* Zone spans the remainder of the Turonian, and may extend into the early Coniacian. The base of the zone is drawn at the disappearance of *S. campanula*, the top at the last appearance of *C. membraniphorum*.

REFERENCES

ALCAYDÉ, G., (1968) — Carte géologique, 1/50,000 Amboise. **Bur. Rech. géol. miniér.**

(1970) — Carte géologique, 1/50,000 Saumur. **Bur. Rech. géol. miniér.**

(1971) — Carte géologique, 1/50,000 Langeais. **Bur. Rech. géol. miniér.**

ALLEN, P., (1967) — Origin of the Hastings Facies in North-Western Europe. **Proc. Geol. Ass.**, 78(27-105.

ALLEN, J.R.L. & NARAYAN, J., (1964) — Cro stratified units, some with silt bands, in the Folkesto Beds (Lower Greensand) of southeast Englan **Geologie Mijnb.**, 43(10), 451-461.

ARKELL, W.J., (1956) — Jurassic geology of the Worl Edinburgh, 806 pp., 46 pls.

et al. (1957) — Cephalopoda Ammonoidea. **Treati on Invertebrate Paleontology**, L, Mollusca 4. 4 + xxii pp.

ARNOLD, H. (1964) — Fazies und Mächtigkeit v Kreidestufen im Münsterland. **Fortschr. Ge Rheinld. u. Westf.**, 7, 599-610;

AUBRY M.P., (1970) — Importance géologique d Nannoconus dans les craies turoniennes de la régi dieppoise. **Bull. Soc. géol. Normandie**, 60, 1-7.

(1972) — *Recherches pétrographiqu stratigraphiques sur les craies de Haut-Normand* Thèse 3ème cycle, Univ. Paris.

BALDWIN, B., CONEY, P.J. & DICKINSON, W.I (1974) — Dilemma of a Cretaceous Time Scale a Rates of Sea Floor Spreading. **Geology**, 2, 267-270.

BANDY, O.L., (1967) — Cretaceous planktonic forami feral zonation. *Micropaleontology*, 13, 1-31.

BARROIS, C., (1875) — Description géologique de Craie de l'Ile de Wight. **Annls. soc. géol. N.**, 6(4), 30.

(1876) — Recherches sur le Terrain Crét Supérieur de l'Angleterre et de l'Irlande. **Mém. s géol. N.**, 232 pp., 3 pls.

BELL T., (1852-1862) — Monograph of the fo Malacostracous Crustacea of Great Britain. **Palaeo togr. Soc. (Monogr.)**

BELLIER, J.P., (1971) — Les Foraminifères planc niques du Turonien-type. **Rév. Micropal.**, 14, 85- 1 pl.

BIZET, P., (1881) — Notice à l'appui du profil géologiq du chemin de fer de Mamers à Mortagne. **Bull. S géol. Normandie.** 8, 40-70.

BLACK, M., (1967) — New names for some coccol taxa. **Proc. geol. Soc. Lond.**, 1640, 139-145.

(1972-1975) — British Lower Cretaceous Coccolith I. Gault clay. **Palaeontogr. soc. (Monogr.)**, 142 p 34 pls.

& BARNES, B., (1959) — The structure of coccoli from the English Chalk. **Geol. Mag.**, 96, 321-328, p 8-12.

BREISTROFFER, M., (1947) — Sur les Zones d'Amm nites dans l'Albien de France et d'Angleterre. **Tr Lab. Géol. Univ. Grenoble**, 26, 17-104.

(1965) — Vues sur les zones d'ammonites de l'Albi **Mem. Bur. Rech. géol. miniér.**, 34, 311-312.

BRETSKY, P.W. & LORENZ, D.M., (1969) — Adapt response to environmental stability: a unifying c cept in paleoecology. **Proc. N. Am. Paleont. Co** 1(E), 522-550.

BRONGNIART, A., (1822) — in CUVIER, G. & BRONGNIART, A., *Description géologique des virons de Paris*. Paris. 410 pp. 18 pls.

BROTZEN, F., (1966) — Faziesveränderungen in Oberkreide Schwedens, **Ber. deutsch. Ges. g Wiss., ser.A (Geol. Paläont.)**, 11, 709-719.

BRUCKSHAW, J.M., GOGUEL, J., HADDING, H.J & MALCOR, R., (1961) — The work of the Chan Tunnel Study Group, 1958-1960. **Proc. Inst. Engrs.**, 18, 149-178.

BRUUN-PETERSON, J., (1975) — Upper Cretace shelf limestone from Ignaberga, Scania (Sweden) its diagenesis. **Int. Congr. Sediment., 9 (Nice)**, 7 33-38.

BRUNSTROM, R.G.W. & WALMSLEY,P.J., (1969) — Permian evaporites in North Sea Basin. **Bull. Am. Ass. Petrol. Geol.,** 53, 870-883.

BUKRY, D., (1969) — Upper Cretaceous coccoliths from Texas and Europe **Paleont. contr. Univ. Kansas,** 51, 1-79, 40 pls.

BURNABY, T.P., (1962) — The palaeoecology of the Foraminifera of the Chalk Marl. **Palaeontology** 4, 599-608.

BUSHINSKII, G.I., (1954) — Lithology of Cretaceous deposits of the Dnieper-Donets basin. **Akad. nauk. S.S.S.R., Trudy Inst. geol. nauk,** 156, 1-307 (Geol. Ser. no. 67) in Russian.

BUTT, A.A., (1966) — Foraminifera of the type Turonian **Micropalaeontology,** 12, 168-182, pls. 1-4.

CALEMBERT, L. (1956) — Le Crétacé supérieur de la Hesbaye et du Brabant. **Ann. Soc. géol. Belg.,** ser.B, 80, 129-156.

CARATINI, C., (1963) — *Contribution à l'étude des coccolithes du Cénomanien supérieur et du Turonien de la région de Rouen.* Thèse, Faculté des Sciences, Univ. Alger. 61 pp., 5 pls.

CASEY, R., (1950) — The junction of the Gault and Lower Greensand in East Sussex and at Folkestone, Kent. **Proc. Geol. Ass.,** 61, 268-298.

(1957) — The Cretaceous ammonite genus *Leymeriella* with a systematic account of its British occurrences. **Palaeontology,** 1, 28-59, pls. 7-10.

(1959) — Field Meeting at Wrotham and the Maidstone By-Pass. **Proc. Geol. Ass.,** 70, 206-209.

(1960) — Cenomanian ammonite zones. **Geol. Mag.,** 97, 173-175.

(1961) — The stratigraphical palaeontology of the Lower Greensand. **Palaeontology,** 3, 487-621, pls. 77-84.

(1962) — A monograph of the Ammonoidea of the Lower Greensand, part 4. **Palaeontogr. Soc. (Monogr.).**

& RAWSON, P.F., (1974) — the Boreal Lower Cretaceous. **Geol. J. Special Issue** 5, 448 pp. (misdated 1973).

CAYEUX, L(ouis)., (1960) — L'Albien des environs du Havre. **Bull. soc. géol. Normandie,** 50, 21-25.

& VILLOUTREYS, O. de (1963) Répartition des echinides réguliers du Cénomanien du Pays de Caux. **Bull. soc. gèol. Normandie,** 53, 13-25.

(1964) — Répartition des echinides irréguliers (1) Holectypoida et Cassiduloida du Cénomanien du Bec de Caux. **Bull. Soc. géol. Normandie,** 54, 35-47, 3 pls.

(1965) - Répartition des echinides irréguliers du Cénomanien du Pays de Caux (2) Spatangoida. **Bull. soc. gèol. Normandie,** 55, 15-27, 2 pls.

CAYEUX, L(ucien), (1897) — Contribution à l'étude micrographique des terrains sedimentaires. I. Etudes de quelques dépôts siliceux secondaires et tertiaires du Bassin de Paris et de la Belgique. II. Craie du Bassin de Paris. **Mém. Soc. gèol. N.,** 4(2), 589 pp., 10 pls.

(1935) — *Les Roches sédimentaires de France. Roches carbonatées (Calcaires et Dolomies).* Paris, 463 pp., 26 pls.

(1939-1950) — Etudes des gîtes minéraux de la France. Les phosphates de chaux sédimentaires de France. 3 vols. **Serv. Carte géol. Fr.**

CHAPMAN, F., (1891-1898) —The Foraminifera of the Gault at Folkestone. **J.R. microsc. Soc.,** 1891, 565-574, pl.9; 1892, 319-330, pls.5-6; 1892, 749-758, pls.11-12; 1893, 579-595, pls.8-9; 1893, 153-163, pls.3-4; 1894, 421-427, pl. 8; 1894, 645-654, pls.9-10; 1895, 1-14,pls.1-2; 1896, 581-591, pls.12-13; 1898, 1-49, pls.1-2.

& SHERBORN, C.D., (1893) — On the Ostracoda of the Gault at Folkestone. **Geol. Mag.,** (3) 10, 345-349, 1 pl.

CHRISTENSEN, W.K., (1970) — *Actinocamax primus* Arkhangelsky from Scania. **Stock. Contr. Geol.,** 21, 69-76.

(1975) — Upper Cretaceous belemnites from the Kristianstad area in Scania. **Fossils ans Strata,** 7, 69 pp., 12 pls.

CIEŚLIŃSKI, S., (1960) —The Albian and Cenomanian transgression in the Danish-Polish furrow. **Intl. geol. Congr. 21 (Norden),** 12, 185-190.

CLARK, D.L., (1965) — Heteromorph ammonoids from the Albian and Cenomanian of Texas and adjacent areas. **Mem. geol. Soc. Am.,** 95, 99 pp., 24 pls.

CLARKE, R.F.A. & VERDIER, J.P., (1967) — An investigation of microplankton assemblages from the Chalk of the Isle of Wight. **Verh. K. ned. Akad. Wet.,** 24, 1-96, pls.1-17.

COOKSON, I. & HUGHES, N.F., (1964) — Microplankton from the Cambridge Greesand (mid Cretaceous). **Palaeontology,** 7, 37-59, pls. 5-11.

COLLIGNON,M., (1965a) — L'Albien à Madagascar ces subdivisions comparées à celles de l'Europe occidentale. Essai de chronstratigraphie aussi générale que possible. **Mem. Bur. Rech. géol. miniér.,** 34, 303-310.

(1965b) — Rapport sur l'étage Albien. **Mém. Bur. Rech. géol. miniér.,** 34, 313-318.

COLLINS, J.S.H., (1974) — Recent advances in the knowledge of Gault Cirripedia. **Proc. Geol. Ass.,** 85, 377-386, pl.11.

COTTEAU, G. & TRIGER, J., (1855-1869) — *Echinides du département de la Sarthe.* 456 + xv pp., 76 pls. Paris.

CURRY, D., (1965) — In SMITH, A.J., STRIDE, A.H. & WHITTARD, W.S., The geology of the western approaches of the English Channel IV. **Colston Pap.,** 17, 287-301.

DANGEARD, L., (1951) — La Normandie. *Géologie Régionale de la France,* 7, 241 pp., 7 pls.

DARWIN, C.R., (1851) — A monograph on the Fossil Lepadidae, or, pedunculated cirripedes of Great Britain. **Palaeontogr. Soc. Monogr.,** 88pp., 5 pls.

DAVEY, R.J., (1969-1970) — Non-calcareous microplankton from the Cenomanian of England, northern France and North America. **Bull. Br. Mus. nat. Hist., (Geol)** 17. 103-180, 11 pls.; 18, 333-397, 10 pls.

DOWNIE C., SARJEANT W.A.S. & WILLIAMS G.L., (1966) — Studies on Mesozoic and Cainozoic dinoflagellate cysts. **Bull. Br. Mus. nat. Hist., (Geol.)** Supplement 3, 248 pp., 26 pls.

DELAUNAY, P., (1934) — *Le Sol Sarthois, 4: Les zones cretacées.* Le Mans, 541-762.

DESTOMBES, P., (1970) — Biostratigraphie des ammonites dans l'Albien inférieur et moyen argileux, du Bassin de Paris. **C.R. hebd. Seanc. Acad. Sci., Paris, (D)** 270, 2061-2064.

& DESTOMBES, J.P., (1965) — Distribution Zonales des Ammonites dans l'Albien du Bassin de Paris. **Mém. Bur. Rech. géol. Miniér.** 34, 255-270.

DESTOMBES, J.P. & DESTOMBES, P. (1938a) — Note sur le Gault de Wissant. **Annals. soc. géol. N.,** 62, 98-113.

(1938b) - Remarques sur l'Albien du Pays de Bray. **Annls. Soc. géol. N.,** 63, 119-125.

(1963) — L'Anticlinal des Quéners au Cap Blanc-Nez (Pas de Calais). **Annals Soc. géol. N.,** 81, 47-56, pl. 10.

DIENER, I., (1967a) - Die Paläogeographie der Oberkreide im Nordteil der D.D.R. in Beziehung zu den

(19?0.b) — Zur Paläogeographie der Oberkreide Nordost Deutschlands. **Ber. deutsch. Ges. geol. Wiss.**, (A - Geol. Paläont.) 12, 493-509.

DIXON, F., (1876) — *The geology and fossils of the Tertiary and Cretaceous formations of Sussex.* 2nd edition. Brighton.

DOUGLAS, R.C., (1960) — Revision of the family Orbitolinidae. **Micropaleontology**, 6, 249-270, pls.1-6.

DOUVILLÉ, R., (1911) — Ammonites gentoni Defrance, in Brongniart 1822. **Palaeont. univers.**, 3, 223.

DRUMMOND, P.V.O., (1970) —The mid-Dorset Swell. Evidence of Albian-Cenomanian Movements in Wessex. **Proc. Geol. Ass.**, 81, 679-714.

DUBOURDIEU, G., (1953) — Ammonites nouvelles des Monts du Mellègue. **Bull. Serv. Carte. géol. Algér.**, (1 - Paléont.) 16, 76 pp., 4 pls.

(1956) — Étude géologique de la région de l'Ouenza Confins Algéro-Tunisiens). **Publs. Serv. Carte géol. Algér.**, 10, 659 pp., 22 pls.

EVANS C., (1870) — On some sections of Chalk between Croydon and Oxtead, with observations on the classification of the Chalk. **Geol. Ass.**, London, 40 pp.

FABRE S., (1940) — Le Crétacé supérieur de la Basse-Provence occidentale : 1. Cénomanien et Turonien. **Annals Fac. Sci. Marseille**, (2) 14, 355 pp., 10 pls.

FALCON N.L. & KENT P.E., (1960) — Geological results of petroleum exploration in Britain 1945-1957. **Mem. geol. Soc. Lond.**, 2, 56 pp., 5 pls.

FELDER W.M., (1974) — Lithostratigraphische gliederung der oberen kreide. **Publtiës natuurh. Genoot. Limburg**, 24, 1-43.

FOLLET A., (1954) — Aperçu géologique de St. Amand-des-Hautes-Terres, Eure. **Bull. Soc. linn. Normandie**, (1954-55), 1-2.

GROSSOUVRE A. de , (1889) — Sur le terrain crétacé dans le sud-ouest du bassin de Paris. **Bull. Soc. géol. Fr.**, 17, 475-525, pls. 11-12.

(1901) — Recherches sur la craie supérieure. 1 : stratigraphie générale. **Mém. Carte géol. dét. Fr.**, 1013 pp., 39 tabl., 3 pls.

(1912) — Le Crétacé de la Loire-Inférieure et de la Vendée. **Bull. Soc. Sci. nat. Ouest. Fr.**, 2, 1-38, 3 pls.

GUÉRANGER E., (1867) — *Album paléontologique du département de la Sarthe.* Le Mans, 20 pp., 25 pls.

GUILLIER A., (1886) — *Géologie du département de la Sarthe.* Le Mans and Paris, 430 pp.

HÅKANSSON E., BROMLEY R.G. & PERCH-NIELSEN K. (1974) — Maastrichtian chalk of north-west Europe a pelagic shelf sediment. In HSÜ K.J. & JENKYNS H.C. (eds) Pelagic Sediments on land and under the sea. **Int. Ass. Sediment, Spec. Pub.**, 1. 211-233.

HALLAM A., (1963) — Major epeirogenic and eustatic changes since the Cretaceous, and their possible relationship to crustal structure. **Am. J. Sci.**, 261, 397-423.

(1969) — Faunal realms and facies in the Jurassic. **Palaeontology**, 12, 1-18.

(1971) — Provinciality in Jurassic faunas in relation to facies and palaeogeography. In Middlemiss F.A., Rawson P.F. & Newall G. (eds.) Faunal Provinces in Space and Time. **Geol. J. Special Issue**, 4, 129-152.

(1972) — Diversity and density characteristics of Pliensbachian-Toarcian molluscan and brachiopod faunas of the North Atlantic margins. **Lethaia**, 5, 389-412.

sterdam.

HANCOCK J.M., (1959) — Les ammonites du Cé[nomanien] manien de la Sarthe. **C. r. Congr. Socs. sav. - Dij[on] 1959 : Colloque sur le Crétacé Supérieur franç[ais]** 249-252.

(1961) — The Cretaceous system in North[ern] Ireland. **Q. Jl. geol. Soc. Lond.**, 117, 11-36.

(1965) — (ed) The Gault of the Weald. **Proc. Ge[ol.] Ass.**, 76, 243-260.

(1969) — Transgression of the Cretaceous sea [in] south-west England. **Proc. Ussher Soc.**, 2, 61-83.

(1973) — Crétacé de l'Angleterre, Pays de Gal[les] Écosse. **Lexique Strat. Int.**, 1 (3a XI), 162 p (dated 1972).

(1975) — The sequence of facies in the Upp[er] Cretaceous of northern Europe compared with that [of] the Western Interior. In Caldwell W.G.E. (ed), T[he] Cretaceous System in the Western Interior of Nor[th] America. **Spec. Pap. geol. Ass. Can.**, 13, 83-118.

HANCOCK J.M., KENNEDY W.J. & KLAUMANN [H.] (1972) — Ammonites from the transgressi[ve] Cretaceous on the Rhenish Massif, German[y] **Palaeontology**, 15, 445-449, pl. 81.

HANCOCK J.M. & SCHOLLE P.A., (1975) — Ch[alk] of the North Sea. In Woodland A.W. (ed), Petroleu[m] and the continental shelf of north-west Europe, Geology, 413-427. London.

HARLAND W.B., SMITH A.G. & WILCOCK [B.] (1964) — (eds) The Phanerozoic Time-Scale. **Spe[c.] Publs. geol. Soc. LOnd.**, 1, 458 pp.

HART M.B., (1970) — *The distribution of the Fora[mi]niferida in the Albian and Cenomanian of S[W] England.* Unpublished Ph. D. Thesis, University [of] London.

(1971) — Micropalaeontological evidence of mi[d-]Cenomanian flexuring in south west England. **Pro[c.] Ussher Soc.**, 2, 315-325.

(1973) — Foraminiferal evidence for the age of t[he] Cambridge Greensand. **Proc. Geol. Ass.**, 84, 65-82.

(1974a) — Some observations on the Chert Beds (U[p]per Greensand) of south west England. **Proc. Ussh[er] Soc.**, 2, 599-608 (mis-dated 1973).

(1974b) — A correlation of the macrofaunal a[nd] microfaunal zonations of the Gault Clay in southe[rn] England. In Casey R. & Rawson P.F., The Bore[al] Lower Cretaceous, **Geol. J. Special issue** 5, 267-28[?] (mis-dated 1973).

HAYS J.D. & PITMAN W.C., (1973) — Lithospher[ic] plate motions, sea level changes and climatic a[nd] ecological consequences. **Nature**, 246, 18-22.

HÉBERT E., (1863) — Note sur la craie blanche et [la] craie marneuse dans le bassin de Paris et sur [la] division de ce dernier étage en quatre assises. **Bul[l.] Soc. géol. Fr.**, (2)20, 605-631.

(1864) — Sur la craie glauconieuse du nord-ouest [du] bassin de Paris. **C.R. hebd. Séanc. Acad. Sci., Pari[s]** 58, 475-479.

(1866) — De la craie dans le nord du Bassin de Pari[s] **C.R. hebd. Séanc. Acad. Sci., Paris**, 62, 1404 ; 6[?] 308.

(1874) — Comparaison de la craie des cô[tes] d'Angleterre avec celle de France. **Bull. Soc. géo[l.] Fr.**, (3)2, 416-428.

(1875) — Classification du terrain crétacé supérie[ur] **Bull. Soc. géol. Fr.**, (3)3, 595-599.

HEYBROEK P., HAANSTRA U. & ERDMAN D.[A.] (1967) — Observations on the geology of the Nor[th]

Sea area. **Wld. Petrol. Congr. 7, Mexico, Proc.**, 2, 905-916.

HOFKER J., (1963) — Studies on the genus *Orbitolina* (Foraminiferida). **Meded. Leid. Geol.**, 56, 182-302, pls. 1-23.

HUDSON J.D., (1967) — Speculations on the depth relations of calcium carbonate solution in Recent and ancient seas. **Mar. Geol.**, 5, 473-480.

JASKOWIAK M., (1966) — Die Oberkreide in Nordpolen. **Ber. deutsch. Ges. geol. Wiss., ser. A (Geol. Paläont.)**, 11, 695-701.

JEANS C.V., (1968) — The origin of the montmorillonite of the European chalk with special reference to the Lower Chalk of England. **Clay Miner**, 7, 311-329.

JEFFERIES R.P.S., (1962) — The palaeoecology of the *Actinocamax plenus* Subzone (Lowest Turonian) in the Anglo-Paris Basin. **Palaeontology**, 4, 609-647, pls. 77-79.

(1963) — The stratigraphy of the *Actinocamax plenus* Subzone (Turonian) in the Anglo-Paris Basin. **Proc. Geol. Ass.**, 74, 1-33, pls. 1-2.

JELETZKY J.A., (1968) — Macrofossil zones of the marine Cretaceous of the Western Interior of Canada and their correlation with the zones and stages of Europe and the Western Interior of the United States. **Geol. Surv. Can. Pap.**, 67-72, 66 pp.

(1971) — Marine Cretaceous biotic provinces and palaeogeography of Western and Arctic Canada : illustrated by a detailed study of ammonites. **Geol. Surv. Can. pap.**, 70-22, 92 pp.

JONES T.R., (1849) — A monograph of the Entomostraca of the Cretaceous formation of England. **Palaeontogr. Soc. (Monogr.)**.

(1870) — Notes on the Cretaceous Entomostraca. **Geol. Mag.**, 7, 74-77.

JONES T.R. & HINDE G.J., (1890) — A supplementary monograph of the Cretaceous Entomostraca of England and Ireland. **Palaeontogr. Soc. (Monogr.)**.

JUIGNET P., (1968) — Faciès littoraux du Cénomanien des environs du Mans (Sarthe). **Bull. Bur. Rech. géol. minièr.** (4)4, 5-20.

(1970) — Précisions stratigraphiques et sédimentologiques sur le Cénomanien du Pays de Caux entre Saint-Jouin-Bruneval et le cap d'Antifer (Seine-Maritime). **Bull. Bur. Rech. géol. minière**, (10)1, 11-15.

(1971) — Modalités du contrôle de la sédimentation sur la marge armoricaine du Bassin de Paris à l'Aptien-Albien-Cénomanien. **Bull. Bur. Rech. géol. minièr.**, (2)3, 113-126.

(1974) — *La transgression crétacé sur la bordure orientale du Massif armoricain.* Thèse, Université de Caen. 806 pp., 28 pls.

JUIGNET P. & KENNEDY W.J., (1977) — Stratigraphie comparée du Cénomanien du sud de l'Angleterre et de Haute Normandie. **Bull. Soc. géol. Normandie amis Mus. Havre**, 63, 1-192.

JUIGNET P., KENNEDY W.J. & WRIGHT C.W., (1973) — La limite Cénomanien-Turonien dans la région du Mans (Sarthe) : stratigraphie et paléontologie. **Annls. Paléont. (Invert.)** 59, 207-242, 3 pls.

JUKES-BROWNE A.J. & HILL, W., (1896) — A delimitation of the Cenomanian. **Q. Jl. geol. Soc. Lond.**, 52, 99-177, pl. 5.

(1900-04) — The Cretaceous rocks of Britain. 3 vols. **Mem. geol. Survey U.K.**

KAHRS E., (1927) — Zur paläogeographie der Oberkreide in Rheinland-Westfalen. **Neues Jb. Miner. Geol. Paläont. Beil. Bd.**, 58B (Festband Pompecjk), 627-687, pls. 42-44.

KAUFFMAN E.G., (1967) — Coloradoan macroinvertebrate assemblages, central Western Interior, United States. **Paleoenvironments of the Cretaceous Seaway - a symposium**, 67-143. Colorado School of Mines.

(1969) — Cretaceous marine cycles of the Western Interior. **Mount. Geologist**, 6, 227-245.

(1970) — Population systematics, radiometrics and zonation - a new biostratigraphy. **Proc. N. Amer. Paleont. Convention**, 1 (F), 612-666.

KAYE P., (1964) — Revision of British marine Cretaceous Ostracoda with notes on additional forms. **Bull. Brit. Mus. nat. Hist. (Geol.)**, 10, 37-79, pls. 1-9.

(1965) — Some new British Albian Ostracoda. **Bull. Brit. Mus. nat. Hist. (geol.)**, 11, 217-253, pls. 1-11.

KEMPER E., (1968) — *Geologischer Fürher durch die Grafschaft Bentheim und die angrenzenden Gebiete* (3rd ed.) Bentheim.

KENNEDY W.K., (1969) — The correlation of the Lower Chalk of south-east England. **Proc. Geol. Ass.**, 80, 459-560, pls. 15-22.

(1970a) — A correlation of the uppermost Albian and the Cenomanian of south-west England. **Proc. Geol. Ass.**, 81, 613-677.

(1970b) — Trace fossils in the Chalk environment. In Crimes T.P. & Harper J.C. (eds.), Trace Fossils. **Geol. J. spec. Issue.**, 3, 263-282.

(1971) — Cenomanian ammonites from southern England. **Spec. Pap. Palaeont.**, 8, 133 pp., 64 pls.

KENNEDY W.J. & GARRISON R.E., (1975) — Morphology and genesis of nodular chalks and hardgrounds in the Upper Cretaceous of southern England. **Sedimentology**, 22, 311-386.

KENNEDY W.J. & HANCOCK J.M., (1970) Ammonites of the genus *Acanthoceras* from the Cenomanian of Rouen, France. **Palaeontology**, 13, 462-490, pls. 88-97.

(1971) — *Mantelliceras saxbii* (Sharpe) and the horizon of the Martimpreyi Zone in the Cenomanian of England. **Palaeontology**, 14, 437-454, pls. 79-82.

KENNEDY W.J. & JUIGNET P., (1973) — Observations on the lithostratigraphy and ammonite succession across the Cenomanian-Turonian boundary in the environs of Le Mans (Sarthe, N.W. France). **Newsl. Stratigr.**, 2, 189-202.

(1974) — Carbonate banks and slump beds in the Upper Cretaceous (Upper Turonian - Santonian) of Haute Normandie, France. **Sedimentology**, 21, 1-42.

(1975) — Répartition des genres et des espèces d'ammonites caractéristiques du Cénomanien du sud d'Angleterre et de la Haute Normandie. **C.R. hebd. Séanc. Acad. Sci., Paris**, (D) 280, 1221-1224.

KENT P.E., (1967) — Outline geology of the southern North Sea, **Proc. Yorks. geol. Soc.**, 36, 1-22.

(1975) — The tectonic development of Great Britain and the surrounding seas. In Woodland A.W., **Petroleum and the continental shelf of north-west Europe. I. Geology**, 3-28. London.

KERMACK K.A., (1954) — A biometric study of *Micraster coranguinum* and *M. (Isomicraster) senonensis*. **Phil. Trans. R. Soc.**, (B) 237, 375-428.

KHAN M.H., (1950a) — On some new Foraminifera from the Lower Gault of southern England. **J.R. micros. Soc.**, 70, 268-279.

(1950b) — Note on the depth and temperature of the Gault sea as indicated by Foraminifera. **Geol. Mag.**, 87, 175-180.

(1952) — Zonal analysis of the Lower Gault of Kent based on Foraminifera. **Contr. Cushman Fdn. foramin. Res.**, 3, 71-90.

KLEIN V. & SOUKUP J., (1966) — The Bohemian Cretaceous basin. **In** Svoboda J. et al., **Regional Geology of Czechoslovakia. I the Bohemian massif.** Prague, Ústřev. ústav geolog. 487-512.

LAUGHTON A.S., (1972) — The Southern Labrador Sea - a key to the Mesozoic and early Tertiary evolution of the North Atlantic. **Initial Rep. Deep Sea Drill. Proj.**, 12, 1155-1179.

(1975) — Tectonic evolution of the northeast Atlantic Ocean : a review. **Norges geol. Unders.**, 316, 169-193.

LECOINTRE G., (1947) — La Touraine. **Géologie régionale de la France.** 4, 250 pp., 4 pls.

(1959) — Le Turonien dans sa région type : La Touraine. **C. r. Congr. Socs. sav. - Dijon 1959 : Colloque sur le Crétacé Supérieur Français**, 415-423.

LEES G.M. & TAITT A.H., (1946) — The geological results of the search for oilfields in Great Britain. **Q. Jl. geol. Soc. Lond.**, 101 (for 1945), 255-317.

LENNIER G., (1867) — *Études géologiques et paléontologiques sur l'embouchure de la Seine et les falaises de Haute Normandie.* Le Havre.

(1882) — Compte-rendu d'une excursion géologique à St-Jouin, Antifer et Etretat. **Bull. Soc. géol. Normandie**, 9, 56-60.

MAGNÉ J. & POLVÊCHE J., (1961) — Sur le niveau à *Actinocamax plenus* du Boulonnais. **Annls. Soc. géol. N.**, 81, 47-62.

MANTELL G.A., (1818) — A sketch of the geological structure of the south-eastern part of Sussex. **Gleaners Portfolio, or Provincial Magazine, Lewes**, 8.

(1822) — *The fossils of the South Downs : or Illustrations of the geology of Sussex.* London. 327 pp., 43 pls.

MARCINOWSKI R., (1970) — The Cretaceous transgressive deposits east of Czestochowa (Polish Jura Chain). **Acta Geol. Pol.**, 20, 413-451, pls. 1-6.

(1974) — The transgressive Cretaceous (Upper Albian through Turonian) deposits of the Polish Jura Chain. **Acta Geol. Pol.**, 24, 117-217, pls. 1-34.

MARCINOWSKI R. & SZULCZEWSKI M., (1972) — Condensed Cretaceous sequence with stromatolites in the Polish Jura Chain. **Acta Geol. pol.**, 22, 515-539.

MARIE G., (1965) — Sur une échelle stratigraphique de l'Albien du bassin parisien basée sur les foraminifères. **Mém. Bur. Rech. géol. minièr.**, 34 (Colloque sur le Crétacé Inférieur, Lyon), 271-288, 2 pls.

MARKS P., (1967a) — *Rotalipora* et *Globotruncana* dans la Craie de Théligny (Cénomanien, dept. de la Sarthe). **Proc. K. ned. Akad. Wet.**, (B) 70, 264-275, 3 pls.

(1967b) — Foraminifera from the Craie de Théligny (Cenomanian, dept. Sarthe, France). **Proc. K. ned. Akad. Wet.**, (B) 70, 425-442, 2 pls.

(1968) — Smaller foraminifera from the 'Couches à *Orbitolina complanata*' at Ballon (Sarthe, France). **Proc. K. ned. Akad. Wet.**, (B) 71, 373-386, 4 pls.

MARLIÈRE R., (1939) — La transgression albienne et cénomanienne dans le Hainaut ; études paléontologiques et stratigraphiques. **Mém. Mus. r. Hist. nat. Belg.**, 89, 440 pp., 8 pls.

(1954) — Le Crétacé. **In Fourmarier P. (Ed), Prodrome d'une description géologique de la Belgique**, Soc. géol. Belg. 417-444.

MATSUMOTO T., SASTRY M.V.A. & SARKAR S. (1966) — Notes on some Cretaceous ammonites fr Southern India. Part 1 : (by **Matsumoto & Sark** *Utaturiceras vicinale* from Southern India. **Mem. F Sci. Kyushu Univ.**, (D) 17, 295-309, pls. 32-33.

MOORKENS T.L., (1969) — Quelques Globotruncanid et Rotaliporidae du cénomanien, turonien coniacien de la Belgique. **Proc. Int. Co Planktonic Microfossils**, 1 (2), 435-459.

MULLER S.W. & SCHENK H.G., (1943) — Standard the Cretaceous System. **Bull. Am. Ass. Petrol. Ge** 27, 262-278.

MURRAY G. & BLACKMAN V.H., (1898) — On t nature of coccospheres and rhabdospheres. **Ph Trans. R. Soc.**, (B) 190, 427-441, pls. 15-16.

NEUMAYR M., (1883) — Über klimatische Zonen wä rend der Jura - und Kreidzeit. **Denkschr. Ak Wiss. Wien.**, 47, 277-310.

NOEL D., (1959) — Étude des coccolithes du Jurassiq et du Crétacé inférieur. **Publs. serv. Carte gé Algér.** (2)20, 155-196, 11 pls. (for 1958).

OBRADOVICH J.D. & COBBAN W.A., (1975) — time-scale for the Late Cretaceous of the Western I terior of North America. **In Caldwell W.G.E.** (ed The Cretaceous System in the Western Interior of N th America. **Spec. pap. geol. Ass. Can.**, 13, 31-54.

ORBIGNY A. d', (1840-42) — *Paléontologie françai Terrains Crétacés. 1. Céphalopodes*, 662 pp., 148 p
(1848-51) — *Paléontologie française. Terrains C tacés. 4.* ***Brachiopodes***. **Paris.**
(1850) — *Prodrome de Paléontologie stratig phique universelle des animaux mollusques et rayo nés.* 2. Paris.
(1852) — *Cours élémentaire de Paléontologie et d géologie stratigraphiques.* 2. (2). Paris.

OWEN E.F., (1962) — The brachiopod genus *Cycl thyris*. **Bull. Brit. Mus. nat. Hist. (Geol.)**, 7, 37-6 pls. 4-5.

(1968) — A further study of some Cretaceous rh ynchonelloid brachiopods. **Bull. Indian Geol. Ass.**, 17-32, pl. 2.

(1970) — A revision of the brachiopod subfami Kingeninae Elliott. **Bull. Brit. Mus. nat. His (Geol.)** 19, 27-83, 14 pls.

OWEN H.G., (1958) — Lower Gault sections in th northern Weald, and the zoning of the Lower Gaul **Proc. Geol. Ass.**, 69, 148-165.

(1960) — The Gault - Lower Greensand junction an the Lower Gault of the Maidstone By-Pass (east se tion), Kent. **Proc. Geol. Ass.**, 71, 364-378.

(1963) — Some sections in the Lower Gault of th Weald. **Proc. Geol. Ass.**, 74, 35-53, pl. 3.

(1971a) — The stratigraphy of the Gault in th Thames estuary and its bearing on the Mesozoic te tonic history of the area. **Proc. Geol. Ass.**, 82, 187-207.

(1971b) — Middle Albian stratigraphy in the Angl Paris Basin. **Bull. Brit. Mus. nat. Hist. (Geol.)** Supp 8, 163 pp., 3 pls.

(1974) — Ammonite faunal provinces in the Middl and Upper Albian and their palaeogeographica significance. **In CASEY, R. & RAWSON, P.F., Th Boreal Lower Cretaceous. Geol. J. Special Issue** 5 145-154. (mis- dated 1973)

(1976) — The stratigraphy of the Gault and Uppe Greensand of the Weald. **Proc. Geol. Ass.**, 86, 475-498 (for 1975).

PEACH, B.N., GUNN, W. & NEWTON, E.T., (1901) - Remarkable volcanic vent of Tertiary age in th

Island of Arran, enclosing Mesozoic fossiliferous rocks. **Q. Jl. geol. Soc. Lond.**, 57, 226-243.

PEAKE, N.B. & HANCOCK, J.M., (1961) — The Upper Cretaceous of Norfolk. **Trans. Norfolk Norwich Nat. Soc.**, 19, 293-339, 1 pl.

PESSAGNO, E., (1967) — Upper Cretaceous planktonic Foraminifera from the western Gulf Coast plain. **Palaeontogr. am.**, 5, 245-445.

PETTITT, N., (1950-54) — A monograph of the Rhynchonellidae of the British Chalk. **Palaeontogr. Soc. (Monogr.).**

PHILLIPS, W., (1821) — Remarks on the Chalk cliffs in the neighbourhood of Dover, and on the Blue Marl covering the Greensand near Folkestone. **Trans. geol. Soc. Lond.**, 5, 16-46.

POPIEL-BARCZYK, E., (1958) — Jezowce rodzaju *Conulus* z Turonu okolic krakowa, Miechowa i Wolbromia. **Prace Mus. Ziemi**, 2, 41-79, pls. 1-5.

PORTHAULT, B., THOMEL. G. & VILLOUTREYS, O. de, (1966) — Étude biostratigraphique du Cénomanien du Bassin supérieur de l'Esteron (Alpes-Maritimes). Le problème de la limite Cénomanien-Turonien dans le sud-est de la France. **Bull. Soc. géol. Fr.**, (7) 8, 423-439, pls. 8-11.

POŻARYSKI, W., (1960) — An outline of stratigraphy and palaeogeography of the Cretaceous in the Polish lowland. **Pr. Inst. geol. (Warszawa)**, 30, 377-440. (in Polish with English summary)

REID, R.E.H., (1973) — Origin of the Mesozoic 'Boreal' realm. **Geol. Mag.**, 110, 67-68.

RICHTER-BERNBURG, C. & SCHOTT, W., (1959) — The structural development of northwest German salt domes and their importance for oil accumulation. Proc. **World Petrol Cong., 5 (New York)**, 1, 81-94.

ROMEIN, B.J., (1962) — On the type locality of the Maastrichtian (Dumont, 1849), the upper boundary of that stage and on the transgression of a Maastrichtian s.l. in Southern Limburg. **Meded. Geol. Sticht.**, (n.s.) 15, 77-84.

ROWE, A.W., (1899) — An analysis of the genus *Micraster*, as determined by rigid zonal collecting from the Zone of ***Rhynchonella Cuvieri*** to that of *Micraster cor-anguinum*. **Q. Jl. geol. soc. Lond.**, 55, 494-547, pls. 35-39.

(1900-1908) — The zones of the White Chalk of the English Coast. **Proc. Geol. Ass.**, 16, 289-368 (1: Kent and Sussex); 17, 1-76 (2: Dorset); 18, 1-51 (3: Devon) ; 18, 193-296 (4: Yorkshire) ; 20, 209-352 (5: Isle of Wight).

SAHNI, M. R., (1929) — A monograph of the Terebratulidae of the British Chalk. **Palaeontogr. Soc. (Monogr.)**

SANDERS, H.L., (1968) — Marine benthic diversity: a comparative study. **Am. Nat.**, 102, 243-282.

SCHLOZ G., (1973) — Sur l'âge de la faune d'Ammonites au Château près de St. Martin-en-Vercours (Drôme) et quelques considérations sur l'évolution des Turrilitides et Hoplitidés du vracono-cénomaniens. **Geologie Alp.**, 49, 119-129.

SHARPE D., (1853-57) — Description of the fossil remains of Mollusca found in the Chalk of England. Part 1, Cephalopoda. **Palaeontogr. Soc. (Monogr.).**

SMART, J.G.O., (1955) — Notes on the geology of the Alton Pancras district. **Bull. geol. surv. G.B.**, 9, 42-50.

BISSON, G. & WORSSAM, B.C., (1966) — Geology of the country around Canterbury and Folkestone. **Mem. geol. Surv. U.K.**

SMITH, A.G., BRIDEN, J.C. & DREWRY, G.E., (1973) — Phanerozoic world maps. In HUGHES, N.F. (ed.) Organisms and continents through time. **Spec. pap. Palaeontology**, 12, 1-42.

SORGENFREI, T., (1969) — Geological perspectives in the North Sea area. **Meddr. dansk. geol. Foren.**, 19, 160-196.

SORNAY, J., (1957) — Crétacé: France, Belgique, Pays-Bas, Luxembourg. **Lexique Strat. Int.**, 1 4a vi, 403 pp.

SOWERBY, J., (1812-1822) — The mineral Conchology of Great Britain. 1 - 4 (pars), pls. 1-383.

SOWERBY, J. de C., (1823-1846) — **The Mineral Conchology of Great Britain.** 4 (pars) - 7, pls. 384-648.

SPAETH, C., (1974) — *Neohibolites ernsti* and its occurrence in the Upper Albian of northwest Germany and England. In CASEY, R & RAWSON, P.F. (eds.). **The Boreal Lower Cretaceous. Geol. J. Special Issue** 5, 361-368. (mis-dated 1973)

SPATH, L.F., (1923-43) — A monograph of the Ammonoidea of the Gault. 2 vols. **Palaeontogr. soc. (Monogr.).**

(1923b) — Excursion to Folkestone with notes on the zones of the Gault. **Proc. Geol. Ass.**, 34, 70-76.

(1923c) — On the ammonite horizons of the Gault and contiguous deposits. **Summ. Progr. geol. Surv. U.K.**, for 1922, 139-149.

(1925) — Notes on the ammonites of the Lower Greensand and Gault - Folkestone and neighbourhood. In WALTON, J.W. (ed.), *Folkestone and the country around.* Folkestone.

(1926) — On the zones of the Cenomanian and uppermost Albian. **Proc. Geol. Ass.**, 37, 420-432.

SPENCER, A.M. (ed.), (1974) — Mesozoic-Cenozoic orogenic belts. **Geol. Soc. Lond. spec. Publs.**, 4, 809 + xvi pp.

STINTON, F.G., (1971) — Easter field meeting in the Isle of Wight. **Proc. Geol. Ass.**, 82, 403-410.

STOKES, R.B., (1975) — Royaumes et provinces fauniques du Crétacé établis sur la base d'une étude systématique du genre *Micraster*. **Mém. Mus. natn. Hist. nat. Paris.** (C) 31, 94 pp., 12 pls.

STOVER, L.E., (1966) — Cretaceous coccoliths and associated nannofossils from France and the Netherlands. **Micropaleontology**, 12, 133-167, 9 pls.

SUESS, E., (1885-1909) — *Das Antlitz der Erde.* 5 vols, Vienna.

SURLYK, F. & BIRKELUND, T., in press. — An integrated stratigraphical study of fossil assemblages from the Maastrichtian white chalk of NW Europe. In KAUFFMAN, E.G. & HAZEL, J.E. (eds.) *Concepts and Methods in Biostratigraphy.*

SUTTON, J., (1968) — Development of the continental framework of the Atlantic. **Proc. Geol. Ass.**, 79, 275-303.

SWINNERTON, H.H., (1936-55) — A monograph of British Lower Cretaceous Belemnites. **Palaeontogr. Soc. (Monogr.).**

TAYLOR, J.C.M. & COLTER, V.S., (1975) — Zechstein of the English sector of the Southern North Sea Basin. In WOODLAND, A.W. (ed.), *Petroleum and the continental shelf of north-west Europe 1, Geology*, 249-263. London.

THIERSTEIN, H.R., (1971) — Tentative Lower Cretaceous calcareous nannoplankton zonation. **Eclog. geol. Helv.**, 64, 459-487, 8 pls.

THOMEL , G., (1961) — Sur la présence du genre *Schloenbachia* dans le Vraconien supérieur de Saint-Laurent de l'Escarène (Alpes-Maritimes). **C.R. soc. géol. Fr.**, for 1961, 37.

(1965) — Zonéostratigraphie et paléobiogéographie du Cénomanien du sud-est de la France. **C.R. 90e Congr. Socs. sav., Nice, sect. sci.**, 127-154.

(1972) — Les Acanthoceratidae Cénomaniens des chaines subalpines méridionales. **Mém. Soc. géol. Fr.**, 116, 204 pp., 88 pls.

(1973) — A propos de la zone à *Actinocamax plenus*: principe et application de la méthodologie biostratigraphique. **Annls. Mus. Hist. Nat. Nice**, 1 (supplement), 1-28.

TILLMAN, H., (1964) — Kreide. **In NATHAN, H. et al.** *Erläuterungen zur Geologischen Karte von Bayern 1:500.000, ch.4*. 141-161. München, Bayerisches Geologisches Landesamt.

TRIGER, J., (1869) — Divisions générale de la carte géologique de la Sarthe; terrain crétacé. 10 pls., 2 tab. **In COTTEAU, G. & TRIGER, J.**, (1855-69), *Echinides du département de la Sarthe*. Paris.

TRÖGER, K.A., (1963) — Stratigraphische-paläontologische und fazielle Probleme der sächsischen Kreide. **Ber. Geol. Ges. D.D.R.**, 8, 107-125.

(1969) — Zur Paläontologie, Biostratigraphie und faziellen Ausbildung der unteren Oberkreide (Cenoman bis Turon) 2. **Abhand. Staatl. Mus. Mineral. Geol. Dresden**, 13, 1-70, 18 pls.

UHLIG, V., (1911) — Die marinen Reiches des Jura und der Unterkreide. **Mitt. Geol. Gesell. Wien.**, 4, 329-448.

UMBGROVE, J.H.F., (1926) — Bijdrage tot de kennis der Stratigraphie, Tektoniek en Petrographie van het Senoon in Zuid-Limburg. **Leid. Geolog. Meded.**, 1, 255-332.

VALENTINE, J.W., (1971) — Plate tectonics and shallow marine diversity and endemism: an actualistic model. **Syst. Zool.**, 20, 253-264.

(1973) — *Evolutionary paleoecology of the marine biosphere*. Englewood Cliffs, New Jersey.

VOIGT, E., (1929) — Die Lithogenese der Flach-und Tiefwassersedimente des jüngeren Oberkreidemeeres. **Jb. halle. Verb. Erforsch. mitteldt. Bodenschätze**, 8, 1-165.

(1962) — Frühdiagenetische Deformation der Turonen Plänerkalke bei Halle-Westf.. **Mitt. geol. StInst. Hamb.**, 31, 146-275.

(1963) — Über Randtröge vor Schollenrändern und ihre Bedeutung im Gebiet der Mitteleuropäischen Senke und angrenzender Gebiete. **Z. dt. geol.** (114 (for 1962), 378-418.

WALSH, P.T., (1966) — Cretaceous outliers in south Ireland and their implications for Creta palaeogeography. **Q. Jl. geol. Soc. Lond.**, 122, 84.

WITHERS, T.H., (1935) — *Catalogue of fossil C pedia in the department of geology 2: Cretac* Brit. Mus. Nat. Hist.

WILSON, R.C.L., (1975) — Atlantic opening Mesozoic continental margin basins of Iberia. **E Planet. Sci. Lett.**, 25, 43-53.

WOOD, C., (1965) — Field meeting on the Lower C between Folkestone and Dover. **Proc. Geol. Ass.**, 301-304.

WOODS, H., (1899-1913) — A monograph of the C taceous Lamellibranchia of England. **Palaeont Soc. (Monogr.)** 2 vols.

(1924-31) — A monograph of the fossil Macru Crustacea of England. **Palaeontogr. soc. (Monog**

WOODWELL, G.M. & SMITH H.H., (1969) — Diver and stability in ecological systems. **Brookhaven S pos. Biol.**, 22, 264 pp.

WORSSAM, B.C. & TAYLOR, J.H., (1969) — Geo of the country around Cambridge. **Mem. geol. S U.K.**

WRIGHT, C.W., (1947) — Albian, Cenomanian, T nian and Senonian stages. **In ARKELL, W.J.,** geology of the country around Weymouth, Swan Corfe & Lulworth. 178-214, **Mem. geol. Surv. U.K**

(1956) — Notes on Cretaceous ammonites *Utaturiceras* gen. nov. and the Metoicoceratinae **A Mag. nat. Hist.**, (12) 9, 391-393.

(1959) — Les étages supracrétacés et la phylog des ammonoides. **C.r. Congr. Socs. sav. - D 1959:** *Colloque sur le Crétacé Supérieur fran* 765-770.

& COLLINS, J.S.H., (1973) — British Cretac Crabs. **Palaeontogr. soc. (Monogr.)**

& WRIGHT, E.V., (1942) — The Chalk of Yorkshire Wolds. **Proc. Geol. Ass.**, 53, 112-127.

(1951) — A survey of the fossil Cephalopoda of Chalk of Great Britain. **Palaeontogr. Soc. (Mono**

Dépôt du manuscrit : 30 Septembr

	NORTH GERMANY	SOUTHERN ENGLAND	AND FRANCE	STAGE
CONIACIAN (part)	*I. koeneni*	*M. coranguinum* (part)	*P. emscheris*	CONIACIAN
	I. deformis	*M. decipiens*	*B. haberfellneri*	
TURONIAN	*I. vancouverensis*	*M. normanniae*	*S. neptuni* ?	TURONIAN
	I. lamarcki	*H. planus*	?...............?	
		T. lata ?...............?	*C. woollgari*	
	I. labiatus	*I. labiatus*	*M. nodosides*	

Table 1. — Principal late Cretaceous facies recognised in western Europe (modified from Hancock 1975)

SUBSTAGE	ZONE	SUBZONE
LOWER CENOMANIAN	*Hypoturrilites carcitanensis*	None recognised
UPPER ALBIAN	*Stoliczkaia dispar*	None recognised
	Mortinoceras inflatum	*Mortoniceras altonense* *Callihoplites auritus* *Hysteroceras varicosum* *Hysteroceras orbignyi* *Dipoloceras cristatum*
MIDDLE ALBIAN	*Euhoplites lautus*	*Anahoplites daviesi* *Euhoplites nitidus*
	Euhoplites loricatus	*Euhoplites meandrinus* *Mojsisovicsia subdelaruei* *Dimorphoplites niobe* *Anahoplites intermedius*
	Hoplites (Hoplites) dentatus	*Hoplites spathi* *Lyelliceras lyelli* *Hoplites (Isohoplites) eodentatus*
LOWER ALBIAN	*Douvilleiceras mammillatum*	*Protohoplites puzosianus* *Otohoplites raulinianus* *Cleoniceras floridum* *Sonneratia kitchini*
	Leymeriella tardefurcata	*Leymeriella regularis* *Hypacanthoplites milletioides* *Farnhamia farnhamensis*
UPPER APTIAN	*Hypacanthoplites jacobi*	*Hypacanthoplites anglicus* *Hypacanthoplites rubricosus* *Nolaniceras nolani*

Table 2. — Standard ammonite zonation of the Albian stage in England and northern France

SUBSTAGE	CLASSIC AMMONITE ZONES	CURRENT AMMONITE ZONES
LOWER TURONIAN		*Mammites nodosoides*
UPPER CENOMANIAN	*Calycoceras naviculare*	*Sciponoceras gracile* *Eucalycoceras pentagonum / Calycoceras naviculare*
UPPER CENOMANIAN	*Acanthoceras rhotomagense*	*Acanthoceras jukesbrownei* *Turrilites acutus* *Turrilites costatus*
LOWER CENOMANIAN	*Mantelliceras mantelli*	*Mantelliceras gr. dixoni* *Mantelliceras saxbii* *Hypoturrilites carcitanensis*
UPPER ALBIAN		*Stoliczkaia dispar*

Table 3. — Standard ammonite zones of the Cenomanian stage in England and northern France

Table 4. — Correlation of the North German stages and inoceramid zones, English / French chalk zones and standard ammonite zones for the Turonian to early Coniacian interval

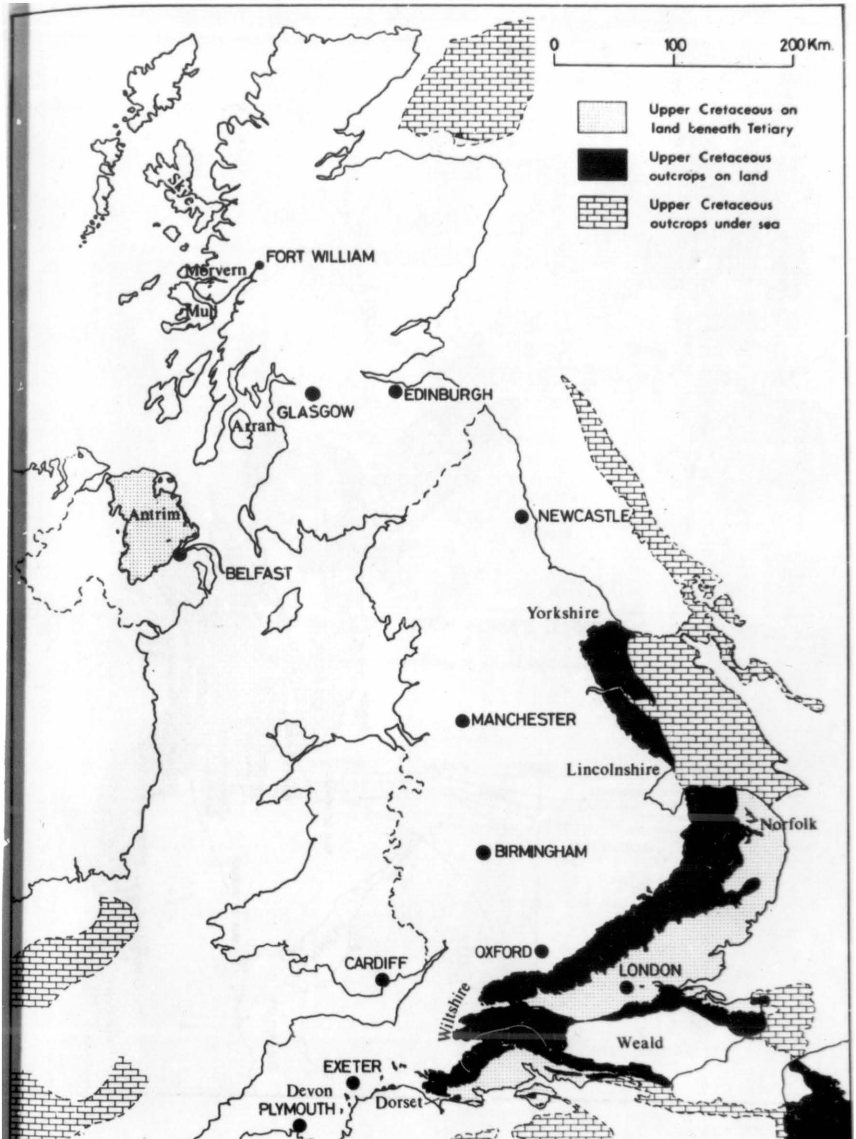
LITHOLOGY	TYPICAL VERNACULAR NAME OF FACIES	EXAMPLES	COMMENTS
Multi-coloured clays to sands and conglomerates	Variegated facies	Niederschönaer Schichten, Saxony (Lower Cenomanian). Peruc Formation, Czechoslovakia (Lower Cenomanian). Parkstein Schichten, Bavaria (Upper Cretaceous); Quedlinburger Flugplatzschichten, Saxony (Coniacian), Argiles d'Ecommoy, Sarthe (Cenomanián).	Freshwater facies, prominent only in Bohemia and Saxony. Lithologies are very variable: there are sometimes rich floras, and unionid bivalves in places.
Planar cross-bedded sands; sets usually 0.3 to 3 m in thickness, with subsidiary trough cross-bedding.	Sandsteinbank	Quadersandtein of Saxony and Bohemia (Cenomanian to Lower Santonian). Folkestone Sands of south east England (Lower Albian) Woburn Sands of south east England (Lower Albian).	Generally unfossiliferous sand wave facies deposited in depths of 50 m or less, arthropod and (?) coelenterate burrows widespread.
Sands with horizons or lenticles of calcareous sandstone. Generally bioturbated. Hardgrounds sometimes developed.	Grizzle	Wilmington Sands of Devon (Lower Cenomanian). Sables du Perche of Sarthe (Upper Cenomanian), Vysatur Sandstone, Kutna Hora, Czechoslovakia (Upper Cenomanian).	Nearshore marine sands. Often richly fossiliferous; grades into sand wave facies.
Glauconitic sandstone with nodular, carbonate cemented concretions. Bioturbated or with parallel or ripple-drift bedding.	Greensand	Chert Beds of Upper Greensand, south west England (Upper Albian), *Inoceramus* Band in the lower part of the Upper Hibernian Greensands, Co. Antrim, Ireland (Upper Turonian - Lower Santonian). Regensburger Grünsandstein of south east Bavaria (Cenomanian). Malnice Greensand, Czechoslovakia (Lower Turonian).	Diverse *Chlamys-Neithea-Entolium* fauna with grypheid Pycnodonts and trace-fossils, notably *Thalassinoides* and *Spongeliomorpha*. Probably deposited in 20-150 m depths 'Greensand' has been used very loosely in Europe; some 'Greensands' contain no glauconite.

Poorly defined alternations of carbonate/chert (often intergrown) and softer silty, marly beds with subsidiary quartz sand.	Gaize	Yellow Sandstone, Ireland (Middle Cenomanian). Malmstone of Surrey and Hampshire, England (Upper Albian). Gaize du Pays de Bray, northern France (Upper Albian). Gaize de Vouziers, Argonne (Upper Albian). Smectite of eastern Belgium (Campanian). Flammenmergel of north west Germany (Upper Albian).	A striking lithology, often spicular, with light, porous, silicified layers conspicuous. Generally burrowed, sometimes with *Zoophycos*. Apparently a relatively quiet water facies.
Bioturbated glauconite sand in clay matrix, often with phosphatic nodules.	Glauconie	Glauconite sands, Ireland (Lower to Middle Cenomanian). Glauconie de Ceton, Normandy (Upper Albian). Soester Greensand, Münster Basin (Middle Turonian).	Clay-lined *Spongeliomorpha* are ubiquitous in this facies, and terrigenous detritus scarse. Often richly fossiliferous with diverse ammonites, bivalves and like, commonly phosphatic with indications of a complex history.
Burrowed black, olive, blue-grey or grey shales and burrowed clays with phosphatic nodule beds.	Slipper Clay	Gault of eastern and southern England (Middle to Upper Albian). Gault of the Paris Basin (Middle to Upper Albian). Unnamed formation in the Viking Graben of the North Sea (Coniacian to Maastrichtian).	These clays generally contain small amounts of quartz sand/silt and glauconite. Fossils are abundant and diverse, often with aragonite preserved ; phosphatised fossils in condensed beds widespread.
Rhythmic cycles of marl passing up into limestone in units 0.6 to 1 m thick.	Chalk Marl	Chalk Marl of southern England, (Lower to Middle Cenomanian). Teplice Formation of Bohemia (Turonian).	Intensely burrowed coccolith micrites with variable clay content. Richly fossiliferous with inoceramid-hexactinellid sponge-ammonite faunas.
Bioturbated glauconitic chalks with variable clay or quartz sand-silt.	Mulatto	Craie Glauconieuse of Normandy Coast (France). Chalk Basement Beds of southern England (Cenomanian).	Generally richly fossiliferous with phosphatic nodules and /or fauna : generally transgressive and typically condensed, less common above Turonian.

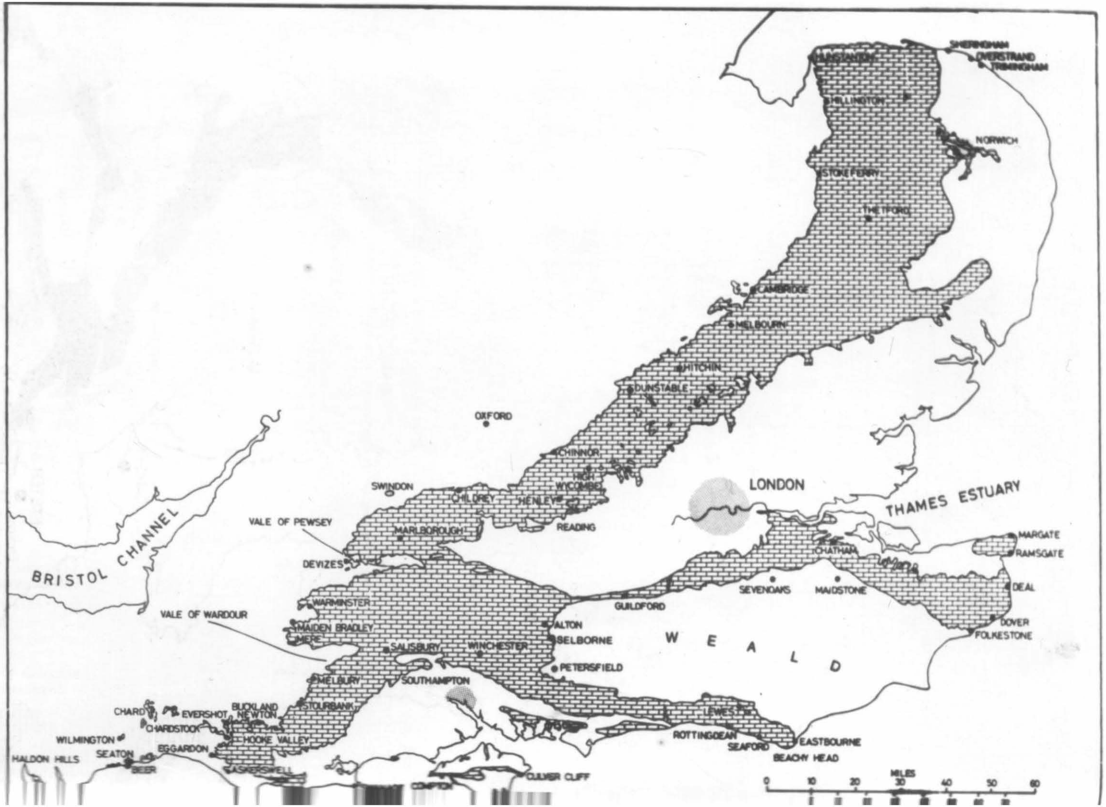
Table 4(b)

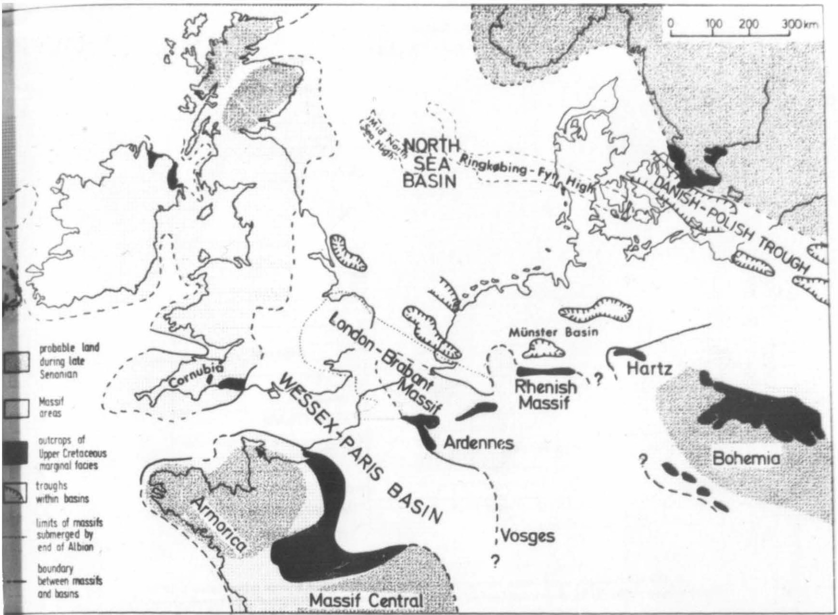
Cavernous, poorly bedded calcarenite	tuffeau	Maastricht Tuffeau of the Netherlands (Upper Maastrichtian), Calcaires à *Baculites*, Cotentin (probaaly Lower Maastrichtian).	Rich in Bryozoans and benthonic forams. Uncommon before the Maastrichtian ; the Turonian tuffeau of France is a slightly different lithology.
Inoceramus calcarenite	shelly chalk	Beer Stone, Devon (Turonian)	Often bedded, a winnowed chalk with fossils such as *Inoceramus*, *Holaster* and *Conulus*.
Bioturbated coccolith micrite	white chalk	Most of the Santonian to Campanian Chalks of southern England, the Paris Basin and like.	Generally uncemented open sea chalks deposited in depths of 80-600m. Fauna often of low diversity ; originally aragonitic fossils absent due to sea floor dissolution. Indications of thixotropic bottoms.
Nodular to massive early lithified coccolith micrites ; may be phosphatised and glauconitised ; frequently capped by erosion surface.	hardground chalk	Chalk Rock, England (Upper Turonian).	Complex levels of early cementation : hardgrounds are but the terminal phase of a series of lithified chalks. Faunas often much more diverse than white chalks, with aragonitic fauna preserved as moulds.
Calcarenitic coccolith micrites with phosphatised fecal pellets.	phosphorite chalk	Craie de Ciply, Belgium (Maastrichtian), Taplow Chalk, England (Santonian-Campanian).	A facies of swell areas, generally condensed, the pellets phosphatised by seafloor replacement.
Dolomitic chalk or dolomite sands, often dedolomitised.	dolomitic chalk	Craie de Bimont, Breteuil, Oise, France.	A diagenetically altered coccolith chalk, into which it passes laterally and vertically. Rare outside France.

Table 4(c)



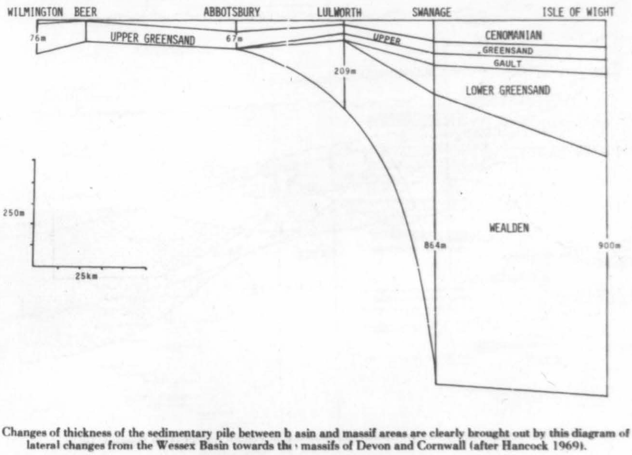
1. — Outcrop map of Cretaceous sediments in the area of study


SHERINGHAM
OVERSTRAND
TRIMINGHAM
HUNSTANTON
HILLINGTON
NORWICH
STOKE FERRY
THETFORD
CAMBRIDGE
MELBOURN
HITCHIN
DUNSTABLE
OXFORD
CHINNOR
HIGH WYCOMBE
SWINDON
CHILDREY
HENLEY
READING
LONDON
THAMES ESTUARY
MARGATE
RAMSGATE
CHATHAM
VALE OF PEWSEY
MARLBOROUGH
DEVIZES
BRISTOL CHANNEL
SEVENOAKS
MAIDSTONE
DEAL
WARMINSTER
GUILDFORD
DOVER
FOLKESTONE
VALE OF WARDOUR
MAIDEN BRADLEY
MERE
ALTON
SELBORNE
W E A L D
SALISBURY
WINCHESTER
PETERSFIELD
MELBURY
SOUTHAMPTON
CHARD
EVERSHOT
BUCKLAND NEWTON
STOURBANK
LEWES
CHARDSTOCK
WILMINGTON
HOOKE VALLEY
ROTTINGDEAN
SEAFORD
EASTBOURNE
BEACHY HEAD
HALDON HILLS
SEATON
EGGARDON
BEER
ASKERSWELL
COMPTON
CULVER CLIFF
MILES
0
10
20
30
40
50
60

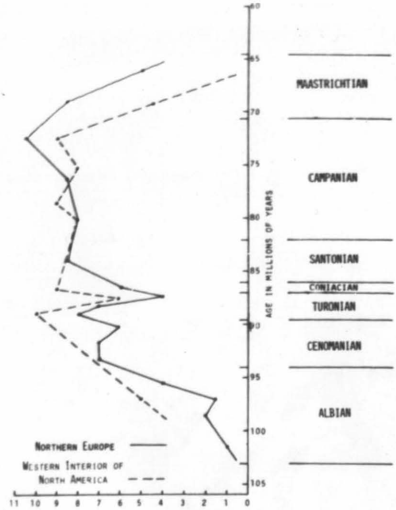


SEDIMENTARY TECTONIC FRAMEWORK OF NORTH EUROPE DURING THE UPPER CRETACEOUS

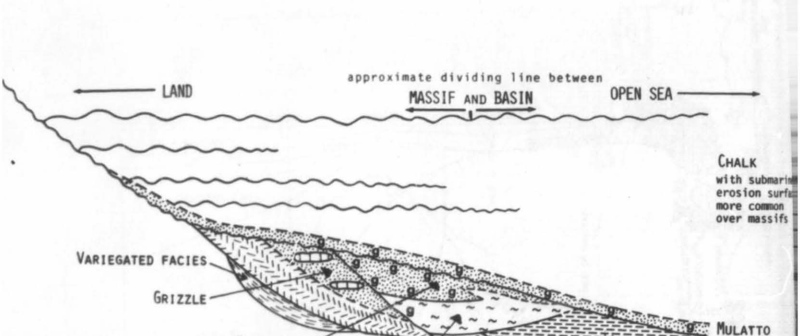
3. The sedimentary-tectonic framework of western Europe during the mid and late Cretaceous (after Hancock 1975).



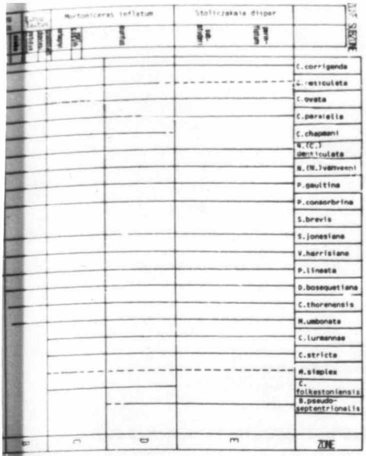
4. Changes of thickness of the sedimentary pile between basin and massif areas are clearly brought out by this diagram of lateral changes from the Wessex Basin towards the massifs of Devon and Cornwall (after Hancock 1969).



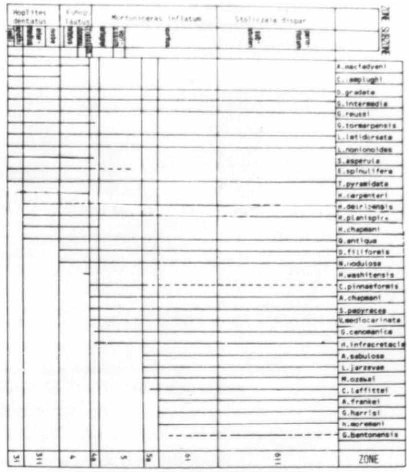
5. The late Cretaceous regressive/transgressive history of north-western Europe (after Hancock 1975). The time scale is that of Obradovich and Cobban (1975). Units of regressive/transgressive magnitude are arbitrary.



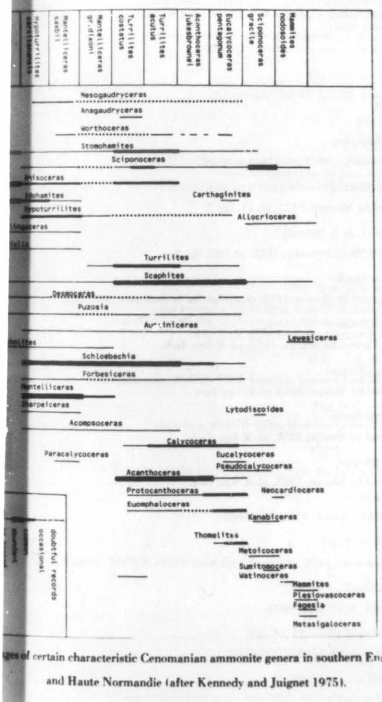
6. Regional facies model for late Cretaceous sedimentation in western Europe (after Hancock 1975).



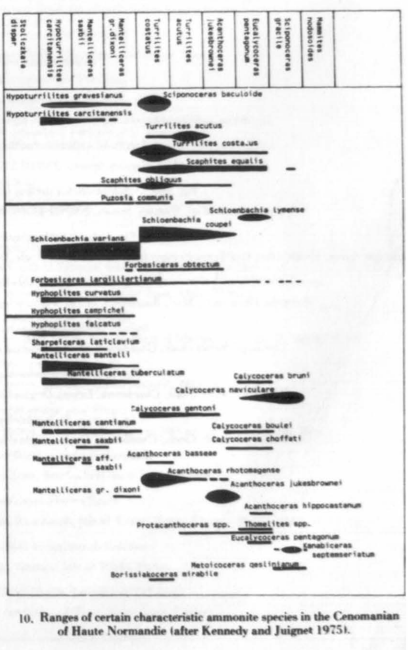
atigraphic distribution of certain Middle and Upper Albian Ostracoda (after Hart 1973).



8. Stratigraphic dictribution of certain Middle and Upper Albian Foraminiferida (after Hart 1973).



ges of certain characteristic Cenomanian ammonite genera in southern England and Haute Normandie (after Kennedy and Juignet 1975).



10. Ranges of certain characteristic ammonite species in the Cenomanian of Haute Normandie (after Kennedy and Juignet 1975).

PLATE 1

Lower and Middle Albian Index Ammonites

Fig. 1a-b. — *Hoplites (Hoplites) dentatus* (J. Sowerby)

Lower Gault, Middle Albian, Folkestone, Kent. Lectotype, figured J. Sowerby, 1821, pl. 308, lower figure; Spath, 1925, p. 101, text fig. 23. BMNH 43927a

Fig. 2a-c. — *Euhoplites lautus* (J. Sowerby)

Lower Gault, Middle Albian, Folkestone, Kent. Holotype of var. *biloba* Spath, figured Spath, 1930, pl. 25, fig. 7, BMNH C35119

Fig. 3a-c. — *Leymeriella regularis* (d'Orbigny)

Gault/Upper Greensand passage beds, Lower Albian, Wrecclesham, Surrey. BMNH C74603.

Fig. 4a-c. — *Douvilleiceras mammillatum* (Schlotheim)

Neotype, main *mammillatum* nodule bed, Lower Albian, Folkestone, Kent.
Figured by Spath, 1923a, pl. 4, fig. 3; Arkeliet al.,1957, fig. 504, 2a; Casey, 1962,pl. 41, figs. 4a-b. BMNH C12491.

PLATE 2

Upper Albian Index and other Ammonites

Fig. 1a-c. — *Mortoniceras (Mortoniceras) inflatum* (J. Sowerby)

Holotype OUM K833 from the Upper Greensand *inflatum* Zone, Isle of Wight, Hants.

Fig. 2. — *Stoliczkaia (Stoliczkaia) dispar* (d'Orbigny)

A specimen from d'Orbigny's Collection, no. 6109a, from the Gaize, *dispar* Zone, Montblainville, Meuse, Musée d'Histoire Naturelle, Paris.

Fig. 3a-b. — *Stoliczkaia (Stoliczkaia) rhamnonotus* (Seeley)

BMNH C4813, upper Albian, *dispar* Zone, Cambridge Greensand, Cambridge. Figured by Spath, 1931, pl. 31, fig. 4.

Fig. 4a-c. — *Stoliczkaia (Stoliczkaia) notha* (Seeley) var. *ultima* Spath

BMNH C77644, Cambridge Greensand, *dispar* Zone, Cambridge. Figured by Spath, 1931, pl. 31, fig. 5.

Fig. 6, 7a-b, 8a-b, 9a-b. — *Stoliczkaia (Stoliczkaia)* spp. juv.

Juveniles of this type are the basis of many of the records of *Submantelliceras* or *Mantelliceras martimpreyi* (Coquand) from the *dispar* Zone.
All specimens in C.W. Wright's collection and from the *dispar* Zone ammonite bed of the Dorset Upper Greensand.
6 is WW 4584, 7 is WW 24473 S. sp. juv. cf. *rhamnonotus* (Seeley) from Durdle Door ; 8 is *S.* cf. *dispar* WW 23138 from White Nothe ;
9. is *S.* cf. *dorsetensis* Spath, from Durdle Door.

PLATE 3

Cenomanian *Schloenbachia*

Fig. 1a-b. — *Schloenbachia varians* (J. Sowerby)

Lectotype, locality unknown. BMNH 43962b. figured by J. Sowerby, 1817, pl. 176, top figure.

Fig. 2a-b. — *Schloenbachia subplana* (Mantell)

Syntype, Chalk Marl, Hamsey, Sussex. BMNH 5724. figured by Mantell, 1822, pl. 21, fig. 2.

Fig. 3a-c. — *Schloenbachia varians tetrammata* (J. de C. Sowerby)

Syntype, Chalk Marl, Hamsey, Sussex. BMNH 43964, figured by J. de C. Sowerby, 1828, pl. 587, fig. 2

Fig. 4a-b. — *Schloenbachia lymensis* Spath

Holotype, 'Lower Chalk' (Bed C of Jukes-Browne & Hill), near Lyme Regis, Dorset. Figured by Sharpe, 1853, pl. 8, figs. 8a, b. Inst. geol. Sci. 7765.

Fig. 5a-b. — *Schloenbachia ventriosa* Stieler

Holotype. Glauconitic Marl, Bonchurch, Isle of Wight. original lost. Figured by Sharpe, 1853, pl. 8, figs. 1a-b.

6a-b. — *Schloenbachia subtuberculata* (Sharpe)

Lectotype. Sandy chalk, Chardstock, Devon. Original lost. Figued by Sharpe, 1853, pl. 8, figs. 5a-c.

Fig. 7a-b. — *Schloenbachia subvarians* Spath

Holotype, Sandy Chalk, Chardstock, Devon. Original lost. Figured by Sharpe, 1853, pl. 8, figs. 7a,b.

Fig. 8a-b. — *Schloenbachia costata* (Sharpe)

Lectotype. Sandy Chalk, Chardstock, Devon. original lost. Figured by Sharpe, 1853, pl. 8, figs. 9a-b.

PLATE 4

Lower Cenomanian Ammonites

Fig. 1a-c. — *Sharpeiceras laticlavium* (Sharpe)

Holotype, Lower Chalk, Bonchurch, Isle of Wight, Figured by Sharpe, 1855, pl. 14, figs. 1a-b. GSM Geol. Soc. 7755 (I.G.S. photo).

Fig. 2. — *Idiohamites ellipticus ellipticus* (Mantell)

Holotype, BMNH 8611, Lower Chalk, Lewes, Sussex. Figured by Mantell, 1822, pl. 23, fig. 9.

3a-b. — *Anisoceras auberti* (Pervinquière)

Glauconitic Marl, *carcitanensis* Zone, Isle of Wight, Hants. BMNH C49.

4a-b, 7a-b, 13. — *Idiohamites alternatus* (Mantell) *vectensis* Spath

4a-b Lectotype, *carcitanensis* Zone, Warminster, Wilts. BMNH 36585a.
7 BMNH 36627a, Glauconitic Marl, *carcitanensis* Zone, Ventnor, Isle of Wight, Hants.
13 BMNH C76423, from Gore Cliff, also in the Isle of Wight.

Fig. 5a-b, 12. — *Idiohamites ellipticus* (Mantell) *radiatus* Spath

5. Paralectotype, Glauconitic Marl, *carcitanensis* Zone, Ventnor, Isle of Wight.
12. BMNH C76428, Glauconitic Marl, *carcitanensis* Zone, Gore Cliff, Isle of Wight, Hants.

6a-b, 11. — *Idiohamites collignoni* Spath

6. Paralectotype, from Warminster, Wilts. BMNH 36586a.
11. BMNH C76422, *carcitanensis* Zone, Glauconitic Marl, Gore Cliff, Isle of Wight.

Fig. 8, 9, 10. — *Hypoturrilites carcitanensis* (Matheron)

Glauconitic Marl, *carcitanensis* Zone, Gore Cliff, Isle of Wight, Hants.
8. is BMNH C76435, 9, BMNH C76437, 10 BMNH C76438.

PLATE 5

Lower Cenomanian Ammonites

Fig. 1, 2a-b. — *Mantelliceras cantianum* (Spath)

1 is the holotype, BMNH 36834, from the Lower Chalk of Dover, Kent, figured by Sharpe, 1857, pl. 18, fig. 1.
2 is BMNH C5027, from the Lower Chalk near Lewes, Sussex, figured by Sharpe, 1857, pl. 18, fig. 2.

3a-c, 4a-b. — *Mantelliceras mantelli* (J. Sowerby)

Lectotype, BMNH 43940a, Chalk Marl, Ringmer, Sussex. Figured J. Sowerby, 1814, pl. 55, lower figure only.
4 BMNH 50161a, Glauconitic Marl, *carcitanensis* Zone, Bonchurch, Isle of Wight, Hants.

Fig. 5a-b. — *Mantelliceras costatum* (Mantell)

Lectotype, BMNH C5028, from the Lower Chalk of Hamsey, near Lewes, Sussex.

Fig. 6. — *Hypoturrilites gravesianus* (d'Orbigny)

and *Hypoturrilites tuberculatus* (Bosc)

BMNH 5762, from the Lower Chalk of Ringmer, near Lewes, Sussex. Figured by Sharpe, 1857, pl. 25, fig. 1.
as *Turrilites tuberculatus*, the specimen consists of 4 whorls of *H. gravesianus* ;
The specimen figured by Mantell, 1822, pl. 24, fig. 6. Only the lower 2 whorls belong to *H. tuberculatus*.

PLATE 6

Lower Cenomanian Ammonites

Fig. 1a-d, 2a-b, 6a-b. — *Mantelliceras saxbii* (Sharpe)

1 is the lectotype, GSM Geol. Soc. 7763 from the Lower Chalk of Ventnor, Isle of Wight. (1a × 1 ; 1b-d × 2) ;
2 is BMNH 50288, the holotype of *Mantelliceras hyatti* Spath, from the Lower Chalk of Bonchurch, Isle of Wight, Hants.
6 is WJK 5341 from the Glauconitic Marl/Popple Bed Junction, *saxbii* Zone, Mere, Wilts.

3a-b. — *Hyphoplites falcatus falcatus* (Mantell)

Lectotype, BMNH 5737, from the Lower Chalk of Middleham, near Lewes, Sussex. Figured Mantell, 1822, pl. 21, fig. 6.

Fig. 4a-c. — *Hyphoplites curvatus* (Mantell)

Holotype, BMNH 5739, from the Lower Chalk of Hamsey, Sussex. Figured Mantell, 1822, pl. 19, fig. 18.

Fig. 5a-b. — *Mantelliceras ventnorense* Diener

Holotype GSM Geol. Soc. 7759, from the Lower Chalk of Ventnor, Isle of Wight. Figured Sharpe, 1857, pl. 23, figs. 6a-c.

Fig. 7. — *Turrilites (Mesoturrilites) aumalensis* Coquand

BMNH C76458, Lower Chalk, ? *saxbii* Zone, Southerham, near Lewes, Sussex.

Fig. 8. — *Ostlingoceras puzosiforme* Spath

Holotype, BMNH 50283, from the Glauconitic Marl, *carcitanensis* Zone, Bonchurch, Isle of Wight, Hants. Figured Sharpe, 1857, pl. 27, fig. 11.

Fig. 9. — *Turrilites (Turrilites) borssumensis* Schlüter

GSM Geol. 7778, Lower Chalk, Ventnor, Isle of Wight, Hants.

Fig. 10, 11. — *Ostlingoceras ? gallienii* (Boule, Lemoine et Thévenin)

BMNH C76386-7, Glauconitic Marl, *carcitanensis* Zone, Stour Bank, Dorset.

Fig. 12a-c. — *Puzosia (Puzosia) octosulcata* (Sharpe)

Lectotype, GSM Geol. Soc. 7761, Grey Chalk of Ventnor, Isle of Wight, Hants. Figured Sharpe, 1857, pl. 19, figs. 3a-b.

PLATE 7

Cenomanian Ammonites

Fig. 1a-b. — *Forbesiceras beaumontianum* (d'Orbigny)

'Type', Ecole des Mines, no. 691, Lower Cenomanian, Lamnay, Sarthe.

Fig. 2. — *Neolobites vibrayeanus* (d'Orbigny)

Holotype, Musée d'Histoire Naturelle, Paris no. 1896-27. Figured d'Orbigny, 1840, pl. 96, figs. 1-3.

Fig. 3. — *Hypoturrilites gravesianus* (d'Orbigny)

BMNH 33557, from the Lower Chalk, Lower Cenomanian, near Lewes, Sussex. Figured Sharpe, 1857, pl. 25, fig. 7a-b.

Fig. 4. — *Turrilites (Turrilites) acutus* Passy.

BMNH C76300. Chalk Basement Bed, *acutus* Zone, Snowden Hill, Chard, Somerset.

Fig. 5a-b. — *Mantelliceras couloni* (d'Orbigny)

'Holotype', 1896-27, Musée d'Histoire Naturelle, Paris, from the Lower Cenomanian of Lamnay, Sarthe.

PLATE 8

Lower Cenomanian Ammonites

Fig. 1a-c. — *Mantelliceras dixoni* Spath

Holotype, BMNH 33630, Lower Chalk, Lower Cenomanian, Sussex. Figured J. de C. Sowerby in Dixon, 1850, pl. 29, fig. 15.

Fig. 2a-b. — *Mantelliceras orbignyi* (Collignon)

Holotype, d'Orbigny Coll, no. 6117, Musée d'Histoire Naturelle, Paris, from the Cenomanian of Le Mans.

Fig. 3, 4a-b. — *Mantelliceras lymense* (Spath)

3 is BMNH C76412, Lower Chalk, *dixoni* Zone, Folkestone, Kent;
4 is BMNH C8002a, from the Cenomanian Limestone, *dixoni* Zone, Pinhay Bay, Devon.

Fig. 5a-b. — *Paracalycoceras wiestii* (Sharpe)

C.W. Wright Coll No. 3556, Cenomanian Limestone, Bed A_2 *saxbii* Zone, White Cliff, Seaton, Devon

Fig. 6a-c. — *Mantelliceras* aff. *souaillonense* (Renz)

BMNH C76414, Lower Chalk, *dixoni* Zone, Folkestone, kent.

PLATE 9

Middle Cenomanian Ammonites

Fig. 1a-b, 2a-b. — *Sciponoceras baculoide* (Mantell)

1 is Sedgwick Museum, Cambridge no. B251, from the Lower Chalk, *costatus* Zone, of Ventnor, Isle of Wight ;
2 is the lectotype (large fragment) and a paralectotype, BMNH 8612, Lower Chalk, *costatus* Zone, Sussex. Figured Mantell, 1822, pl. 23, fig. 6.

Fig. 3a-b, 4a-c. — *Calycoceras gentoni* (Brongniart)

3 is BMNH C76400, a distantly ribbed variant from the Chalk Basement Bed, *acutus* Zone, Snowden Hill, Chard, Somerset ;
4 is a finely ribbed variant BMNH C76372, from the Chalk Basement Bed, *acutus* Zone, Beaminster, Devon.

Fig. 5, 10-14. — *Stomohamites simplex.* (d'Orbigny)

5 is Sedgwick Museum, Cambridge B21347, from the Lower Chalk, Cenomanian of Ventnor, Isle of Wight.
10-14 are five of the syntypes, d'Orbigny Collection no. 6134, Musée d'Histoire Naturelle, Paris, from the *costatus* Zone fauna of the Rouen Fossil Bed, Côte St Catherine, Rouen, Seine Maritime. The original of fig. 14 has been designated lectotype (Sornay, 1955). Figured d'Orbigny 1840, pl. 134, figs. 12-1[illegible]

Fig. 6a-b. — *Acanthoceras jukesbrownei* Spath.

Holotype, BMNH 50162, Chalk Basement Bed, *jukesbrownei* Zone, Man'o'war Cove, Dorset. Figured Sharpe, 1857, pl. 17, fig. 2.

Fig. 7a-b. — *Acanthoceras rhotomagense* (Brongniart) *sussexiense* (Mantell)

Ecole des Mines, Paris, no. A654, from the Rouen Fossil Bed, *costatus* Zone, Rouen, Seine Maritime.

Fig. 8. — *Scaphites (Scaphites) equalis* J. Sowerby

BMNH 4798, Lower Chalk, Cenomanian, Sussex. Figured Mantell, 1822, pl. 22, figs. 8, 12.

Fig. 9. — *Scaphites obliquus* J. Sowerby

BMNH 4799a, from the Chalk Marl, Cenomanian, of Hamsey, Sussex. Figured Mantelll, 1822, pl. 22, figs. 9, 11.

PLATE 10

Fig. 1a-b. — *Calycoceras* aff. *cenomanense* (d'Archiac)

M149, Laboratoire de Géologie, Faculté des Sciences, Le Mans. From the Cenomanian of Le Mans (Sarthe).

Fig. 2a-b, 3a-c, 5a-b, 6a-c. — *Calycoceras gentoni* (Braongiart) and varieties

2 is BMNH 80287, the holotype of *Calycoceras subgentoni* (Spath) from the Chalk Basement Bed, Middle Cenomanian of Chardstock, on the Somerset/Devon border. figured Sharpe, 1857, pl. 18, figs. 3 -b.
3 is Brongniart's original specimen in the collection of the Sorbonne, figured by Brongniart 1822, pl. 6, fig. 6, from Rouen, Seine Maritime.
6a-c the 'cotype' from Westphalia, figured by R. Douvillé, 1911, figs. C1-C4.
5 is BMNH C76397 a spinose variant - *Calycoceras gentoni bathyomphalum* (Kossmat) from the Chalk Basement Bed, *acutus* Zone, Snowden Hill, Chard, Somerset.

Fig. 4. — *Scaphites (Scaphites) equalis* J. Sowerby

Holotype, BMNH 43986, from the Chalk Basement Bed, south west England (probably north Dorset), figured J. Sowerby, 1813, pl. 18, figs. 1-3.

PLATE 11

Upper Cenomanian Ammonites from Division C of the Cenomanian Limestone, Charton Bay-Humble Point, South Devon

Fig. 1a-b, 2a-b, 3a-b. — *Acanthoceras hippocastanum* (J. de C. Sowerby)

1 is the lectotype, GSM 37667, figured J. de C. Sowerby, 1826, pl. 514, fig. 2 ;
2 is WW 21898 ; 3 is BMNH C76471.

Fig. 4a-b. — *Euomphaloceras euomphalum* (Sharpe)

Holotype, BMNH 50138, figured Sharpe, 1855, pl. 13, figs. 4a-c and erroneously said to be from Man o'War Cove, Dorset.

Fig. 5.— *Carthaginites* cf. *laevigatus* (Collignon)

BMNH C76469

Fig. 6a-c. — *Calycoceras (Lotzeites) aberrans* (Kossmat)

WW 19797.

Fig. 7a-b. — *Eucalycoceras pentagonum* (Jukes-Browne)

J.M. Hancock Collection no. CC740.

PLATE 12

Upper Cenomanian Ammonites

Fig. 1. — *Calycoceras bruni* (Fabre)

Lectotype, in the collections of the Geology Department of the University of Lyon (no. 14011) said to be from Dorset (fide Fabre, 1940) but matrix suggests the Marnes à *Ostrea biauriculata* of Sarthe.

Fig. 2a-b. — *Protacanthoceras bunburianum* (Sharpe)

Holotype, BMNH 50155, figured by Sharpe, 1853, pl. 9, figs. 3a-c. Said to be from Chardstock, Devon, but probably from Division C of the Cenomanian Limestone on the Devon coast.

Fig. 3a-b, 4. — *Calycoceras newboldi* (Kossmat), varieties

3 is BMNH C76376, 4 is BMNH C76375, Chalk Basement Bed, basal *naviculare* Zone, Askerswell, Dorset.

Fig. 5a-b. — *Protacanthoceras compressum* (Jukes-Browne)

Lectotype GSM 53484 from Division C of the Cenomanian Limestone,PinhayBay, South Devon.

Fig. 6a-b, 8. — *'Eucalycoceras' rowei* (Spath)

6 is WW 21889, 8 is BMNH C7285 (the lectotype). Horizon and locality as for 5a-b.

Fig. 7a-b. — *Thomelites* aff. *sornayi* (Thomel)

Marnes à *Ostrea biauriculata*, Briollay (Maine et Loire). Musée d'Histoire Naturelle, Angers.

Fig. 9a-b. — *Thomelites* sp. juv.

GSM 53482, one of the paralectotypes of *Protacanthoceras compressum* (Jukes-Browne)

Fig. 10. — *Pseudocalycoceras* cf. *lattense* (Thomel)

Marnes à *Ostrea biauriculata*, Saumur (Touraine). Collections of the Chateau de Saumur.

PLATE 13

Upper Cenomanian Ammonites from North-Western France

Fig. 1a-c, 2. — *Sciponoceras gracile* (Shumard)

Sables à *Catopygus obtusus*, '*gourdoni*' Zone, Briollay (Maine et Loire). Musée d'Histoire Naturelle, Angers.

Fig. 3. — *Metoicoceras geslinianum* (d'Orbigny)

'Type', Musée d'Histoire Naturelle, Paris (Vibraye Collection). Said to be from Vibraye (Sarthe) ; the specimen is probably from Saumur.

Fig. 4. — *Kanabiceras septemseriatum* (Cragin)

Horizon and locality as for fig. 1a-c ; 2. Musée d'Histoire Naturelle, Angers.

Fig. 5a-c. — *Metengonoceras dumbli* Cragin

Musée d'Histoire Naturelle, Nantes. From the Sables à *C. obtusus* equivalents of Touvois (Loire Inférieure).

Fig. 6. — *Metoicoceras* sp. juv. cf. *geslinianum* (d'Orbigny)

Sables à *C. obtusus*, Briollay (Maine et Loire). Musée d'Histoire Naturelle, Angers.

PLATE 14

Upper Cenomanian Ammonites from North-Western France.

Fig. 1a-b. — *Metoicoceras geslinianum* (d'Orbigny)

The holotype of *Metoicoceras gourdoni* (de Grossouvre) from the Sables à *C. obtusus*, Briollay (Maine et Loire). Musée d'Histoire Naturelle, Angers

Fig. 2a-c. — *Calycoceras naviculare* (Mantell)

The holotype of *Metacalycoceras grossouvrei* Spath (= *Fagesia navicularis* Mantell, de Grossouvre, 1912, pl. 3, figs. 1a-b) from the Sables à *C. obtusus* equivalents at Touvois (Loire Inférieure). Musée d'Histoire Naturelle, Nantes.

PLATE 15

Upper Cenomanian and Lower Turonian Ammonites from Southern England

Fig. 1a-b. — *Mammites nodosoides* (Schlotheim)

Middle Chalk, Melbourn Rock, *nodosoides* Zone, Dover, Kent. Kennedy Coll.

Fig. 2a-b, 3a-b. — *Neocardioceras juddi* (Barrois and Guerne)

WW 14048 and WW 14042, Neocardioceras Pebble Bed, Haven Cliff, Axmouth, Devon (remanié fauna).

Fig. 4. — *Watinoceras coloradoense* (Henderson)

Kennedy Collection, Neocardioceras Pebble Bed, Haven Cliff, Axmouth, Devon (indigenous fauna).

Fig. 5a-b. — *Sumitomoceras faustum* Matsumoto and Muramoto

Hancock Coll. No. CT61. Cenomanian Limestone, Division C, 'indigenous' fauna, White Cliff, Seaton, Devon.

Fig. 6a-b. — *Neocardioceras* sp. nov. ?

Kennedy Coll., Neocardioceras Pebble Bed, Haven Cliff, Axmouth, Devon, (indigenous fauna).

PLATE 16

Turonian Ammonite

Fig. 1a-c. — *Metasigaloceras rusticum* (J. Sowerby)

Holotype, Oxford University Museum, K2048, from the Middle Chalk (*nodosoides* Zone), 'Lyme Regis' Dorset.

PLATE 17

Turonian Ammonite

Fig. 1a-c. — *Collignoniceras woollgari* (Mantell).

Lectotype, BMNH 5682, from Sussex.

PLATE 18

Turonian Ammonite

Fig. 1a-c. — *Kamerinoceras salmuriense* (Courtiller)

One of Courtiller's syntypes, from the Tuffeau de Bourré of the Saumur region (Touraine). Collections of the Chateau de Saumur.

PLATE 19

Turonian Ammonites

Fig. 1a-b, 2a-b. — *Kamerunoceras salmuriense* (Courtiller)

Two of Courtiller's syntypes from the Tuffeau de Bourré of the Saumur region (Touraine). Collection of the Chateau de Saumur.

Fig. 3a-b. — *Selwynoceras ? papale* (d'Orbigny)

(= *Mammites vielbancii* (d'Orbigny)

Laboratoire de Géologie, Faculté des Sciences, Le Mans, from the Tuffeau de Bourré (reduced × 0.9).

PLATE 20

Turonian Ammonites

Fig. 1a-c. — *Neoptychites cephalotus* (Courtiller)

Collections of the Chateau de Saumur, no. 631, from the environs of Saumur (Touraine), reduced ; actual diameter is 181 mm. Specimen is from the Tuffeau de Bourré.

Fig. 2a-c. — *Selwynoceras ? papale* (d'Orbigny)

Septate juvenile from the Tuffeau de Bourré, Laboratoire de Géologie, Faculté des Sciences, Le Mans.

PLATE 21

Turonian Ammonite

Fig. 1a-c. — *Romaniceras deverioide deverioide* (de Grossouvre)

Lectotype, Ecole des Mines, Paris, figured de Grossouvre, 1889, pl. 12, figs. 1, 2, from the Tuffeau de Bourré (Loir et Cher).

PLATE 22

Turonian Ammonite

Fig. 1a-b. — *Romaniceras deveroide* (de Grossouvre) var. *armata* (de Grossouvre)

Musée d'Histoire Naturelle, Paris, from Poncé, Sarthe.
According to most authors this is a synonym of *R. ornatissimum* Stoliczka, referred to the genus *Yubariceras* by Matsumoto and others.

PLATE 23

Fig. 1a-b. — *Romaniceras deveroide* (de Grossouvre) var. *inerme* (de Grossouvre)

A301 Collection de l'Ecole des Mines, Paris, from the Tuffeau de Bourré of Poncé, Sarthe.

PLATE 24

Turonian Ammonite

Fig. 1a-c. — *Lewesiceras peramplum* (Mantell)

Musée d'Histoire Naturelle, Paris, 1893-12, from the Tuffeau de Bourré, Poncé (Sarthe).

PLATE 25

Turonian Ammonite

Fig. 1a-b. — *Selwynoceras carolinum* (d'Orbigny)

Musée d'Histoire Naturelle, Paris, d'Orbigny Collection no. 6778 from the Tuffeau de Bourré of Poncé (Sarthe).
This specimen is identified in the catalogue of the d'Orbigny Collection as *Ammonites woollgari*, the name generally applied to large specimens of this species in Touraine. reduced × 0.75.

PLATE 26

Turonian Ammonites

Fig. 1a-b, 2a-b, 3a-c. — *Sehcynoceras carolinum* (d'Orbigny)

All specimens in the Musée d'Histoire Naturelle, Paris.
1 is 1946-12, 2 is 1904-32 from Sarthe, 3 is the 'type' from Martrous, near Rochefort.

PLATE 27

Turonian Ammonites

Fig. 1a-b. — *Pseudotissotia (Pseudotissotia) galliennei* (d'Orbigny)

Musée d'Histoire Naturelle, Paris.
Specimen from the Tuffeau de Bourré, figured by Peron (1896, pl. 3, fig. 1, pl. 17, fig. 2).

Fig. 2a-b. — *Jeanrogericeras revelièreanum* (Courtiller)

One of Courtiller's syntypes from the Tuffeau de Bourré of the Saumur region (Touraine). Collections of the Chateau de Saumur.

Fig. 3a-c. — *Lewesiceras mantelli* Wright and Wright

Holotype, BMNH 88587 probably from the Chalk Rock, *planus* Zone, Oldbury Hill, Wilts. figured Sharpe, 1853, pl. 10, figs. 3a-b.

PLATE 28

Turonian Ammonites

Fig. 1a-c. — *Lewesiceras mantelli* Wright and Wright

BMNH C32290, Chalk Rock, *planus* Zone, Hitch Wood, near Hitchin, Herts. Figured Billinghurst, 1927, text-fig. 2c.

Fig. 2a-b. — *'Prionotropis' turoniense* Sornay (? = *'P' fleuriausianum* (d'Orbigny)).

Holotype, from Bourré (Loire et Cher). Figured Sornay 1951, pl. 21, figs. 1-3.

PLATE 29

Turonian Ammonites

Fig. 1a-b. — *Romaniceras deverianum* Sharpe (? non d'Orbigny)

BMNH 34549 from the Middle Chalk of Sussex. Figured by Sharpe, 1857, pl. 19, fig. 5.
This specimen has been designated the type of a new species, *Romaniceras sharpei* (Zázvorka).

Fig. 2a-b, 3a-b. — *Romaniceras deverianum* (d'Orbigny)

2 is a specimen from the Faluns de Touraine in the Musée d'Histoire Naturelle, Paris ;
3 photographs of a cast from the Tuffeau of Nonans (Indre et Loire), also in the Musée d'Histoire Naturelle, Paris (Lecointre Coll.).

PLATE 30

Turonian Ammonites

Fig. 1a-b, 2a-b, 3. — *Romaniceras deverianum* (d'Orbigny) (? = *R. uchauxiense* Collignon)

Musée d'Histoire Naturelle, Paris. All specimens from the Grès d'Uchaux, Uchaux (Vaucluse).

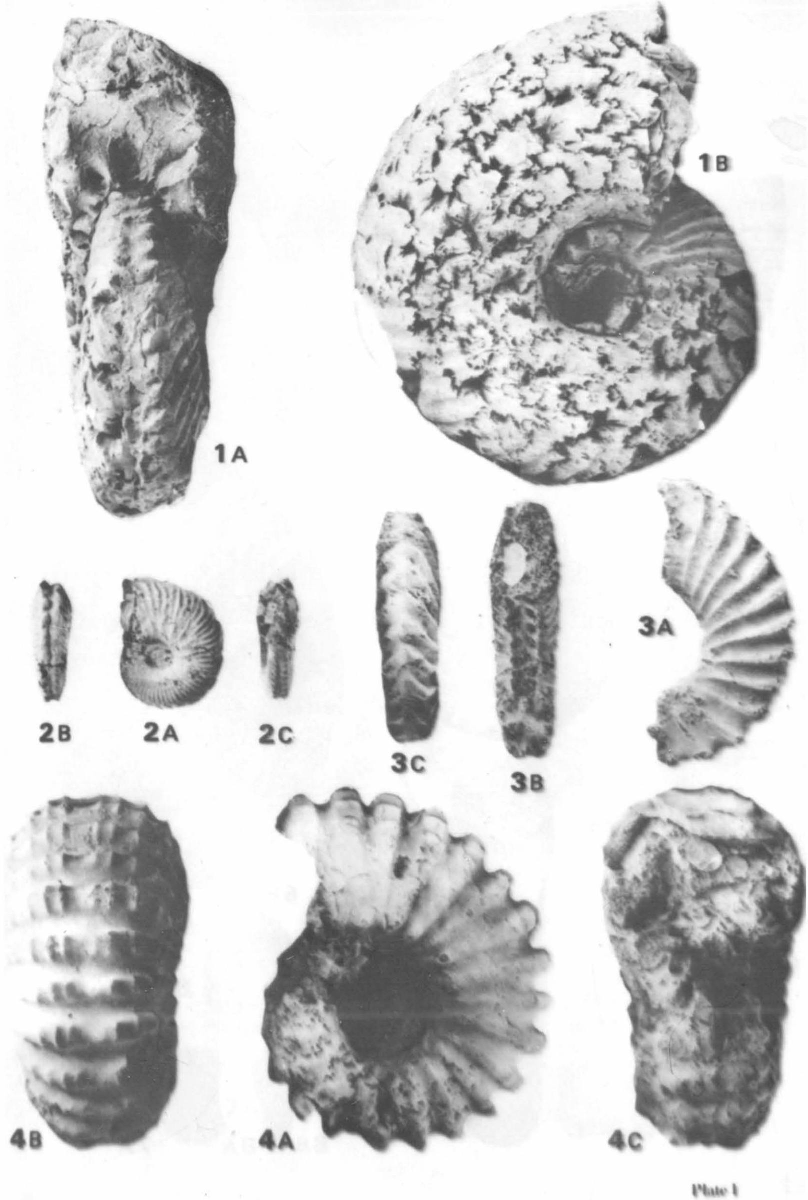


Plate I

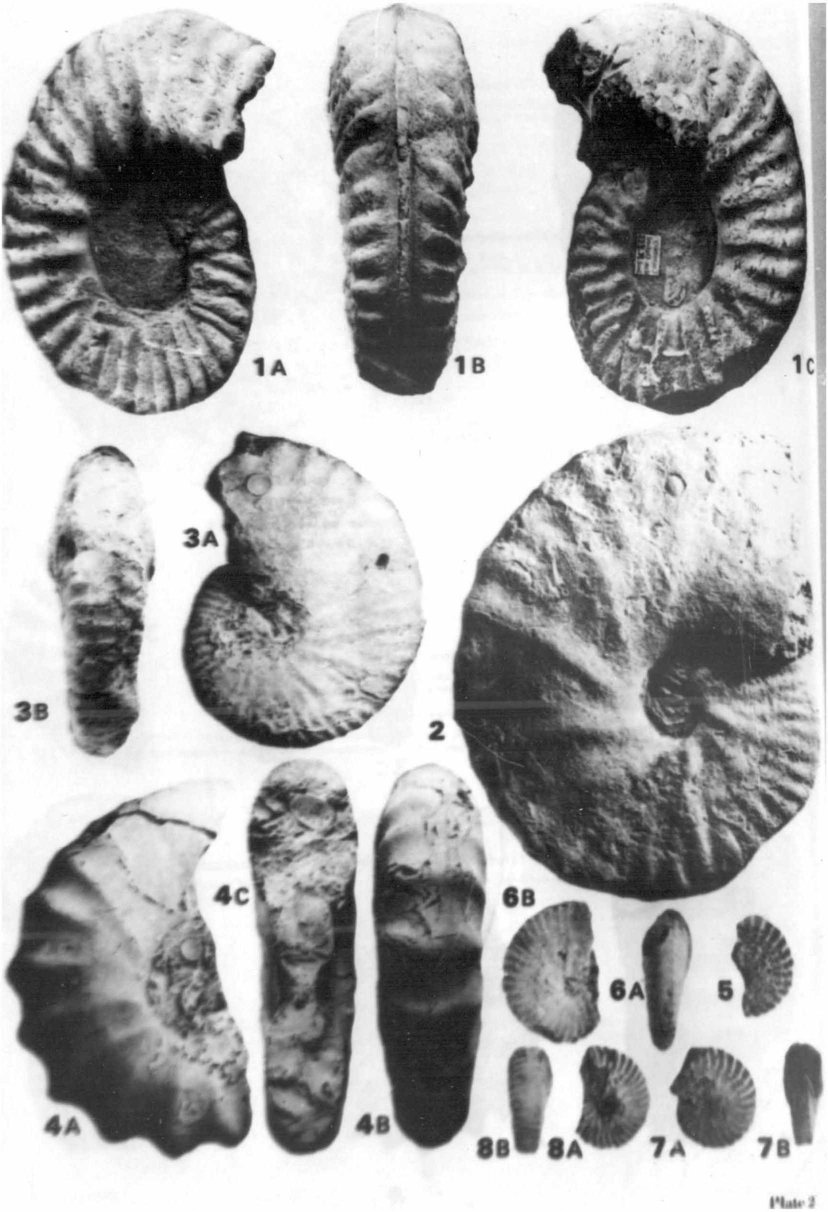


Plate 2

PLATE 26

Turonian Ammonites

Fig. 1a-b, 2a-b, 3a-c. — *Schcynoceras carolinum* (d'Orbigny)

All specimens in the Musée d'Histoire Naturelle, Paris.
1 is 1946-12, 2 is 1904-32 from Sarthe, 3 is the 'type' from Martrous, near Rochefort.

PLATE 27

Turonian Ammonites

Fig. 1a-b. — *Pseudotissotia (Pseudotissotia) galliennei* (d'Orbigny)

Musée d'Histoire Naturelle, Paris.
Specimen from the Tuffeau de Bourré, figured by Peron (1896, pl. 3, fig. 1, pl. 17, fig. 2).

Fig. 2a-b. — *Jeanrogericeras reveliereanum* (Courtiller)

One of Courtiller's syntypes from the Tuffeau de Bourré of the Saumur region (Touraine). Collections of the Chateau de Saumur.

Fig. 3a-c. — *Lewesiceras mantelli* Wright and Wright

Holotype, BMNH 88587 probably from the Chalk Rock, *planus* Zone, Oldbury Hill, Wilts. figured Sharpe, 1853, pl. 10, figs. 3a-b.

PLATE 28

Turonian Ammonites

Fig. 1a-c. — *Lewesiceras mantelli* Wright and Wright

BMNH C32290, Chalk Rock, *planus* Zone, Hitch Wood, near Hitchin, Herts. Figured Billinghurst, 1927, text-fig. 2c.

Fig. 2a-b. — *'Prionotropis' turoniense* Sornay (? = *'P' fleuriausianum* (d'Orbigny)).

Holotype, from Bourré (Loire et Cher). Figured Sornay 1951, pl. 21, figs. 1-3.

PLATE 29

Turonian Ammonites

Fig. 1a-b. — *Romaniceras deverianum* Sharpe (? non d'Orbigny)

BMNH 34549 from the Middle Chalk of Sussex. Figured by Sharpe, 1857, pl. 19, fig. 5.
This specimen has been designated the type of a new species, *Romaniceras sharpei* (Zázvorka).

Fig. 2a-b, 3a-b. — *Romaniceras deverianum* (d'Orbigny)

2 is a specimen from the Faluns de Touraine in the Musée d'Histoire Naturelle, Paris ;
3 photographs of a cast from the Tuffeau of Nonans (Indre et Loire), also in the Musée d'Histoire Naturelle, Paris (Lecointre Coll.).

PLATE 30

Turonian Ammonites

Fig. 1a-b, 2a-b, 3. — *Romaniceras deverianum* (d'Orbigny) (? = *R. uchauxiense* Collignon)

Musée d'Histoire Naturelle, Paris. All specimens from the Grès d'Uchaux, Uchaux (Vaucluse).

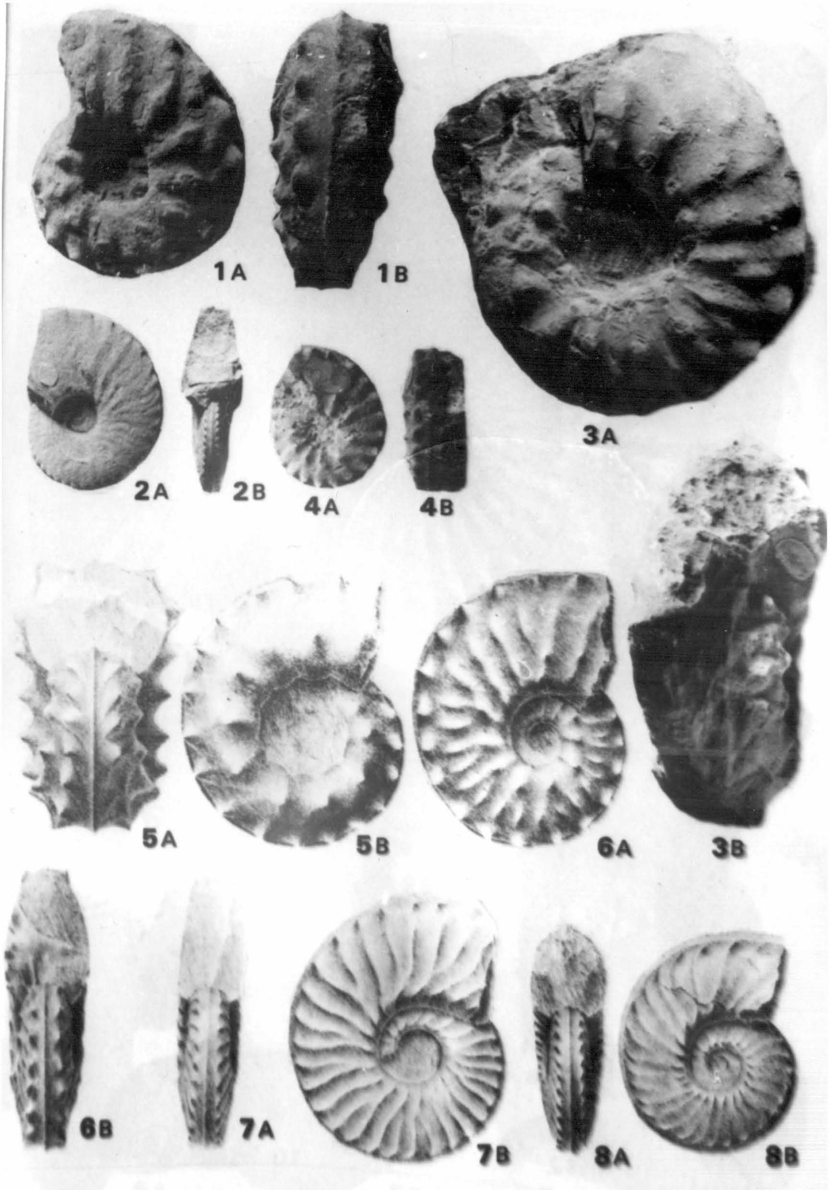


Plate 3

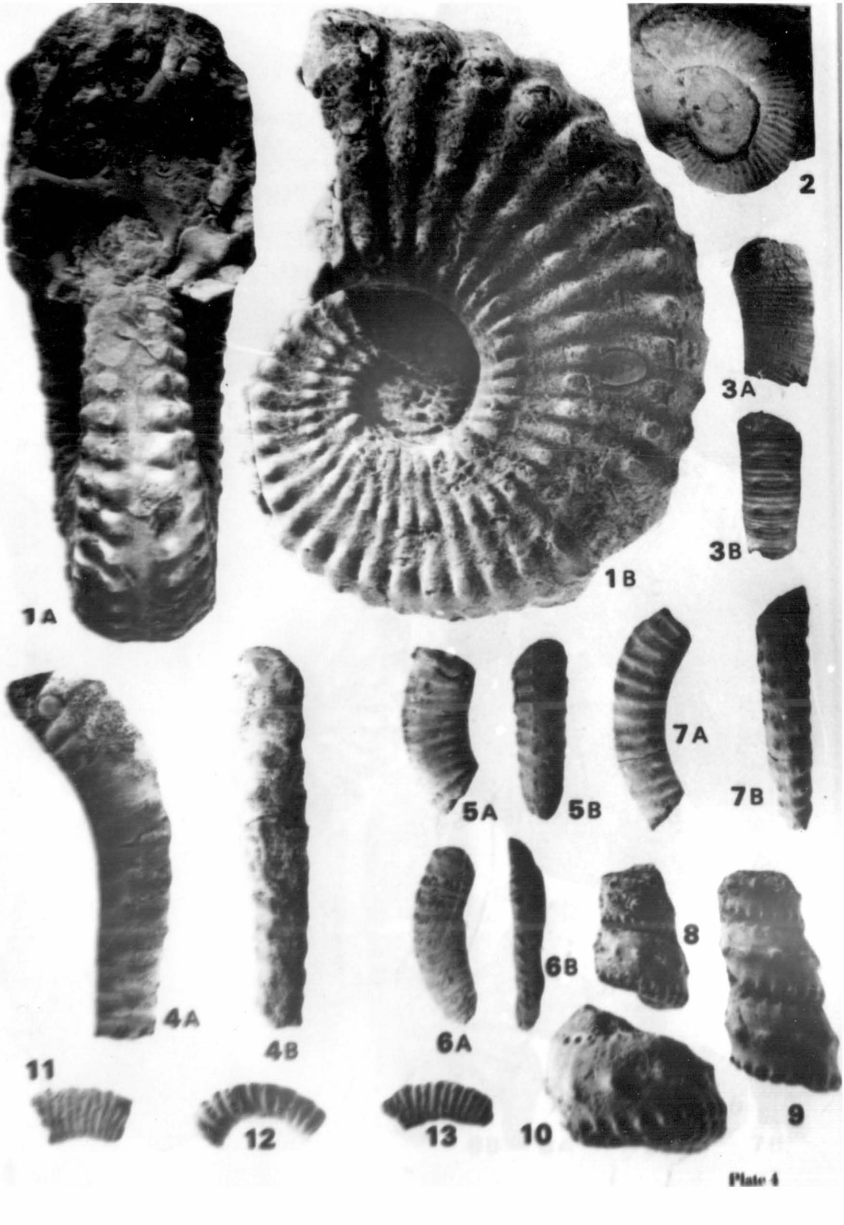


Plate 4

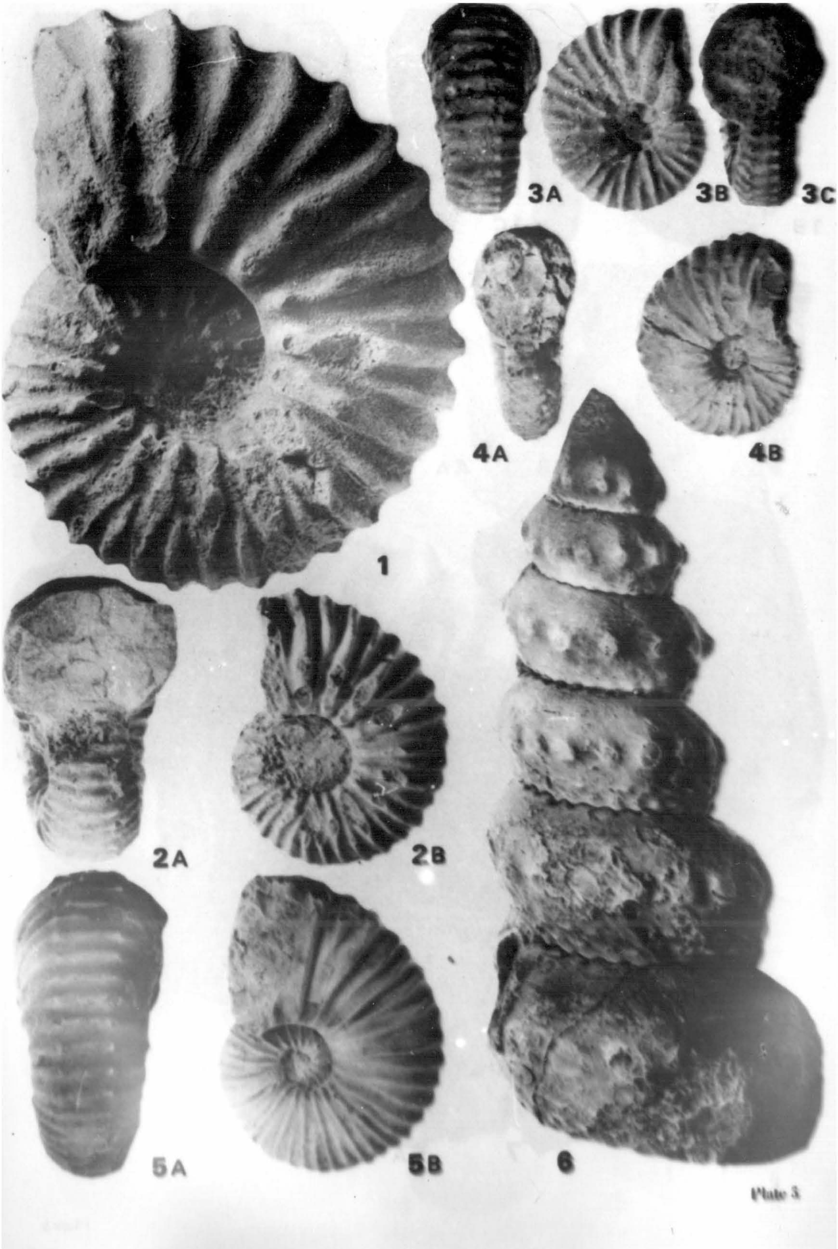


Plate 5

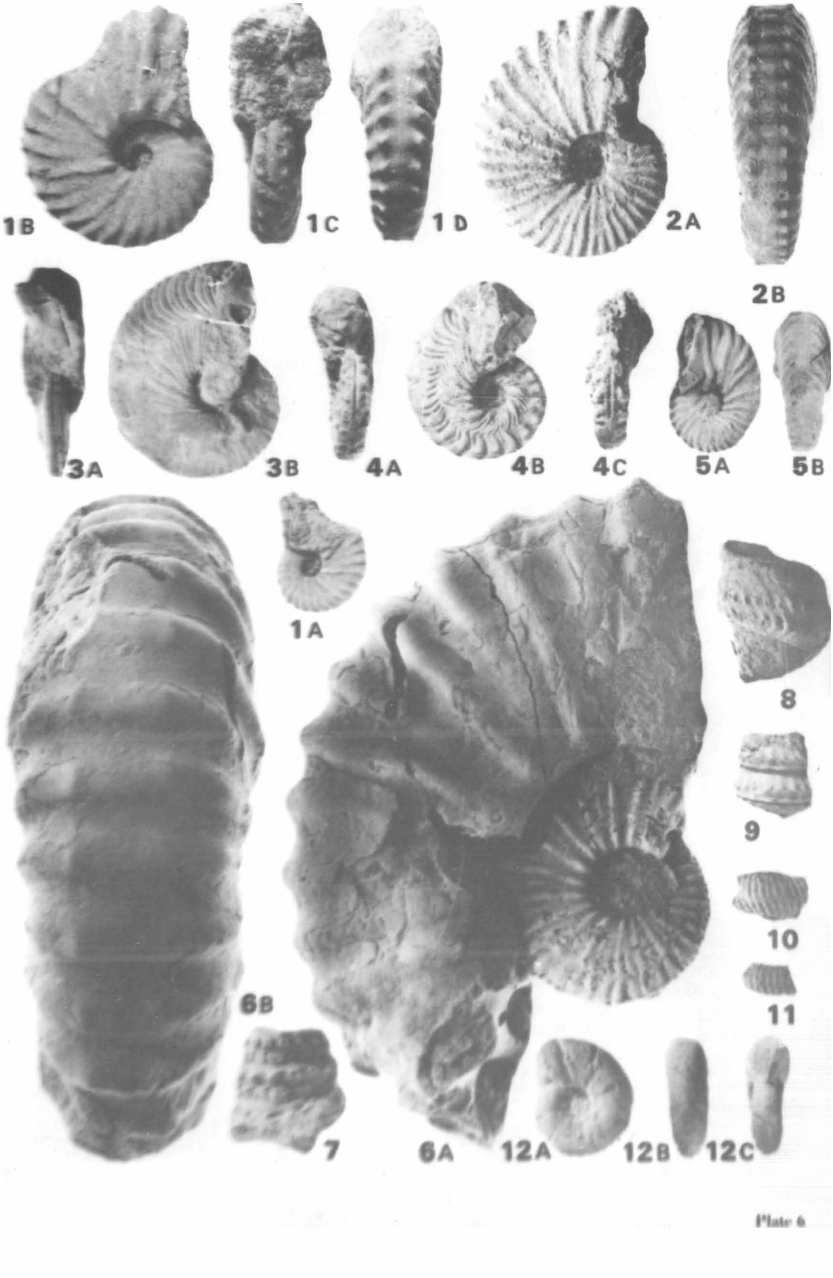


Plate 6

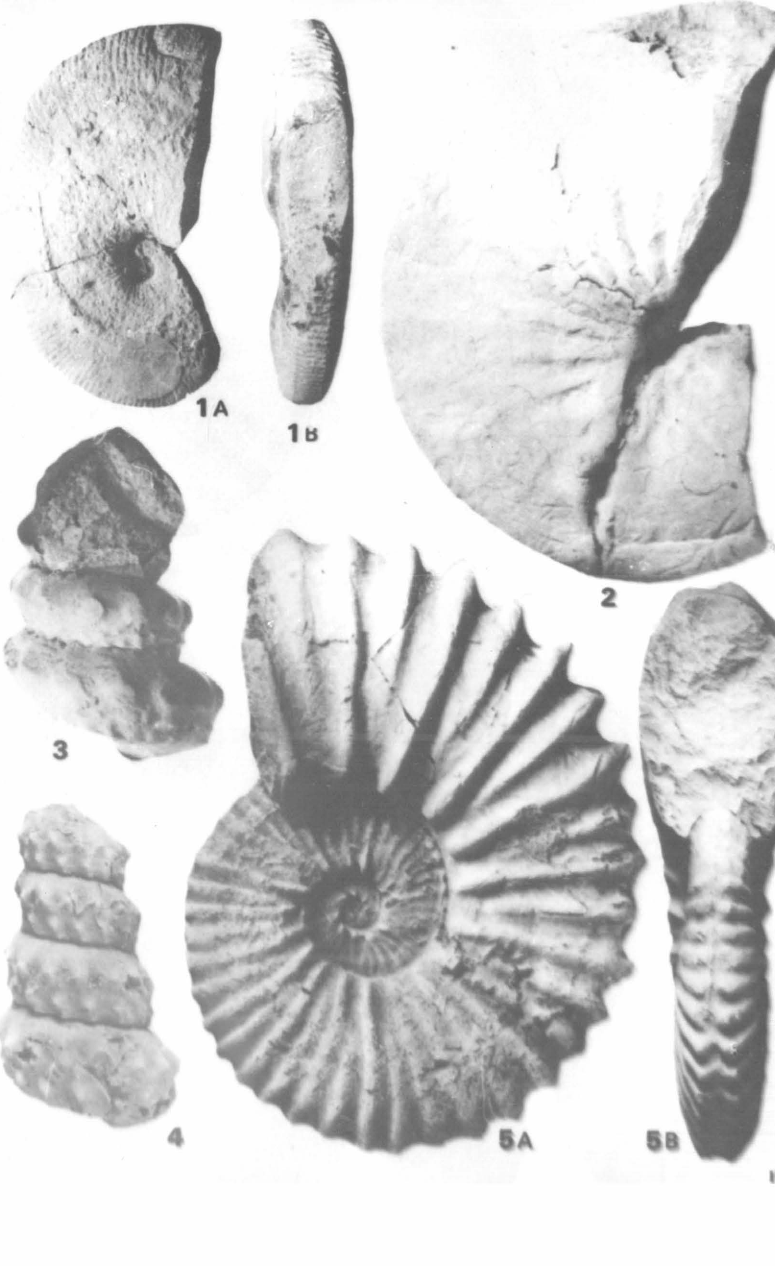


Plate 2

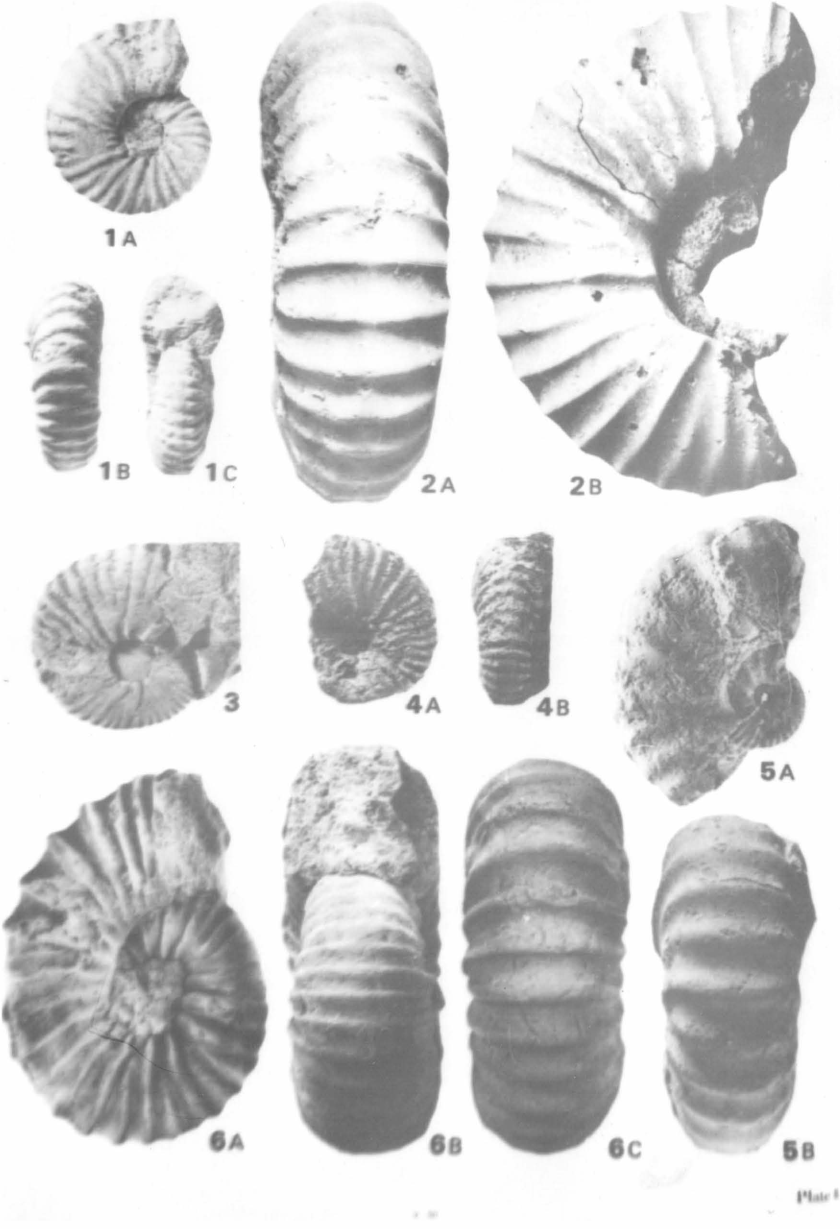


Plate I

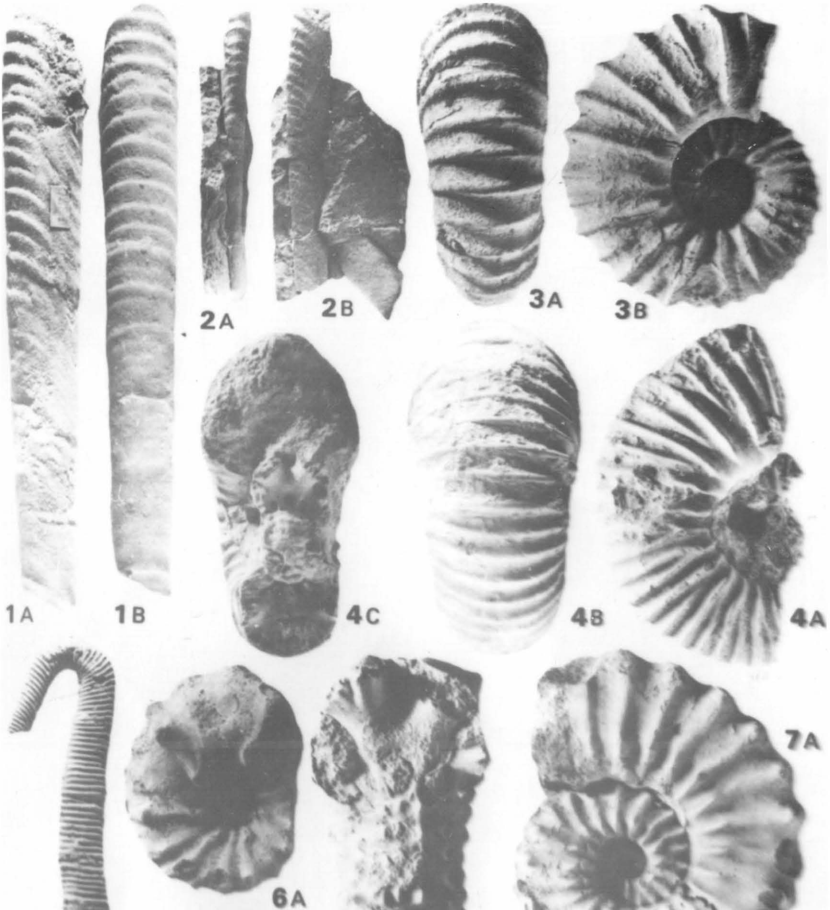


Plate 9

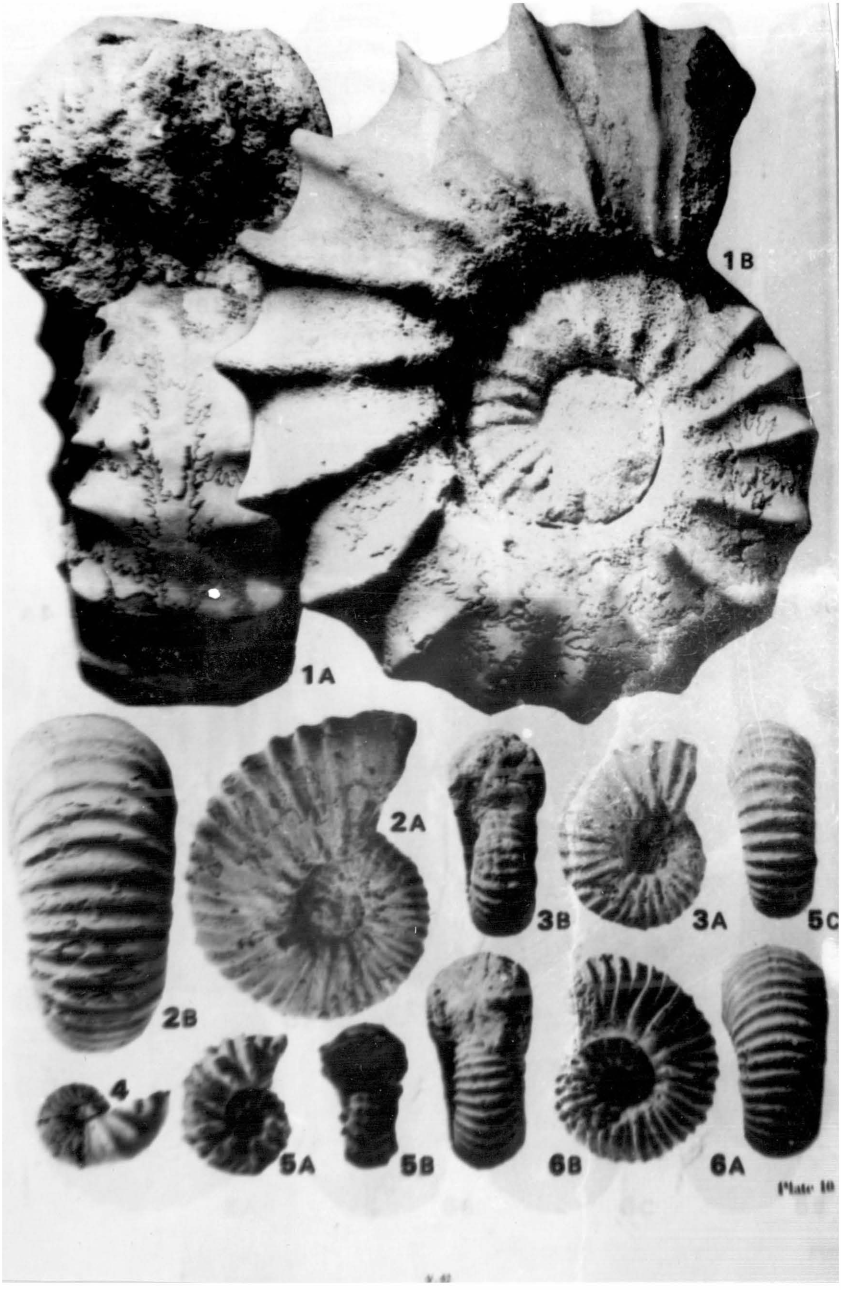


Plate 10

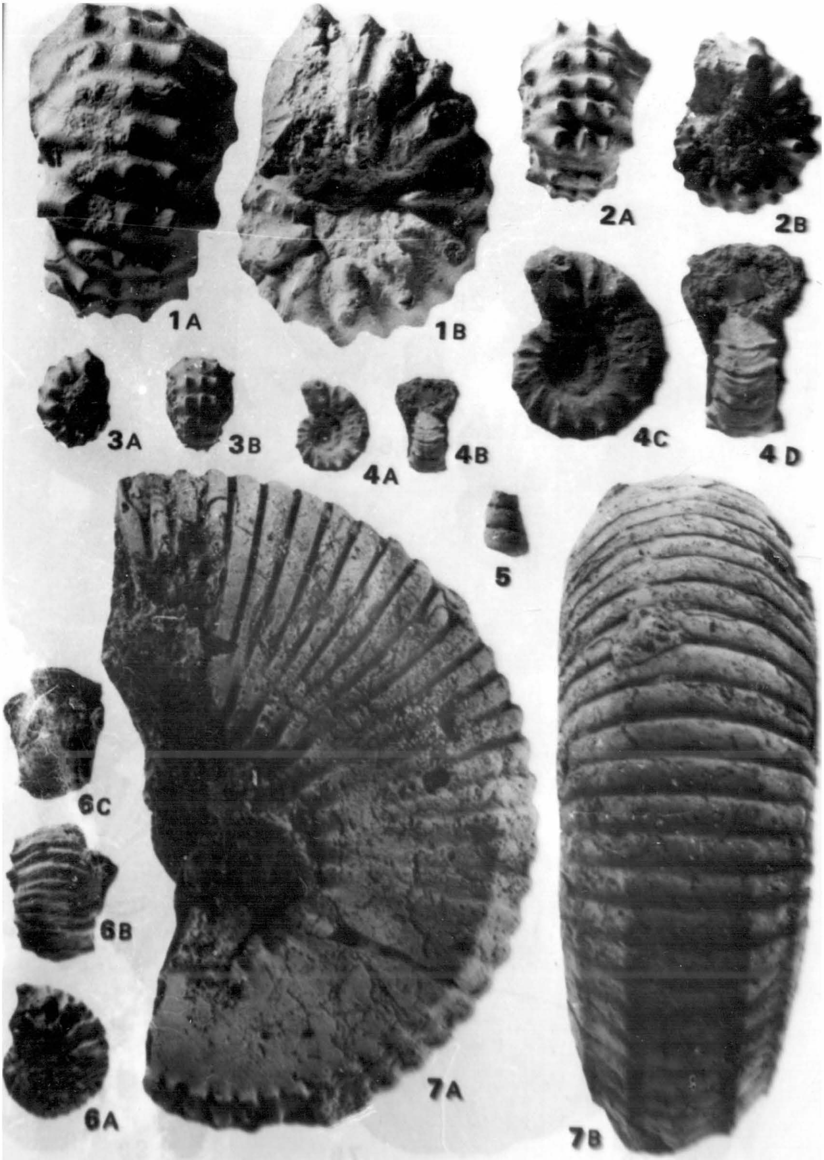


Plate II

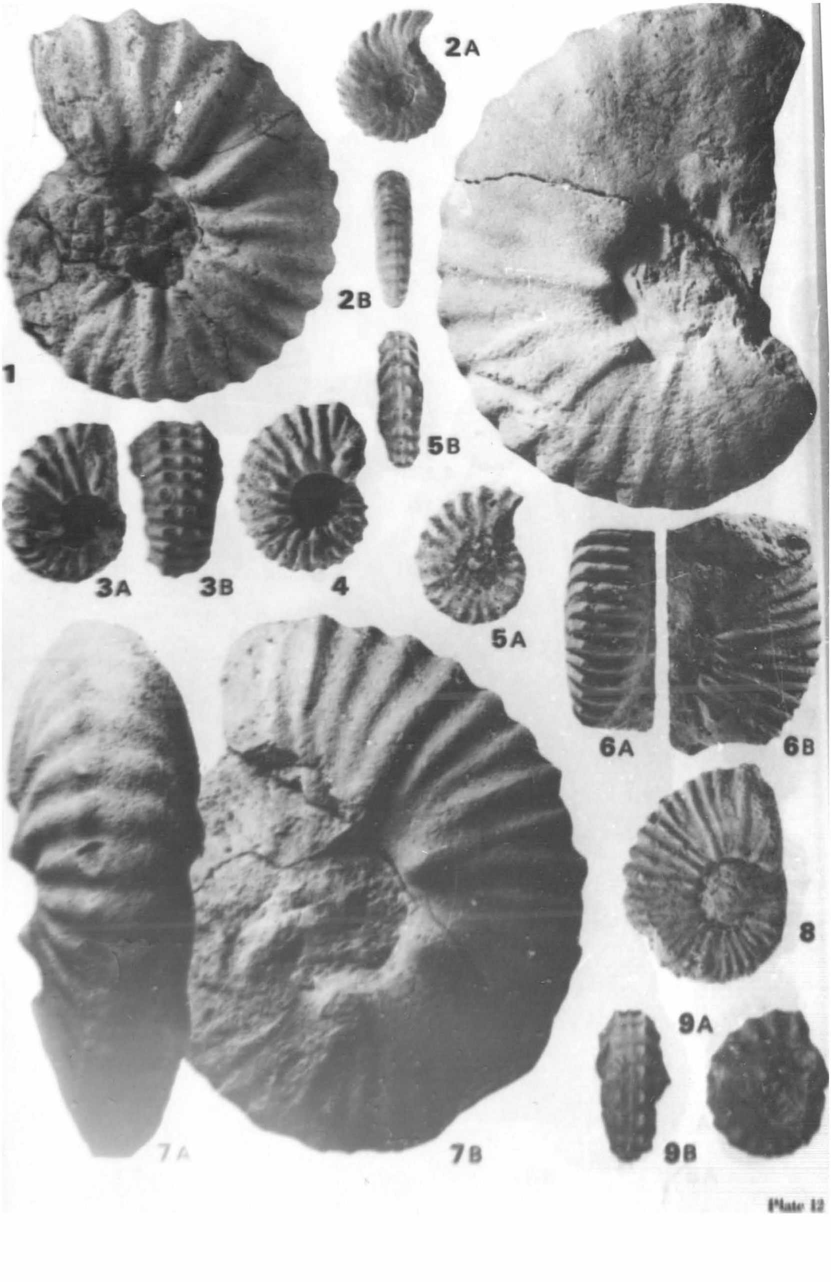


Plate 12

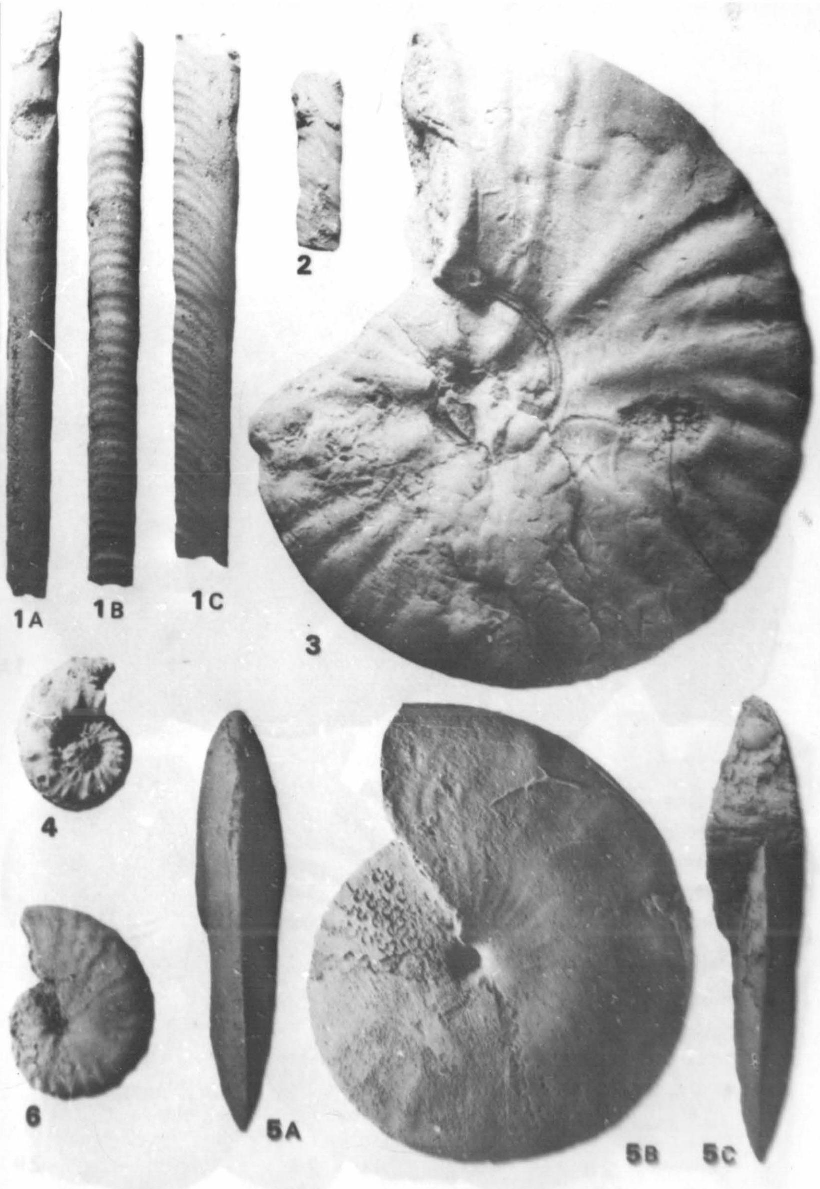


Plate IX

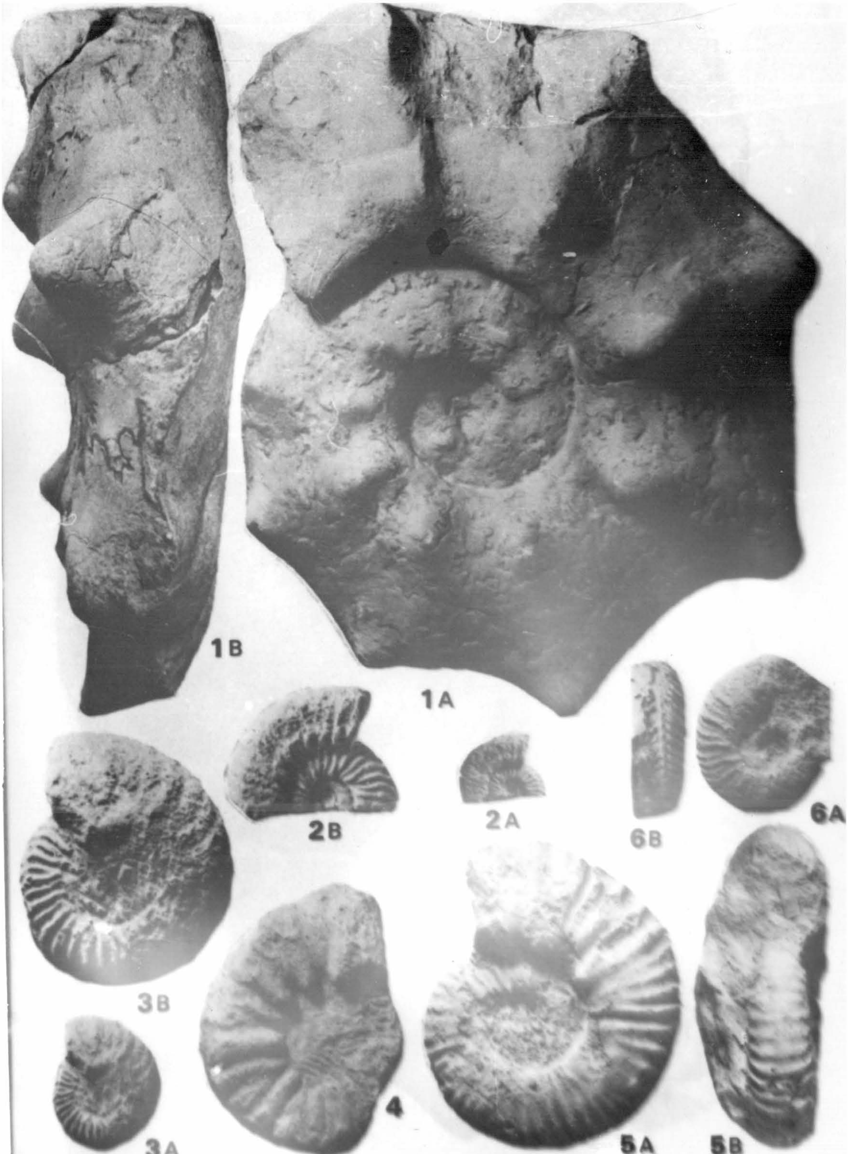


Plate 15

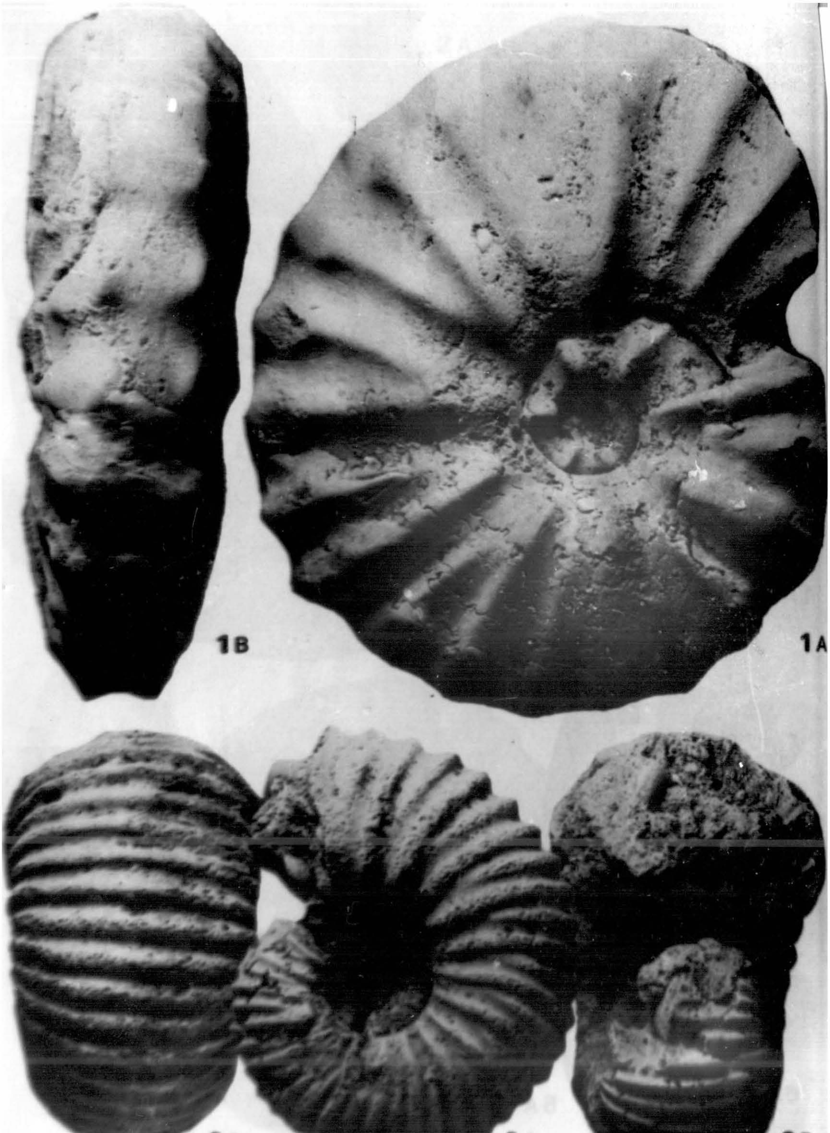


Plate 1

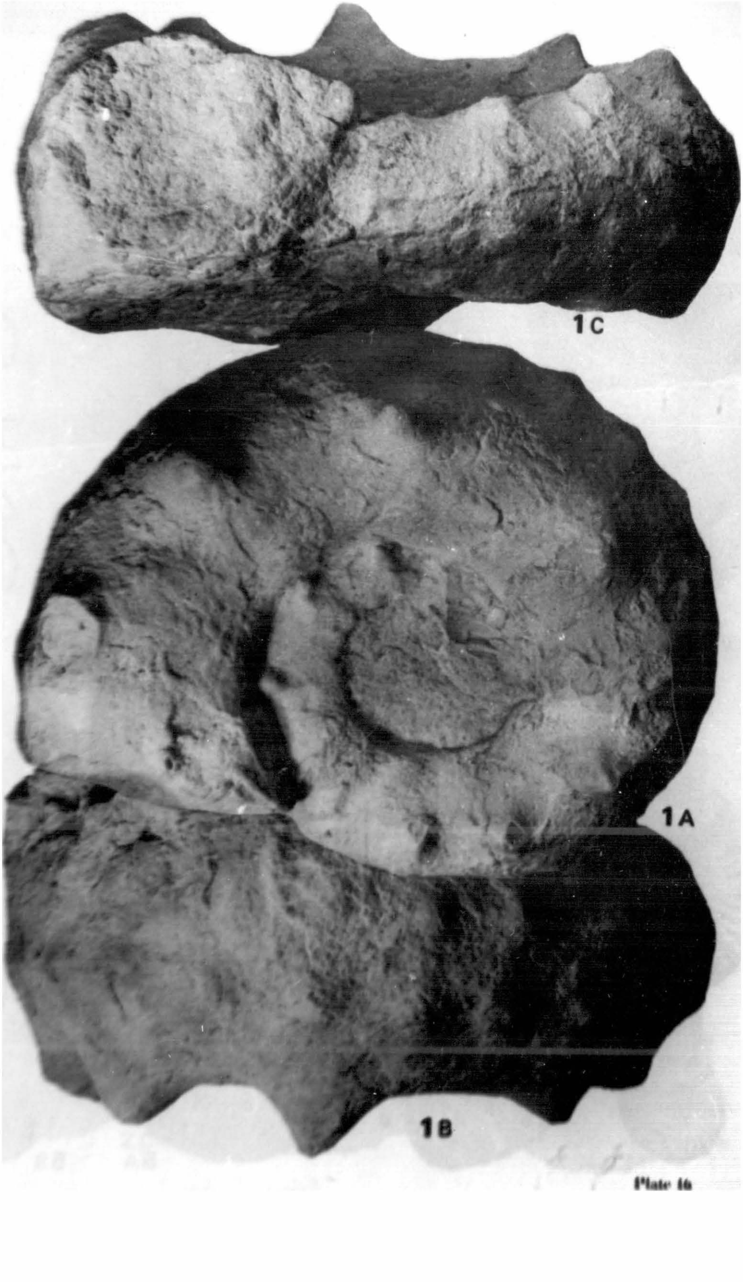


Plate 16

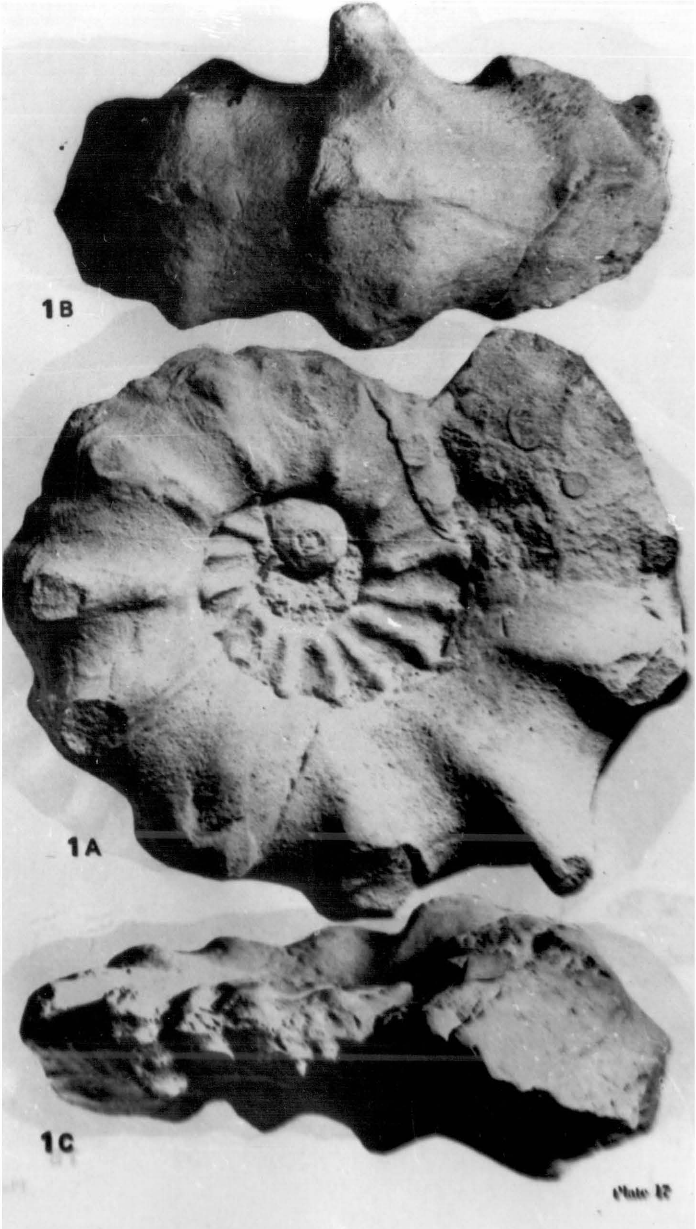


Plate 12

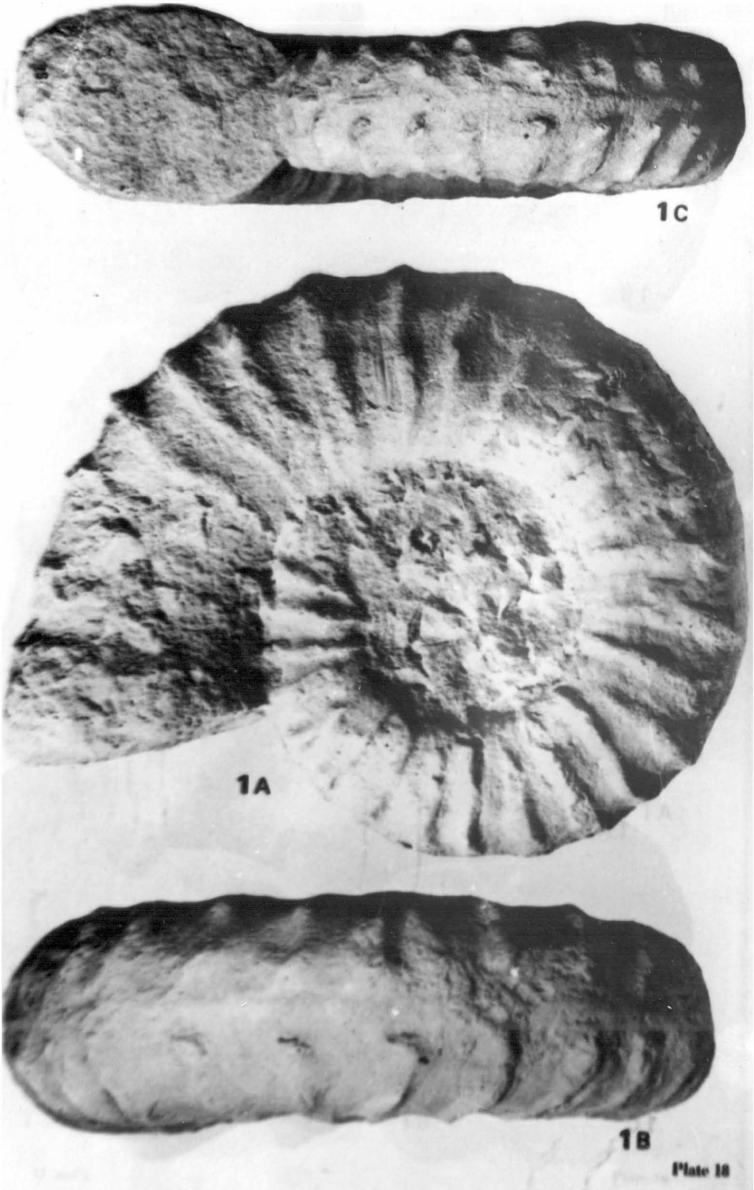


Plate 18

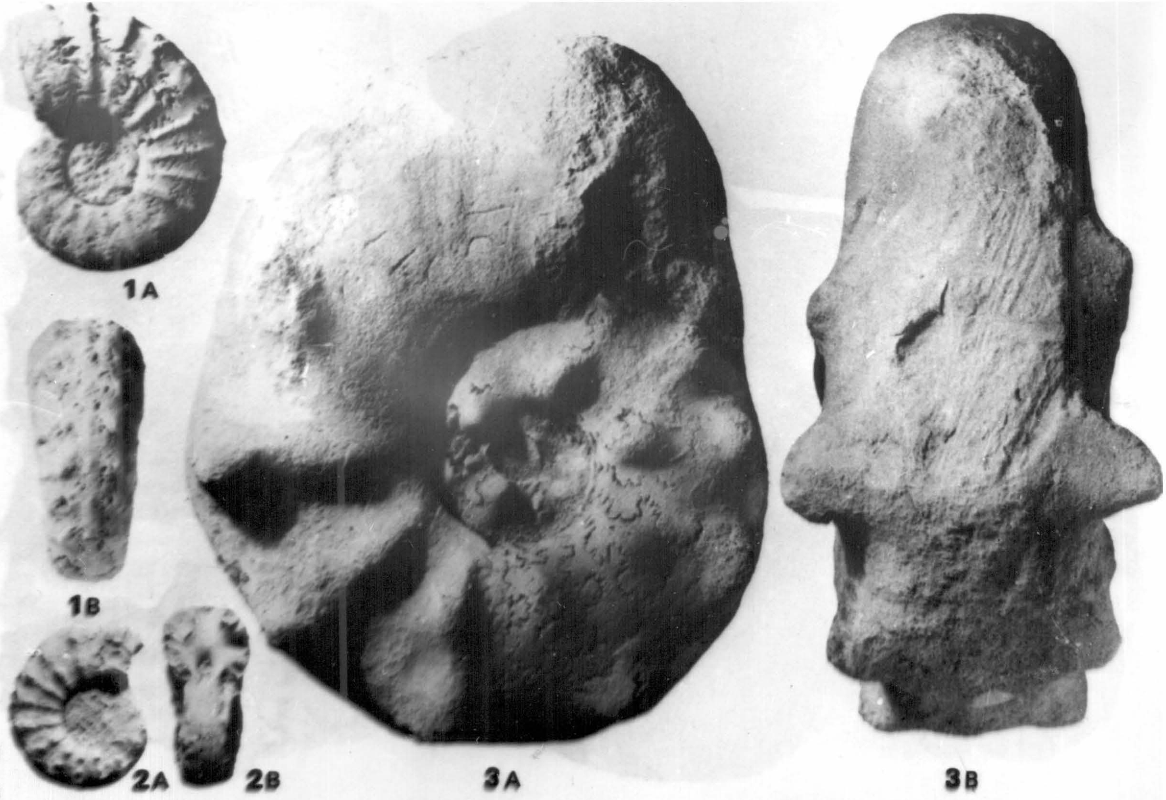


Plate 19

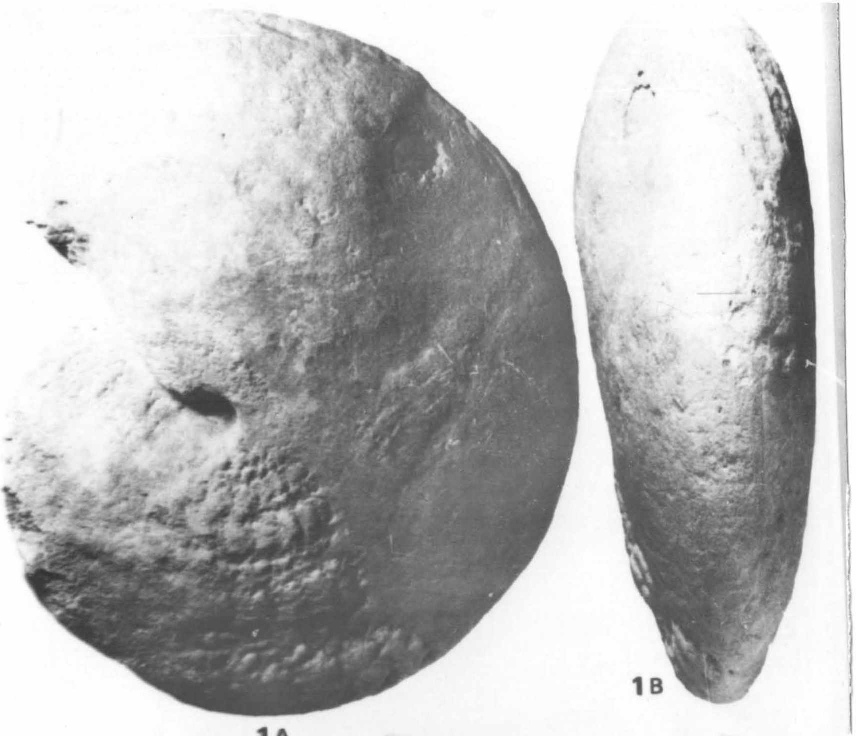
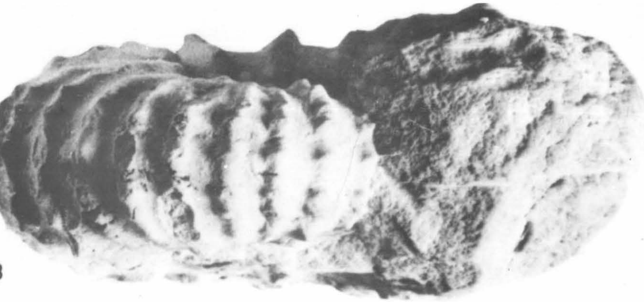
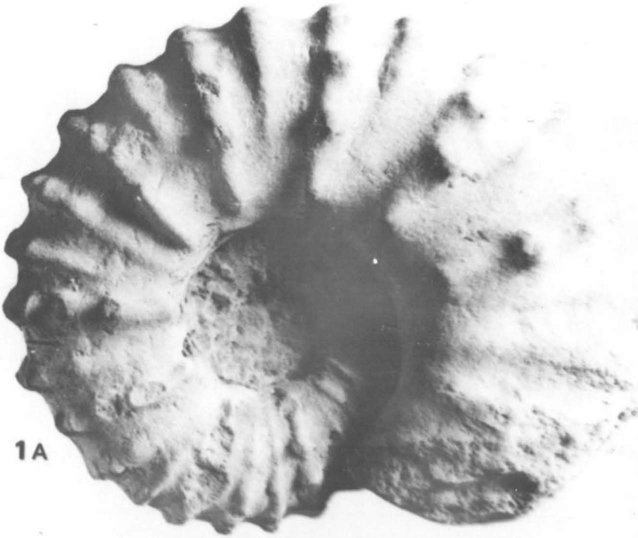


Plate 20



1B



1A

1C

Plate 21

1B

1A

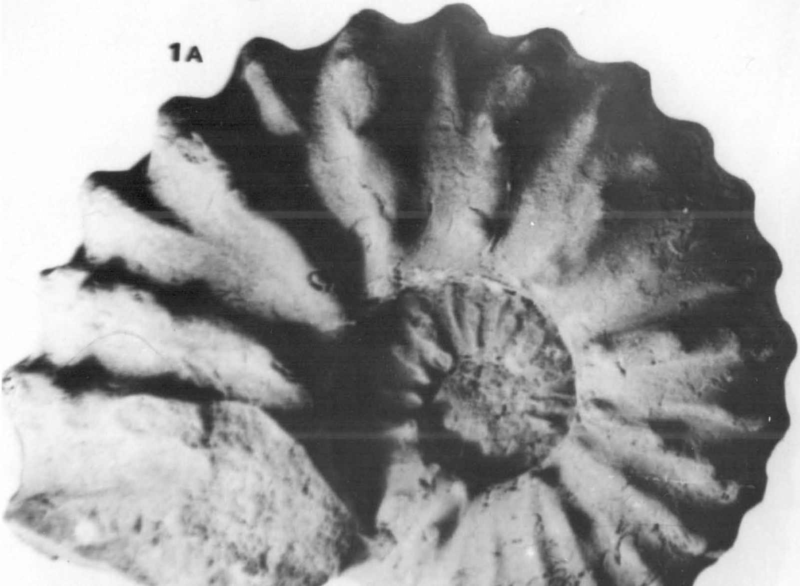
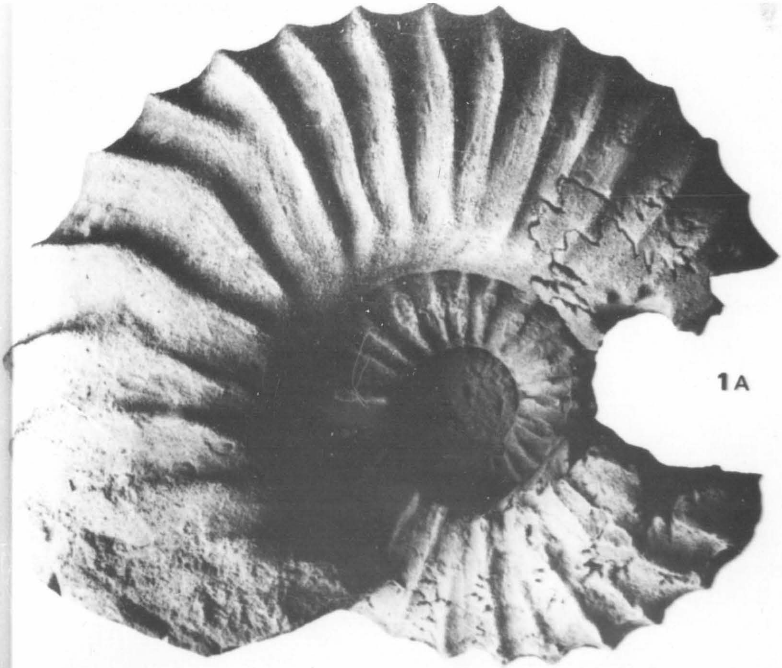


Plate 22

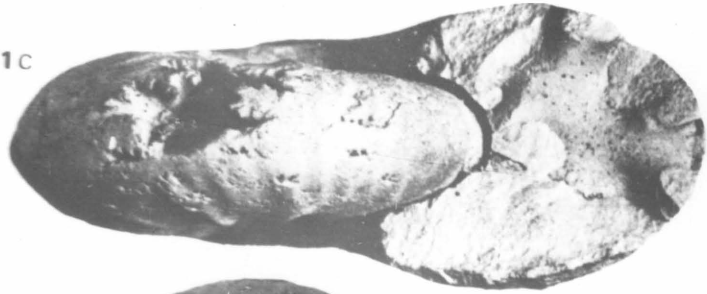


1A

1B

Plate 23

1C



1A

1B

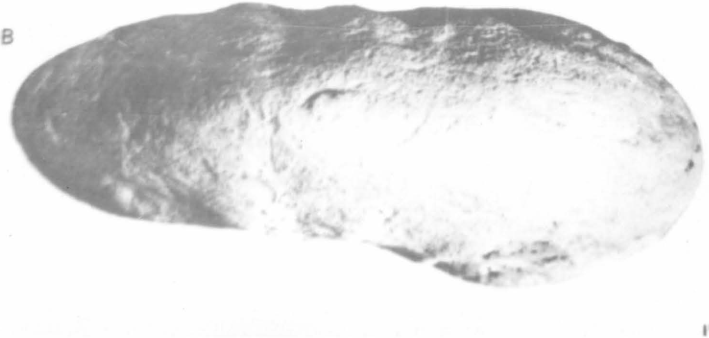


Plate 24

Plate 25

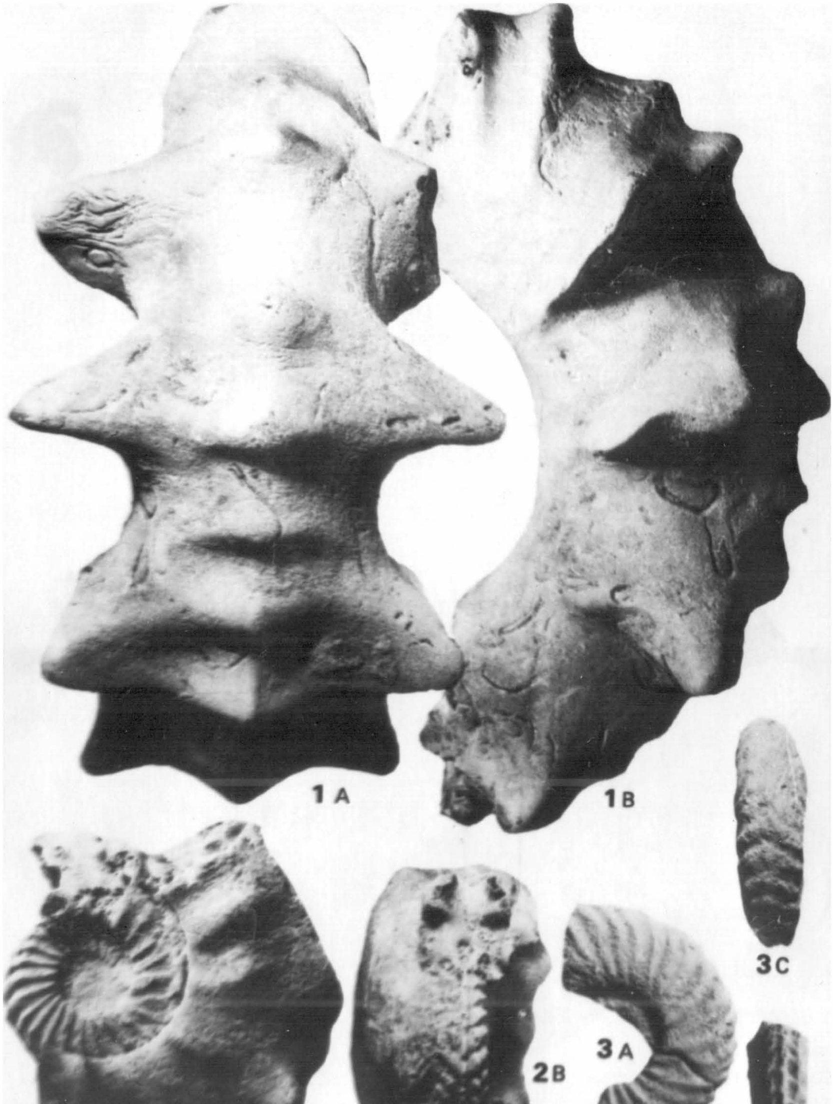


Plate 26

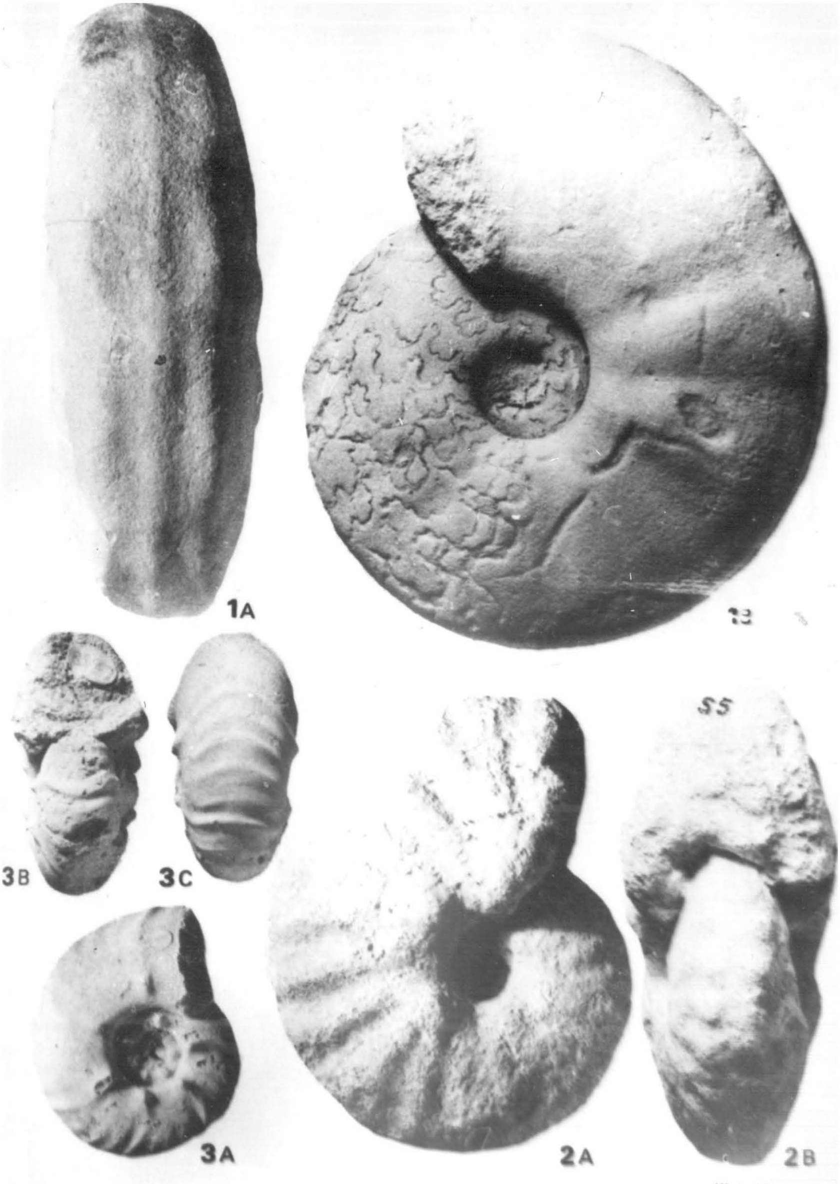


Plate 27

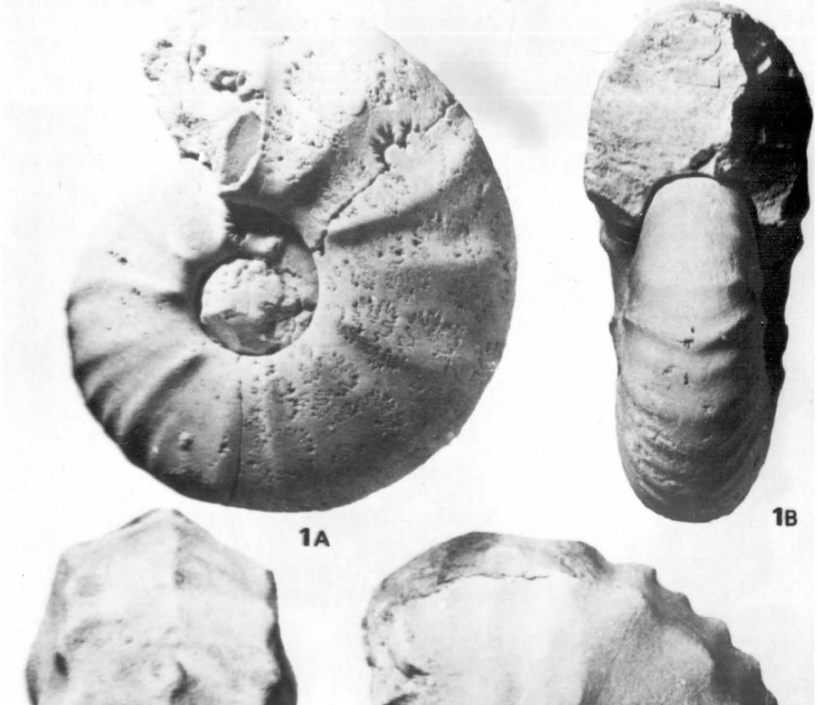


Plate 28

1A

1B

2A

2B

3B

3A

Plate 29

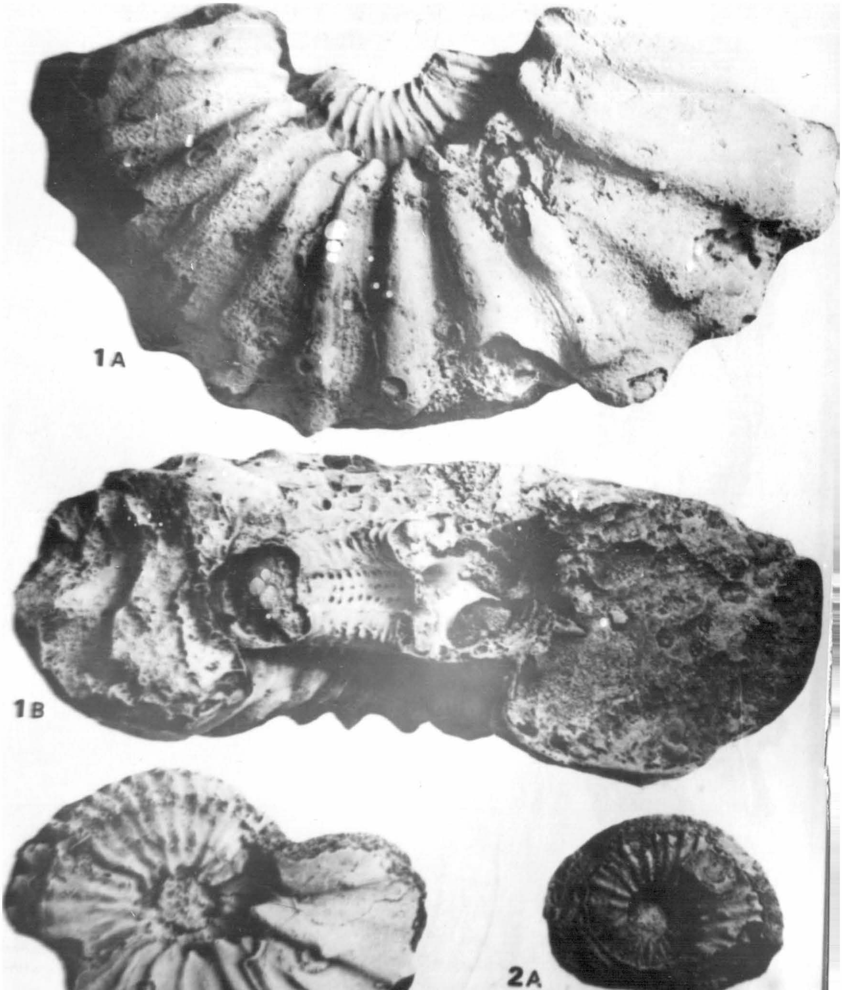


Plate 30