MIOCENE OSTRACODA OF THE WEALD

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SCHOOL OF EARTH SCIENCES

Thames Polytechnic
Itinerary

Day 1
Locality 1.1: River Line, near Battle.
Jurassic/Cretaceous Boundary. Lulworth Beds and Durlston Beds Formations.
Locality 1.2: Ashdown Brickworks, Bexhill. Wadhurst Clay.

Day 2
Locality 2.1: Philpots Quarry, West Hoathly.
Grinstead Clay Formation.
Locality 2.2: Clock House pit, Capel. Weald Clay Group.

Day 3
Locality 3.2: Shakespeare Cliff, Dover.
Cenomanian/Turonian Boundary (top of Abbots Cliff Chalk Formation, Plenus Marl Formation and base of Dover Chalk Formation).
Locality 3.3: Langdon Stairs, East of Dover.
Turonian and Coniacian Chalk (upper part of Dover Chalk Formation, lower part of Ramsgate Chalk Formation).
GEOLOGICAL MAP OF THE CRETACEOUS OF THE WEALD

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Localities:
- Dover
- Folkestone
- Ashford
- Tunbridge Wells
- Reigate
- Dorking
- Brighton
- Eastbourne
- Horsham
- East Grinstead

Figure 1: Geological map of the Cretaceous of the Weald.
INTRODUCTION

The Weald of SE England is a geographical area encompassing parts of the counties of Kent, Surrey, Sussex and Hampshire. It is defined by a geological structure: the Weald Anticline, an inversion structure of Late Cretaceous to Tertiary age (Fig.1). The North and South Downs, hills of Upper Cretaceous chalk on the limbs of the anticline, are the natural geographical boundaries of the area. At the foot of the chalk scarp runs the narrow outcrop of the Gault Clay (giving way westwards, in part, to Upper Greensand), below which the thick Lower Greensand often forms a second line of hills. Within these inward-facing scarps, the horseshoe-shaped outcrop of the Weald Clay forms a broad vale, and the ground rises again in the core of the anticline where sandstones of the Hastings Beds form the hills of the High Weald. Considerable thicknesses of Jurassic strata, some potentially containing economic hydrocarbons, are known from boreholes, but the only outcrops are small inliers of Purbeck limestones and shales. Deeper still, rocks of Silurian to Triassic age have been proved, and in the East lies the concealed Kent Coalfield: Upper Carboniferous Coal Measures exist some 350m below the famous white chalk cliffs of Dover.

LOWER CRETACEOUS (WEALDEN SERIES)

The filling of the Weald sub-basin with clastic sediments began at the very beginning of the Cretaceous with a near-marine transgression: the Wealden Series consists of the Hastings Beds Group (Ryazanian - Valanginian), here taken to include everything from the Durlston Beds Formation (= "Purbeck" from the base of the Cinder Beds upwards; see below) to the Upper Tunbridge Wells Sand Sand Formation inclusive (following Allen, 1976), and the Weald Clay Group (Hauterivian - Barremian) (see Figs 1 & 2).

The Weald sub-basin (of the Weald-Wessex basin) is considered as an embayment bounded to the north by the uplifted fault blocks of the "Londinia" massif, with intermittent connections with the Boreal sea through the Cornubia-Londinia gap in the north-west of the Weald (Allen, 1981). The palaeolatitude was around 35°N; the weather was warm and periodically wet. An alluvial outwash plain (informally known as "Pallenland") filled the sub-basin during deposition of the arenaceous formations (Ashdown Beds, Lower and Upper Tunbridge Wells Sands), retreating to the edges of expanding lakes and lagoons during the argillaceous episodes (Wadhurst, Grinstead and Weald Clays). These argillaceous / arenaceous "megacycles" were controlled, at least partly, by the tectonically active massifs bordering the basin: marginal uplift and high relief generated the outwash plains, down-faulting and low relief the lake-lagoon-bay-estuary environments.
Table: Generalised Succession for the Purbeck and Wealden of the Central Weald (not to scale).

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**Fig 2.**

The "Purbeck Beds" and the Jurassic/Cretaceous Boundary

The interbedded limestones and shales collectively known as the "Purbeck Beds" straddle the Jurassic/Cretaceous boundary. The base of the Cinder Beds, represented in the type area (Dorset) by a distinctive, 1-3m thick, argillaceous limestone packed with valves of the oyster Praeexogyra distorta, was suggested as the boundary by Casey (1963). The Purbeck environment was one of fluctuating marine and freshwater influences and the Cinder Beds represent a major incursion of sea-water into the basin (related by Casey (1973) to the early Ryazanian transgression seen in the marine sequence of Norfolk), although its rather restricted fauna suggests that conditions were never fully marine. The ambiguous units of "Lower", "Middle" and "Upper" Purbeck Beds are now rejected in favour of the Jurassic Lulworth Beds Formation and the Cretaceous Durlston Beds Formation (Townson, 1975). The idea that the sea-water entered the basin from the north (e.g., Allen, 1976) was refuted by Morter (1984) in his study of the mollusc faunas; furthermore, he suggested that the Cinder Beds transgression should be regarded as a cyclothem that includes underlying and overlying beds of fresh and brackish-water origin, the base of which equates with the base of the Cypridea granulosa fasciculata ostracod Zone of Anderson & Bazley (1971); this effectively lowers the Jurassic/Cretaceous boundary. On the other hand, Kelly's (1983) interpretation of the evidence suggests a possible late Jurassic age for the Cinder Beds. There is obviously scope for further debate, but the Cinder Bed remains a convenient, if not always easily mappable, base for the Cretaceous of the Weald-Wessex Basin.

Purbeck Beds are exposed in Sussex in three inliers, described in detail by Howitt (1964), which have resulted from the erosion of en echelon anticlinal structures, largely fault-bounded, in the core of the Weald Anticline. Despite the small area of outcrop, the Purbeck Beds of the Weald are of considerable economic importance; the limestones were used extensively in the eighteenth and nineteenth centuries for building stone and as a source of agricultural lime, while boreholes sunk in 1872-76 led to the discovery of exploitable gypsum deposits in the lowermost Purbeck Beds at Mountfield. The gypsum is now worked in two mines, one at Mountfield and the other near Brightling, and is used in the manufacture of plaster, plasterboard and Portland Cement; the underlying Portland Sandstone is also mined for use as roadstone (Highley, 1975).

In the Weald, the Lulworth Beds Formation ("Lower" to "Middle Purbeck") was deposited in shallow, sometimes emergent conditions, as indicated by the occurrence of evaporites, suncracks, rain-pits and soil horizons, initially marine but with increasing freshwater influence. Due to lateral salinity variations within the basin the Cinder Beds "marine" transgression is not represented.
everywhere by the typical Cinder Beds lithology and mollusc fauna (Morter, 1984); in the River Line section (Locality 1.1) Howitt tentatively correlated it with a more argillaceous bed containing few oysters ("cinders") - certainly a typical Cinder Bed ostracod fauna may be obtained from the shales at about this level (Anderson & Bazley, 1971). Above the Cinder Bed Member the Durlston Beds Formation ("Middle" to "Upper Purbeck") was deposited in muddy, brackish conditions with increasing influxes of sand and fresh water, a trend that was continued into the overlying Ashdown Beds Formation. The transition from Jurassic to Cretaceous was also marked by a climatic change from semi-arid to humid temperate (Sladen & Batten, 1984).

Ashdown Beds to Upper Tunbridge Wells Sand

The argillaceous Durlston Beds, Wadhurst Clay and Grinstead Clay Formations were deposited in a muddy coastal alluvial plain with freshwater pools and brackish lagoons, crossed by muddy and sandy channels. There were frequent incursions of sea-water from the north-west. The massifs bounding the basin had low relief: rainfall was low and evaporation increased salinities in some of the water bodies (Sladen & Batten, 1984). Periodic uplift of the massifs and high rainfall resulted in sandy, freshwater sedimentation as braided rivers spread coalescent fans out from the fault-scarps on the basin margins (Ashdown Beds, Lower and Upper Tunbridge Wells Sand Formations); herbivorous dinosaurs roamed the swamps, which were colonised by horsetails (Equisetites) and clubmosses (Lycopodites) (Allen, 1976, 1977, 1981). Freshwater conditions are characterised by Cypridea-dominated ostracod faunas and molluscs such as Viviparus and Unio; the bivalve Neomiodon, non-Cypridea ostracod faunas and rare foraminifera colonised the brackish bays and lagoons.

Clay ironstone (mostly siderite) in the clay formations was formerly of economic importance; smelting commenced in pre-Roman times and the industry was at its peak in the 16th and 17th centuries. The ore was extracted from bell-shaped pits several metres deep which widened downwards; water was the main source of power for the ironworks and many reservoirs, known locally as "Hammer ponds", were constructed. By the eighteenth century the Weald iron industry was finding it difficult to compete with cheaper iron from elsewhere in Britain and abroad, and the last Weald furnace closed down in the early nineteenth century (Gallois, 1965; Gibbons, 1981). The clay formations remain important for brick-making, although the overlying Weald Clay is far more important in this respect; the sandstone formations are quarried for building stone.
Weald Clay Group

The long reversion to muddy deposition of Weald Clay times differed from earlier argillaceous phases; it was not followed by a rejuvenation of Londinia, and most of the sandy incursions were from the western massifs (Allen, 1976). Salinity fluctuations were greater than in Hastings Beds times; oysters, Filosea (replacing Neomiodon), foraminifera, cirripedes and brackish/marine ostracods (e.g., Hutsonia) indicate near-marine incursions into the prevailing freshwater conditions typified by Viviparites and Cypridea (Kilenyi & Allen, 1968). Worssam (1973) has reviewed the stratigraphy of the Weald Clay Group.

The Weald Clay is overlain unconformably by the marine Atherfield Clay (Aptian).

PURBECK/WEALDEN OSTRACODS: FAUNICYCLES, ASSEMBLAGES AND ZONES.

The late F.W. Anderson's extensive studies on the Purbeck and Wealden ostracod faunas of England have been drawn together and summarised in a posthumous publication (Anderson, 1985). His application of ostracods to the stratigraphy and environmental history of these sediments, particularly through the concept of C-phase/S-phase faunicycles, is well-known, although not without its critics. Ostracod faunas in Purbeck/Wealden sequences repeatedly alternate between assemblages dominated by species of the freshwater genus Cypridea (and therefore referred to as "C-phase") and those dominated by other genera (e.g., Fabanella, Orthonotacythere), believed to indicate more saline conditions (= "S-phase"); a faunicycle consists essentially of an S-phase and a succeeding C-phase, although there is much variation on this simple theme (Anderson & Bailey, 1971). Anderson (1985) recognised no fewer than 98 faunicycles in the English Purbeck/Wealden succession, grouped into 15 assemblages (see Fig.2); additionally, species of the rapidly-evolving Cypridea provided the basis for 12 ostracod zones, ranging from the C. dunkeri Zone ("Lower Purbeck") to the C. valdensis Zone at the top of the Weald Clay.

Kilenyi & Neale (1978) presented a zonation scheme that differs both from Anderson's earlier schemes (e.g., 1971), as used by Worssam (1973), and from Anderson's (1985) revised scheme; they stated that they had adopted the zonal scheme of Anderson (1973) - but that reference contains no zonal scheme, rather a tabulation of Anderson's ostracod assemblage scheme, which at that time consisted of 10 assemblages, later refined to 15 (Anderson, 1985).

The concept of C- and S-phases is based on the assumption that at least some of the ostracods had particular and different salinity tolerances, and it is concerning the presumed salinity preferences of certain genera that some authors (e.g., Bate, 1965; Kilenyi & Allen, 1968) have disagreed with Anderson, who regarded as brackish water forms genera such as Phinocypris, Bisulcocyparis and...
Theriosynoeicum) that others would consider as freshwater forms (curiously, Anderson (1985) made no mention of the work of Kilenyi & Allen (1968) on marine/brackish bands in the Weald Clay, nor of the new species that they described). At least part of the difficulty may stem from the failure of many workers to distinguish between ostracods tolerant of fluctuating salinities, such as are found in an estuary, and those which become acclimatized to stable brackish conditions. In seeking analogues for the Purbeck/Wealden environment we should perhaps look more carefully at ostracod associations such as those reported in the northern part of the Baltic Sea, by Hagerman (1967) and more recently by Savolainen & Valtonen (1983), where "freshwater" species such as Candona neglecta, Darwlnula stevensoni and species of Limnocythere live side-by-side with true "brackish-water" species such as Cyprideis torosa and Cytherura gibba in salinities of 1-7 o/oo. Useful parallels might be drawn, too, with the ostracod faunas of athalassic (i.e., not connected with the sea) saline lakes as reviewed by De Deckker (1981), who commented on the difficulty of reconciling different authors' definitions of salinity and brackish water; chlorinity is often equated with salinity, but this may be misleading in certain waters and total ionic concentration is a more appropriate measurement. Consideration might also be given to the distinction between permanent bodies of freshwater and those which dry up on a seasonal basis: the latter are more likely to be colonised by those ostracods that can lay desiccation-resistant "resting" eggs - perhaps this, rather than salinity, could explain the different occurrences of Cypridea and Theriosynoeicum. The time may be ripe for a reappraisal of the environments represented by Purbeck/Wealden ostracod faunas: this is not to detract from the outstanding and painstaking work of Anderson, however, who recognised the difficulty of attributing precise salinity ranges to fossil ostracods and arbitrarily grouped them to enable sediments deposited in environments nearer to freshwater (C-phase) to be distinguished from those with a more brackish or marine character (S-phase), thus facilitating more detailed correlation than is possible by other means.
LOWER CRETACEOUS (LOWER GREENSAND - GAULT CLAY)

The series of sediments known collectively as the Lower Greensand is now divided into four Formations in the Weald: Atherfield Clay, Hythe Beds, Sandgate Beds and Folkestone Beds. Lower Greensand deposition began with the Aptian marine transgression that inundated the Weald sub-basin, and high-energy marine conditions prevailed for much of Aptian and Lower Albian time. There was still land in the London area, and in the northern part of the Weald the inflow of rivers was an influence during much of Lower Greensand time (Middlemiss, 1976). Sandy sedimentation followed, probably due to rejuvenation of Londinia; in the western Weald the Hythe Beds are cross-bedded sands with chert beds, while in the east there are alternating beds of hard, sandy limestone and soft sand, known to local quarrymen as "rag" and "hassock" respectively. A period of tectonic activity followed, particularly along the line of the present Hog's Back near Guildford; that Jurassic rocks were exposed and eroded at this time, probably by a river, is shown by the abundance of reworked Jurassic fossils and ooliths in the Bargate Beds (Chapman, 1894), a local development of cross-bedded sands in the north-west of the Weald. Further east, in the Sandgate Beds, are economically important deposits of fuller's earth, a secondary bentonite (Ca-smectite) representing volcanic ash that originated from subaerial volcanism (in the region of what is now the southern North Sea) and was washed into the sea from the neighbouring landmass (Jeans, Merriman & Mitchell, 1977). Fuller's earth was formerly used primarily for degreasing or "fulling" woollen cloth, but now has many other industrial applications such as in the refining of oils and syrups (Highley, 1976). Volcanogenic clay also occurs in the succeeding Folkestone Beds and Gault (Jeans, Merriman, Mitchell & Bland, 1982). With the deposition of the Folkestone Beds (Upper Aptian - Lower Albian), cross-bedded sands with a high iron content, the sea encroached further onto the land; Londinia may even have been totally submerged, although a remaining an area of shallow water and non-deposition (Middlemiss, 1976).

Lower Greensand ostracod faunas of the Weald are generally poor and have attracted little interest; good Aptian faunas have recently been obtained from a borehole in Sussex, however, particularly from fuller's earth in the Hythe Beds Formation (Bristow, Morter & Wilkinson, 1987).

The base of the Gault is marked by a Middle Albian marine transgression that covered the whole of southern England; in the extreme east of the Weald, borehole evidence from the Kent coalfield shows that it oversteps the Lower Greensand, Jurassic strata and eventually Palaeozoic rocks. The Gault and Upper Greensand are laterally equivalent (in part) lithostratigraphic units in the Middle and Upper Albian sequence; the Upper Greensand represents shallow, near-shore deposition, while the Gault was deposited further offshore in water that was quieter and deeper. The Gault Clay is composed dominantly of illite and contains many thin
concentrations of phosphatic nodules, representing episodes of scouring by currents that winnowed away the clay (Owen, 1976). The classic stratotype section of the Gault exposed at Copt Point, Folkestone (Locality 3.1), was described in detail by Price (1874), who numbered the beds I - XIII (see Fig. 12), and more recently by Owen (1976). Best known for its molluscan fauna, particularly the ammonites, the Gault Clay has diverse and well preserved macro- and microfaunas and microfloras.

Ostracods from the Gault were described by Jones (1849, 1870), Jones & Hinde (1890) and Chapman & Sherborn (1893), whose taxonomy was later revised by Kaye (1964, 1965). More recently, Hart (1973) illustrated the vertical distribution of the commoner species at Copt Point and proposed an interim zonal scheme that was later modified by Neale (1978). Many of the species range up into the overlying Cenomanian Chalk (e.g., Cythereis thoerenensis Triebel, Cytherella ovata (Roemer), Schuleridea jonesiana (Bosquet)).

The main faunal change occurs in the vicinity of the cristatum nodule bed, on the Middle/Upper Albian boundary (Fig. 12): new species appearing at about this level include Cythereis luermannae Triebel, Cythereis folkestonensis Kaye and Cythereelloidea stricta (Jones & Hinde). Other relevant publications include those of Van der Wiel (1973) on the Gault of Petit Blanc-Nez (just across the English Channel from Copt Point) and Wilkinson & Morter (1981) on the East Anglian Gault.

The Gault Clay was used in brickmaking and cement manufacture, while "firestone", a calcareous fine sandstone from the Upper Greensand in the northern Weald, was quarried as building stone in the seventeenth to nineteenth centuries (Highley, 1976).
The base of the Cenomanian is marked by a major eustatic transgression (Hancock & Kaufmann, 1979); the early Cenomanian Glauconitic Marl rests abruptly on the Gault (or, in the western Weald, on the Upper Greensand) and is overlain by the lowest, argillaceous, part of the Chalk. Chalk is a micritic, soft, white limestone composed largely of debris from planktonic algae (coccolithophores); it is a pelagic sediment representing an extension of open ocean deposition onto the continental shelf during a period of high eustatic sea-level (Hakansson, Bromley & Perch-Nielsen, 1974; Hancock, 1976). The depth of the Chalk sea is a contentious subject, but in the Campanian, at the peak of the transgression, it may have been as much as 600m. Normal marine salinities prevailed.

The well-known tripartite subdivision of the English Chalk into Lower, Middle and Upper parts does not adequately represent the lithological variations that are now recognised. Two important lithostratigraphic studies of the Chalk of southeast England were recently published, by Mortimore (1986) on the South Downs and by Robinson (1986) on the North Downs, each defining different Formations and giving different names to the same marker horizons. It remains to be seen how this unfortunate situation will be resolved; since the localities described in this guidebook are on the North Downs, the lithostratigraphic scheme and nomenclature used herein are those of Robinson (1986).

The typical "white chalk" lithology is soft and fine-grained, composed mainly of coccolith material with up to 25% foraminifera and calcispheres; although in the field it often appears featureless, treatment of smoothed surfaces with oil usually reveals a high degree of bioturbation (Bromley, 1981). Calcareous chalks containing a large proportion of inoceramid bivalve fragments are thought to have formed by the winnowing of white chalk by currents. Intensely bioturbated marly chalks derive their grey colour from a high clay mineral content or the presence of finely disseminated pyrite which weathers rusty orange (Hancock, 1976). There are three main types of marker horizon. From the mid-Turonian upwards the Chalk is characterised by conspicuous beds of black flints, formed by the redistribution of organic silica during early diagenesis (Clayton, 1986). Detailed lithostratigraphical correlation has shown individual flint beds to be laterally extensive over thousands of square kilometres. The complex shapes of many flints indicates that they were formed in burrows, particularly the crustacean burrow Thalassinoidea. Nodular chalks and hardgrounds formed by early diagenetic cementation are also traceable over long distances. Greenish-grey marl seams, too, are laterally widespread and allow correlation with the Paris Basin and northern England; usually only a few centimetres thick, they contain up to 35% of non-carbonate minerals and it has been suggested that many are the result of airborne ashfalls (Facey, 1984; Robinson, 1986).
The basal unit of the Chalk Group, the Glaucolithic Marl Member (East Wear Bay Chalk Formation), is a highly bioturbated calcareous glauconitic sand of variable thickness (1-7 m) containing phosphatic nodules. It is succeeded by the lowest Chalk ("Chalk Marl" - through which most of the Channel Tunnel is being bored) which is blue-grey in colour due to a significant clay content. It is rhythmically bedded on a decimetre scale, and the boundaries between the alternating marls and marly limestones are conspicuously burrowed, indicating the primary nature of the rhythmicity. It has recently been suggested that these rhythms, and the chalk-flint rhythms in the Coniacian-Maastrichtian Chalk, may be the result of climatic forcing (Milankovitch cycles) (Hart, 1987; Hart & Swiecicki, 1987), although Hallam (1986) has cast doubt on the validity of similar interpretations of Jurassic limestone-shale cycles.

The argillaceous rhythms become less distinct in the succeeding Abbots Cliff Chalk Formation (Middle to Upper Cenomanian), which is sharply overlain by the Upper Cenomanian Plenus Marl Formation, a distinctive sequence of marls and marly chalks. The base of the Plenus Marl is a prominent omission surface with dark clay-rich marl filling burrows in the underlying chalk, and significant erosion has been demonstrated at this level in some areas. Jefferies (1962, 1963a, 1963b) defined a sequence of beds within the Plenus Marl, numbered 1 to 8 in ascending order, all of which can be recognised in basinal successions throughout the Anglo-Paris Basin although some are absent where the formation thins out in marginal areas. The Plenus Marl is followed by a succession of nodular and intraclastic chalks forming the basal part of the Dover Chalk Formation (uppermost Cenomanian to high Turonian), the remainder of which consists of white chalk with conspicuous marl bands and, towards the top, the first laterally persistent flints (Robinson, 1986).

The overlying Ramsgate Chalk Formation (uppermost Turonian to basal Campanian) is characterised by well developed flint bands; no top has been defined for this formation, which is truncated by a Palaeocene erosion surface (Robinson, 1986).

Important early publications dealing with British Chalk ostracods are those by Jones (1849, 1870) and Jones & Hinde (1890); Kaye (1964) revised their taxonomy but gave little stratigraphic information. Since Neale (1973) remarked on the lack of modern work on British Upper Cretaceous ostracods, the faunas of the Cenomanian have been well described by Weaver (1981, 1982), but those of the Turonian to Campanian of south-east England still await in-depth treatment. Horne & Rosenfeld (in Jarvis et al. (1988)) illustrated late Cenomanian and early Turonian ostracods from Dover, and have made a preliminary (and as yet unpublished) investigation of Turonian to Santonian faunas in east Kent, some data from which are presented herein (see Locality 3.3). Two factors appear to have contributed to the lack of interest in Chalk ostracods; firstly, they are much less abundant than foraminifera and secondly, most
assemblages are overwhelmingly dominated by species of Cytherella. With a little patience, however, diverse faunas may be obtained, particularly from the more easily disaggregated marls (see Weaver, 1982 and Jarvis et al., 1988, for processing techniques); Weaver (1981) pointed out the necessity of picking the finer fractions in order to find small (under 300 µm long) species of the Cytheruridae.

Many species range across the Albian/Cenomanian boundary, which, according to Weaver (1982), is marked by the extinction of Isocythereis fissicostis (Triebel) and I.fortinodis (Triebel); more significant are the disappearances of many species at the level of the mid-Cenomanian non-sequence, just above which Oertliella alata Weaver and Pontocyprella robusta Weaver appear, but the most important changes in Chalk ostracod faunas took place in the Plenus Marl Formation, as a result of the Cenomanian-Turonian Oceanic Anoxic Event.

The Cenomanian-Turonian Oceanic Anoxic Event

The anomalous lithological, geochemical and faunal characteristics of Upper Cenomanian to low Turonian marine sediments in many parts of the world have been attributed to an "Oceanic Anoxic Event" (OAE) (Schlanger & Jenkyns, 1976). The bottom waters of the Chalk Sea in NW Europe became increasingly dysaerobic, resulting in the extinction of many taxa. At Dover (see Locality 3.2) a variety of microfossil groups (benthonic and planktonic foraminifera, ostracods, dinoflagellate cysts and calcareous nanofossils) show abundance and diversity minima which correspond closely to the peak of a carbon stable-isotope excursion (Jarvis et al., 1988). The disappearances were progressive: an expanding oxygen-minimum zone in the water column increasingly affected the benthos as it impinged on the sea floor and caused the extinction of first deeper-water, then shallower-water planktonic forams as its top rose towards the surface. The height of the OAE is marked by an abundance of calcispheres and a temporary absence of dinoflagellate cysts at the base of the Melburn Rock Beds. Virtually all of the Cenomanian podocopid ostracod species became extinct and the earliest Turonian assemblages consist almost exclusively of surviving platycopids. Diversity increased only gradually through the Turonian; the first additions to the ostracod fauna were Cythereis cf. C.longaeva Pokorný, Curfsina senior Pokorný and a species of Mosaelateris (= M.interruptoidea (Van Veen) sensu Pokorný, 1973), followed near the top of the Shakespeare Cliff Member by Cythereelloidea oblirugata (Jones & Hinde) and Parvocythereis subparva (Pokorný). The genus Xestoleberis becomes an important constituent of assemblages near the top of the Turonian. Most of the species appearing during the Turonian seem to be long-ranging; Coniacian assemblages show little change. The Cenomanian-Turonian OAE is thus seen as the single most important event in the history of marine Upper Cretaceous ostracod faunas in southern England.
Shelly limestones and shales with *Neomiodon*, *Corbula*, *Viviparus*.

Sandstones and silty shales.

Argillaceous shelly limestone in shale.

Limestone with *Praeexogyra distorta* at base.

LOCATION MAP FOR LOCALITY 11

Lithological succession modified from Howitt (1964).

FIGURE 3
ITINERARIES

Day 1 Thursday 21:7:33


The River Line section to the SW of the Mountfield gypsum mines is reached by a footpath which runs to the mines from the road at Netherfield (TQ 715186)(Fig.3). Exposure is limited so please avoid unnecessary hammering; handful-sized samples are sufficient to yield abundant ostracods.

The lowest good exposure is in the outside bank of a meander, where the thin limestones and shales of the uppermost part of the Broadoak Calcareous Member of the Lulworth Beds Formation (the Blues Limestones of Howitt, 1964) may be sampled. The ostracods obtained here probably belong to the Goldspur Faunicycle (no.16: Assemblage 3, Cypridea granulosa Zone of Anderson, 1985; see Fig.2), and include:

- Cypridea dunkeri carinata Martin, 1940
- Cypridea tumescens (Anderson, 1939)
- Damonella ellipsoidea (Wolburg, 1962)
- Darwinula leguminella (Forbes, 1855)
- Fabanella boloniensis (Jones, 1882)
- Klleana alata Martin, 1940
- Mantelliana wealdensis (Wolburg, 1962)
- Scabriculocypris trapezoides Anderson, 1941
The Cinder Beds Member of the Durlston Beds Formation is exposed about 200m further upstream, in a low cliff on the southern bank of the stream; the intervening shales of the Plant and Bone Beds Member (Lulworth Beds Formation) are poorly exposed, mostly in the stream bed, and in places are contorted due to valley-bulging. In Gibbons' (1981) guidebook the Cinder Beds Member is located by reference to "a large fallen tree trunk that lies across the stream": following the great storm of October 16th, 1987, which felled millions of trees in the Weald, this tree was still distinctive but no longer unique to the section! The characteristic "Cinder Bed" lithology is not seen here: downstream from the fallen tree is an 18cm-thick, blue-grey, impure and shelly limestone, overlain by about 2m of grey shale/clay which yields a typical Cinder Beds ostracod fauna:

- Galliaeocytheridea postsinuata Wolburg, 1962
- Klieana dictyota Anderson, 1971
- Orthonotacythere cineraria Anderson, 1971

This is followed in turn by a 20-30cm-thick nodular limestone packed with rather chalky bivalve shells and occasional oysters, outcropping in the cliff upstream from the tree. The section continues upstream with intermittent outcrops in the Arenaceous Beds Member and Greys Limestones Member of the Durlston Beds Formation. Higher beds may be seen in the section NE of the mines; according to Anderson & Bazley (1971) the shales at the top of the section probably belong to the Battle Faunicycle (no. 40; Assemblage 7; Cypridea setina Zone) which places them near the top of the Fairlight division of the Ashdown Beds Formation.
Locality 1.2: Ashdown Brickworks, Bexhill (TQ 722095). Wadhurst Clay Formation.

Permission to visit this pit may be obtained by writing to J.G. Pickles (Geologist), Redland Bricks Ltd, Graylands, Horsham, West Sussex RH12 4QG.

The old pit at the Ashdown Brickworks (Fig. 4) exposes part of the Tunbridge Wells Sand Formation (see Lake & Shepard-Thorn, 1987, for details), situated on the downdrop side of the Whydown Fault which runs along the northern edge of the pit. The new pit, opened in recent years on the upthrow side of the fault, offers a section in the upper part of the Wadhurst Clay Formation. A conspicuous sandstone unit within the succession here may be correlated with a sandstone seen in the Wadhurst Clay in the Cooden Borehole about 3km away (see Fig. 4) and mapped locally as the Northiam Sandstone. In May 1988 a good vertical section was accessible in the beds underlying the Northiam Sandstone (Fig. 5); local faulting and dip variations (due to valley bulge?) made it difficult to trace individual beds (other than the sandstone) around the pit.
Fine silty sandstone.
Grey clay with micaceous sandy laminae, carbonaceous debris, root casts and burrows.
Laminated silty sand passing up into ripple-laminated fine sand with ferruginous bands.
Pebble bed.
Fine silty sandstone, horizontally and ripple-laminated, with plant debris and vertical plants;
upper part ferruginous with irregular base cross-cutting laminae.
Green/blue-grey mottled clay.
Green clay weathering red/brown at top.
Grey/green clay with ostracods (mainly Cypridea), conchostracans, fish bits and plant debris.
Thin ferruginous claystones, and Neomiodon and Cypridea limestones, in grey shale.
Striped siltstones and clays.
Ripple-marked siltstone.
Lenses of fish bits and pebbles in silty clay.
Ferruginous claystone.
Striped silts & clays with lenses of fish bits.
Grey/green clay with ferruginous nodules, weathering red/brown towards top.
Grey clay with crushed Cypridea and Neomiodon.
Neomiodon limestone with Cypridea & fish bits.
Striped siltstones & clays: alternating laminae with some ripple-lamination, micro-faulting,
undercut erosion surfaces, bivalve dimples, root casts, Neomiodon, small Viviparus, fish bits and occasional ferruginous pebbles;
locally an erosion surface with intraclasts (channel?).
The ostracods found in these beds included abundant crushed specimens of a fragile species probably referable to *Cypridea bispinosa* Jones, 1878, of which forms corresponding to the subspecies *suthrigensis* Anderson, 1967 (with a single subcentral spine) and *birini* Anderson, 1967 (without spines) have been tentatively identified. Well-preserved specimens of *Cypridea laevigata* (Dunker, 1846), *Cypridea pendae* Anderson, 1967 and *Cypridea aculeata* Jones, 1885 have also been found, together with occasional examples of *Rhinocypris jurassica* (Martin, 1940).

By comparison with the Cooden Borehole (Anderson, in Lake, 1975) the beds immediately below the Northiam Sandstone are at the base of the *Cypridea aculeata* Zone (Lindfield Faunicycle - no.54); below this, the topmost faunicycle (53; Fairlight) of the *Cypridea paulsgrovensis* Zone may be exposed towards the bottom of the pit. In the Cooden borehole the Lindfield Cycle included:

- *Cypridea aculeata antiqua* Anderson, 1967 (common)
- *Cypridea tuberculata* (J.de C. Sowerby, 1836)
- *Cypridea laevigata* (Dunker, 1846)
- *Darwlnula leguminella* (Forbes, 1855)
- *Darwlnula oblonga* (Roemer, 1839)
- *Damonella pygmaea* (Anderson, 1941)
- *Mantelliana phillipsiana* (Jones, 1888)

while the Fairlight Cycle included:

- *Cypridea aculeata antiqua* Anderson, 1967
- *Cypridea bispinosa* Jones, 1878
- *Cypridea frithwaldi* Anderson, 1967
- *Cypridea lasius* Anderson, 1967
- *Cypridea melvillae* Anderson, 1967
- *Cypridea menevensis* (Anderson, 1939)
- *Cypridea paulsgrovensis* (Anderson, 1939)
- *Cypridea pendae* Anderson, 1967
- *Cypridea recta* Wolfburg, 1959
- *Cypridea tuberculata* (J.de C. Sowerby, 1836)
- *Cytheridea (Haplocytheridea) delicatula* (Martin, 1961)
- *Darwlnula leguminella* (Forbes, 1855)
- *Darwlnula oblonga* (Roemer, 1839)
- *Mantelliana phillipsiana* (Jones, 1888)
- *Rhinocypris jurassica* (Martin, 1940)
- *Theriocynoecum alleni* (Pinto & Sanguinetti, 1962)
Locality 2.1: Philpots Quarry, West Hoathly (TQ 354322).
Grinstead Clay Formation.

Written permission to visit this quarry must be obtained from Mr L. Hannah, Philpots Quarry, West Hoathly, Sussex.

The unmade road leading to the quarry from West Hoathly is rough and narrow, and parking is very limited; coach parties must disembark in the village and proceed on foot (Fig. 6).

The quarry exposes the Ardingley Sandstone Member of the Lower Tunbridge Wells Sand Formation, overlain by the Grinstead Clay Formation (Lower Grinstead Clay and Cuckfield Stone (part) Members) (Fig. 7). Detailed sedimentological descriptions and interpretations have been given by Allen (1976, 1977).
Clay with siltstone and sandstone lenticles, burrows, plant fragments and *Unio*.

Ironstone.

Clay with runnel-casts.

Ironstone.

Calcareous runnel-casts with vertical plants, ostracods, *Unio*, *Neomiodon* and minute gastropods.

Ironstone.

Laminated clay with C- and S-phase ostracods on separate laminae.

Silty clay.

Pebble bed.

Giant 'scoop' cross-bedded sandstone.

Fine trough cross-bedded and plane-bedded sandstone.

Dark laminated clay with ostracods, fish and plant bits.

Sandstone with in situ *Lycopodites*, logs and bones.

**SECTION IN PHILPOTS QUARRY, WEST HOATHLY**

(modified from Allen, 1977).
Anderson (1985) listed four faunicycles at Philpots Quarry: nos 59 (Chilcombe), 60 (Grinstead), 61 (Philpots) and 62 (Copyhold), all within the Cypridea aculeata Zone (see Fig. 2). The best ostracod faunas are to be found between one and two metres above the base of the Grinstead Clay and include:

- *Cypridea aculeata aculeata* Jones, 1885
- *Cypridea bispinosa bispinosa* Jones, 1878
- *Cypridea laevigata philpottsi* Anderson, 1967
- *Cypridea recta* Wolburg, 1959
- *Cypridea verrucosa* Jones, 1878
- *Darwinula sp.*
- *Mantelliana phillipsiana* (Jones, 1888)
- *Theriosyncocum allenii* (Pinto & Sanguinetti, 1962)
- *Rhinocypris jurassica* (Martín, 1940)
Locality 2.2: Clock House Pit, Capel (TQ 175385).

Written permission to visit this pit must be obtained from the Works Manager, Butterley Brick Ltd, Clock House Brickworks, Horsham Road, Capel, Nr Dorking, Surrey RH5 5JL.

The location of the pit is shown in Fig. 8.

The beds exposed in the Clock House Pit belong to the upper part of the Lower Division of the Weald Clay Group; the base of Bed 3a (Okehurst Sand), which occurs at the top of the Clock House section (see below), marks the boundary between the Lower and Upper Divisions and also serves as a mappable lithological marker of the Hauterivian / Barremian boundary (Worssam, 1978).

According to Anderson (1985), however, the junction of the Lower and Upper Divisions (and therefore the Hauterivian / Barremian boundary) is marked by the boundary between the Ewhurst and Capel faunaicycles, which he recorded at Clock House, presumably from near the top of the section but below the Okehurst Sand. Kilinyi & Neale (1978) placed the Hauterivian / Barremian boundary at the junction of their Cypridea clavata and Cypridea valdensis Zones, which actually appears to be the same horizon as that indicated by Anderson (see earlier discussion of zonation schemes).

Anderson (1985) listed 10 faunaicycles in the pit; the lowermost, no. 81 (Plumpton) is at the top of the Cypridea tuberculata Zone and Assemblage 12; nos 82-86 (Buxted, Ockley, Horley, Slinfold and Newdigate) represent the Cypridea marina Zone and belong to Assemblage 13; the succeeding Romney and Ewhurst (87, 88) faunaicycles are also in Assemblage 13, and together with nos 89 and 90 (Capel and Bonninton; Assemblage 14) belong to the Cypridea clavata Zone.

Kilenyi & Allen (1968) described the ostracods of a brackish-marine band containing oysters, cirripedes and foraminifera in the old pit at Clock House (this probably corresponds to the Ockley faunaicycle; see Anderson, 1971); unfortunately their section is now degraded and difficult of access (see below). Kennedy & MacDougall (1969) identified burrows in the Clock House Sandstone as Ophiomorpha which is generally taken to indicate brackish/marine conditions; the identity of the burrows has recently been questioned by my colleague Dr A.S. Gale, who suggests that they may be of freshwater or even terrestrial origin. Jarzemowski (1978) has found insect fossils (predominantly beetle elytra) in the Clock House Pit.

Unfortunately it is not clear how Anderson's faunaicycles are related to the lithostratigraphy of Clockhouse Pit; moreover, the published sections (Kirkaldy & Bull, 1968; Kilinyi & Allen, 1968; Worssam, 1973) are all for the old pit which is now permanently flooded and its tanks
overgrown (TQ 174384 to TQ 175382). The section provided here (Figs 9 & 10) was logged in early 1988 in the new pit, to the East of the old one; the beds exposed correspond well with part of Worssam's (1973) section in the old pit (see Fig.8) and although excavation had not yet reached the brackish-marine beds (of Kilenyi & Allen, 1968) near the bottom of Worssam's section, it seemed likely that these would be revealed in the near future. In the new pit the lower part of the succession (Section A; Fig.9) is exposed along the East face (TQ 178385), with additional exposures of some of the beds on faces within the pit; across the North face the gentle dip takes the topmost siltstones of Section A from high up on the Northeast corner to near the bottom at the Northwest corner (TQ 177386), from where section B (Fig.10) was logged. Beds above the topmost sandstone on Section B are exposed on the North face, if somewhat overgrown; they include clays with calcareous ('race') nodules, and, at the very top, the base of a sandstone (Bed 3a of Worssam, 1978).

The following ostracods have been recorded here:

**Cypridea clavata** Anderson, 1939
**Cypridea hispida** Anderson, 1985
**Cypridea marina** Anderson, 1967
**Cypridea pumila** Anderson, 1967
**Cypridea tuberculata** (J.de C. Sowerby, 1836)
**Cypridea valdensis** (J.de C. Sowerby, 1836)
**Cytheridea (Haplocytheridea) delicatula** Martin, 1961
  (=Schuleridea (Ecshuleridea) wealdensis Kilenyi & Allen, 1968)
**Damonella pygmaea** (Anderson, 1941)
**Darwinula oblonga** (Römer, 1839)
**Darwinula leguminella** (Forbes, 1855)
**Fagainella boloniensis** (Jones, 1882)
**Hutsonia capelensis** Kilenyi & Allen, 1963
**Mantelliana mantelli** (Jones, 1882)
**Miccytheridea henfieldensis** (Anderson, 1939)
**Sternbergella** (Para sternbergella) wolburgi Kilenyi & Allen, 1963
**Theriosyncoeum fittoni** (Mantell, 1844)
Grey/green clay with lenses of silt and of ostracods, passing up into shale with ostracods and fish bits concentrated on laminae.

Ripple-laminated siltstones with black clay partings, vertical and horizontal plants; fish bits at base.

Grey clay.

Small *Viviparus* limestone with fish bits.

Grey clay.

Siltstone and clay with abundant conchostracans.

Grey clay with a lenticular siltstone.

Green clay with a band of small *Viviparus* at top.

Ferruginous claystone sometimes extending down cracks, interrupted by fine sandstone basin casts.

Grey shale with siltstone at top.

Ferruginous claystone, locally with fish bits and rolled coprolites at base.

Grey shales and lenticular siltstones with horizontal root casts.

Brown silty shales and siltstone lenses with fish bits, rolled coprolites, conchostracans & concentrations of ostracods (*Cypridea* and *Mantelliana*).

Ripple-laminated siltstone.

Grey shale with a band of red/brown shale (above) and a parting of crushed small *Viviparus* (below).

Ostracod limestone (*Cypridea*, *Theriosynoeicum*, *Darwinula*).

Grey shale with ripple-laminated siltstone at base.

Grey silty clay with fine sandy lenses and abundant ostracods (mainly *Cypridea* & *Miocytheridea*).

Sandy ostracod limestone (*Cypridea* and *Darwinula*).

Inversely graded sandstone with fish bits, rolled coprolites, chert pebbles and a fluted base, wrapped and penetrated by fine root casts.

Siltstones in grey clay with ostracods and fish bits.
WEALD CLAY GROUP

SECTION B NORTHWEST FACE

LOCALITY 2.2 CLOCK HOUSE NEW PIT

WEALD CLAY GROUP

Fine micaceous sandstone with ripples and fine plant debris.
Brown clay with Filosina, conchostracans and ostracods (mainly Darwinula).
[Abundant lignite in ferruginous clay.]

Clays with Filosina and ferruginous nodules.

1 m

Ferruginous clay with Filosina and large Viviparus. Green silty clay.
[Clock House Sandstone]
Rippled micaceous sandstone with burrows and vertical plants.
[Silty clays with fish bits.]
[Micaceous sandy siltstones with ripples, dessication cracks and burrows, separated by a ferruginous clay.]
[Green and red/brown clays. Ferruginous claystone.]
[Grey/green clay.]
[Crushed large Viviparus.]

Brown clay passing up into green clay.

[Laminated siltstone with abundant fish bits in (?) runnel casts at base, fining up into silty clay.]
[Green and red mottled clay with (?) vertical plants.]

SECTION A
Locality 3.1: Copt Point, Folkestone (TR 242365).

Gault Clay (Albian).

From the road west of the point (TR 238364) a cliff-top path should be followed along the side of the golf-course to just east of the point, where the descent may be made to beach level (except at high tide) (Fig. 11). This section is likely to be extremely sticky in wet weather.

The top of the Folkestone Sands and the lower half of the Gault Clay may be examined in the cliff at Copt Point. This locality also affords excellent views eastwards across the Folkestone Warren landslip, beyond which cliffs of Cenomanian to Turonian Chalk continue to Dover. In spite of its history of landslides and rockfalls Folkestone Warren was chosen as the route for the Folkestone - Dover railway, which was tunneled into the Warren at each end and opened in 1844. Many landslips have occurred since then, the most notable in 1915 when the entire Warren moved seawards, displacing the railway line as much as 50m. Movement was mainly on slip planes extending down to the base of the Gault, lubricated by water under artesian pressure in the Folkestone Sands (Gibbons, 1981; Hutchinson, Bromhead & Lupini, 1980). Since the 1940's the construction of drainage adits, concrete toe weights and an extended sea wall has been largely successful in preventing further slippage. The upper part of the Gault and the transition to the Cenomanian (Glauconitic Marl) are from time to time beautifully exposed on the foreshore in the eroded toe of the slip when shingle is removed by storms.

Well-preserved ostracods may be obtained from most levels in the Gault; a good place to sample is in the vicinity of the cristatum nodule bed which marks the boundary between Middle and Upper Albian.
The commoner species are listed below; for further details and illustrations see Hart (1973) and Neale (1978).

Cornicythereis larivourensis (Damotte & Grosdidier, 1963) (=Praephacorhabdotus erici Malz, 1982) *
Cythereis folkestonensis Kaye, *
Cythereis luermannae Triebel, 1940 *
Cythereis reticulata Jones & Hinde, 1890
Cythereis hirsuta Damotte & Grosdidier, 1963
(=Cythereis thorenensis Triebel, 1940 sensu Kaye, 1964)
Cytherella ovata (Roemer, 1840)
Cytherelloidea stricta (Jones & Hinde, 1890) *
Dolocytheridea bosquetiana
Isocythereis folkestonensis Malz, 1982 *
Mandocythere harrisiana (Jones, 1870)
Neocythere (Centrocythere) denticulata Mertens, 1956
Neocythere (Neocythere) vanveeni Mertens, 1956
Platycythereis gaultina (Jones, 1849)
Protocythere consobrina Triebel,
Protocythere lineata (Chapman & Sherborn, 1893)
Schuleridea jonesiana (Bosquet, 1852)

* Species which first appear at or just above the level of the cristatum nodule bed.
Approx. 20m below base of Cenomanian

Scale at left of column in metres.

Roman numerals refer to bed classification of Price (1874).

Clay with abundant

\textit{Inoceramus sulcatus}

- \textit{cristatum} nodule bed

- Phosphatic nodules with abundant shell debris

- Black centered phosphatic nodules

- \textit{dentatus} nodule bed

- "Sulphur Band" - phosphatic nodules with jarosite and iron pyrites

- \textit{mammillatum} nodule bed

\textbf{FIG. 12} SECTION OF TOP FOLKESTONE BEDS AND GAULT CLAY AT COPT POINT, FOLKESTONE (logged by A.S. Gale).
Locality 3.2: Shakespeare Cliff, Dover (TR 308397).
Cenomanian/Turonian Boundary (top of Abbots Cliff Chalk Formation, Plenus Marl Formation and base of Dover Chalk Formation).

Access from the road is via a footbridge over the railway line, just east of Shakespeare Cliff (Fig. 11). The section may be difficult or impossible to reach at high tide.

Jarvis et al. (1983) collected samples from the Plenus Marl about three kilometres west of here on the Abbots Cliff path; the section at Shakespeare Cliff is virtually identical, however, and more suitable for a large party. Works connected with the Channel Tunnel may be visible just west of here, at Akers Steps.

Representative Upper Cenomanian faunas may be obtained from the top few metres of the Abbots Cliff Chalk Formation, but more or less the same species occur in the lowest bed (Bed 1) of the overlying Plenus Marl Formation which is more easily processed; the higher beds of the Plenus Marl contain progressively fewer species. The well-indurated nodular chalks of the Melbourn Rock Beds (within which the Cenomanian/Turonian boundary is placed about 1m above the top of the Plenus Marl Formation) are difficult to process and are unlikely to yield more than a few platycopids. The commoner species from the Abbots Cliff Chalk and Bed 1 of the Plenus Marl are listed below; for further detail and illustrations see Jarvis et al. (1988).

**Bairdopilata pseudoseptentrionalis** Mertens, 1956
**Bairdopilata southerhamensis** Weaver, 1982
**Bythoceratina harrigi** Weaver, 1982
**Bythoceratina umbonatoides** (Kaye, 1964)
**Cythereis** sp. A (*sensu* Weaver, 1982)
**Cytherella** cf. *C. chathamensis* Weaver, 1982
**Cytherella** concava Weaver, 1982
**Cytherella** cf. *C. contracta* Van Veen, 1932
**Cytherella** ovata (Roemer, 1840)
**Cytherelloidea** bonnemai Weaver, 1982
**Cytherelloidea** kayei Weaver, 1982
**Herrigocythere** donzel (Weaver, 1982)
**Imhotepia** euglyphea Weaver, 1982
**Isocythereis** elongata Weaver, 1982
**Loxoconcha? bluebellensis** Weaver, 1982
**Oertheilla** alata Weaver, 1982
**Phodeucythere** cuneiformis Weaver, 1982 *
**Pontocythere** robusta Weaver, 1982
**Pseudobythocythere** colini Weaver, 1982 *

* occurs only in Bed 1 of the Plenus Marl
FIG. 13  SECTION FOR LOCALITY 3.2  (logged by I. Jarvis)
Locality 3.3: Langdon Stairs, Dover (TR 345424).
Turonian and Coniacian Chalk (upper part of Dover Chalk Formation, lower part of Ramsgate Chalk Formation).

The top of Langdon Stairs is reached from the west along the cliff-top path leading below the Coastguard Station (Fig.11).

The zig-zag cliff path known as Langdon Stairs was constructed during the Napoleonic Wars and allows easy access to a superb section through Turonian to Coniacian Chalk. There are six straight sections of stairs cut into the chalk, their bases numbered in ascending order (LGS 1, LGS 2, etc.); the foot of the lowermost (LGS 1 on Fig.14) is at the level of the Crab Bay Marl, from which the descent to the beach is made by a wooden ladder.

The commoner ostracod species are mostly long-ranging, although their relative abundances differ through the section. Representative assemblages are best obtained from the more easily processed marl bands. Recommended sampling horizons in the Turonian are the uppermost of the Langdon Bay Marls (accessible at beach level west of the foot of the stairs only at low tide), the Crab Bay Marl (at the foot of the stairs) and the softer chalk below the first of the South Foreland Hardgrounds (2-3 metres below the Turonian/Coniacian boundary, placed immediately below South Foreland Hardground 3)); in the Coniacian, the East Cliff Marls (towards the top of the stairs – LGS 4) should yield good faunas.
FIG. 14  SECTION FOR LOCALITY 3.3  (continued from Fig. 13)
A preliminary species list for the Turonian and Coniacian of Dover is provided below (Horne & Rosenfeld, unpublished data).

**Amphicytherura** sp.
**Aversivalva vscriptum** (Van Veen, 1936) *
**Bairdopplata** sp. A
**Bythoceratina** cf. **montuosa** (Jones & Hinde, 1890)
**Curfsina** kaťkai kaťkai Pokorný, 1967
**Curfsina** senior Pokorný, 1967
**Cythereis** cf. **C.** condemniensis Breman, 1976
**Cythereis** cf. **C.** longaeva Pokorný, 1963
**Cytherella** cf. **C.** chathamensis Weaver, 1982
**Cytherella concava** Weaver, 1982
**Cytherella** cf. **C.** contracta Van Veen, 1932
**Cytherella ovata** (Roemer)
**Cytherelloidea** granulosa (Jones, 1849)
**Cytherelloidea** hindei Kaye, 1964
**Cytherelloidea** kayei Weaver, 1982
**Cytherelloidea obliquirugata** (Jones & Hinde, 1890)
**Golccythere**? **calcari** (Bonnema, 1941)
**Imhoteapia** marssoni marssoni (Bonnema, 1941)
**Imhoteapia** marssoni antennabra (Pokorný, 1964)
**Mosaeleberis** sp.A **
**Neocythere** (Physocythere) **virginea** (Jones, 1849)
**Parvacythereis** subparva (Pokorný, 1967)
**Pontocyprella** sp.
**Spinoleberis** cf. krejci Pokorný, 1968
**Trachyleberidea** zeinitzii (Reuss, 1874)
**Xestoleberis** sp.A
**Xestoleberis** sp.B

* Coniacian only.

** Two forms occur; a smooth one (similar to Karsteneis (Prosteneis) nodifera (Kafka, 1886) in Pokorný, 1963) and an ornamented one (= M. interruptoiidea (Van Veen) sensu Pokorný, 1978); see Jarvis et al. (1988) for further discussion.
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MAJOR SOURCES


Proceedings of the Geologist's Association. 36 (part 4, 1975; published May 1976), 373-628. [Special issue commemorating the centenary of publication of "The Geology of the Weald", by William Topley; several papers contained therein are referenced individually below]


GUIDE BOOKS


Geologist's Association Guides:


REFERENCES


