



Re-excavation and Interpretation of Key Sections in the Purbeck Group (Tithonian-Berriasian): Teffont Evias, Vale of Wardour, Wiltshire, England

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Abstract

The largely non-marine Tithonian-Berriasian (terminal Jurassic–basal Cretaceous) Purbeck Group of the Vale of Wardour, Wiltshire, western England, was well exposed during the nineteenth century and yielded numerous fossils, notably a rich insect fauna from fine-grained micrites of lagoonal origin. In early 2025, re-excavation of the Teffont Evias Lane Cutting and Quarry Site of Special Scientific Interest (around the boundary of the Lulworth and Durlston formations) allowed re-examination of a key part of the succession for its stratigraphy, paleontology and paleoenvironmental interpretation. Current interpretation of the Teffont Evias sections is summarized, with thoughts on future research potential and direction.

Keywords: Purbeck Group, England, Paleontology, Geoconservation

Introduction

Richly fossiliferous Tithonian-Berriasian (Upper Jurassic–Lower Cretaceous) carbonate-dominated strata occur within the core of an eroded anticline centered on the picturesque Vale of Wardour, Wiltshire, western England. These comprise the marine Portland Group and overlying predomi-

nantly non-marine Purbeck Group (Arkell 1933; Wimbledon 1980; following the lithostratigraphic nomenclature of Hopson *et al.* 2008). The Portland-Purbeck strata, estimated at up to around 75 m thick (Hopson *et al.* 2008), are the product of the widely documented Late Jurassic regression (Haq 2017) and were deposited at a paleolatitude of around 35 degrees north under a warm to hot

climate among the North-Western European archipelago (Ogg *et al.* 1994). Sedimentation took place within a sub-basin on the hanging-wall of the Mere Fault, located on the northern margin of the Wessex Shelf (Coe 1996; Barton *et al.* 1998).

This communication focuses upon the Purbeck Group, currently taken as upper Tithonian–Berriasian in age (Hopson *et al.* 2008). Limestone was once widely dug from the Portland and Purbeck beds in the Vale of Wardour as a source of building stone. Quarry sections, augmented by railway cuttings, allowed Andrews and Jukes-Browne (1894) to assemble a composite stratigraphic section for the Purbeck Group, recognizing a broadly comparable succession of lithofacies and faunas to that of the Dorset type-area, similarly dominated by micritic to coarse-grained limestones and shales. Many of the beds in the Vale of Wardour were fossiliferous, yielding non-marine to quasi-marine biotas including plants, molluscs, arthropods and fish. Insect fossils, made famous by the discoveries of the Reverend Peter Bellinger Brodie (Brodie 1845, 1854), came from so-called ‘marlstone’ beds - generally hard, porcelaneous micrite beds. In recent decades, reinvestigation of these lithologies especially for their paleoentomology has confirmed a rich insect fauna as well as plant fragments, ostracods, isopods and fish remains (Jarzembowski and Palmer 2010; Coram and Jepson 2012). The coarser-grained, commonly bioclastic limestones and shales within the Purbeck Group often yielded molluscs, ostracods and vertebrate debris. Slightly below the middle of the succession, an oyster-rich quasi-marine horizon (Cinder Bed) was documented by Andrews and Jukes-Browne (1894) as a fine-grained limestone bed rich in oysters and trioniid bivalves (also see Etheridge 1881; Woodward 1895). This marks the base of the Durlston Formation of modern accounts (Hopson *et al.* 2008).

The Teffont Evias SSSI

Today, most of the quarries are disused and many have disappeared altogether. Basal Purbeck beds (Lulworth Formation) remain exposed above Portland limestones in a working quarry at Upper Chicks Grove and continue to yield important non-marine and terrestrial fossils (Stear *et al.* 2023). Including the Upper Chicks Grove site, there are six geological Sites of Special Scientific Interest (SSSI) in the Vale of Wardour covering the Portland-Purbeck succession. A SSSI describes an area of land of particular interest to science due to its rare flora, fauna, geology, geomorphology, or a mixture of these natural features. The designation of a SSSI is the primary statutory mechanism in Great Britain for protecting a nationally and internationally important geological site, such as Teffont Evias Quarry / Lane Cutting (Evans *et al.* 2023). The designation of geological SSSIs is underpinned by the Geological Conservation Review (GCR), which is an academic-led project that involves the systematic identification of a large suite of geological sites across Great Britain based on their scientific value. The main phase of the GCR occurred between 1977 and 1990, with sites selected for: 1) being of international importance, 2) containing exceptional features, and 3) being representative of a geological feature, event or process, which is fundamental to understanding Britain’s geological history.

Teffont Evias Quarry / Lane Cutting SSSI (NGR ST 990310 and ST 994309; Fig. 1) is underpinned by two GCR sites: site 436 selected in 1980 for its Portlandian (now Tithonian) and Berriasian (Jurassic-Cretaceous boundary) stratigraphy found in the relic quarry, and site 808 selected in 1981 for its paleoentomology found in the cutting faces. Once selected, these two GCR sites were then proposed and notified as a single SSSI by the Nature Conservancy Council, a predecessor of Natural England, in 1989, after which the site received full

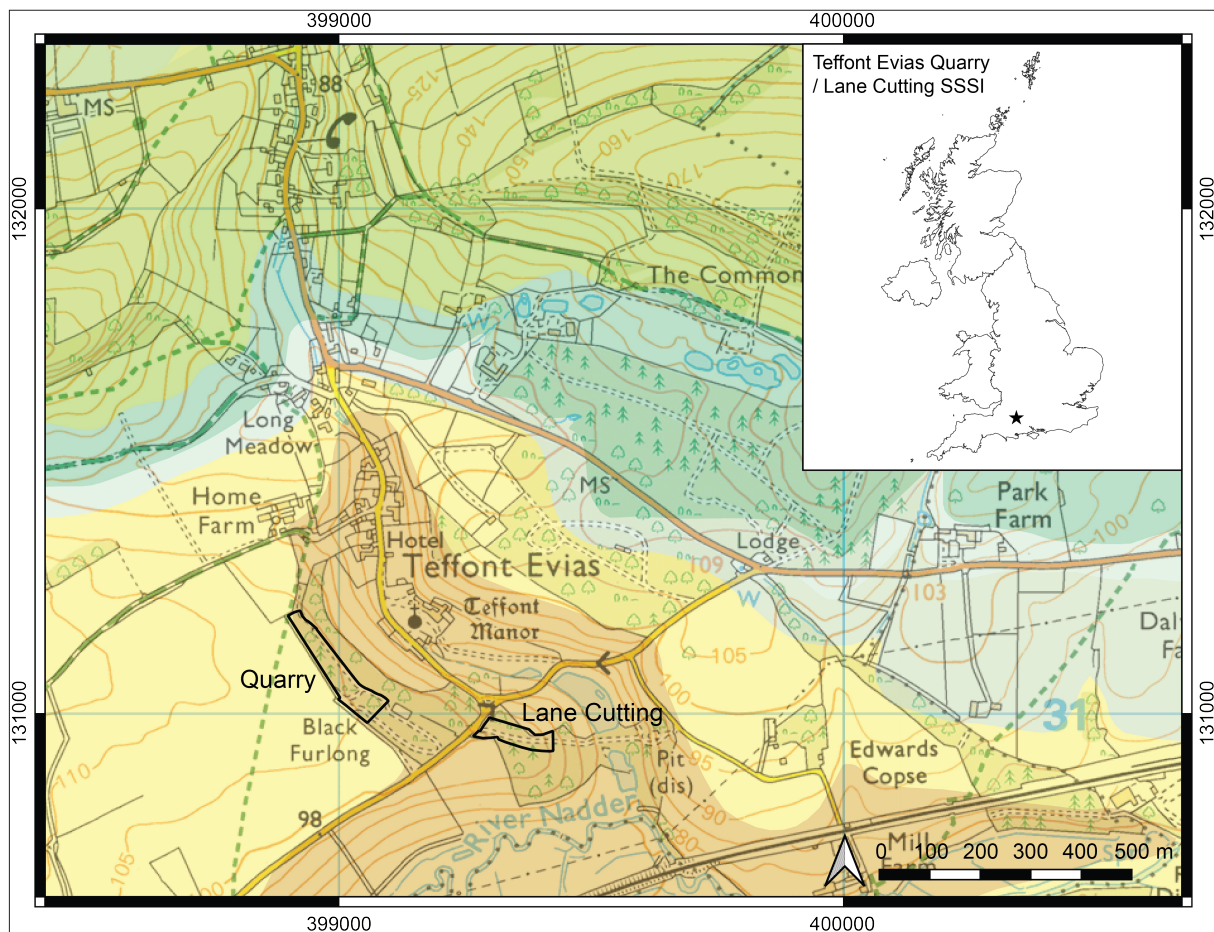


Figure 1. Map showing the location of Teffont Evias Quarry / Lane Cutting Site of Special Scientific Interest (SSSI) (Wiltshire, UK), in relation to the solid bedrock geology. The bedrock is coloured based on the relevant lithostratigraphic units, as shown in Figure 2. The SSSI boundary for the quarry and lane cutting is shown as the thick black line. Topographic basemap created in QGIS (v.3.8.1), using Ordnance Survey 25k mapping data © Crown copyright and database right 2025. OS licence no. AC0000851168. Coordinate Reference System: British National Grid. Contains British Geological Survey 50k mapping data © UKRI 2025.

legislative protection. The quarry and lane cutting presently expose the highest part of the Lulworth Formation and lower part of the overlying Durlston Formation (Fig. 2), probably all of early–mid Berriasian age from correlation with the Purbeck Limestone Group in its type area (Allen and Wimbledon 1991; Callomon and Cope 1995). Lower, possibly latest-Tithonian strata were exposed in the lane cutting in 2002 (see below).

When in work during the nineteenth and early twentieth century, Teffont Evias Quarry exposed approximately 9.5 m of limestones and subordinate mudstones, including insect-bearing ‘marlstones’ now only seen in the nearby lane cutting

(Andrews and Jukes-Browne 1894; Woodward 1895). It was visited by the Geologists’ Association in 1911 and photographically illustrated as the ‘Limekiln Pit’ in a report of the excursion (Ord and Reader 1912; Fig. 3). The quarry was enhanced by English Nature’s Face Lift Programme which was initiated in 1999 to fund clearance work on English geological SSSIs (Prosser *et al.* 2006). The Face Lift Programme funded scrub management, clearance of scree and rock debris, scaling and re-profiling of faces, rubbish removal and access management at more than 130 geological SSSIs over a four-year period (Murphy 2002). In 2002, work under this scheme on the Teffont Evias sites

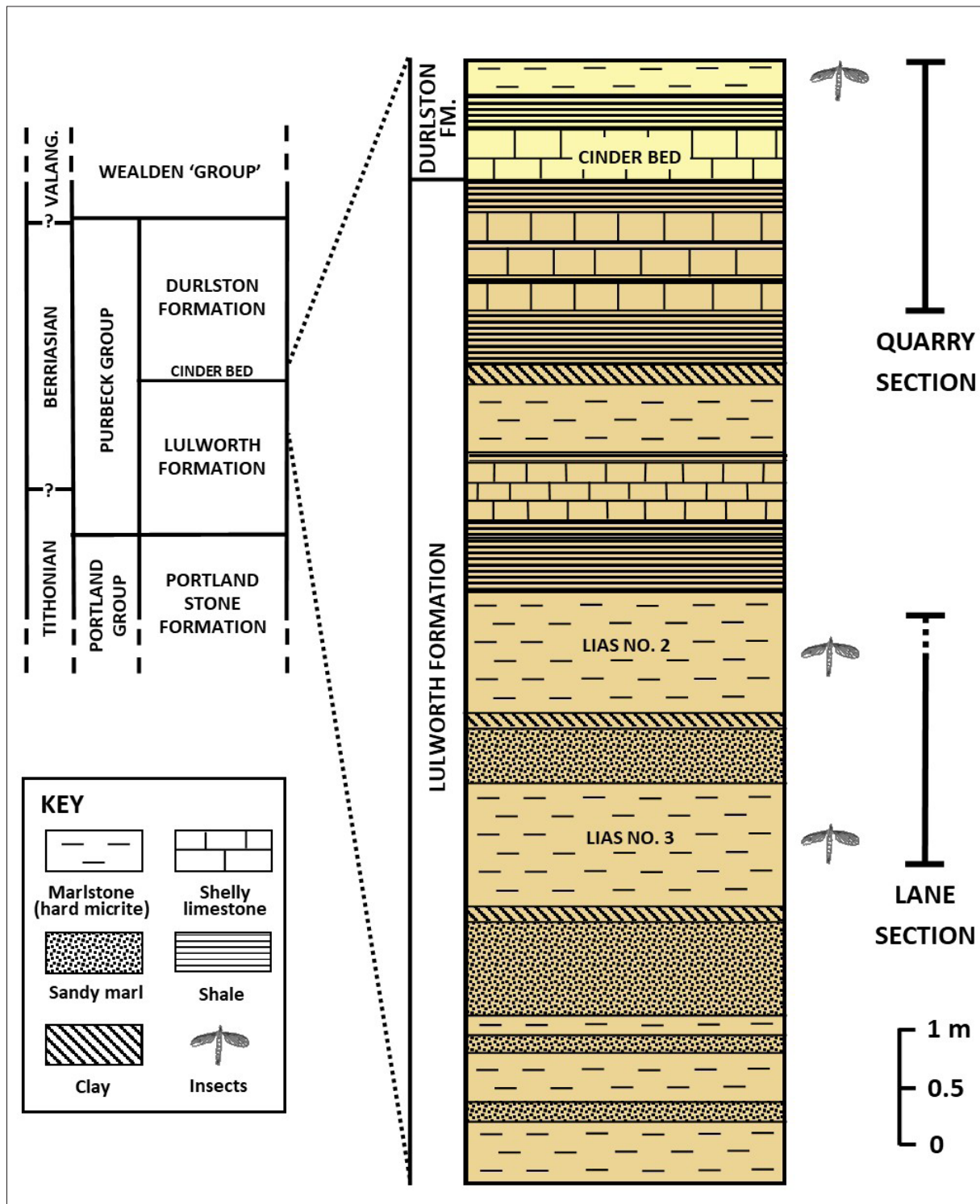


Figure 2. Stratigraphic section and broader stratigraphic context of strata exposed at the Teffont Evias Quarry / Lane Cutting Site of Special Scientific Interest (SSSI) (Wiltshire, UK). The Lulworth Formation (Tithonian-Berriasian) is shaded light brown; the overlying Durlston Formation (Berriasian) is shaded light yellow.



Figure 3. Teffont Evias Quarry ('Lime Kiln Pit') photographed during an excursion of the Geologists' Association, 1911. Image is from the Geologists' Association's Carreck Archive and is reproduced courtesy of the British Geological Survey. Source: BGS GeoScenic (Image P250101).

allowed re-exposure of insect-bearing horizons and collection of further material (Coram and Jepson 2012). The most recent account of the quarry section, published for the GCR (Jarzembowski and Palmer 2010), reproduces Andrews and Jukes-Browne's section, with metric measurements.

Following the 2002 Face Lift Programme, the Teffont Evias sections once again became obscured by weathering, slumping and vegetation encroachment. This deterioration led to the condition of the SSSI being assessed as *Unfavourable* during a visit by Natural England (succeeding English Nature) in February 2021, as part of an intensive monitoring programme to generate up-to-date data to meet the requirement to report on the condition of geological SSSIs for the G2 Indicator of the UK

Government's Environmental Improvement Plan (EIP) for England (HM Government 2023; Prosser and Townley 2025). The UK Government's EIP has set a long-term target to restore 75% of protected sites to *Favourable* condition by 2042, and an interim target for 50% of SSSIs to have actions on track to achieve *Favourable* condition by January 2028 (HM Government 2023). For geological SSSIs, *Favourable* condition is achieved or maintained when the following seven conditions are met: 1) the features of interest are adequately exposed or can be re-exposed by one or two people, using hand tools, in less than three hours, 2) there is no unconsented tipping or landfill obscuring or damaging the features of interest or preventing access to the faces, 3) vegetation is not obscuring or damaging the features of interest, 4) there is no

unconsented tree planting obscuring or damaging the features of interest, 5) there are no engineering works, including inappropriate restoration works, obscuring or damaging the features of interest, 6) planning conditions and restoration agreements are being observed on site, and 7) there is no irresponsible or inappropriate specimen collecting (Evans *et al.* 2023).

Considering its declining condition and the requirement to meet the goals set out in the UK Government's EIP, Teffont Evias was subsequently identified by Natural England as an appropriate SSSI to undergo restoration for its conservation needs, using their Conservation and Enhancement Scheme (CES) funding initiative. CES funding aims to improve the condition of SSSIs that are not eligible or suitable for UK Government-funded

Countryside Stewardship support and helps them achieve or maintain *Favourable* status (Evans *et al.* 2023). A CES agreement was prepared between the private landowner and Natural England, which included a management plan prescribing a list of activities and deliverables needed to enhance the condition of the site. In March 2025, staff (Margaret Feneley and Jonathan Hall) from Natural England and contractors spent two days restoring, where practical, the geological interest of both the lane cutting and nearby quarry, under this initiative (Fig. 4). Mechanical excavation, involving careful removal of soil, loose weathered rock and vegetation re-exposed parts of the section recorded by earlier authors. These works have since drastically improved the condition of the site and have returned the stratigraphical and paleo-

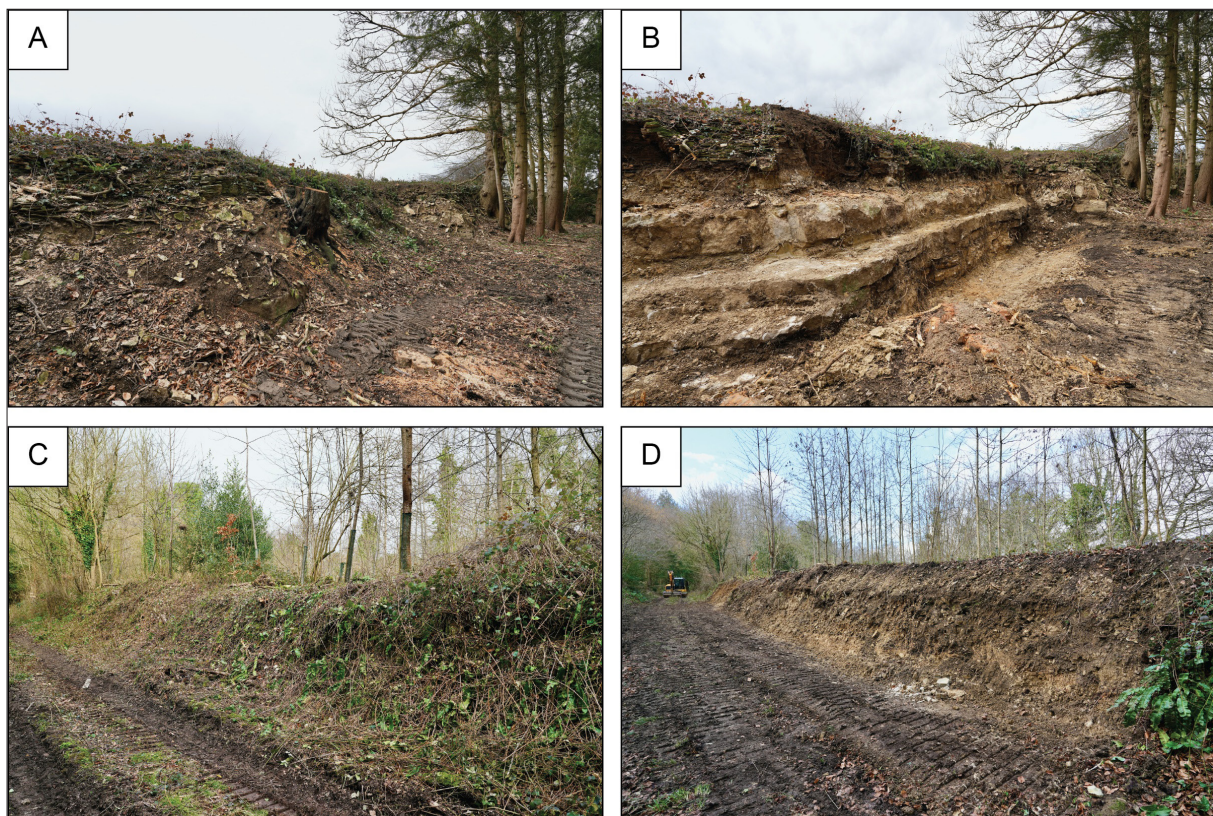


Figure 4. Photographs of Teffont Evias Quarry / Lane Cutting Site of Special Scientific Interest (SSSI) (Wiltshire, UK) before and after restoration (March 2025). **A)** Teffont Evias Quarry. **B)** The lower bench comprises the 'Hard, grey, shelly limestone in three courses' of Andrews and Jukes-Browne (1894). The higher bench comprises the Cinder Bed. **C)** Teffont Evias Lane Cutting. **D)** The pale band in the lower part of the re-exposed section is micrite equating to 'Lias No. 3' of Andrews and Jules-Browne (1894).

entomological features of interest to *Favourable* condition once more. The CES agreement will last for up to five years, so that the re-exposed sections can be accessed and maintained for the time ahead. The future of the site also depends on the active co-operation and involvement of local geology interest groups who can help conserve and secure the condition of these geological features in the long term.

The re-exposed lane section (Fig. 4) shows two beds of cream-weathering hard gray micrite - the ‘marlstone’ beds referred to by Victorian quarrymen as ‘Lias No. 3’ (Fig. 5) and the higher ‘Lias No. 2’. Andrews and Jukes-Browne (1894) give the thickness of each as 3’ 6” (just over 1 m) but this could not be confirmed in the lane cutting at the time of re-excavation due to the limited height of the exposure and weathering at the top. The two beds are separated by approximately 56 cm of soft, yellowish-weathering sandy calcareous mudstone equating to Andrews and Jukes-Browne’s ‘brown clay’ and ‘soft, yellowish, marly sand’. One of us (Robert Coram) recovered a beetle wing case and indeterminate (although probably conifer) foliage fragments from ‘Lias No. 3’ during re-excavation (Fig. 2).

The re-exposed Teffont Evias quarry face shows beds above those seen in the nearby lane cutting (Fig. 2). Andrews and Jukes-Browne’s ‘Hard, grey, shelly limestone in three courses’ is exposed at the base of the section (Fig. 4), indicating an unexposed interval of approximately 2.25 m above ‘Lias No. 2’ in the nearby lane. The published list of fossils from these coarser-grained shelly limestones includes ostracods, estheriids, fish and turtle remains.

Above, the Cinder Bed at the base of the Durlston Formation (Figs. 2, 4) comprises well-cemented, sharp-based, massive, slightly sandy argillaceous limestone, roughly 40-50 cm thick, containing abundant disarticulated bivalve shells, dispersed

and randomly oriented through the matrix (Fig. 6). These are mostly calcitic valves of small oysters (*Praeexogyra* cf. *distorta* (J. de C. Sowerby)) with poorly-preserved molds of other taxa, including trioniids (*Laevitrigonia* cf. *cineris* Kelly).

Beds re-exposed at the top of the section similarly match those described by Andrews and Jukes-Browne (1894). Above the Cinder Bed, a 25–30 cm brown-gray mudstone bed encloses thin seams of fibrous calcite and nodules of friable gray chert containing uncompact, disarticulated shells of small bivalves identified as *Neomiodon* sp. (Fig. 7). At the very top of the restored section, weathered, thinly bedded, laminated, cream-weathering gray micrite equates to the ‘Rubble of white limestone’ recorded by Andrews and Jukes-Browne. *Ex situ* fragments revealed thin seams of predominantly disarticulated *Neomiodon* sp. preserved as ferruginous casts, possibly representing oxidized pyrite. A beetle elytron was discovered by



Figure 5. ‘Lias No. 3’ of Andrews and Jules-Browne (1894) exposed in the Teffont Evias Lane Cutting following restoration (March 2025). Hammer head is 18 cm in length.



Figure 6. Weathered surface of the Cinder Bed exposed in the Teffont Evias Quarry following restoration (March 2025). Note abundant bivalve fossils, including the oyster *Praeexogyra* cf. *distorta*. Hammer head is 17 cm in length.

(Robert Coram, personal observations, 2002) in a limestone fragment derived from this level (Figs 2,8). These limestones additionally produced insect wings (mostly flies - Diptera) and a small leptolepiform fish following earlier Face Lift clearance (Robert Coram, personal observations, 2002), with isopod and plant material additionally reported by Jarzembowski and Palmer (2010).

Interpretation

In Purbeck times, the Mere Sub-basin (Vale of Wardour) was separated from the northern part of the Portland-Wight depocentre approximately 50 km to the south by the largely or wholly emergent Wessex Shelf (Hawkes *et al.* 1998; Underhill 2002). Connection between the depocentres, potentially around the eastern end of the Wessex Shelf (Hawkes *et al.* 1998), is indicated by the broadly comparable successions and one or more quasi-marine horizons common to both areas (Andrews and Jukes-Browne 1894; Wimbledon 1987). On the broadest scale, the vertical change from la-



Figure 7. Chert specimen (85 mm in length) collected from 'Marly shale, with a layer of 'beef' and lenticular seams of chert crowded with silicified shells of *Cyclas*' [= *Neomiodon*] of Andrews and Jules-Browne (1894): top of Teffont Evias Quarry following restoration (March 2025). Note the well-preserved, uncompacted shell biofabric.



Figure 8. Beetle elytron (12 mm in length) collected from 'Rubble of white limestone' of Andrews and Jukes-Browne (1894): top of Teffont Evias Quarry following restoration (March 2025).

goonal lithofacies, depleted in benthos (lane section), to higher energy lacustrine lithofacies below the Cinder Bed (lower part of the quarry section) was potentially under climatic control (Allen *et al.* 1998; Coram and Radley 2021) and possibly of chronostratigraphic significance if correlation can be confirmed with similar changes in the Portland-Wight Basin and further afield.

Jarzembowski and Palmer (2010) reported insect material obtained from the lane cutting during the 2002 Face Lift Programme, including the holotype of the dragonfly-like *Saxomyrmeleon keatingei*

Nel and Jarzembowski, 1998 (figure 2 of their account). Recovered from relatively soft creamy-gray micrites from the lower part of the Lulworth Formation, these are evidently from a lower level than that exposed in 2025. Jarzembowski and Palmer (2010) noted abundant charcoal fragments, burnt (fusainized) beetle elytra and evaporite (halite) molds, all indicating hypersalinity in isolated or semi-isolated lagoons as well as frequent wildfires in a generally arid climate.

We similarly interpret the insect-bearing ‘Lias’ micrites re-exposed in 2025 at a higher stratigraphic level in the lane section (Figs. 2, 4, 5) as calcareous mud deposited in shallow, low-energy coastal lagoons (also see Coram and Jepson 2012), with insect and foliage remains indicating vegetated land close by. No evaporite molds were observed, suggesting that the water was not hypersaline, which is supported by Andrews and Jukes-Browne’s (1894) report of the presence of a variety of fish. Some charcoal is present (Robert Coram, personal observations), testifying to wildfires, although it does not occur in the density often seen lower in the Purbeck, suggesting that the climate had become less arid. This climatic amelioration is well recorded in the Purbeck Group of the Dorset coast as well as, sometimes diachronously, other European basins (Allen *et al.* 1998; Coram and Radley 2021).

Since Victorian times, the Purbeck strata have informally been split into ‘Lower’, ‘Middle’ and ‘Upper’ divisions, the boundary between the ‘Lower’ and ‘Middle’ (within the Lulworth Formation) corresponding to a reduction in evaporite frequency and increase in preserved biotic abundance and diversity (in particular, vertebrates). Andrews and Jukes-Brown (1894) considered their ‘Lias’ beds to represent the highest part of the ‘Lower’ Purbeck. Their faunistic diversity, benign water conditions and evidently less arid climate, however, as well as their stratigraphic position, are

more suggestive of strata that on the Dorset coast would have been considered around that time to be lowermost ‘Middle’ Purbeck (e.g., see Fisher 1856; Strahan 1898).

The nineteenth-century accounts show that bioclastic limestones and shales yielding small bivalves (*Neomiodon*) and ostracods replace the lagoonal micrite lithofacies seen in the lane cutting, culminating in the bioclastic limestones forming the lower part of the refreshed quarry section (Figs. 2, 4). These mark a shift to a higher energy environment, with low salinities indicated by *Cypridea*-dominated ostracod microfaunas and *Neomiodon*-dominated bivalve assemblages (Morter 1984; Horne 2002; Radley 2002). A shift to a less protected lagoonal or lacustrine setting seems likely, with weak marine connections tempering any tendencies towards hypersalinity (Coram and Radley 2021).

Above, the abrupt change to argillaceous limestone with an oyster-dominated quasi-marine fauna (Cinder Bed; Morter 1984; Radley 2002; Figs. 2, 4, 6) indicates a possible local occurrence of the transgressive surface present above low-salinity Purbeck facies seen in the Portland-Wight Basin to the south (Allen and Wimbledon 1991). The taxonomic composition of the Cinder Bed bivalve fauna in the Portland-Wight depocentre suggests that transgression came from the Western Approaches Trough and/or Paris Basin (Wimbledon and Hunt 1983). The fauna in the Vale of Wardour appears to be more diverse than that in the Portland-Wight type area (Kelly 1983). This raises the possibility of either an additional marine connection to the west (through the Bristol Channel Basin; Cope 2020) or that the Cinder Bed in the Vale of Wardour represents a different quasi-marine incursion.

The reversion above to *Neomiodon*-dominated mudrocks and thin limestones (Fig. 2) marks the re-establishment of a non-marine regime follow-

ing post-Cinder Bed sea-level fall. Uncompacted shell fabrics preserved within chert nodules (Fig. 7) indicate that silicification must have occurred at a shallow depth within the sediment, quite soon after deposition. Like other early cemented Purbeck shell beds (El-Shahat and West 1983), they provide a window into biostratigraphic processes; the densely-packed, randomly oriented shells suggest persistent hydrodynamic agitation in a lake-margin setting. The micritic limestones at the top of the section (Fig. 2) signify a return to restricted lagoonal conditions during further regression. Insect and fish remains recovered during the earlier Face Lift programme suggest that they are the lateral equivalent of Brodie's more productive 'Insect Limestone' at nearby Dinton (Brodie 1845; Coram and Jepson 2012). There, in 2002, it yielded remains of aquatic bugs (Hemiptera), which, along with the bivalves (*Neomiodon*) at Teffont Evias, suggest brackish-water conditions (Morter 1984; Radley 2002; Coram and Jepson 2012).

Ways Ahead

New avenues of investigation underline the importance of maintaining the Teffont Evias SSSI sections as accessible and clearly exposed geological sites for the foreseeable future. The lane section has much potential for further paleontological discoveries, exposing two thick micrite beds, well known to Victorian paleontologists, and with lower productive strata also present, although currently unexposed (Jarzembowski and Palmer 2010). *Ex situ* material now available from the highest bed in the quarry section, known to yield insect remains, also holds promise for future discoveries.

The quarry section revealed other features of interest that will be followed up. Neomiodontid and trigoniid bivalves, recorded herein, have the potential to further resolve salinity fluctuations within the Purbeck waterbodies, with possible significance for paleoclimatic studies (Coram and Radley 2021) and paleogeography (Wimbledon

and Hunt 1983; Cope 2020), and understanding Early Cretaceous sea-level change. In particular, the Cinder Bed molluscs require systematic collection to further assess their diversity relative to the Portland-Wight Basin and their paleobiogeographic affinities. Mudrock units (including shales) and argillaceous limestones (Cinder Bed) could yield ostracods, microvertebrates and other microfossils. These will assist overall biostratigraphical, paleoenvironmental and paleoecological interpretation. Ostracods and estheriids, in particular, might provide further biostratigraphic links between the Vale of Wardour and Dorset coast (Horne 2002; Li *et al.* 2021). Analysis of clay minerals, as undertaken in the Portland-Wight Basin (Allen *et al.* 1998), has a potential bearing on paleoclimatic and paleobiogeographic interpretation and chronostratigraphy. Molluscan shell biofabrics, well preserved within the Cinder Bed and overlying units, are a potentially useful tool for assessing a range of parameters such as depositional rates, shell concentration mechanisms, and water depth (Radley 2002).

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Authors' Contributions

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collection, Formal analysis, Methodology, Visualization, Writing, Editing.

Jonathan R. Hall: Fieldwork and Data collection, Methodology, Visualization, Writing, Editing.

Margaret Feneley: Fieldwork and Data Collection, Methodology, Visualization, Writing, Editing.

Conflict of Interest

The authors do not have any conflicts of interest to declare.

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