The effect of environmental change on Early Aptian Ostracoda in the Wessex Basin, Southern England

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A major phase of transgression in the Wessex Basin (southern England) during the earliest Aptian resulted in the collapse of the generally fresh water Barremian environment and the initiation of the marine mileu.

Cypridea-rich faunas low in the Shepherd's Chine Member (Vectis Formation), were gradually replaced by faunas dominated by *Sternbergella cornigera, Mantelliana mantelli* and *Theriosynoecum fittoni.* This change is interpreted as indicating that salinities had passed from fresh-oligohaline to meso- and pliohaline and that ephemoral water bodies were replaced by more widespread, permanent, lagoonal waters. The ostracods from the highest part of the Vectis Formation, appear to be heralding the major transgression that was about to engulf the Wessex Basin.

The marine incursion during the *obsoletum* Subzone brought with it newly formed environmental niches that were rapidly occupied by microfaunas. Several ostracod species are euryhaline, but others appear to have been restricted to marine or near marine salinities. The earliest marine ostracod faunas were recorded from the Perna Bed Member, Isle of Wight, and include abundant *Asciocythere albae* and frequent to common *Schuleridea derooi, Neocythgere gottisi, N. bordeti* and *Cytherelloidea* sp. Other species include rare *Cythereis geometrica, C. semiaperta, Cytheropteron stchepinskyi* and *Protocythere croutesensis.* In addition, elsewhere in southern England, *Protocythere mertensi langi, Dolocytheridea intermedia, Paranotacythere (P.) oertlii* and *P. (P.) atypica* occur. The relationship of this earliest Aptian population with that of the Paris Basin cannot be mistaken.

Key words: Ostracoda, Aptian, Wessex Basin, palaeoenvironmental change.

1. Introduction

The earliest Aptian was a time of major change in the Wessex Basin with marine conditions returning for the first time since the end of the Jurassic. Flooding of the low-lying, topographically subdued areas in which the Wealden Clay and Vectis formations had accumulated, was geologically instantaneous. The abrupt palaeoenvironmental change profoundly affected the ostracod community of the Wessex Basin- in broad terms the fresh water faunas of the late Barremian were replaced by marine taxa by the early Aptian.

The *Cypridea*-rich associations of southern England have been described in detail by Anderson in several classic papers (1985 and references therein) and his concepts were later discussed by Horne (1995). Previous work on the earliest marine Aptian ostracod faunas of southern England has concentrated on taxonomy (Kaye, 1965), but their relationship to the stratigraphy and palaeoecology has not been considered in any detail (Wilkinson, 1996). The aim of the present work is to examine the earliest Aptian ostracod faunas of the Wessex Basin in detail, in order to determine how these major palaeoenvironmental changes affected their migration into the region. In order to do this, successions from the Isle of Wight and boreholes in Sussex and Surrey (Fig. 1) are considered.

2. Stratigraphy

2.1 Vectis and Weald Clay formations

The Shepherd's Chine Member at the top of the Vectis Formation has traditionally been placed into the Upper Barremian. However, it is at least in part younger than the earliest Aptian magnetostratigraphic chron CM-0 (suggesting a position within the *bodei* Subzone *fissicostatus* ammonite Zone) (Fig. 2). The overlying Perna Beds have a *fissicostatus* Zone, *obsoletus* Subzone macrofauna, so that, unlike eastern England, the earliest macrofossil subzone in the Vectis Basin (*bodei* Subzone) is represented by non-marine facies. Thus, the stratigraphical gap between the Vectis Formation and overlying Atherfield Bone Bed, at the base of the Perna Beds, represents a very short period of time.

The Vectis Formation of the Isle of Wight (Text figure 2), which comprises mainly dark grey mudstones, is divided into three members, but only the highest of these, the Sheperd's Chine Member, is considered here. This member consists of rhythmic grey, fine-grained sands and silts passing up into dark grey clay in about 65 thin, upwardly fining units (Insole et al., 1998). The base of each unit is generally erosional. Towards the top of the member, thin, shelly, argillaceous limestones occur containing the bivalve *Filosina* and, near the top, *Ostrea.*

The Formation correlates, in part, with the uppermost part of the Weald Clay Formation in the Wealden Province of Surrey, Sussex and Kent (Text figure 2). The formation is rarely exposed in this region, although it was formerly recorded in a few brick pits, where it was composed of grey and brown clays, locally shaley or silty, with beds of 'Paludina' limestone and occasional ironstone (e.g. Thurrell et al., 1968; Young & Lake, 1988; Insole et al., 1998).

2.2 Atherfield Clay Formation

The Perna Member, which accumulated in a shallow marine environment, was named after the bivalve *Mulletia mulleti*, formerly *Perna mulleti*, which occurs in large numbers. The unit comprises a basal grit (the Atherfield Bone Bed of Simpson, 1985), a transgressive lag consisting of small pebbles, phosphatic nodules (some containing Kimmeridgian ammonites) and fish and reptile debris (Simpson, 1985, Hart et al., 1991). Overlying the bone bed are dark greenish-grey, fine-grained clayey sand and sandy clay, containing bivalves, echinoids, brachiopods as well as the earliest microfaunas, including rare, generally agglutinated foraminifera and very rare dinoflagellate cysts (Hart et al., 1991). Shelly, microfossils have not been recorded from the more indurated, glauconite-rich, highly bioturbated medium- to coarse grained, calcareous sandstone of the Upper Perna Bed. Casey (1961) placed the Perna Beds Member in the *Prodeshayesites obsoletus* Subzone, although hinted that, although evidence is lacking, the Atherfield Bone Bed might be of *Prodeshayesites bosei* subzonal age.

The Chale Clay Member (formerly called the Atherfield Clay) (Simpson, 1985) comprises up to 21 m of brown-weathering, dark grey, silty clay, with red nodules in the lower part. On sedimentological grounds the unit accumulated in shallow marine conditions with storm events resulting in silty lags (Insole et al., 1998). Although poorly fossiliferous, bivalves occur and the ammonites place the unit within the *Deshayesites fittoni* Subzone.

The remainder of the Atherfield Clay Formation (Fig. 2) comprises brown-grey mudstones and fine sands which show upward coarsening in some parts. Scattered phosphatic and calcareous concretions are present and occasional wave ripples and scoured surfaces occur. Between Chale Bay and Atherfield Point, Isle of Wight, this part of the formation can be divided into three units, which have variously been called 'divisions', 'beds' or 'members' (e.g. Fitton, 1847; Casey, 1961; Simpson, 1985; Insole et al., 1998): Upper Lobster Bed (at the top), Crackers Bed and Lower Lobster Beds (at the base). These subdivisions are geographically very restricted; they rapidly become more uniform, so that, for example, the Crackers Beds is represented only by a sandstone interval at Red Cliff (Simpson, 1985) and offshore in BGS Borehole 75/35 (Dingwall & Lott, 1979; herein).

In Surrey, the Atherfield Clay comprises "15-60 feet [4.6-18.3 m] of brown and grey sandy clay and buff loam with concretions of clay ironstone or calcareous stone at the base (Perna Beds)" (Casey, 1961). It is rarely exposed, but in the past brick pits have yielded the characteristic macrofaunas seen in the Isle of Wight. In Sussex, the Atherfield Clay Formation comprises brown and grey silty clays up to approximately 18 m thick, although, again, it is very rarely exposed and the Perna Member has not been observed.

3. Ostracods in the Wessex Basin

3.1 Isle of Wight

Atherfield Bay (Fig. 3). Anderson (1971) lised the ostracods from the upper 40m of the Shepherd's Chine Member. Species of *Cypridea*, such as *C. cuckmerensis* and *C fasciata* commonly occurred and, although less common, non-*Cypridea* taxa such as *Sternbergella cornigera* and *Mantelliana mantelli* were present. However, at the top of the section (about 6m below the Perna Beds), *Cypridea* is less dominant, replaced by more numerous "S-phase" species. *Cypridea* was found in a sample 3m below the top of the Shepherd Chine Member in the Atherfield-Shepherd's Chine area, but the fauna recovered from 0.3 m below the base of the Perna Member is dominated by the 'S-phase' species *Sternbergella cornigera*, and *Mantelliana mantell*;, species of *Cypridea* had disappeared from the record.

Sandown Bay (Fig. 4). Stewart *et al.* (1991) indicated that C-phase ostracods are not found in the highest part of the Vectis Formation (highest Shepherds Chine Member), the fauna being entirely S-phase, although no details were given. The present author examined a sample from the highest Vectis Formation at Sandown Bay, 0.25m below the contact with the Atherfield Bone Bed, where only very rare specimens of *Sternbergella cornigera* were found.

The earliest marine ostracod faunas to enter the Wessex Basin were recorded from the lower Perna Bed, which were examined at Sandown Bay, Isle of Wight (Figure 4). The more successful species include abundant *Asciocythere albae* and frequent to common *Asciocythere* sp, *Schuleridea derooi, Schuleridea* sp, *Neocythere gottisi, N. bordeti* and *Cytherelloidea* sp. Other species include rare *Cythereis geometrica, C. semiaperta, Cytheropteron stchepinskyi* and *Protocythere croutesensis*. There is little difference in the faunas throughout the Lower Perna Bed, except *Cythereis* tends to become more common up sequence at the expense of *Neocythere* and *Cytherelloidea*.

BGS Borehole 75/35 (Fig. 5) A sparse fauna, was recovered in a borehole (British Geological Survey borehole 75/35) to the east of Sandowm, Isle of Wight (Latitude 50° 37.81' N Longitude 1° 5.54'W). Here the Atherfield Clay Formation comprised upwardly coarsening rhythms which can be related to the Atherfield succession only with difficulty (Dingwall & Lott, 1979).

Upper Lobster Bed. Olive-brown, silty, micaceous clay with ammonites (21.6m thick)

?*Crackers Bed.* brown-grey, silty, shelly clay, overlain by brown-grey, silty, fine-grained sandstone (5.75m thick)

?Lower Lobster Bed. Grey, micaceous siltstone with clay lenses, overlain by grey, silty sandstone (9.60m thick)

Chale Clay Member:

Brown-grey, fossiliferous mudstone with occasional calcareous and phosphatic nodules. 29.35m (base not seen).

Kaye (1965) described a fauna comprising 19 species from the Chale Bay Member (D. *forbesi* Zone, *D. fittoni* Subzone), onshore, although he gave little stratigraphical and geographical information. In borehole 75/35, ostracods were less diverse (Text-Fig. 5), however, it is characterised by *Schuleridea derooi, S. sulcata, Neocythere*

(*Centrocythere*) *bordeti* and *Cythereis geometrica* together with occasional *Asciocythere alba,* and *Dolocytheridea intermedia* at the base and *Paranotacythere inversa tuberculata* and *Protocythere mertensi langtonensis* in the upper part.

Kaye (1965) mentioned only *Schuleridea sulcata* from the Upper Lobster Member and no species at all from the Lower Lobster Member. Unfortunately samples from the higher part of the Atherfield Clay in borehole 75/35, were almost barren of ostracods, although rare agglutinated foraminifera and 'lignite' chips were present. The only ostracods recovered were from the Crackers Bed, which contained very rare *Cythereis geometrica* and *Veeniacythereis* cf *blanda,* and a specimen of *C. geometrica* from the upper part of the Upper lobster Bed.

3.2 West Sussex

Unlike the Isle of Wight, moderately diverse associations were encountered in the upper part of the Atherfield Clay Formation of Paylins Copse Borehole (National Grid Reference SU8691 2383), Pound Common Borehole (SU8756 2471) and Frog Farm Borehole (SU9725 2048), West Sussex (Figs. 6, 7 and 8 respectively). The lower and middle parts of the formation yielded *Dolocytheridea intermedia, Neocythere* (*C.*) *bordeti, Schuleridea sulcata* and *Protocythere derooi,* with less common *Paracypris* sp., *Dolocythere rara, Cythereis* sp. and *Cytherella* cf. *ovata*. Towards the top of the formation, *Neocythere* (*C.*) *gottis, Veeniacythereis* cf. *blanda, Cythereis* cf. *buechlerae* and *Schuleridea* sp characterise the assemblage.

The Hoes Farm Borehole (National Grid Reference SU 9808 1962) penetrated through the Sandgate and Hythe formations before terminating in the Atherfield Clay Formation (Bristow et al., 1987). The last named formation can be placed within the *D. callidiscus* Subzone and is, therefore, equivalent to the Upper Lobster Bed and Crackers members of the Isle of Wight succession. The fauna is almost identical to the lower part of the *forbesi* Zone. The most common species found here (Fig. 9) were *Dolocytheridea intermedia*, *Neocythere* (*C.*) *bordeti* and *Schuleridea sulcata,* although none of the faunas contained abundant ostracods, but *Protocythere croutesensis* and *P. mertensi langtonensis* were occasionaly present.

There is a change in the fauna in the basal part of the Hythe Formation (*D. deshayesi* Zone, *C. parinodum* Subzone) with the appearance of species such as *Neocythere* (*C.*)

gottisi, Platycythereis cf. *rectangularis, Cythereis geometrica geometrica* and *Veeniacythereis* cf. *blanda*.

4. Biostratigraphy

The Aptian succession of southern England can be subdivided into two zones and four subzones (Fig. 2) based on the distribution of ammonites (Casey, 1961). The *bodei* Subzone at the base of the fissicostis Zone cannot be recognised in the Wessex Basin because salinity during the accumulation of the Shepherd's Chine Member was too low (the subzone was defined in East Anglia). It is shown here to include that part of the Aptian below the first ammonite-bearing strata and above the magnetostratigraphic chron CM-0.

Previous studies of the marine ostracods have concentrated on the systematic palaeontology, rather than biostratigraphy. The Shepherd's Chine Member can be assigned to Assemblage 15 (of Anderson, 1985) and the *Theriosynoecum fittoni* Zone (of Horne, 1995). No attempt has been made to subdivide the Atherfield Clay by means of ostracods, however, there is sufficient evidence to suggest the presence of:

> a lower zone defined by the appearance of *Neocythere gottisi* with *Cythereis semiaperta, Cytheroptern stchepinskyi* and *Schuleridea derooi*. It is equivalent with the *P. obsoletus* and *D. fittoni* subzones of the standard macrofaunal scheme.

> an upper zone in which *Schuleridea sulcata* becomes the more characteristic species, accompanied by long-ranging taxa, but lacking *Cythereis semiaperta, Cytheroptern stchepinskyi* and *Schuleridea derooi*. *Neocythere bordeti* tends to replace *N. gottisi*. The Zone is equivalent to the *D. kiliana* and *D. callidiscus* standard macrofaunal subzones. Its top is placed at the incoming of *Platycythereis rectangularis* and *Asciocythere albae rectilinea* at the base of the Ferruginous Sands/Hythe formations (the *Deshayesites deshayesi* standard macrofaunal Zone).

5. Migration

With the opening of the sea way at the beginning of the Aptian, three basins became interconnected, allowing migration between: the Wesex Basin, the Celtic Sea Basin in the west and the Paris Basin to the south-east.

A diverse ostracod population has been recovered from the Aptian of the Celtic Sea, dominated by *Bairdoppilata* and *Cytherella* (Colin et al., 1981; Ainsworth, 1985, 1986, 1987; Ainsworth et al., 1985, 1987). Few species appear to have migrated from the Celtic Sea Basin into the Wessex Basin, implying that a physical or biological barrier seperated the two. It is interesting to note that, only five species are common to both the Celtic and Wessex Basin (although several others show close affinities), despite their close proximity. One example, is a single fragment of *Quasihermanites* sp cf *bicarinata* is similar to that figured by Hart & Crittenden (1985) (as *Eucythere ornata*) from the latest Barremian of the Goban Spur. Of those present in the two basin, several appear to have originated in the Paris Basin and taken the opportunity to migrate widely. *N*eocythere (*Centrocythere*) *bordeti* and *N.* (*C.*) *gottisi*, for example, appear to have migrated from the Paris Basin into both the Wessex and Celtic Basins during the early Aptian.

Only early Aptian (*D. deshayesi* Zone) ostracods have been recognised in the Paris Basin (Deroo, 1956; Damotte & Grosdidier, 1963; Damotte, 1971; Damotte & Magniez-Jannin, 1973; Babinot et al., 1985). *Neocythere* (*Centrocythere*) *bordeti* and *Eocytheropteron stchepinskyi* continue through from the highest Barremian, but a number of species appear for the first time in the Aptian, including *Cythereis* (*Rehacythereis*) *geometrica*, *Neocythere* (*Centrocythere*) *gottisi*, *Protocythere croutesensis*, *Asciocythere albae* and *Schuleridea derooi*. *Cythereis lamplughi* was recorded in the upper part of the *D. deshayesi* Zone in the Paris Basin (Babinot et al., 1985). Ostracods in the earliest Aptian deposits of the Wessex Basin bear a close resemblance to faunas of the Paris Basin. *Asciocythere albae albae*, is particulary comon in both the Wessex and Paris basins and appears to have been a succesful opportunist. Others, such as *Eocytheropteron stchepinskyi*, *Protocythere croutesensis* and *Cythereis* (*Rehacythereis*) *geometrica*, are not common in southern England, although the last named species ranges up into the *bowerbanki* Zone (*transitoria* Subzone) in Sussex.

Sauvagnat (1999) ajnd Sauvagnat *et al*. (2001) showed that further south-east, in the Bedoulian of the Jura and Alps, *Asciocythere*, *Schuleridea*, *Paracypris*, *Protocythere* and *Cythereis* are particularlt diverse. Several species recovered here have a wide geographical distribution; e.g. *Neocythere* (*C.*) *gottisi*, *Protocythere croutesensis*, *Eocytheropteron stchepinskyi* and *Schuleridea* cf *derooi*. *Protocythere* and *Cythereis* are biostratigraphically useful in the Mesogean region of France (Babinot et al., 1985 and references therein). Very rare specimens tentatively assigned to Bedoulian taxa have been found in the Wessex Basin: "*Protocythere*" sp 3 and *Cythereis buchlerae*, for example, were originaly found in the Aptian of Mesogean France (Oertli, 1958; Babinot *et al*., 1985). *Strigocythere*? *reticulata* ("*Cythereis*" sp 307 of Oertli, 1958), was first described from the Gargasian of Apt, but has since been described from elsewhere in south-eastern France (Sauvagnat, 1999; Sauvagnat *et al*., 2001) and as far north as the Celtic Basin (Colin et al., 1981).

It seems clear, therefore, that despite the fact that a few species may have been derived from the west, by far the largest number of species in the Wessex Basin originated in the Paris Basin, perhaps having migrated there from yet further south east. Geologically rapid migration took place with the opening of the early Aptian seaway.

Despite the sudden transgression into the Wessex Basin, reworked species are rare. The thin shelled, fresh water taxa of the Wealden Clay are probably too fragile to be transported far. However, a single, quartz encrusted valve of *Macrodentina* (*Polydentina*) cf *steghausi* found in the Perna Member of Sandown, appears to have been reworked from the lower Kimmeridge Clay Formation.

6. Palaeoenvironments

Earliest Aptian ostracod faunas have been recorded from the East Midlands Shelf of eastern England, where conditions limited the assembalges to a few species capable of tolerating kenoxia, such as *Acrocythere hauteriviana, Apatocythere ellipsoidea, Pontocyprella rara* and *Schuleridea hammi* (Wilkinson, 1996). In the southern North Sea Basin, diversity was much higher (Lott et al., 1985) in the better oxygenated waters. Here, a number of taxa that had first appeared in the Barremian extended through to the early Aptian, including *Veeniacythereis acuticostata, Cytheropteron reightonensis, Infracytheropteron exquisita, Paranotacythere inversa tuberculata* and *Cardobairdia minuta.* They occur together with more typical Aptian forms such as *Protocythere intermedia, Paracytheridea minutissima* and *Paracypris acuta.* However, faunas of the Wessex Basin show many differences due to the palaeogeography at that time. It was only with the opening of the Bedfordshire

Straights during the mid and late Aptian that ostracod faunas in the two basins began to mix.

***P. fissicostis* Zone**

The Shepherd's Chine Member is interpreted as a shallow, storm influenced lagoon deposit (Stewart, et al 1991), on the basis of sedimentary structures. Its cyclicity reflects intermittent increases in the fluvial input and flooding events into the lagoon, and it has been suggested that these may be climatically controlled (Insole, Daley and Gale, 1998). Ruffell (1988) and Radley (1995) argued that the faunas indicate an upward increase in salinity.

The typical uppermost Wealden Clay/Vectis Formation ostracod assemblages, are dominated by *Theriosynoecum fittoni*, together with less common *Mantelliana mantelli, Sternbergella cornigera, Darwinula leguminella*, and rare *Cypridea spinigera, C. fasciata, C. tenuis* etc. In the sense of Anderson (1985, and references therein), the S-phase element dominates over the C-phase, but it is not clear how much of this is a reflection of salinity (Anderson's favoured explanation), and how much other parameters such as water chemistry, permanency of the water body, climatic fluctuations, etc.

Cypridea was restricted to fresh-water and oligohaline conditions (<3 mille) at this time, but it also had dessication resistant eggs and was therefore able to colonise ephemeral waters (Whatley, 1990). *Theriosynoecum* and *Darwinula* apparently preferred oligo- and mio- haline conditions (Fig. 10), and although they tolerated salinities up to the lower part of the mesohaline range, they colonised only permanent water bodies. *Mantelliana* was euryhaline, although probably colonised areas only when miohaline salinities had been reached. *Sternbergella cornigera* probably had similar environmental requirements.

At the end of the Barremian and the beginning of the Aptian, ostracod assemblages varied according to the local environmental conditions. For example, in Surrey, *Cypridea* is found together with *Theriosynoecum fittoni* in the upper part of the Weald Clay (Butler, 1922), but in the highest part, within a few metres of the Perna Bed, only *T. fittoni* was recorded. On the northern margin of the Wessex Basin, in the Warlingham Borhole, *Theriosynoecum fittoni* comprises 90% of the uppermost 7m of the Weald Clay Formation and within the topmost 1.5m foraminifera also appear

(Anderson 1971). This would suggest that salinities had passed from fresh-oligohaline to meso- and pliohaline. On the other hand, Anderson (1967, 1985) indicated that *Cypridea* is present, although scarce, in the highest part of the Weald Clay, in Warlingham Borehole and Atherfield, possibly derived from nearby localities where fresh and oligohaline conditions continued.

There is also a suggestion that the introduction of non-*Cypridea* faunas occurred when ephemoral water bodies were replaced by more widespread, permanent, lagoonal waters. The ostracods from the highest part of the Vectis Formation, therefore appear to be heralding the major transgression that was about to engulf the Wessex Basin.

***P. fissicostis* Zone, *P. obsoletus* Subzone**

The Atherfield Bone Bed at the base of the Perna Member (Simpson, 1985), represents a transgressive lag. The remainder of the Perna Member contains evidence of shallow, oligohaline to miohaline conditions, probably associated with the lagoonal and interdistributary bays (Kerth & Hailwood, 1988; Stewart et al., 1991; Hart et al., 1991). The marine incursion into the region took place during the *obsoletum* Subzone, and brought with it both macro and micro faunas which rapidly occupied the newly formed environmental niches. The typical Wealden assemblages were replaced by associations employing new strategies.

The relationship of the earliest Aptian population Sandown Bay, Isle of Wight with that of the Paris Basin (Damotte & Grosdider, 1963; Damotte & Magniez-Janin, 1973; Babinot *et al*., 1985) cannot be mistaken. There are some similarities with the latest Barremian to early Aptian faunas of the Fastnet Basin and Celtic Sea (Ainsworth, 1985, 1986, 1987; Ainsworth et al., 1985, 1987), although *Cytherella* is more abundant, probably due to greater kenoxia. There appears to be little in common with south-eastern France, with the possible exception of a single specimen of a species very closely related to *Protocythere* sp.3 (Babinot et al., 1985) from the Bédoulien of Ardèche. This shallow, near-shore, warm water fauna must have entered the Wessex Basin *via* the Paris Basin, very quickly after the opening of the marine connection during the earliest Aptian, when salinities had edged towards the upper part of the brachyhaline range and fully marine.

***D. forbesi* Zone, *D. fittoni* Subzone**

The Chale Bay Member accumulated in a shallow marine environment which suffered occasional storm events that resulted in the formation of thin silty lags. Ostracods include *Neocythere (N.) gottisi, Neocythere (C.) bordeti, Protocythere croutesensis, Cythereis geometrica, Eocytheropteron stchepinskyi, Schuleridea derooi, Dolocytheridea* cf. *intermedia* and a number of species of *Paranotacythere* including *P. (P.) oertlii* and *P. atypica*. The assemblage is similar to the faunas recovered from the Perna Bed, although *Paranotacythere* is more numerous.

Of those taxa found in the Chale Bay Member, *Schuleridea* is a euryhaline genus that apparently tolerated Pliohaline to fully marine salinities and *Dolocytheridea* could tolerate reduced salinities down to the higher part of the brachyhaline salinity range (Fig. 10). The remaining species, however, are restricted to fully or near marine salinities. *Paranotacythere (P.) oertlii* and *Protocythere mertensi langtonensis,* which appear towards the upper part of the member, are restricted to the shallow marine milieu.

D. forbesi Zone, *D. kiliana* Subzone

According to Insole *et al* (1998), in the Isle of Wight, the upper part of the Atherfield Formation accumulated in shallow, and gradual shallowing, marine conditions, resulting in a general up-section coarsening through the Lower Lobster Bed and an increase in the presence of storm generated deposits. Ostracods are extremely rare in the upper part of the Atherfield Clay Formation around Atherfield, Isle of Wight, and their provenance is uncertain.

D. forbesi Zone, *D. callidiscus* Subzone

Heselbo, Coe & Jenkyns. (1990) considered that the 111 Ma maximum flooding surface (of Haq et al., 1987) could be placed at the Crackers Bed (*callidiscus* Subzone). The Crackers Bed shows a number of breaks in sedimentation resulting in ommission surfaces with scour, fluid escape and slump structures and current alligned macrofossils testifying to the very shallow water environment. The Upper Lobster Beds shows a return of environmental conditions similar to those for the Lower Lobster Bed.

Ostracods are rare in the upper part of the Atherfield Clay Formation of the Isle of Wight: Kaye (1965) mentioned only *Schuleridea sulcata* from the Upper Lobster Member of Atherfield and *Cythereis geometrica* and *Veeniacythereis* sp cf V. *blanda* occur in the Crackers in borehole 75/35. In Sussex, however, ostracods in the *D. callidiscus* Subzone are essentially similar to that of the Chale Bay Member. Species such as *Schuleridea sulcata* are euryhaine (pliohaline to euhaline), while *Dolocytheridea intermedia* can tolerate salinities as low as mid brachyhaline. However, the majority (e.g. species of *Protocythere*, *Cythereis*, *Paranotacythere* and *Asciocythere*) are near marine (upper brachyhaline) to marine (euhaline) taxa.

7. Conclusions

The distribution of Aptian Ostracoda in the shallow water deposits of Britain is dependant on both local and regional factors related to palaeogeography, facies, salinity, temperature, etc.

In the Wessex Basin, the earliest Aptian was a period of rapid transgression, during which time ostracod populations characteristic of oligohaline and miohaline conditions were replaced by brachyhaline and fully marine faunas. Species of genera such as *Cypridea* were replaced by *Mantelliana* and by the *obsoletus* Subzone *Asciocythere*, *Schuleridea*, *Neocythere* and *Cytherelloidea* dominated the faunas. Populations in southern England closely compare with the Paris Basin, showing only slight similarity with the Celtic Sea area to the west. With the opening of the seaway in the earliest Aptian, therefore, species migrating from the south-east appear to have been the most successful. Essentially similar ostracod associations during the late *fissicostis* Zone (obsoletus Subzone) and *forbesi* Zone indicate comparable environmental conditions throughout the Wessex Basin at that time.

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Plate Caption

Ostracoda from the Perna Member (Atherfield Clay Formation) of Sandown Bay, Isle of Wight. All material is housed in the palaeontological collections of the BGS, Keyworth, UK. Bar: 100µm

1. Neocythere (Centerocythere) bordeti, left valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
2. Neocythere (Centrocythere) gottisi, left valve lateral view: from 0.2m above base of the Perna Member (Atherfield Clay Formation).
3. Eocytheropteron stchepinskyi, carapace, right valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
4. Asciocythere albae albae, left valve lateral view; from 0.7m above base of the Perna Member (Atherfield Clay Formation).
5. Asciopcythere albae albae, right valve lateral view;from 0.7m above base of the Perna Member (Atherfield Clay Formation).
6. Schuleridea sulcata, right valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
7. Cythereis (Rehacythereis) geometrica, left valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
8. Platycythereis sp 1, right valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
9. Schuleridea sulcata, left valve lateral view; from 0.7m above base of the Perna Member (Atherfield Clay Formation).
10. Cythereis cf buechlerae, right valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
11. "Protocythere" sp 3 of Babinot et al, 1985, right valve lateral view; from 0.7m above base of the Perna Member (Atherfield Clay Formation).
12. Cythereis cf lamplughi, left valve lateral view; from 1.2m above base of the Perna Member (Atherfield Clay Formation).
13.Protocythere derooi carapace, left valve lateral view; from 0.7m above base of the Perna Member (Atherfield Clay Formation).
14.Protocythere croutesensis, left valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).
15. Cytherelloidea sp nov., left valve lateral view; from 0.2m above base of the Perna Member (Atherfield Clay Formation).

Figure Captions

Fig. 1. Sketch map of the Wessex Basin to show localities discussed in the text.

Fig. 2. Early Aptian stratigraphy in the Wessex Basin together with the ranges of selected, biostratigraphically useful species. (D.d. *Deshayesites deshayesi* Zone; ABB Atherfield Bone Bed)

Fig. 3. Distribution of ostracoda in the earliest Aptian at Atherfield, Isle of Wight. For lithological key, see Fig. 6.

Fig. 4. Distribution of ostracoda in the earliest Aptian at Sandown, Isle of Wight. For lithological key, see Fig. 6.

Fig. 5. Distribution of ostracoda in the Atherfield Clay Formation in BGS borehole 75/35. For lithological key, see Fig. 6.

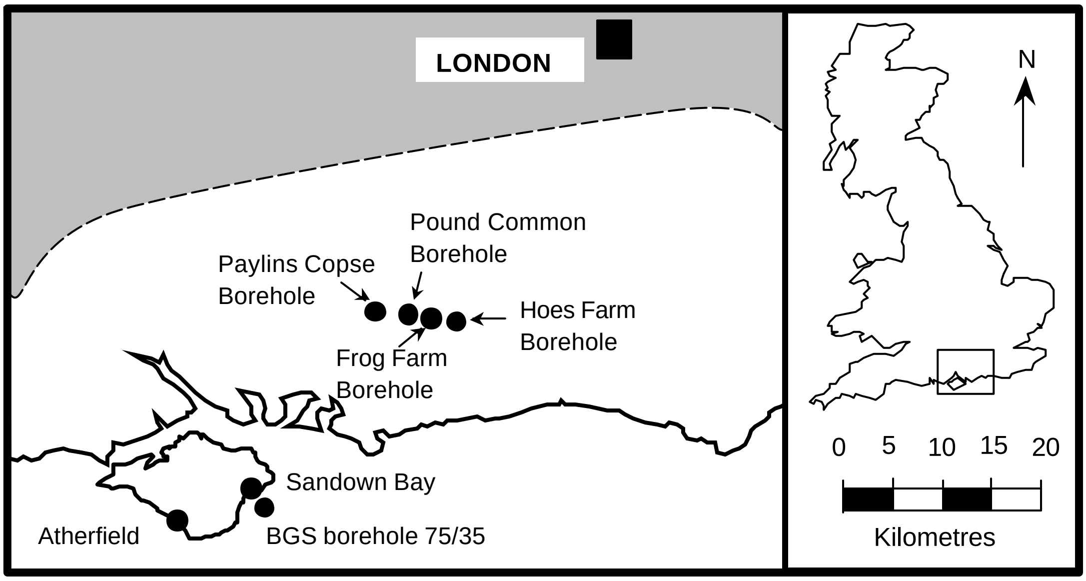
Fig. 6. Distribution of ostracoda in the Atherfield Clay Formation in Paylins Copse Borehole, Sussex.

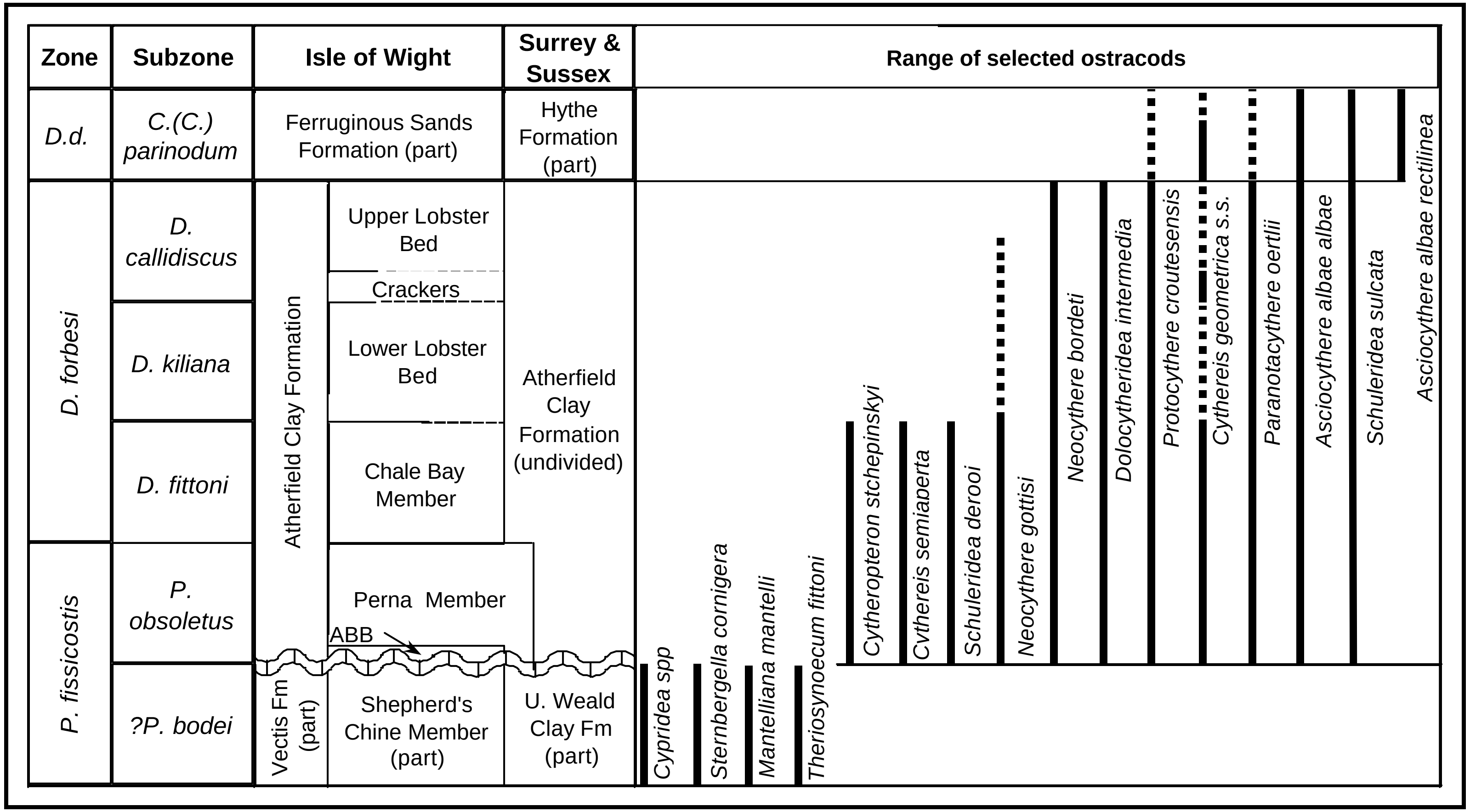
Fig. 7. Distribution of ostracoda in the Atherfield Clay Formation in Pound Common Borehole, Sussex. For lithological key, see Fig. 6.

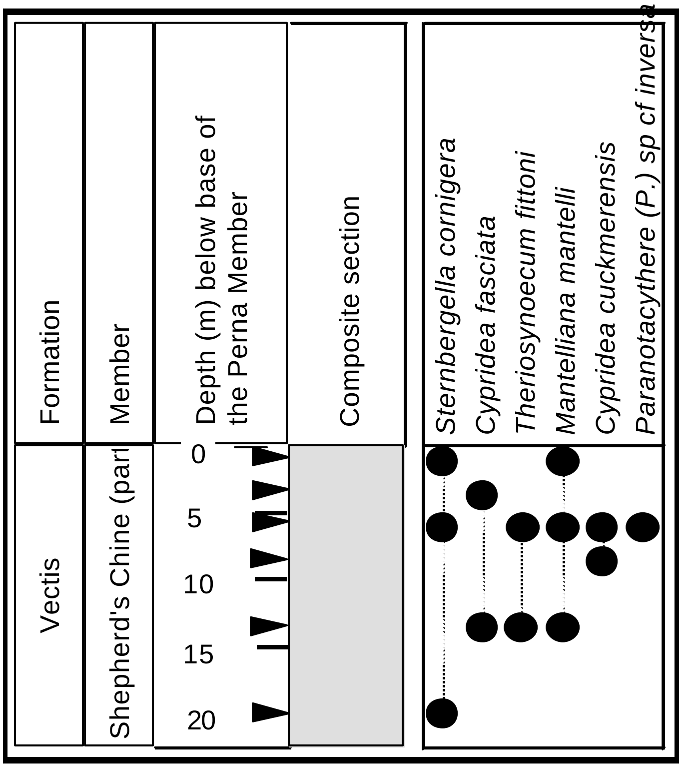
Fig. 8. Distribution of ostracoda in the Atherfield Clay Formation in Frog Farm Borehole, Sussex. For lithological key, see Fig. 6.

Fig. 9. Distribution of ostracoda in the Atherfield Clay and basal Hythe formations in Hoes Farm Borehole, Sussex. For lithological key, see Fig. 6.

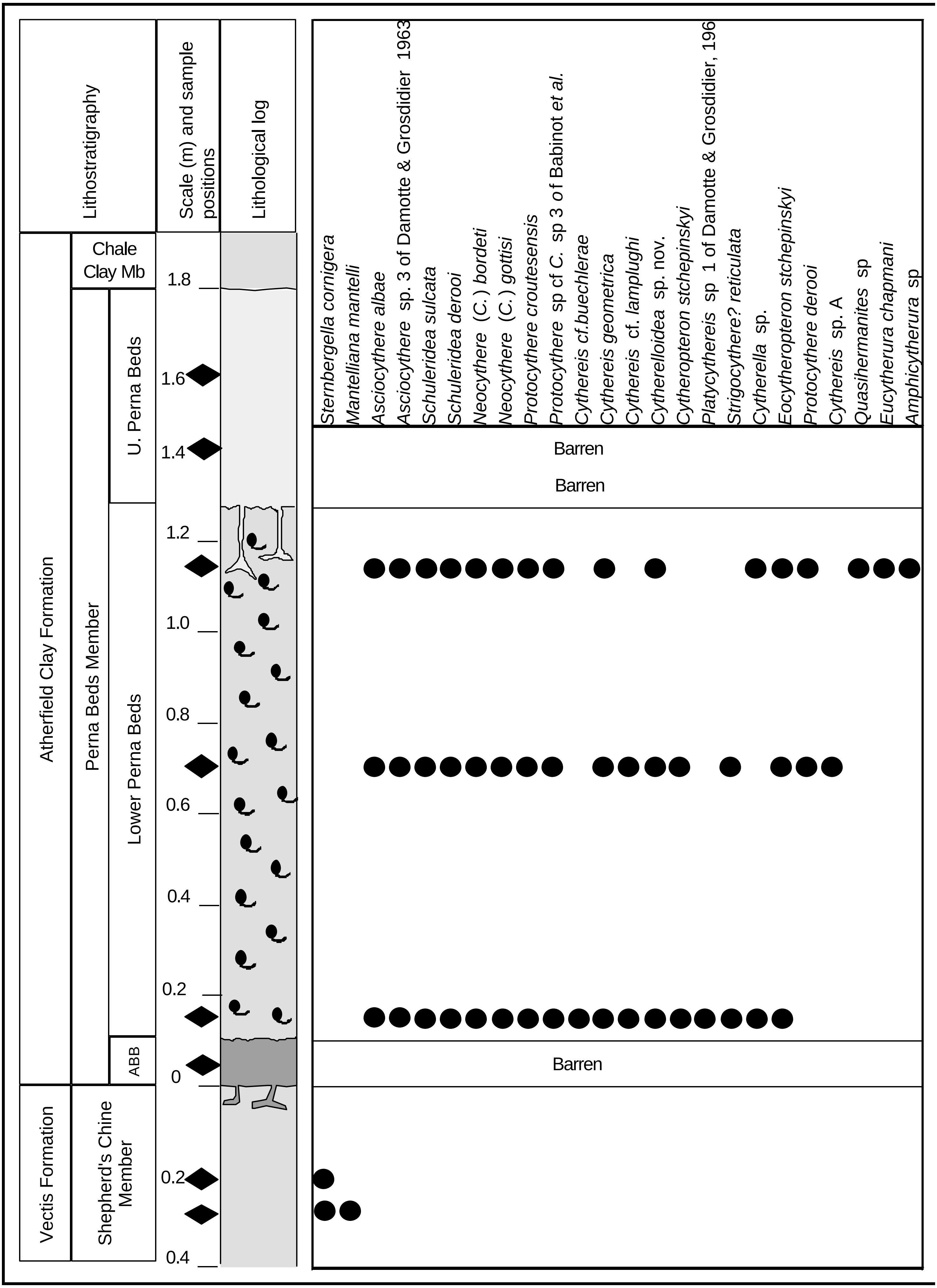
Fig. 10. Suggested relationship between ostracod genera and salinity in the early Aptian of the Wessex Basin.

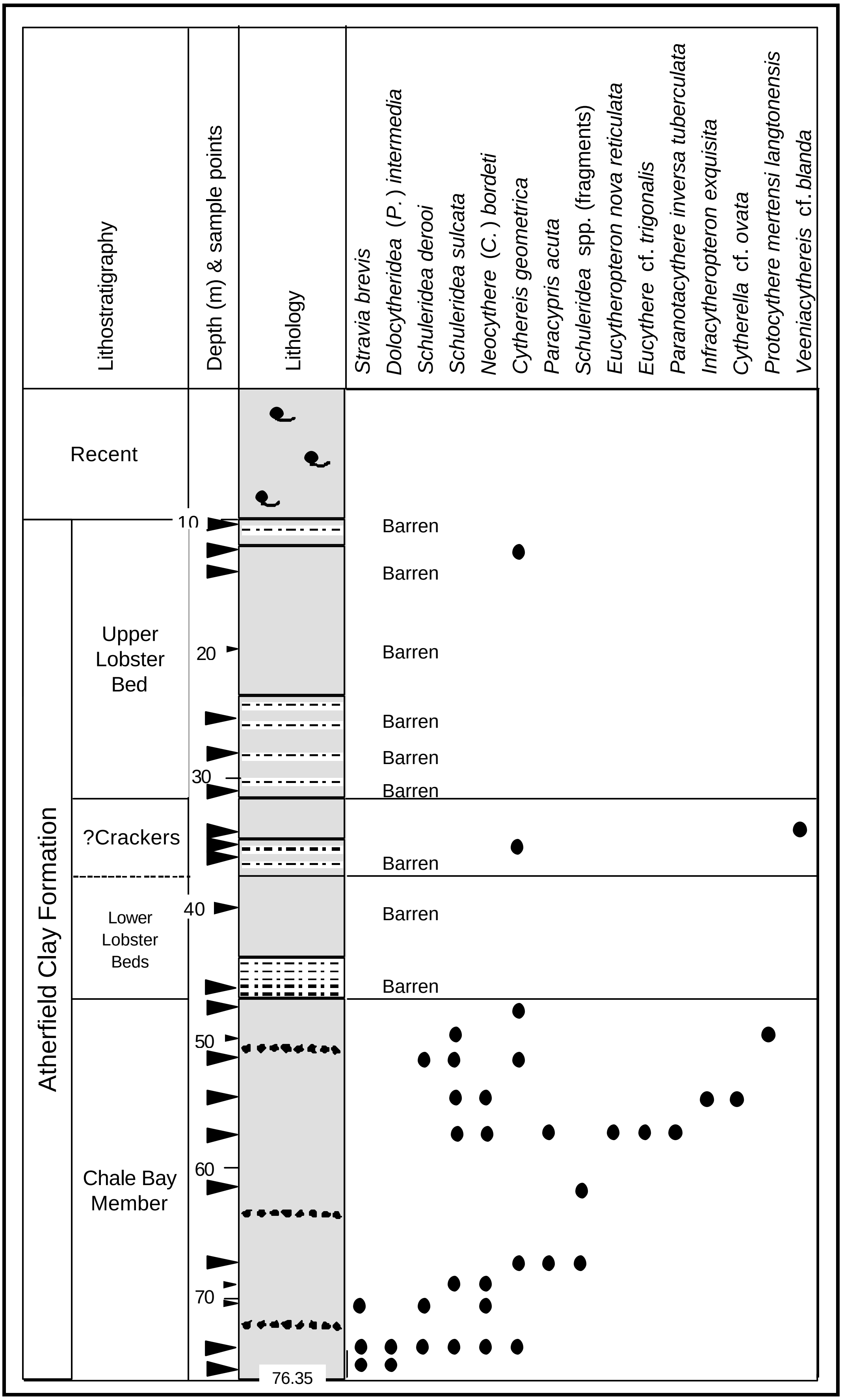

LONDON
Pound Common
Borehole
Paylins Copse
Borehole
Hoes Farm
Borehole
Frog Farm
Borehole
Sandown Bay
Atherfield
BGS borehole 75/35
N
0
5
10
15
20
Kilometres

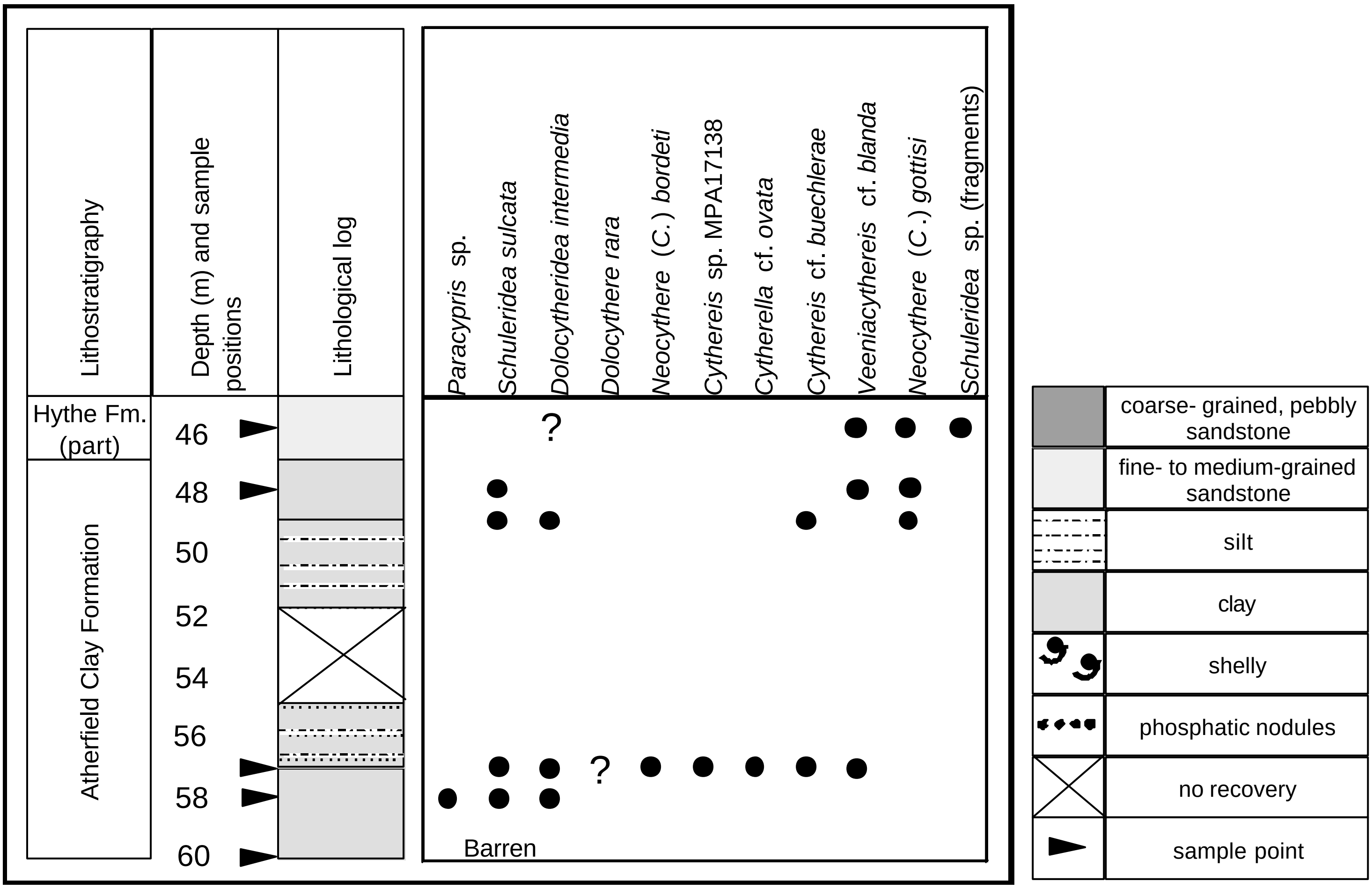

Zone
Subzone
Isle of Wight
Surrey & Sussex
Range of selected ostracods
D.d.
C.(C.) parinodum
Ferruginous Sands Formation (part)
Hythe Formation (part)
D. forbesi
D. callidiscus
D. kiliana
D. fittoni
P. fissicostis
P. obsoletus
?P. bodei
Atherfield Clay Formation
Upper Lobster Bed
Crackers
Lower Lobster Bed
Chale Bay Member
Perna Member
ABB
Vectis Fm (part)
Shepherd's Chine Member (part)
Atherfield Clay Formation (undivided)
U. Weald Clay Fm (part)
Cypridea spp
Sternbergella cornigera
Mantelliana mantelli
Theriosynoecum fittoni
Cytheropteron stchepinskyi
Cythereis semiaperta
Schuleridea derooi
Neocythere gottisi
Neocythere bordeti
Dolocytheridea intermedia
Protocythere croutesensis
Cythereis geometrica s.s.
Paranotacythere oertlii
Asciocythere albae albae
Schuleridea sulcata
Asciocythere albae rectilinea

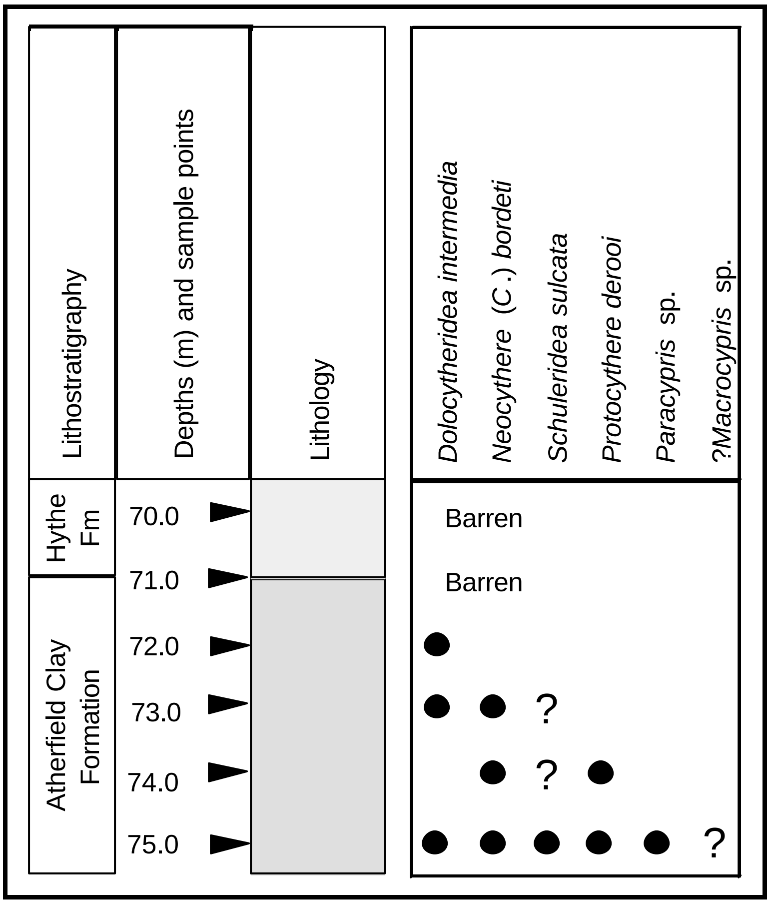


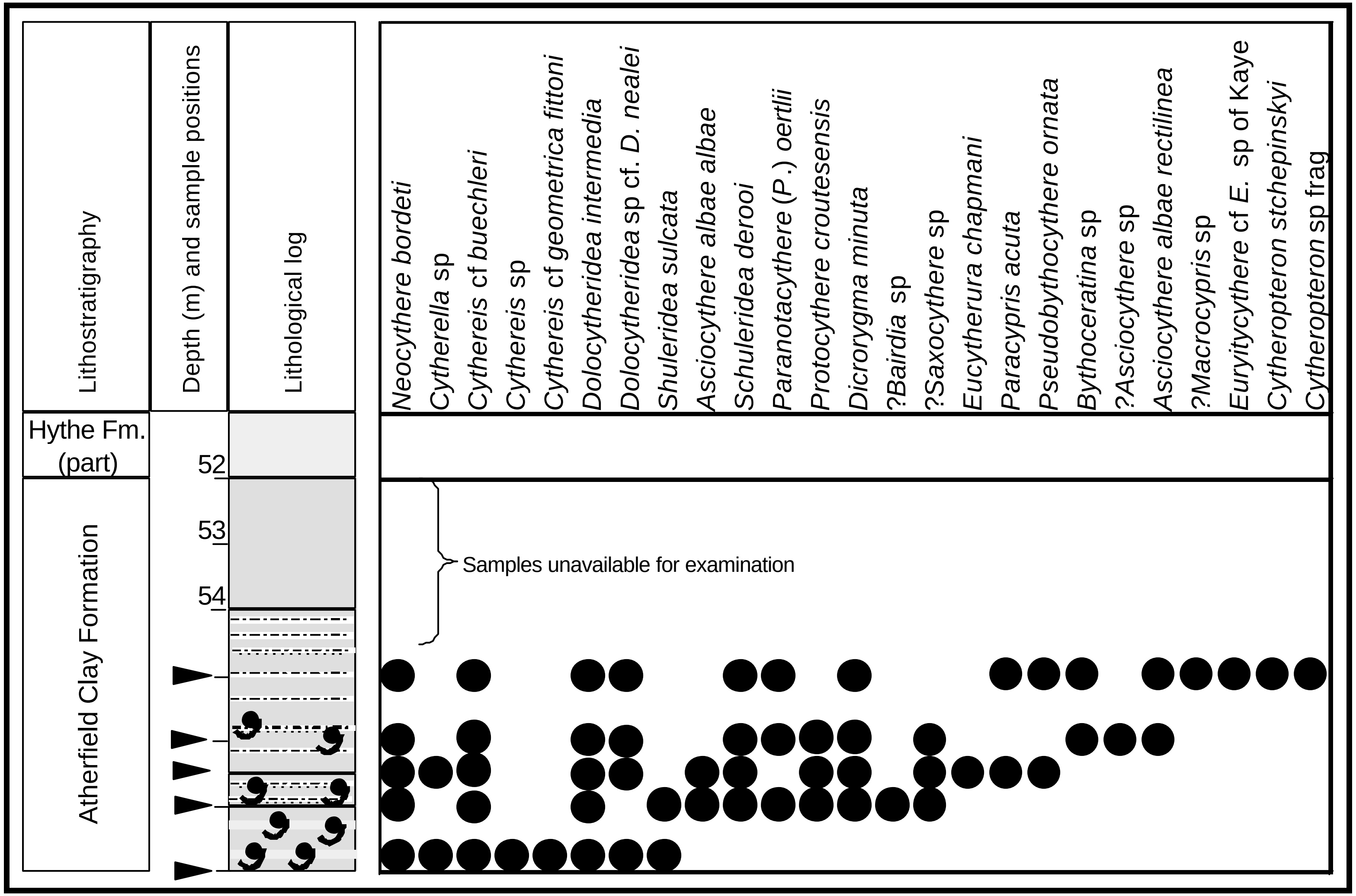
Formation
Member
Depth (m) below base of the Perna Member
Composite section
Sternbergella cornigera
Cypridea fasciata
Theriosynoecum fittoni
Mantelliana mantelli
Cypridea cuckmerensis
Paranotacythere (P.) sp cf inversa
Vectis
Shepherd's Chine (part
0
5
10
15
20

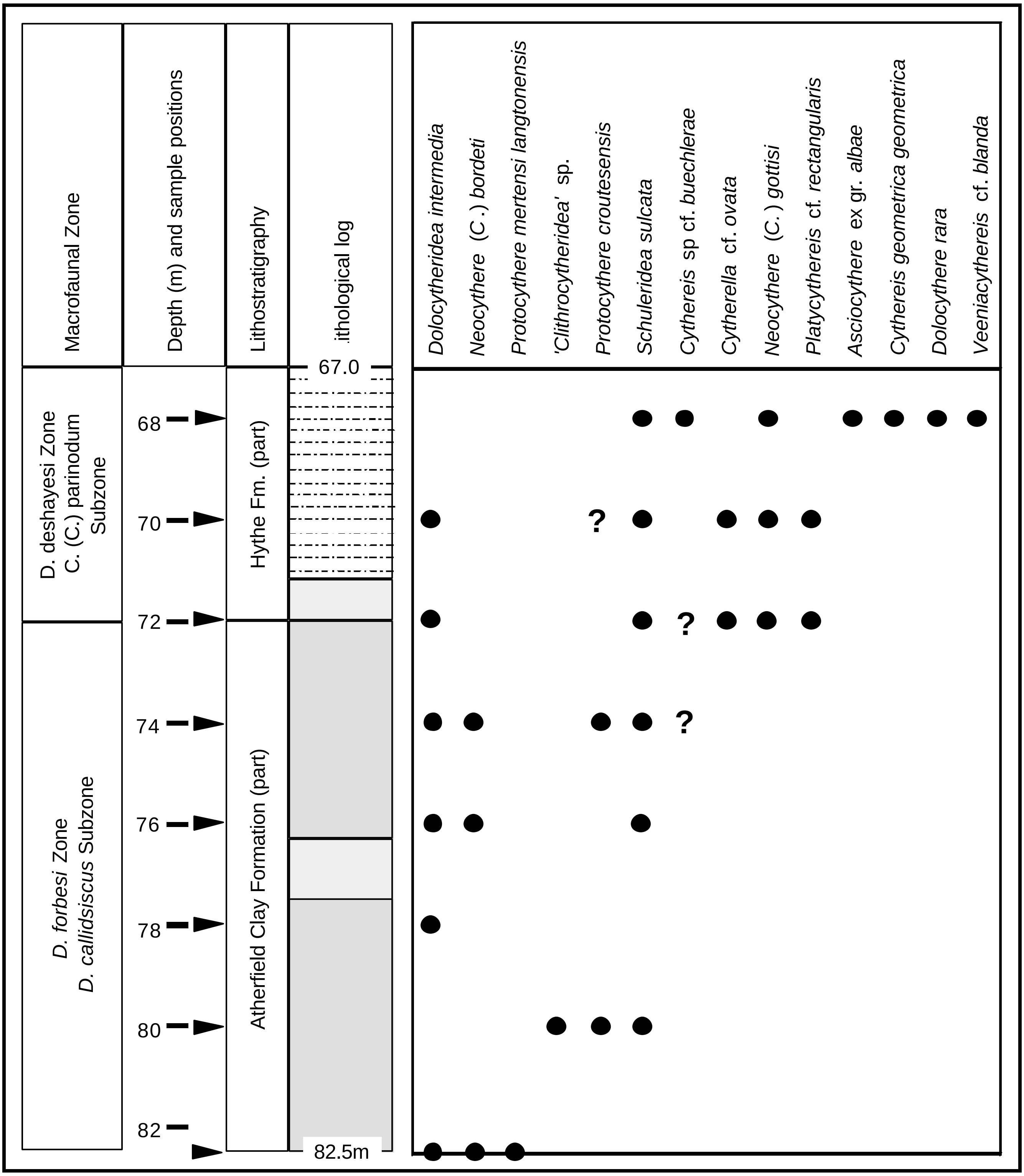

Lithostratigraphy
Scale (m) and sample positions
Lithological log
Atherfield Clay Formation
Chale Clay Mb
Perna Beds Member
U. Perna Beds
Lower Perna Beds
ABB
Vectis Formation
Shepherd's Chine Member
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
Sternbergella cornigera
Mantelliana mantelli
Asciocythere albae
Asciocythere sp. 3 of Damotte & Grosdidier 1963
Schuleridea sulcata
Schuleridea derooi
Neocythere (C.) bordeti
Neocythere (C.) gottisi
Protocythere croutesensis
Protocythere sp cf C. sp 3 of Babinot et al.
Cythereis cf.buechlerae
Cythereis geometrica
Cythereis cf. lamplughi
Cytherelloidea sp. nov.
Cytheropteron stchepinskyi
Platycythereis sp 1 of Damotte & Grosdidier, 196
Strigocythere? reticulata
Cytherella sp.
Eocytheropteron stchepinskyi
Protocythere derooi
Cythereis sp. A
Quasihermanites sp
Eucytherura chapmani
Amphicytherura sp
Barren
Barren
Barren

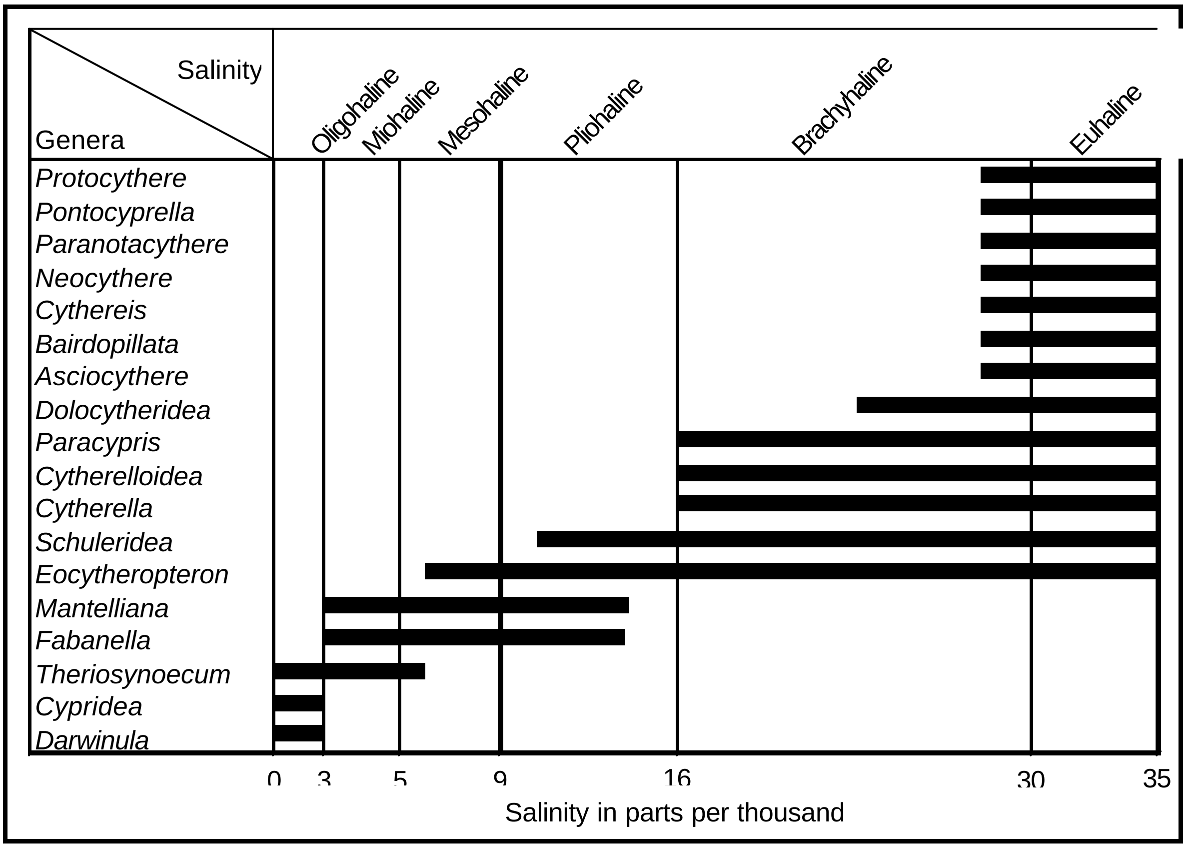

Lithostratigraphy
Depth (m) & sample points
Lithology
Stravia brevis
Dolocytheridea (P.) intermedia
Schuleridea derooi
Schuleridea sulcata
Neocythere (C.) bordeti
Cythereis geometrica
Paracypris acuta
Schuleridea spp. (fragments)
Eucytheropteron nova reticulata
Eucythere cf. trigonalis
Paranotacythere inversa tuberculata
Infracytheropteron exquisita
Cytherella cf. ovata
Protocythere mertensi langtonensis
Veeniacythereis cf. blanda
Recent
Atherfield Clay Formation
Upper Lobster Bed
?Crackers
Lower Lobster Beds
Chale Bay Member
10
20
30
40
50
60
70
76.35
Barren

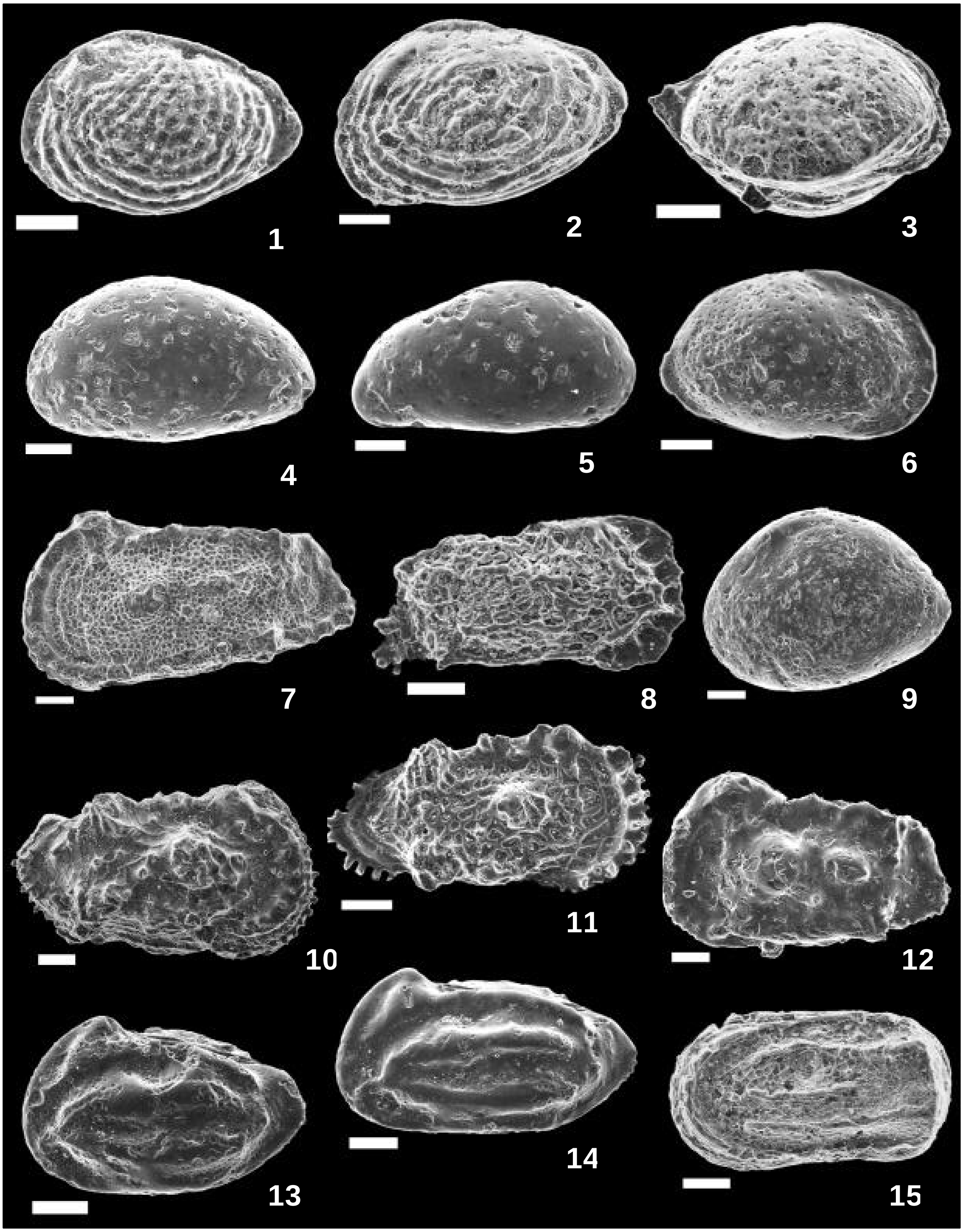

Lithostratigraphy
Depth (m) and sample positions
Lithological log
Paracypris sp.
Schuleridea sulcata
Dolocytheridea intermedia
Dolocythere rara
Neocythere (C.) bordeti
Cythereis sp. MPA17138
Cytherella cf. ovata
Cythereis cf. buechlerae
Veeniacythereis cf. blanda
Neocythere (C.) gottisi
Schuleridea sp. (fragments)
Hythe Fm. (part)
Atherfield Clay Formation
46
48
50
52
54
56
58
60
?
?
Barren
coarse- grained, pebbly sandstone
fine- to medium-grained sandstone
silt
clay
shelly
phosphatic nodules
no recovery
sample point


Lithostratigraphy
Depths (m) and sample points
Lithology
Dolocytheridea intermedia
Neocythere (C.) bordeti
Schuleridea sulcata
Protocythere derooi
Paracypris sp.
?Macrocypris sp.
Hythe Fm
Atherfield Clay Formation
70.0
71.0
72.0
73.0
74.0
75.0
Barren
Barren


Lithostratigraphy
Depth (m) and sample positions
Lithological log
Neocythere bordeti
Cytherella sp
Cythereis cf buechleri
Cythereis sp
Cythereis cf geometrica fittoni
Dolocytheridea intermedia
Dolocytheridea sp cf. D. nealei
Shuleridea sulcata
Asciocythere albae albae
Schuleridea derooi
Paranotacythere (P.) oertlii
Protocythere croutesensis
Dicrorygma minuta
?Bairdia sp
?Saxocythere sp
Eucytherura chapmani
Paracypris acuta
Pseudobythocythere ornata
Bythoceratina sp
?Asciocythere sp
Asciocythere albae rectilinea
?Macrocypris sp
Euryitycythere cf E. sp of Kaye
Cytheropteron stchepinskyi
Cytheropteron sp frag
Hythe Fm. (part)
Atherfield Clay Formation
52
53
54
Samples unavailable for examination


Macrofaunal Zone
Depth (m) and sample positions
Lithostratigraphy
Lithological log
D. deshayesi Zone
C. (C.) parinodum
Subzone
D. forbesi Zone
D. callidsiscus Subzone
Hythe Fm. (part)
Atherfield Clay Formation (part)
67.0
82.5m
68
70
72
74
76
78
80
82
Dolocytheridea intermedia
Neocythere (C.) bordeti
Protocythere mertensi langtonensis
'Clithrocytheridea' sp.
Protocythere croutesensis
Schuleridea sulcata
Cythereis sp cf. buechlerae
Cytherella cf. ovata
Neocythere (C.) gottisi
Platycythereis cf. rectangularis
Asciocythere ex gr. albae
Cythereis geometrica geometrica
Dolocythere rara
Veeniacythereis cf. blanda
?
?
?


Salinity
Genera
Oligohaline
Miohaline
Mesohaline
Pliohaline
Brachyhaline
Euhaline
Protocythere
Pontocyprella
Paranotacythere
Neocythere
Cythereis
Bairdopillata
Asciocythere
Dolocytheridea
Paracypris
Cytherelloidea
Cytherella
Schuleridea
Eocytheropteron
Mantelliana
Fabanella
Theriosynoecum
Cypridea
Darwinula
0
3
5
9
16
30
35
Salinity in parts per thousand


1
2
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4
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11
12
13
14
15