# Cutties Hillock, Grampian

[NJ 185 638]

## Highlights

Cutties Hillock Quarry is world-famous for its fauna of dicynodonts and pareiasaurs, bulky medium-sized, plant-eating reptiles. Four or more species have been reported, and these provide unique information on the reptiles of the latest Permian, just before a major global mass extinction event at the Permian/Triassic boundary.

## Introduction

The main Cutties Hillock Quarry lies concealed in Quarrywood Forest, in the eastern portion of Quarry Wood, 400 m south-east of Quarrywood School, and is reached along forest roads. The quarry, now mostly overgrown, exposes sections in aeolian units of the Cutties Hillock Sandstone Formation. Some fresh rock has been broken up at the eastern end, where access is easiest. The quarry yields an important fossil reptile fauna of latest Permian age which includes at least two genera of dicynodont, a specialized pareiasaur, and a possible procolophonid, the chief references to which are: Newton (1893), Walker (1973), Rowe (1980), Benton and Walker (1985) and Maxwell (1991). Further commercial working would doubtless yield more fossils in view of the number collected between 1885 and 1890.

Cutties Hillock quarry was opened for building stone in the early 19th century. Many of the buildings in Elgin, including the Town Hall, are built of sandstone from this quarry. The uniform nature of the stone also made it suitable for mill stones, and it is probable that this is the millstone quarry referred to by Harkness (1864) and others.

Fossil reptiles were collected around 1884, and displayed at the Aberdeen meeting of the British Association in 1885. Further nearly complete skeletons were obtained in 1884 and 1885 (Judd, 1885, 1886a, 1886b; Traquair, 1886) and these were described by Newton (1893) as species of the new dicynodont genera *Gordonia* and *Geikia*, and the new horned pareiasaur *Elginia*.

The Geological Survey drove test pits in the quarry in 1885, in an attempt to settle the contentious question of the true age of the Elgin reptile beds: most others had admitted their New Red (Permo-Triassic) age by that time. It was agreed by all that the reptiles had been found in the working portion of the quarry, and that a diagnostic Old Red Sandstone (Devonian) fish (*Holoptychius*) had been found 20–25 ft below in the trial pit. Judd (1886a, pp. 400–2) claimed he could identify a pebble band between two sandstone units, presumably marking the base of the New Red Sandstone. However, Linn, the Survey geologist, and J. Gordon Phillips, the Elgin Museum curator, did not see this pebble bed, and it might have been merely a local phenomenon (Gordon, 1892, p. 242; Peacock *et al.,* 1968, pp. 73–5).

A New Red, possibly Triassic, age was widely accepted by 1890 for the sandstones of Lossiemouth and Spynie which lie nearby, and it was assumed at first that the Cutties Hillock animals could be of the same age. A Permian age was, however, proposed early on (Taylor, 1894; Huene, 1902; Watson, 1909a), but Walker (1973) tentatively suggested a lowermost Triassic assignment. Benton and Walker (1985) opt firmly for a latest Permian (Tatarian) age on the basis of comparisons of the reptiles with independently dated faunas in southern Africa and Russia.

## Description

The quarries at Cutties Hillock comprise the type locality for the Cutties Hillock Sandstone Formation (*sensu* Benton and Walker, 1985, pp. 215–16). The sandstones of Cutties Hillock were formerly supposed to represent only the lower part of the Hopeman Sandstone Formation. Because of lithological similarity and tracks found near Cutties Hillock Quarry, Watson and Hickling (1914) correlated the 'Sandstones of Cutties Hillock' (Quarry Wood) and Hopeman. This has been accepted until recently by most authors (Peacock *et al.,* 1968; Williams, 1973). Benton and Walker (1985) questioned the validity of such a correlation and erected the Cutties Hillock Sandstone Formation to include the reptile-bearing beds around Cutties Hillock, and to distinguish them from the coastal series of rocks, the Hopeman Sandstone Formation.

The Cutties Hillock Sandstone Formation is a 30–45 m thick succession of coarse- to medium-grained, predominantly aeolian sandstones which outcrop as a series of isolated fault-bounded blocks in a belt stretching south-south-west from the district of Cutties Hillock. Two main units of the formation are recognized (Peacock *et al.,* 1968; Williams, 1973), comprising a lower member of up to 4 m of pebbly sandstones and an upper member, about 30 m thick, of large-scale, yellow to light-brown, cross-bedded sandstone (Figure 3.3). The base of the formation lies discordantly on Old Red Sandstone. The lower pebbly beds have been interpreted as sheet-flood deposits, but occasional pebble beds, up to 20 m thick, may contain ventifacts, providing evidence of wind erosion during deposition of at least a part of the unit (Mackie, 1902; Watson, 1909b; Watson and Hickling, 1914). The sandstones show unidirectional foresets which indicate fossil barchan dunes and star dunes (Williams, 1973). The sandstone is reworked Old Red Sandstone and is lithologically very similar, which explains the difficulty in identifying the boundary. The petrology of most of the sandstones shows aeolian characters, such as abundant well-rounded, millet-seed quartz grains (Williams, 1973).

Judd (1886a, pp. 400–2) presented the following section, recorded from the trial pit (as summarized in Peacock *et al.,* 1968, p. 74):

| | Thickness (ft) |
|---|---|
| Coarse sandstone, white to pale yellow, often felspathic and gritty, becoming pebbly downwards; five reptiles recovered from one horizon, and one from the course below | 20 |
| grades into | |
| Conglomerate; pebbles of white and purple quartz up to fist size | c. 4 |
| sharp contact | |
| Finely laminated, pink and red sandstone with much false bedding. Yielded at base *Holoptychius nobilissimus* | 13 |

The Cutties Hillock Sandstone Formation broadly correlates with the Hopeman Sandstone Formation (Peacock *et al.,* 1968; Warrington *et al.,* 1980; Glennie and Buller, 1983) on the basis of striking lithological similarities and, the presence of footprints that might have been formed by reptiles like those of Cutties Hillock. An associated footprint and other trackways have been discovered on Quarry Hill near the main Cutties Hillock quarries (Linn, 1886; Huene, 1913; Watson and Hickling, 1914), and A.D. Walker (pers. comm. to M.J.B., 1990) discovered a dicynodont trackway *in situ* in the main quarry. A slab in Elgin Museum, showing footprints with a tail-drag on top of ripple marks, probably came from 'Robbies Quarry', the position of which is uncertain, but it was apparently one of the Crownhead group of quarries, on the south side of Quarry Wood Hill.

The reptiles *Elginia, Gordonia* and *Geikia* all came from Cutties Hillock Millstone Quarry [NJ 185 638], apparently from aeolian sandstones just above the pebbly sandstones. Judd (1886a, pp. 400–1) noted that 20 ft (6.2 m) of the 'Reptiliferous Sandstone' was to be seen above the pebbly layers, that the remains of five reptiles all came from one horizon and that a sixth came from the bed below. Phillips (1886) confirmed this. Gordon (1892, p. 242) referred to 'a portion of this conglomerate containing reptilian remains'. Newton (1893, pp. 462, 466) also noted that the specimens of *Gordonia fuddiana* and *Geikia elegans* contained pebbles in the matrix like those of the 'conglomerate' bed. Similar pebbles are also preserved in the slabs containing *Gordonia duffiana.* These respectively (ELGNM, 1978.559.1, 2) show quartz pebbles up to 20 mm and up to 7 mm in diameter.

In general, the reptile skeletons are preserved in articulation, with most elements in their natural positions. Skulls are usually in position aligned with the attitude of the rest of the anterior skeleton. However, some remains lack certain elements. The type specimen of *Elginia* (BGS(GSE)4783–8) lacks its lower jaws. A record of the natural association of parts has been lost in some specimens because of poor techniques of collection, and many blocks in museum collections are no longer associated. Most of the reptiles are preserved on their sides, although the isolated pelvis (NMS, 1966.42.3) lies horizontal to the bedding. Some elements of the skeletons, however, may pass vertically through bedding (e.g. vertebrae and limb bones in *G. duffiana;* ELGNM, 1978.559.1, 2). The alignment of skulls in relation to the bedding seems to be related to skull broadness and length; narrow long skulls are usually preserved sideways on to bedding whereas broad backed skulls, such as the skull of *Elginia,* generally lie flat.

The fossil bones are preserved in the form of natural moulds from which the bone has been removed by percolating solutions. The bone/rock interface is frequently stained with black material containing iron, manganese and cobalt (Newton, 1893, p. 425). The cavities may be deformed to the extent that opposite walls may almost touch, and skulls are often vertically compressed (Newton, 1893; Walker, 1973; Rowe, 1980). Prefossilization damage is rare, but specimens lacking certain elements (e.g. the skull of *G. duffiana*) suggests disarticulation through erosional forces or through the activities of scavengers. The open cavities permit casts to be made for study, and various synthetic, flexible, rubber-like materials (e.g. RTV silicone rubber, PVC) provide excellent representatives of the original bone morphology.

### Fauna

**Anapsida: Pareiasauridae**

*Elginia mirabilis* Newton, 1893 2 individuals: BGS(GSE) 4783–8, ELGNM, 1978.550

**Anapsida: ?pareiasaurid**

'procolophonid' of Walker, 1973, p. 179 1 individual: EM, 1978.560; ?BMNH R4807

**Synapsida: Therapsida: Dicynodontia**

*Gordonia traquairi* Newton, 1893 3 individuals: BGS(GSE) 4805–6, 11703, ?ELGNM, 1978.550

*Gordonia huxleyana* Newton, 1893 (?= *G. traquairi*) 2 individuals: BGS(GSE) 4799–802, 11704–5, ?ELGNM, 1978.549

*Gordonia duffiana* Newton, 1893 (?= *G. traquairi*) 1 individual: ELGNM, 1978.559

*Gordonia juddiana* Newton, 1893 (?= *G. traquatri*) 1 individual: ELGNM 1890.3

*Geikia elginensis* Newton, 1893 1 individual: BGS(GSM) 90998–1015

'dicynodonts indet.' 7 individuals: BMNH R4794, ELGNM, 1935.8, 1978.558, 886, NMS, 1956.8.3, 1966.42.1–3, 1984.20.7

## Interpretation

In the absence of any associated fossils, the reptiles provide the only means of dating the Cutties Hillock Sandstone. Comparison with similar forms from South Africa led Walker (1973) to suggest an age in either the upper *Cistecephalus* or *Daptocephalus* Zone (uppermost Permian), or more probably in the *Lystrosaurus* Zone (lowermost Triassic). Rowe (1980) showed that the close relatives of *Geikia,* the cryptodontid dicynodonts, all come from the Late Permian of South Africa or Zambia (*i.e. Daptocephalus* Zone) and implied a similar age for the Cutties Hillock Sandstone. Benton and Walker (1985) accept a latest Permian age for the Cutties Hillock Sandstones, based on the nature of the dicynodonts and the pareiasaur, known elsewhere only from the Late Permian. These reptile-defined biozones are generally (e.g. Anderson and Cruickshank, 1978) assigned to the Tatarian Stage.

*Gordonia* and *Geikia* are dicynodonts, members of a group of specialized, herbivorous mammal-like reptiles with beak-like snouts, most of which had no teeth except for a pair of 'tusks' midway along the upper jaws. *Gordonia* (Figure 3.4)A is represented by the remains of skulls and skeletons of between eight and thirteen individuals; Newton (1893) established four species (*G. traquairi, G. huxleyana, G. duffiana, G. juddiana*), but they are probably all synonymous, the differences being the result of individual variation, age and sex differences, and the susceptibility of the Cutties Hillock fossils to early post-depositional distortion (Walker, 1973; King, 1988, p. 93). *Gordonia* has a heavy, broad skull, 100–180 mm long, modified to house a powerful musculature for mastication. *Gordonia,* the only known member of its infra-order from Europe, is a generalized dicynodont — a group of herbivorous mammal-like reptiles that have highly reduced dentition, and often only a pair of bony canine tusks. Cluver and King (1983, p. 268) stated that *Gordonia* was 'possibly related to *Kingoria* or *Dicynodon',* whereas King (1988, p. 93) synonymized *Gordonia* with *Dicynodon,* a genus known otherwise from the Late Permian of South Africa.

The single specimen of *Geikia* (Figure 3.4)B has no teeth at all, the skull is very short and the snout is square. The foreshortening of the skull, and its great breadth at the back, could both be connected with the development of a powerful biting mechanism to deal with tough vegetation. The foreshortening of the skull is like that of *Lystrosaurus* from Gondwanaland, but the similarity is only superficial. In *Geikia* the intertemporal area is broadened, the interorbital area broadened and depressed, and the premaxillae descend abruptly vertically. Rowe (1980) has redescribed the specimen and assigned it to the Cryptodontidae, a family otherwise known from the Late Permian of South Africa and Zambia. He also placed '*Dicynodon*' *locusticeps* (Huene, 1942) from the Late Permian Lower Bone-Bearing Series of Kingori, Tanzania in the genus *Geikia* and noted that the closest relative of *Geikia is Pelanomodon.* Cluver and King (1983) placed *Pelanomodon* in the new family Aulacephalodontidae, a view confirmed by Cruickshank and Keyser (1984) and King (1988, pp. 88–9).

*Elginia* was a pareiasaur with a highly spines-cent skull (Figure 3.4)C. The 210 mm long holotype skull is broad and covered with rough pits and spines of various lengths and sizes. Other remains of *Elginia* include vertebrae and a sacrum probably belonging to the holotype, as well as an undescribed partial skeleton and skull. The teeth are leaf-shaped, indicating that *Elginia* was probably a herbivore. The 'frill' at the back of the skull was probably to protect the neck, and the spines are also defensive structures (compare Cretaceous ceratopsian dinosaurs). The body was also covered in spinose scutes — overall an animal highly armoured against a predator that has not yet been found, but probably a large cynodont, gorgonopsian, or therocephalian, mammal-like reptile. *Elginia* shows relationship with pareiasaurs from the *Cistecephalus* and *Daptocephalus* Zones of South Africa and Zone IV of Russia, but seemingly it is cladistically more derived (Walker, 1973, p. 181; Maxwell, 1991).

A fourth reptile from Cutties Hillock is represented by a small partial skeleton described by Newton (1893, pp. 461–2, pl. 33, fig. 5) as a tail of *?Gordonia.* This specimen, consisting of seven dorsal vertebrae, the blades of two scapulae and the blade of an ilium, was later identified as a nearly complete postcranial skeleton and was assigned to the Procolophonidae by Walker (1973). A re-examination of the material by P.S.S. (1994), however, revealed characters, including a tall and narrow scapular blade, very wide, flattened neural arches of the dorsal vertebrae, and long laterally projecting ribs, that are shared by pareiasaurids, and hence *Elginia.* Thus, EM, 1978.560 may well represent an immature *Elginia,* and also one of the smallest pareiasaurid specimens known.

### Comparison with other localities

Reptiles comparable to those from Cutties Hillock have been obtained from York Tower Hill (Knock of Alves) [NJ 162 629] where, in 1953, Walker discovered parts of the skull and jaws of an unnamed dicynodont allied to *Geikia* (Walker, 1973). An unidentified bone in Forres Museum was found in Crownhead Quarry [NJ 183 630] on the south side of Quarry Wood Hill in sandstones of the same age. Apart from a small scrap of bone (Peacock *et al.,* 1968, p. 59), the coastal exposure of the time-equivalent Hopeman Sandstone Formation has yielded nothing except reptile tracks.

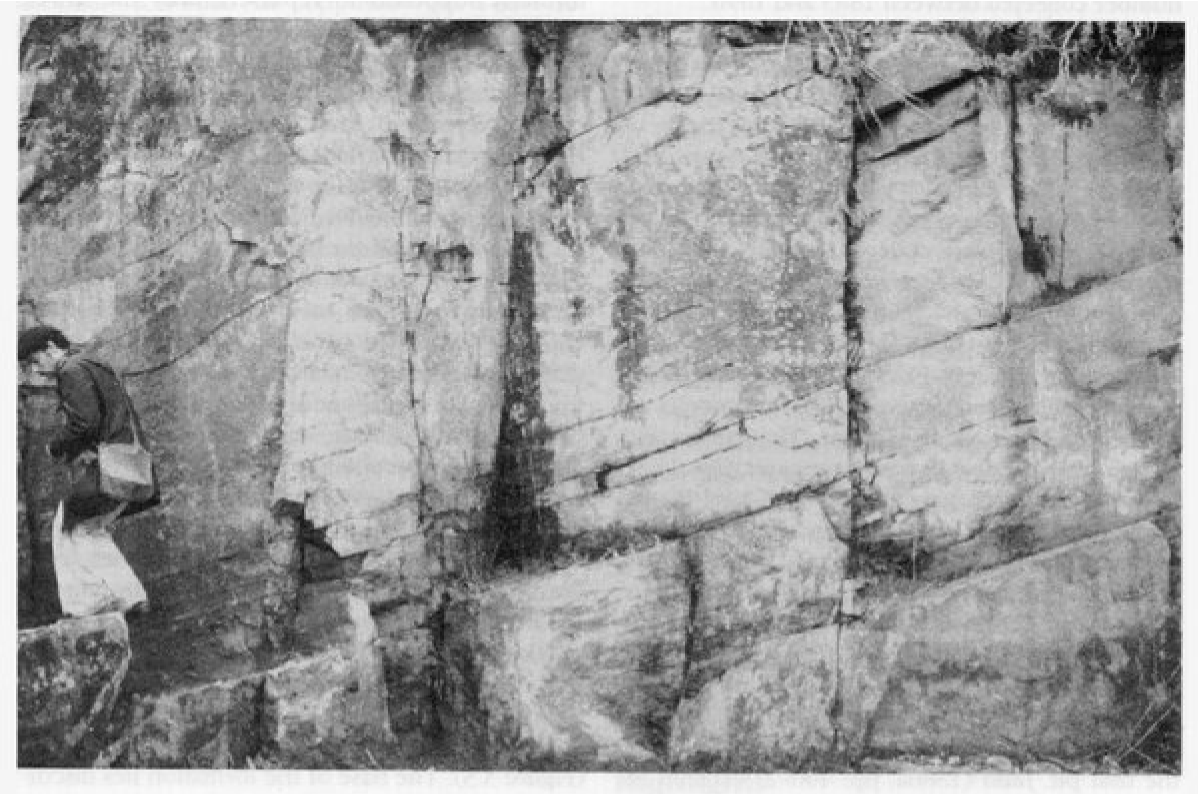
The Cutties Hillock fauna shows most similarity with uppermost Permian faunas of southern Africa, especially the *Cistecephalus* and *Daptocephalus* biozones, and Zone IV of Russia. This points to a Tatarian age. There are no comparable localities in the British Isles or in Europe.

## Conclusions

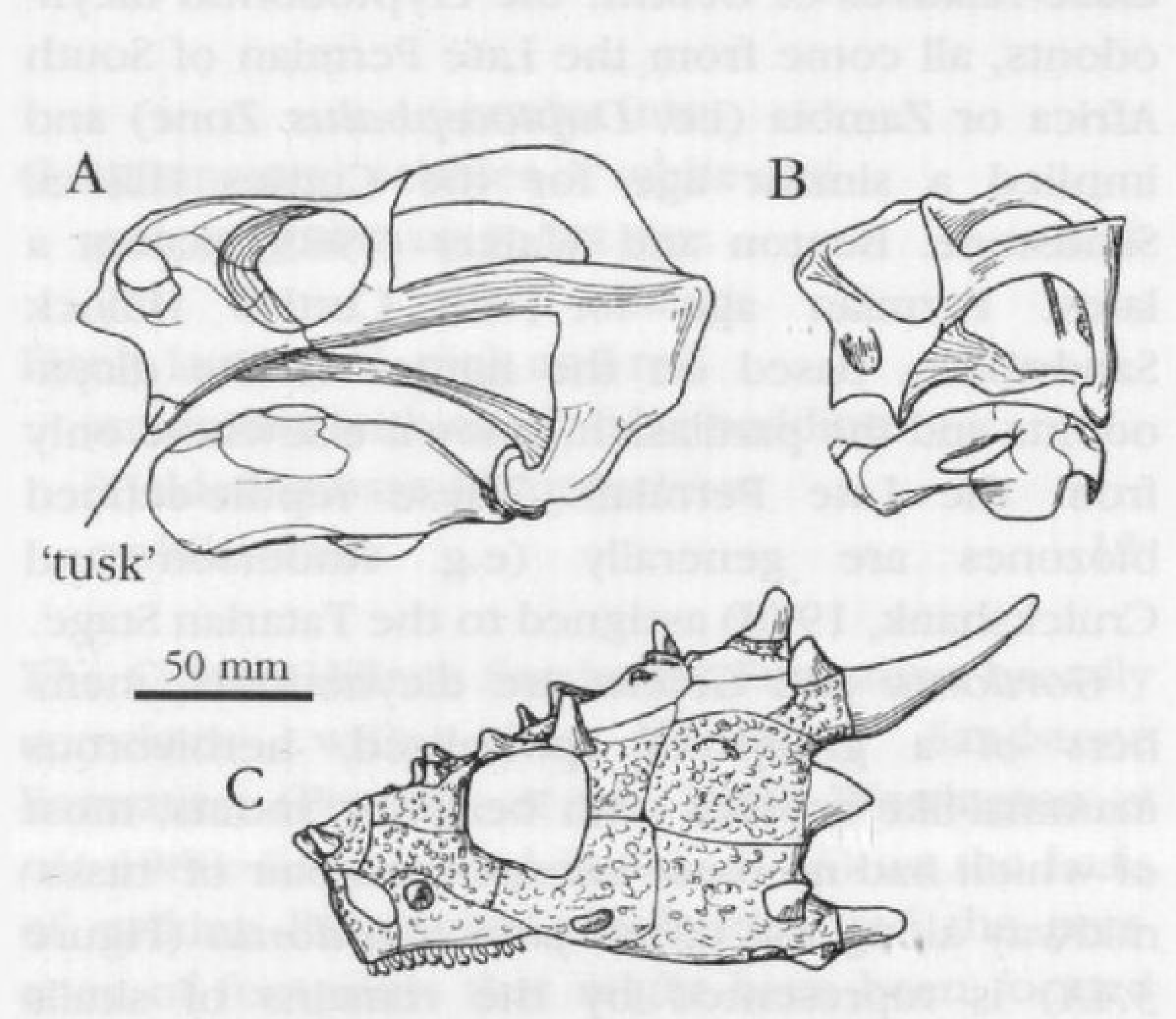
Cutties Hillock Quarry is a key Permian reptile locality because of its unique fauna (Figure 3.4) which provides clear links between the Gondwana faunas of southern Africa and the mainland Eurasian faunas of western Russia. The dicynodonts *Gordonia* and *Geikia* are well preserved, and offer much useful palaeobiological information. *Elginia* is one of the most specialized pareiasaurs, being distinguished by its excessive spinescence.

The conservation value of this quarry lies in its uniqueness in Britain, its international importance and potential for future significant finds with reworking.

[References](#)



*(Figure 3.3) Part of the worked face at the east end of the main quarry, Cutties Hillock, showing cross-bedding. The fossil reptile remains were recovered from the foot of the cross-bedded units. (Photo: M.J. Benton.)*




*(Figure 3.4) Reptile specimens from the Late Permian Cutties Hillock Sandstone Formation of Cutties Hillock Quarry, Morayshire. Skulls of (A) Gordonta; (B) Geikia; and (C) Elginia, all drawn to the same scale. After Benton and Walker (1985).*