POSSIBLE TETRAPOD BURROWS IN THE MID TRIASSIC OTTER SANDSTONE FORMATION AT SIDMOUTH, DEVON, UK

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Trace fossils interpreted as tetrapod burrows have been reported from fluvial Triassic deposits in geographically widely separated parts of the former Pangea supercontinent, including Morocco, South Africa, the USA and Antarctica. The burrows at most of these localities are hosted in deposits of ephemeral braided rivers that formed in arid to semi-arid settings. Vertebrate fossils have been recorded from all the burrowed formations, and in some examples vertebrate skeletons have been found in the burrows. Evidence of periods when the climate was sufficiently wet to support mature vegetation is present in the form of rhizocretions and caliche deposits that are associated with all the burrowed horizons. The depositional environments at all these localities, as evidenced by their sedimentology and faunas, are closely similar to those of the Mid Triassic Otter Sandstone Formation of South-West England. The *c*. 200 m thick formation is almost wholly exposed on the east Devon coast, but no trace fossil other than rhizocretions and a single reptile footprint has previously been recorded from the Otter Sandstone Formation. The sizes and shapes of some of the trace fossils described in the present account are similar to Triassic burrows in Antarctica, Morocco and South Africa that have been attributed to the access tunnels and resting chambers of small therapsid reptiles. Other, less well defined, structures in the Otter Sandstone Formation that disturb bedding features may represent the resting places or egg-laying sites of tetrapods. The small number of possible tetrapod burrows recorded and the sparse and fragmentary nature of vertebrate fossil occurrences in the Otter Sandstone Formation mean that it is not possible at the present time to determine which tetrapods might have made the burrows.

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INTRODUCTION

An almost complete section through the Otter Sandstone Formation (OSF) is exposed on the Devon coast in sea-cliffs up to 160 m high between Budleigh Salterton [SY 062 817] and Sidmouth [SY 130 873] (Benton *et al.*, 1994). The coastal outcrop exposes about 150 m of strata in which an unknown thickness of beds is cut out by faulting where the outcrop is broken by the valley of the River Otter. Up to 210 m of OSF has been proved nearby in inland boreholes (Edwards and Gallois, 2005). The formation consists of yellow- and orange-brown, cross-bedded, fine- and medium-grained sandstones with a few lenticular beds of conglomerate (channel-lag deposits) up to 0.5 m thick and lenticular red-brown mudstones up to 2 m thick. In the coastal exposures the unbroken succession east of the Otter Valley can be divided on the basis of sedimentary structures into three members (Figure 1) that approximately correlate with Units B to D of Hounslow and Macintosh (2003). A sharp lithological change at the base of each member probably represents an upward change to a different rainfall pattern and a climate that was drier overall (McKie *et al.*, 1998). At Budleigh Salterton the OSF rests with sharp lithological contrast on a reddish brown, silty clay palaeosol which rests on the Budleigh Salterton Pebble Beds Formation. The palaeosol was interpreted by (Wright *et al.*, 1991) as representing a major break in sedimentation of uncertain duration.

At Steamer Steps [SY 0632 8176] on the west side of the Otter Valley, the lowest part of the formation comprises aeolian sandstones overlain by fluvial, cross-bedded, fine-grained sandstones with small (up to 50 mm) angular mudstone clasts (Unit A of Hounslow and Mackintosh, 1993). Within the valley, a degraded sea cliff [SY 0703 8200] exposes a stratigraphically higher level with calcretes and associated calcareous rhizocretions. On the east side of the River Otter, lithologically similar cross-bedded sandstones with calcrete sheets and rhizocretions in the Otterton Point Sandstone Member are exposed in the sea cliff [SY 0774 8192] together with lenses of channel-lag gravel that contain calcrete debris and far-travelled rock clasts. The lithologies and sedimentary structures indicate that there is no overlap between the youngest beds at Steamer Steps and the promenade section, and between there and the sea cliff (Figure 1). North eastwards from the River Otter, the Otterton Point Sandstone Member is wholly exposed in continuous cliffs as far as Ladram Bay [SY 097 851] where a low easterly dip brings the junction with the Ladram Bay Sandstone Member down to beach level. The outcrop of the junction is repeated by faulting eastwards from there with the result that it is well exposed between Big Picket Rock and Sidmouth (Figure 2). The base of the Ladram Bay Sandstone Member is taken at a sudden upward change (Figure 3b) from sandstones with relatively narrow (up to 10 m wide) channels with numerous caliche beds and rhizocretions to sandstones with broad channels up to 100 m wide with pebbly basal-lag deposits that contain angular and rounded rip-up clasts of sandstone, caliche and red mudstone. The youngest part of the formation, the Pennington Point Member, comprises red playa-lake mudstones cut by a succession of up to eight sand-filled channels that were deposited by flash floods which became progressively weaker with time (Gallois, 2004). The last of the sandstones marks the