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Abstract: ABSTRACT Augering to the east of Newport has proved the presence of the 'Variolarius Bed' at the top of the Selsey Sand Formation. As well as its characteristic flood of the foraminifer Nummulites variolarius it contains a biostratigraphically useful ostracod assemblage, characterised by dominant Leguminocythereis haskinsi and subdominant Cytherella dixoni, with less numerous Cytheridea rigida, Oertliella aculeata, Cytheretta forticosta and Pterygocythereis cornuta.

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Editor
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Dear Sir

I am submitting a corrected manuscript for the Themed Set of papers on the Isle of Wight. The title of the paper is 'The variolarius Bed near Newport, Isle of Wight and its ostracod assemblage'. I have corrected all points brought up by the referee and thank him/her for the time and attention they have given making this a better manuscript.

Regarding the use of 'Selsey Sand Formation', the BGS includes the lithological epithet within the name, so I have not changed it here.

Several of the referee's comments appear to have resulted from differences in the lithostratigraphy used. I have therefore included an additional figure outlining the most recent lithostratigraphy as presented by King (2006).

Yours sincerely

Ian Wilkinson

The 'Variolarius Bed' near Newport, Isle of Wight, and its ostracod assemblage

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ABSTRACT Augering to the east of Newport, Isle of Wight, has proved the presence of the 'Variolarius Bed' at the base of the Barton Clay Formation. As well as its characteristic flood of the foraminifer *Nummulites variolarius* it contains a biostratigraphically useful ostracod assemblage, characterised by dominant *Leguminocythereis haskinsi* and subdominant *Cytherella dixoni,* with less numerous *Cytheridea rigida, Oertliella aculeata, Cytheretta forticosta* and *Pterygocythereis cornuta*.

Key words: 'Variolarius Bed', Eocene, ostracods, biostratigraphy

INTRODUCTION

The coastal sections on the Isle of Wight at Whitecliff Bay and Alum Bay provide some of the best exposures of Upper Paleocene to Upper Eocene clays and sands in Britain. However, although the Paleogene sequence has been mapped inland, there are few exposures or sections, in part due to its very steep or vertical dip, and mapping is based mostly on auger traverses. The currently available 1:50 000 scale geological map of the Isle of Wight is based on original field surveys at 1:10 560 scale during 1886 and 1887. During the re-survey by the British Geological Survey (2007-2010), the Paleogene succession was subject to detailed auger traverses at several places along its outcrop. Two auger traverses in the Newport area identified the 'Variolarius Bed', which was included within the 'Bagshot Beds' on the published 1:50,000 geological map (Institute of Geological Sciences, 1976).

The micro- and meiofaunas from the small auger samples proved to be of low diversity. However, the 'Variolarius Bed', which is characterized by the presence of abundant *Nummulites variolarius,* was identified 150 m south-east of Great Pan Farm, [SZ 50775 88529], 1 km south-east of the centre of Newport (Fig. 1a) and 150 m south-west of Combley Farm [SZ 54316 87825], 1.5 km north-east of Arreton (Fig. 1b). In addition to the distinctive foraminiferal assemblages, ostracods were present in sufficient numbers to relate the fauna to the biozonation erected by Keen (1978). Although the small bivalves and gastropods present

in the auger samples were not examined in detail for the present study, it is worth noting the presence of filter feeding (*Ostrea*), infaunal suspension feeding (*Nemocardium* and *Corbula*) and epifaunal suspension feeding (*Lentipecten*) bivalves and the vagile, carnivorous gastropod (*Turritella*).

STRATIGRAPHY

Lithostratigraphy. The Bracklesham Group of the Isle of White is lithologically diverse, comprising seven formations deposited in lagoonal, estuarine and shallow open shelf environments (Insole & Daley,1985; Plint 1984, 1988; Huggett & Gale 1997; Insole et al., 1998; Gale et al., 1999; King 2006) (Fig. 2). There have been several interpretations regarding the position of the boundary between the Selsey Sand Formation and the overlying Barton Clay Formation. Edwards & Freshney (1987) placed the top of the Selsey Sand Formation between Beds XVI and XVII of Whitecliff Bay (sensu Fisher, 1862). However, Insole et al. (1998) placed the top of their transgressive/regressive cycle 4 (and top of the Selsey Sand Formation) at the upper boundary of the "Nummulites variolarius Bed" (i.e. at the top of bed XVII). King (2006) placed the base of the Barton Clay at the base of the 'Huntingbridge Beds' (which equate with Beds XVIII and XIX of Fisher, 1862) and recognised a sequence boundary.

The 'Variolarius Bed' has been described as a 'seagrass meadow' facies in a shallow warm marine milieu (Curry, 1965; Murray & Wright, 1974). It comprises yellow-brown glauconitic, sandy clay, similar to the 0.51 m thick bed L11iii of Kemp (1985), at Lee-on-the-Solent. On the Isle of Wight, the 'Variolarius Bed' is best known at Whitecliff Bay (e.g. Fisher, 1862) and although it has also been recorded at Gunville (west of Newport) and Afton (near Freshwater Bay) (Curry, 1942) it has not been observed in the section at Alum Bay.

Biostratigraphy. Murray and Wright (1974) and Murray *et al*. (1989) recorded a diverse assemblage of benthonic foraminifera from the Eocene of theIsle of Wight and summarised their stratigraphical importance and geographical distribution. The stratigraphical distribution of the main forms of *Nummulites* was described by Fisher (1862) and this was extended onto the English mainland by Murray & Wight (1974) and Todd (1990). To some extent the distribution of the genus has been affected by reworking during the inversion associated with the formation of the Sandown pericline (Gale, et al., 1999). However, the 'Variolarius Bed' has been observed at, for example, Studley Wood (Todd, 1990); the 'Clibs.' at Selsey (Gardner et al., 1888); at Lee-on-the-Solent (Kemp, 1985); as well as on the Isle of Wight (e.g. Fisher 1862; Curry, 1942; Murray & Wright, 1974). Although small, the auger samples

collected during the present re-survey yielded low diversity ostracod faunas, the presence of *Nummulites variolarius* in flood proportion provides ample evidence of the 'Variolarius Bed' (Fisher's Bed XVII) (Fig. 3).

OSTRACODA

Augering provided only small samples that yielded low diversity faunas (Table 1), compared to those recorded by Keen (1978) and Lord et al. (2009). Despite the low diversity, the taxa recovered can be placed in a biostratigraphical context.

Cytheridea rigida (Fig. 4 a-b) appears to have evolved from *Cytheridea primitia* during the late Lutetian (Haskins, 1969; Keen, 1978) and the presence of intermediate forms in Fisher Bed IX of Whitecliff Bay were recorded by Keen (1978). However the species, sensu stricto, with its punctate carapace, three antero-marginal ribs and postero-ventral node, did not appear until Bed XI equivalent at Selsey. Keen (1978) used it first appearance to define the base of his ostracod zone 9 (Fig. 3). It is closely related to *Cytheridea punctata*, but can be differentiated on the basis of ornamentation and size. These two taxa were originally given subspecific ranking, but are considered to be distinct species herein. The stratigraphically youngest record of *Cytheridea rigida* is from Bed XVII.

Cytheretta forticosta is a biostratigraphically useful species being both a characteristic morphology and restricted vertical distribution. The left and right valves differ considerably in outline (Fig. 4 c-d), but both have a distinctively arched, swollen, dorsal margin; an obliquely disposed longitudinal rib-like swelling; and a ventral complex of riblets. The species has been found in Bed XVII (and possibly the lateral equivalent of Fisher Bed XVIII) at Whitecliff Bay, Selsey, Bramshaw and Le Ruel (France) (Keen, 1972), in ostracod zones 9 and 10 of Keen (1978). Higher in the Bartonian, in Ostracod Zone 11, it evolved into *C. laticosta*.

Cytherella dixoni (Fig. 4 e-f) also first appears in Bed XVII in Whitecliff Bay, and ranges up into the "Huntingbridge Beds" of the Barton Clay Formation in the Hampshire Basin (Keen, 1978, fig. 6), although it has not been recorded in Alum Bay, on the western end of the Isle of Wight. Sexual dimorphism is pronounced in this species with the female being ovate and the male more elongate and narrower towards the posterior; characteristics that were misinterpreted by Jones & Sherborn (1887, 1889) as pointed out by Haskins (1968a). Its first appearance is a useful marker for the upper part of ostracod Zone 9 (Keen, 1978 fig. 6).

Pterygocythereis cornuta (Fig. 4 g-h) is a long-ranging species; the stratigraphically oldest record is Ypresian and it continues up into the late Bartonian (Keen, 1978; Lord et al.,

2009). Roemer's (1838) original species concept is not clear as the type figure is too stylised to be of taxonomic value. However, there is considerable variation in outline and in the details of the ornamentation (cf. Haskins, 1968b; Keen, 1978, Bossio et al., 2006; Lord et al., 2009). Even within the Variolarius Bed of the Isle of Wight there are variations, although this may be due to preservation: fig. 4 g shows anastomosing riblets in the postero-dorsal area, whereas the specimen in Fig. 4 h is smooth.

Echinocythereis scabropapulosa, represented in the auger holes by two poorly preserved specimens, also first appears in Bed XVII (in the upper part of ostracod Zone 9) and ranges up into the "Huntingbridge Beds" (lower Barton Clay Formation) in the Hampshire Basin (Keen, 1978, fig. 6.).

Of the remainder, the presence of *Leguminocythereis haskinsi* (Fig. 4 i-j) in large numbers is worthy of note because the present record extends the range of this species. Keen (1978) showed its range to be confined to his *Cytheretta laticosta* Zone (Zone 11) (in the Bartonian), however, its presence here suggests that it first evolved during the late Lutetian. *Oertliella aculeata* (Fig. 4 k-l) is a long ranging species that has been recorded throughout much of the Eocene of Britain (Lord et al., 2009) and Haskins (1971) recorded it (as *Trachyleberis aculeata*) in the London Clay, Bracklesham Beds of Whitecliff Bay and in the Barton Beds of Alum Bay. *Loxoconcha* cf. *curryi* is represented by a single juvenile valve so that its identification is only tentatively attempted here.

Although the ostracod assemblages recovered from the small auger samples are low in diversity, they are sufficiently characteristic to recognise Zone 9 (the *Cytheridea rigida* Zone) sensu Keen (1979). In addition, the appearance of species such as *Cytheretta forticosta*, *Cytherella dixoni* and *Echinocythereis scabropapulosa* in Bed XVII suggests that an upper subzone can be defined.

CONCLUSIONS

The 'Variolarius Bed' (Fisher Bed XVII) is known from Whitecliff Bay, the Newport area and Afton, near Freshwater, although it has not been recognised in Alum Bay. Near Newport it comprises a yellow-brown glauconitic, fossiliferous sandy clay, lithologically similar to Bed L11iii at Lee-on-the-Solent, Hampshire (Kemp, 1985). Only small auger samples were available in the present study, but they were found to contain biostratigraphically important, flood occurrences of *Nummulites variolarius*, together with low diversity ostracod assemblages characterised by *Cytheridea rigida, Cytherella dixoni, Echinocythereis scabropapulosa, Cytheretta forticosta, Leguminocythereis haskinsi*, *Oertliella aculeata* and

Pterygocythereis cornuta. This ostracod assemblage is characteristic of the late Lutetian and Zone 9 (the *Cytheridea rigida* Zone) sensu Keen (1978), although the assemblages are sufficiently different from the faunas in the lower part of the zone to suggest subdivision into subzones is possible.

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Figure Captions

Fig. 1. Geological maps to the area south of Newport, Isle of Wight showing the auger localities of the 'Variolarius Bed' at **a.** Great Pan Farm and **b.** Combley Farm. Inset: The area around the Solent showing localities mentioned in the text.

Fig. 2 The Lithostratigraphy of the Lutetian succession of the Isle of Wight (modified from King, 2006). Not to scale.

Fig. 3. The distribution of biostratigraphically important foraminifera and ostracods in the Variolarius Bed.

Fig. 4. Characteristic ostracods of the 'Variolarius Bed'near Newport, Isle of Wight. Specimens illustrated are from Combley Farm, Arreton, except e-f and k-l, which are from Great Pan Farm, Newport. Figured specimens are deposited in the biostratigraphical collections of the British Geological Survey, Nottingham, UK. Bars: 300 µ.
a-b. ***Cytheridea rigida*** **Haskins, 1969**. a. Right valve lateral view, MPK14111. b Left valve lateral view, MPK14112. **c-d.** ***Cytheretta forticosta*** **Keen 1972**. c. Right valve lateral view, MPK14113. d. Left valve lateral view, MPK14114. **e-f.** ***Cytherella dixoni*** **Jones & Sherborn, 1887**. e., Right valve lateral view, female, MPK14115. f. Left valve lateral view, female, MPK14116. **g-h.** ***Pterygocythereis cornuta*** **(Roemer, 1838).** g. Right valve lateral view, MPK14117. h. Left valve lateral view, MPK14118. **i-j.** ***Leguminocythereis haskinsi*** **Keen, 1978**. i. Right valve lateral view, MPK14119. j. Left valve lateral view, MPK14120. **k-l.** ***Oertliella aculeata*** **(Bosquet, 1852).** k. Right valve lateral view, MPK14121. l. Left valve lateral view, MPK14122.

Table Caption

Table 1. Ostracoda recorded from auger samples near Newport, Isle of Wight.

Table

1. Great Pan Farm	Just 59 specimens were recovered comprising *Leguminocythereis haskinksi* (62.7%), *Cytherella dixoni* (22%), *Oertliella aculeata* (13.6%) and a fragment of *Echinocythereis scabropapulosa* (1.7%).
2. Combley Farm	The richer and more diverse ostracod assemblage comprised 94 specimens: *Leguminocythereis haskinsi* (45.7%), *Cytheridea rigida* (20.2%), *Cytherella dixoni* (16%), *Cytheretta forticosta* (8.5%), *Pterygocythereis cornuta* (5.5%), *Echinocythereis scabropapulosa* (1.1%), *Loxoconcha curryi?* (single juvenile) (1.1%) and *Oertliella aculeate* (1.1%).

Table 2

Figure

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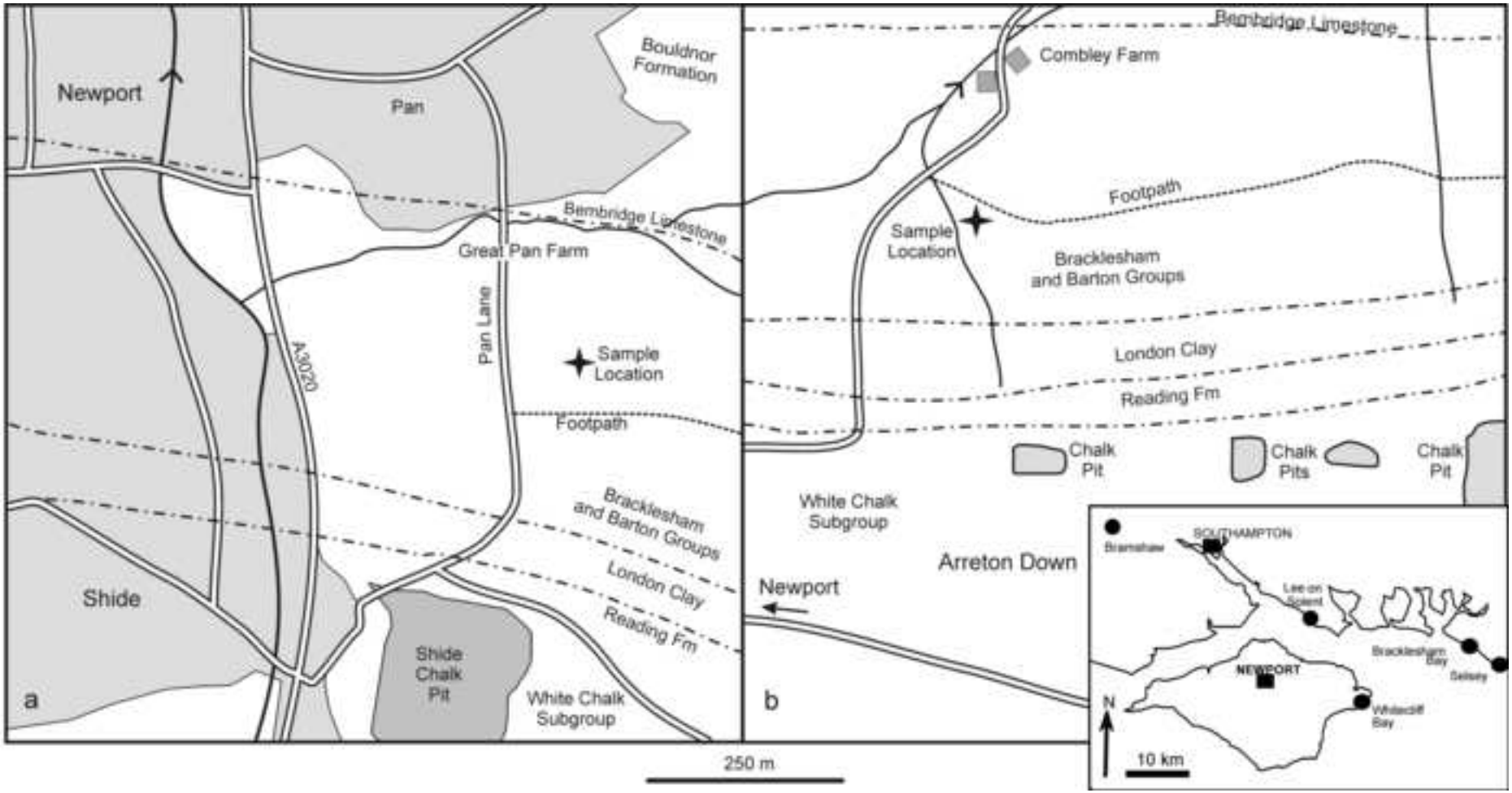

Figure

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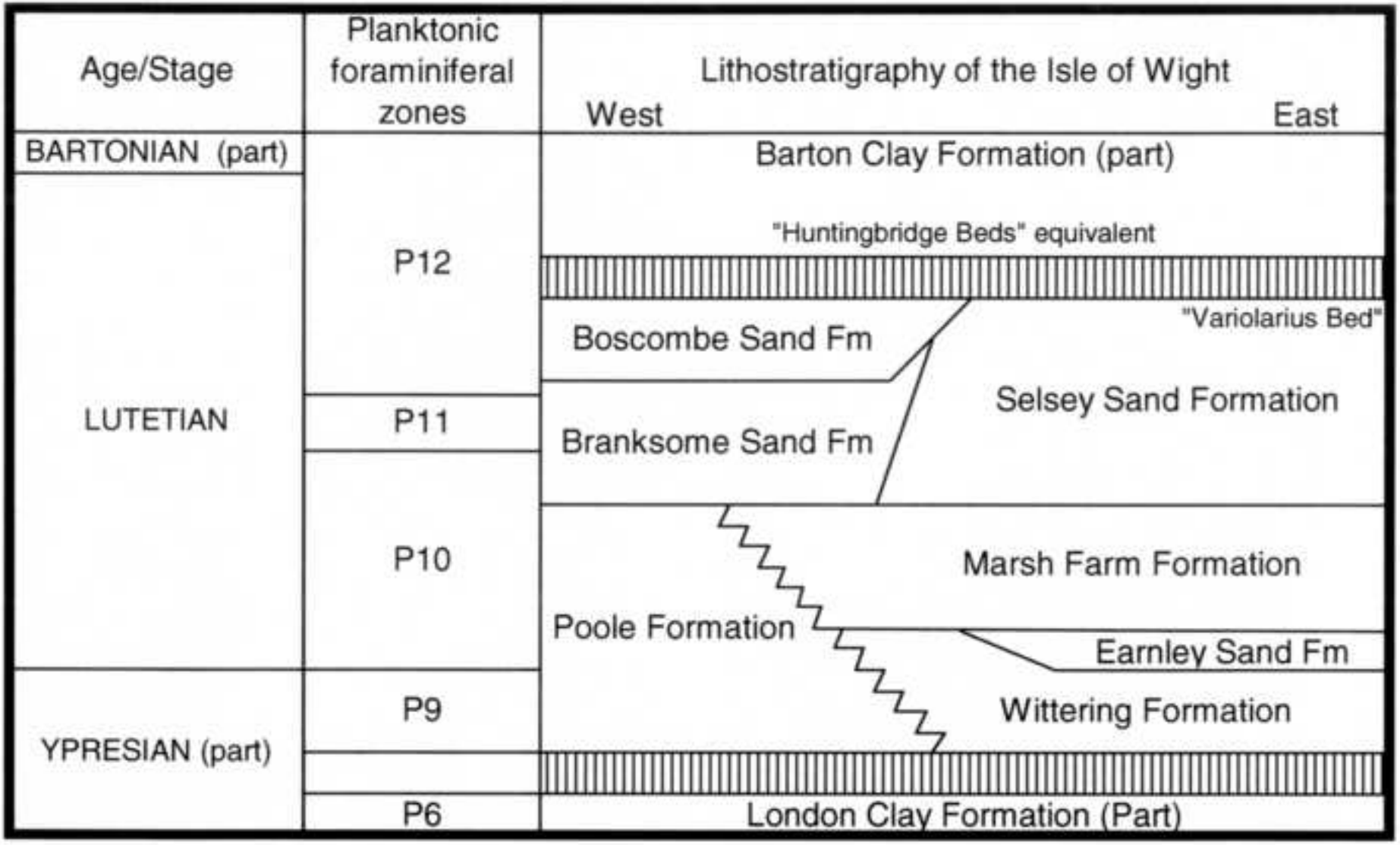

Figure

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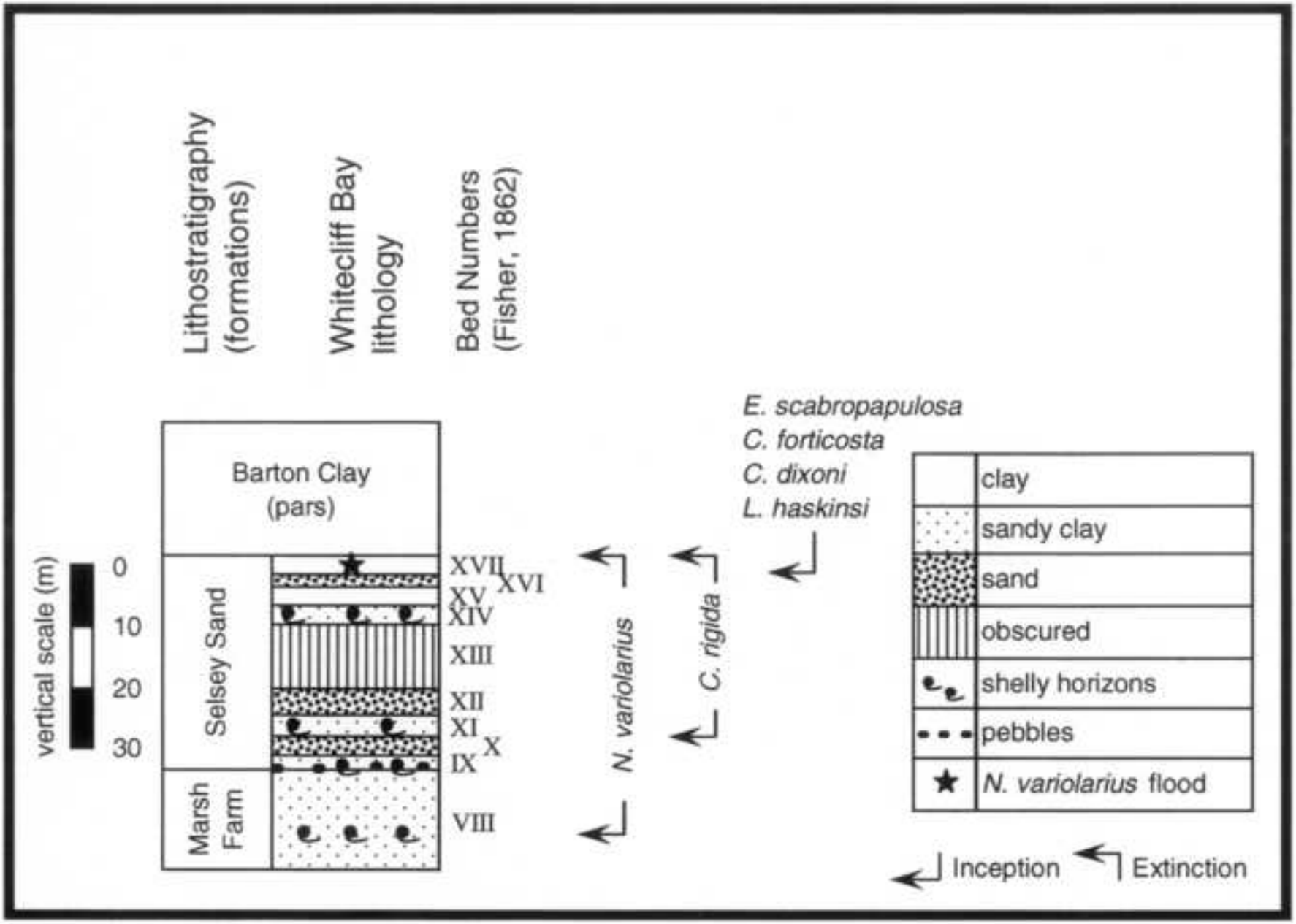

Figure

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