# Chapter 3 British Permian fossil reptile sites

## Introduction: Permian stratigraphy and sedimentary setting

British Permian time can be grouped into two broad units, an earlier phase of predominantly terrestrial deposition and a later phase characterized by greater marine influence. The Early Permian of the British Isles, and also of much of northern Europe, was mostly a time of terrestrial subaerial erosion with desiccation of newly uplifted areas that had been generated during the final phases of the Variscan Orogeny. A large number of fault-bounded sedimentary basins developed, with the creation of wide-ranging facies variations of coarse- and fine-grained sediments as well as evaporites. Later in the Early Permian, aeolian deposits and evaporites became dominant, indicating a prevailing arid climate. The sediments were deposited in a westward extension of the German-Dutch basin and are known as the Rotliegendes. By the end of the Early Permian, Britain had been reduced to a gently rolling peneplain (Smith *et al.,* 1974; Smith, 1989; Smith and Taylor, 1992), which was largely an inhospitable desert.

A major marine transgression in the Late Permian led to the development of an inland (epicontinental) sea which flooded the North Sea Basin and part of mainland Britain, leading to deposition of the thick, evaporitic Zechstein sequences. The Zechstein deposits of north-east England, the North Sea and Germany comprise five major sedimentary cycles, each commencing in shelf carbonates and grading up into evaporites. The base of each cycle is sometimes marked by widespread development of bituminous shale which passes directly into the main carbonate sequence. The earliest of these deposits contain plant remains, perhaps reflecting a temporary increase in humidity following the establishment of the Zechstein seaway. This, however, was short-lived, as the return of arid conditions led to a re-establishment of evaporite sedimentation.

Arid and semi-arid conditions continued to the end of the Permian throughout the British region, but in the isolated sedimentary basins of northeast Scotland a diverse reptilian fauna appears to have flourished in spite of the harsh conditions.

The lack of biostratigraphic indicators makes relative dating of Permian deposits in Britain very difficult (Smith *et al.,* 1974), and only parts of the succession may be dated with any degree of accuracy. The diversity of facies and their diachronous nature rule out wide-ranging lithological correlations and such correlations do not in any case necessarily amount to time-equivalence. The most important sequences bearing reptiles are the Marl Slate (Early Permian), of County Durham and the Cutties Hillock Sandstone Formation and Hopeman Sandstone Formation (Late Permian) of Scotland. (Figure 3.1) shows the distribution of Permian rocks in Great Britain and the position of the GCR Permian reptile sites.

## Reptile evolution during the Permian

During the Early Permian, reptiles broadly replaced amphibians to become the dominant terrestrial tetrapods and, during this time, the main reptile groups that had radiated towards the close of the Carboniferous Period continued to evolve, establishing themselves in a wide variety of previously vacant ecological niches. Most significant in this respect were the synapsid reptiles (mammal-ancestors), and among these, the carnivorous and herbivorous pelycosaurs. These were the most diverse tetrapods of the Early Permian, representing upwards of 70% of the known reptiles. Pelycosaurs are best known from the mid-western United States (Texas, Oklahoma, New Mexico), but sporadic occurrences from Central Europe have shown similar faunas. Their remains are largely absent in Britain, apart from a site at Kenilworth, and a number of footprint localities (see below) which show that these reptiles did occupy the region but their skeletal remains are rarely preserved.

The Late Permian was marked by further radiation of the synapsids, with the appearance of numerous new groups belonging to the major derived group, the therapsids. Key groups include the dicynodonts (specialized herbivorous forms with reduced numbers of teeth), the dinocephalians (an assemblage of large herbivores and carnivores) and the gorgonopsians (moderate to large-sized carnivores, many with 'sabre'-teeth). The dicynodonts, and certain other groups,

survived with reduced diversity beyond the end-Permian extinctions into the Triassic, whereas the dinocephalians and gorgonopsians died out. Other important reptile groups from the Permian include the anapsids (e.g. captorhi-nomorphs) and primitive diapsid reptiles, whose descendants were to dominate the course of reptile evolution to the present day.

The best information on Late Permian reptilian evolution comes from the early parts of the Beaufort Group of the Karroo Basin in South Africa, with supplementary information from Madagascar, central Europe and eastern Russia, all of which confirm the general story. The British sites illustrate parts of this story, with typical South African/Russian-style dicynodonts from Elgin, and smaller diapsid reptiles, like those of Madagascar and central Europe, from Durham.

## British Permian reptile sites

Early Permian fossil reptile bones have been reported from Whitemoor Brickpit, Kenilworth [SP 294 717], probable source of remains of the large amphibian *Dasyceps bucklandi,* and certain source of the 'pelycosauf mammal-like reptiles *Sphenacodon britannicus* (Huene, 1908a) (type: BGS(GSM) 22893–4) and *Haptodus grandis* Paton, 1974 (type: WARMS Gz 1071) (Huene, 1908a; Paton, 1974b; Reisz, 1986, p. 78). The Enville Beds here contain a limited flora including the conifer *Lebachia (= Wakhia*) dated as earliest Permian (Shotton, 1929; Smith *et al.,* 1974). A second site, 'one mile north-west of Coventry', yielded a jaw bone of *Ophiacodon* sp. in the Kenilworth Breccia (Murchison and Strickland, 1840; Paton, 1974b).

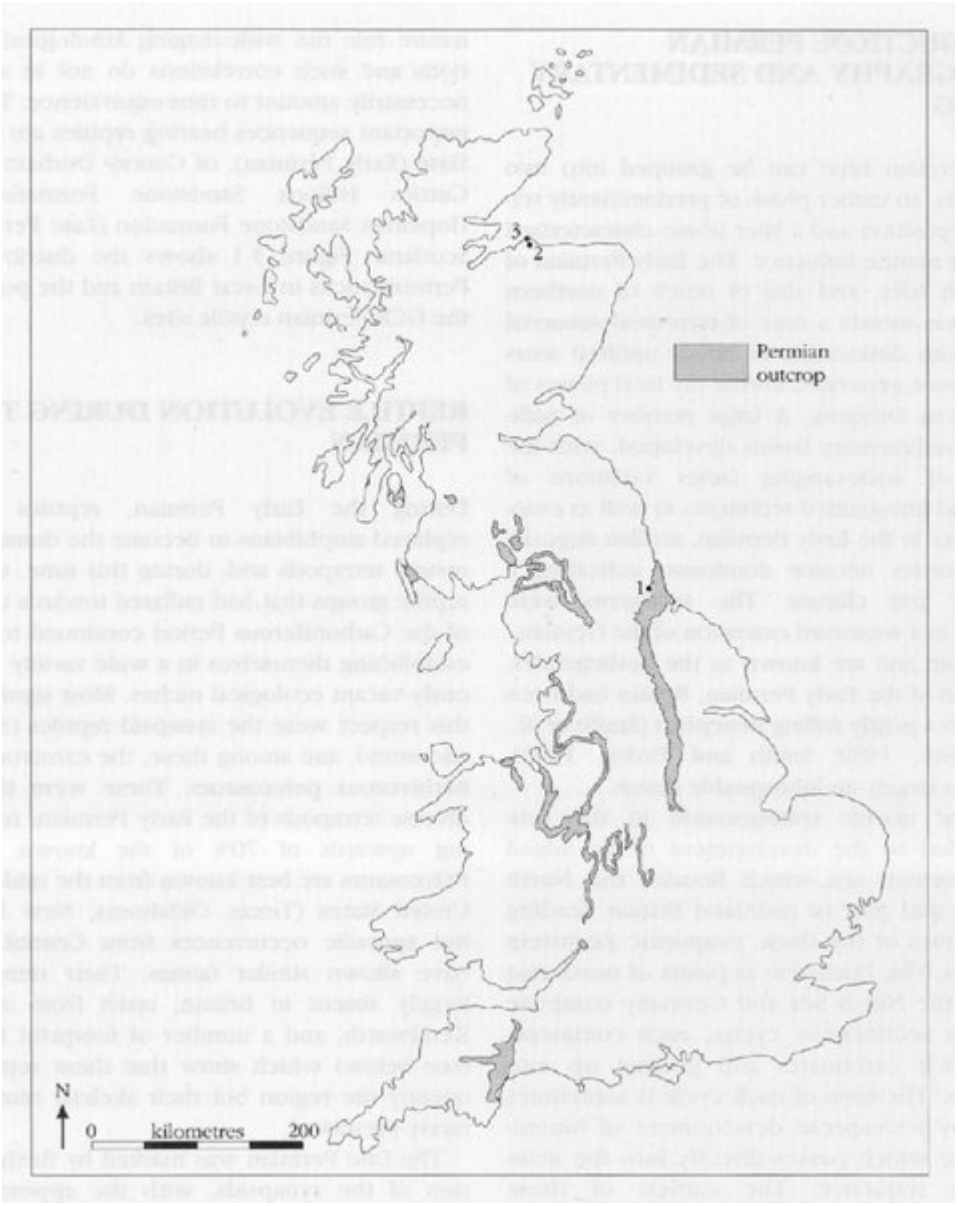
Other sites have yielded Early Permian footprints (McKeever, 1990, 1991). The key localities are in Dumfriesshire at Corncockle Muir [NY 086 870], Locharbriggs [NX 907 813], and Greenmills [NY 023 692], all old quarries in the Locharbriggs Sandstone Formation (Brookfield, 1978a), which is the same as the Dumfries Sandstone of Smith *et al.* (1974). Footprints were reported from the 1820s onwards, these being some of the first tetrapod footprints recorded in the literature (Grierson, 1828; Harkness 1850, 1851; Hickling, 1909; Sarjeant, 1974; Delair and Sarjeant, 1985). Similar footprint faunas have been found in the Penrith Sandstone at Penrith, Cumbria (?[NY 5729]) (Smith, 1884; Sarjeant, 1974). None of these could be selected as a GCR site since they have all been filled to a greater or lesser extent. The main hope is that current sporadic quarrying in the Dumfries area may reveal more footprints.

Late Permian reptiles are known from the Marl Slate of the Durham area, in quarries at Eppleton, Middridge and Quarrington (Mills and Hull, 1976; Bell *et al.,* 1979; Evans and King, 1993), and from the Cutties Hillock Sandstone Formation of Cutties Hillock Quarry, near Elgin, Morayshire (Benton and Walker, 1985).

Late Permian reptile footprints have been reported from the Lower Magnesian Limestone of Rock Valley Quarry, Mansfield Nottinghamshire [SK 524 613], now filled in (Hickling, 1909; Sarjeant, 1974, pp. 332–4) and from Poltimore, Devon in the Broadclyst Sandstone Member of the latest Permian Dawlish Sandstone Formation (Clayden, 1908a, 1908b; Warrington and Scrivener, 1990). Footprints are also known from Masonshaugh Quarry, and other sites, in the Hopeman Sandstone Formation of the Morayshire coast (Peacock *et al.,* 1968; Benton and Walker, 1985; McKeever, 1991). Three locations are selected as GCR sites to represent British Permian reptiles:

1. Middridge, Durham [NZ 2455 2535]. Upper Permian (Ufimian–lowest Kazanian), Marl Slate.
2. Cutties Hillock, Grampian [NJ 185 638]. Upper Permian (Tatarian), Cutties Hillock Sandstone Formation.
3. Masonshaugh, Cummingstown, Grampian [NJ 125 692]. Upper Permian (Tatarian), Hopeman Sandstone Formation.

**References**




*(Figure 3.1) Map showing the distribution of Permian rocks in Great Britain. GCR Permian reptile sites: (1) Middridge; (2) Cutties Hillock; (3) Masonshaugh.*