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# Charnwood Forest

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## Introduction

The fossils of Charnwood Forest are the only examples of a truly diverse late Precambrian fauna known in Britain and Western Europe, and as such they represent a unique and important aspect of the history of life on Earth. The fossils are from six stratigraphical levels in the Charnian Supergroup (Figure 8.1), and the geographical distribution of the fossil-bearing localities is shown on (Figure 2.1). The main horizons are in the Bradgate Formation, near the top of the Maplewell Group. Not far below this horizon a few fossils have been recorded at a further level in the Beacon Hill Formation. The oldest fossils are in the Ives Head Formation of the Blackbrook Group, towards the base of the exposed sequence. Burrows of *Teichichnus* type have been found in the Swithland Formation, which is the youngest unit in the Charnian sequence, but these are Cambrian forms and thus constitute a specialized occurrence, the significance of which is discussed in the section on 'The Brand' GCR site (Chapter 9). The sedimentology of the Charnian Supergroup was outlined by Moseley and Ford (1989) and further sedimentological descriptions of many fossil-bearing sites are given in Chapter 2.

Although ring-like markings were noted in the mid-19th century and were sufficiently well-known to give the local name of 'Ring Pit' to one of the quarries (Ramsay *et al.*, 1858; Harrison, 1877), they were generally regarded as of inorganic origin. The possibility that they could be trace fossils was overlooked until the first frondose organisms, *Charnia masoni* and *Charniodiscus concentricus* were discovered by Roger Mason in 1957 (Ford, 1958). This find stimulated a search of rocks at the equivalent horizon throughout Charnwood Forest and five further localities were found with more trace fossils. Later, different trace fossils were found at a much lower horizon (Boynton and Ford, 1995). Dubio-fossils have been found at other localities but are not discussed further herein (Boynton, 1978).

With the exception of the *Teichichnus* burrows, the fossils are regarded as members of the Ediacara fauna, named from the localities near Ediacara in the Flinders Ranges of South Australia. Apart from the rich assemblages in the latter (Glaessner, 1984; Glaessner and Wade, 1966), examples of the Ediacara fauna have since been found in many parts of the world, as discussed in the introduction to this chapter.

The age-range of Ediacaran fossils is currently the subject of much investigation, but unfortunately there is as yet no precise age date for the Charnian Supergroup, as discussed in the introduction to Chapter 2. Indirect correlations with radiometrically dated rocks in Nuneaton suggest that its fossiliferous beds could be older than 603 million years. However, the Ediacaran fossils, which are usually assigned to the Vendian Stage of the late Proterozoic (Glaessner and Wade, 1966), are presently believed by many to be no older than 580 Ma (e.g. McIlroy *et al.*, 1998). At the outside, a lower age limit of 600 Ma is considered by Narbonne (1998). At the other end of the timescale, Ediacara-type fossils have been found in strata younger than 543 Ma (Narbonne *et al.*, 1997), this being the currently accepted age for the base of the Lower Cambrian (Bowring *et al.*, 1993).

## Summary of the main fossil forms

The Precambrian fossils of Charnwood Forest are preserved as impressions on the upper bedding surfaces of fine-grained volcanoclastic siltstones, i.e. in hyporelief. The impressions have resulted from moderately soft-bodied organisms coming to rest on the silts, with fairly rapid burial pressing them down into the sediment. Counterparts on the under surfaces of overlying beds have not yet been found. Little is seen of the fossils' three-dimensional shape and no hard parts are preserved. A leathery integument (or covering) was probably present in at least some cases. The fossils fall into the six principal categories below and their stratigraphical distribution is indicated by (Figure 8.1).

1. Simple frondose colonies. The best known are *Charnia masoni* and *Charniodiscus concentricus*. Other examples of the simple frondose organisms include the large *Charnia grandis* and a miniature version similar to *Charniodiscus*

*concentricus*.

2. Complex frondose colonies. Faint impressions of these colonies are exemplified by *Bradgatia linfordensis*.
3. Discs and disc-like impressions. These are the most common Charnian fossils, ranging in diameter from less than 10 mm up to 162 mm on the long axis. Most are slightly ovoid and only a few circular discs have been seen. The discs occur in five types:
  1. Ovoid with an outer wide depression around a raised central boss. They include *Cyclomedusa cliffi*, Boynton and Ford (1995).
  2. Circular to ovoid discs with clusters of faint lobes in the centre. They include *Ivesbeadia lobata*, *Shepshedia palmata* and *Blackbrookia oaksii*.
  3. Ovoid discs with many concentric rings and with only faint indications of a central boss. These include *Cyclomedusa cf. davidi*.
  4. Ovoid discs with a few gently arched concentric rings.
  5. Ovoid with a raised rim but no central boss or concentric rings.
4. Arthropod-like impressions. Only one of these has been seen, named *Pseudovendia charnwoodensis*.
5. Trails. A few isolated examples, which appear to be 'worm' trails, have been found (Boynton and Ford, 1995), though their identification must be viewed with some doubts as only single individuals have been found. They bear some resemblance to *Planolites*.
6. Problematica. Faint traces of what may be fragments of stems with branches have been found on the Memorial Crags in Bradgate Park and the North Quarry of Charnwood Golf Course near Woodhouse Eaves. So little detail is visible that at present it is not possible to assign them to any biological group.

The descriptions that follow are not exhaustive, but photographic illustrations and discussions of most of the principal Charnwood discoveries are provided in Boynton and Ford (1995) and Ford (1999).

### **Description of the fossil localities**

With the exception of the Ives Head locality, all occurrences lie within the stratigraphical GCR sites indicated on (Figure 2.1); descriptions of the lithology and sedimentology of the host strata at these sites can therefore be found in Chapter 2. A single discoid fossil impression at Beacon Hill is also described in Chapter 2.

#### **Ives Head, Shepshed [SK 477 170]**

The fossils here are the oldest that have been found in Charnwood Forest, occurring some 2000 m lower down the Charnian stratigraphical succession than the fossil-bearing localities of Bradgate Park. They occur immediately above the crags that are located to the west of the Ives Head trigonometric point (Figure 8.2). These exposures show a varied sequence of graded volcanoclastic mudstones, siltstones and sandstones typical of the Ives Head Formation, Blackbrook Group, as seen at the Morley Quarry GCR site (Chapter 2). The highest graded sandstone–siltstone package is 2.5 m thick (Carney, 1999) and is surmounted by a single very prominent bedding plane, capped only by remnants of the overlying medium- to coarse-grained sandstone. It is this surface that contains the several impressions once regarded as dubio-fossils (Boynton, 1978) but later re-interpreted (below) as medusoids (Boynton and Ford, 1995, 1996). They are characterized by forms with circular to ovoid discs with irregular rims and clusters of faint lobes in the centre. The fossils include *Ivesbeadia lobata*, an associated form with a short stem named *Shepshedia palmata* (Figure 8.3), and *Blackbrookia oaksii*, which appears to have three fairly large 'discs' in contact. In addition to these, a new form consisting of a drooping head on a long stem (*Shepshedia aff. palmata*) has recently been recognized by Boynton (1999), who also described an associated frondose organism sharing some similarities with *Charnia masoni*. It should be noted that the Ives Head occurrences are both bizarre and unique, and their affinities are not fully understood at the time of writing (H. E. Boynton, pers. comm.).

#### **Old John, Bradgate Park [SK 525 113]**

The fossiliferous beds here belong to the Old John Member of the Beacon Hill Formation, low down in the Maplewell Group, and their location is shown on the map for the Bradgate Park GCR site report (Figure 2.8). The walled enclosure

some 8 m to the south of the Tower contains a single steeply dipping bedding plane bearing several faint discoid impressions, interpreted as medusoids. There are also faint traces of 'worm' trails. The crags to the north of the Tower have some small but quite well-preserved discs and possible trails consisting of ovoid-shaped, raised impressions.

### **Memorial Crags, Bradgate Park [SK 524 110]**

These crags are located near the Leicestershire Yeomanry Memorial (Figure 2.8). The fossil-bearing bedding plane (Figure 2.9) is in volcanoclastic mudstone or silty mudstone and represents the highest part of a graded sedimentary package in the Hallgate Member. About 10 m lower down, on the eastern side of these crags, are coarse-grained lithologies of the Sliding Stone Slump Breccia, which marks the base of the Bradgate Formation. The bedding plane covers an area of about 25 m<sup>2</sup> and on it some 50 fossil impressions have been found (Boynton and Ford, 1995). Some of these are very faint and difficult to see except in good oblique light provided during late afternoons in September. The fauna includes several impressions of complex frondose organisms, 'designated as *Bradgatia linfordensis* (Figure 8.4); see also, the North Quarry site report). At first sight they resemble tangled balls of seaweed but on close examination they appear to be radiating bundles of *Charnia*-like fronds. These colonies are up to 40 cm in diameter and individual parts are preserved well enough to show the characters of *Charnia* fronds (plaster replicas of the type specimens from here are in Leicester City Museum). Other fossils on this bedding plane include an incomplete impression of a large more complex frond, *Charnia grandis* (Figure 8.5), now 60 cm long but possibly a metre long when complete, as well as a minute cf. *Charniodiscus concentricus* only 15 mm long (and including a disc at the base). There are several types of discs, some of which may be holdfasts, or floats.

### **The Outwoods [SK 516 161]**

The fossil bed occurs in strata inferred to lie immediately above the Outwoods Breccia Member (equated with the Sliding Stone Slump Breccia, see description of the Outwoods–Hangingstone Hills GCR site). It may be the close contemporary of the fossil-bearing bed at Memorial Crags, Bradgate Park. A few square metres of bedding planes have yielded several ovoid impressions with multiple, sharp-edged ridges concentric about a poorly defined boss. The larger one shows faint traces of possible tentacles from the centre. They have been identified as the medusoid *Cyclomedusa* cf. *dauidi* (Ford, 1968; Boynton, 1978; (Figure 8.6)). A single incomplete medusoid specimen of the same type was found on a loose block. Several small oval-shaped, single-ringed discs have also been found. Another loose block yielded an impression interpreted tentatively as part of a primitive arthropod *Pseudovendia charnwoodensis* (Boynton and Ford, 1979), now in Leicester Museum.

### **North Quarry, Charnwood Golf Course [SK 522 155]**

This small and long-disused quarry lies close to the north-eastern edge of the golf course (Figure 2.15). It reveals the largest bedding plane exposure to be seen anywhere in Charnwood Forest (Figure 2.17). The fine-grained volcanoclastic mudstones and siltstones here show excellent parallel lamination and are correlated with a distal turbidite or suspension-sedimentation event in the Bradgate Formation (Hallgate Member), higher up in the Maplewell Group than the otherwise comparable fossil locality at the Memorial Crags. Ring-like markings were noted here over a century ago, hence the name of 'Ring Pit' for this quarry, but were dismissed as of inorganic origin. In 1957, the first frond-like impressions were found by Roger Mason (Ford, 1958). These were the first macrofossils of Precambrian age to be recognized in Britain and were named *Charnia masoni* and *Charniodiscus concentricus* (Ford, 1958, 1963, 1968). Both consist of fronds 25–30 cm long with a series of lobes on each side obliquely divergent from an ill-defined median axis, which suggests that the supporting structure lay outside the plane of the impression. *C. masoni* has lost its basal disc (Figure 8.7) but *Charniodiscus concentricus* still shows the disc at its base (Figure 8.8). The lobes on the fronds are divided into segments, which could have held small polyps though no direct evidence is preserved (the type specimens are now in Leicester City Museum).

Faint impressions of the complex *Bradgatia linfordensis* occur on the same bedding plane (see also, Memorial Crags site report). A similar very large form named *Bradgatia* aff. *linfordensis*, with a prominent disc near the centre, has recently been discovered on a bedding plane 3 m higher (Boynton, 1999). Several other less well-preserved fronds are present on this higher bedding plane. The ring-like markings have been interpreted as the detached holdfasts, or floats, of the

frondose organisms. A single short length of 'worm' trail has also been found.

### **Cliffe Hill Quarry, Markfield [SK 476 107]**

The north-east face of this now disused and partly flooded quarry consists of strata equated with the Bradgate Formation. Due to the isolated position of this site (Figure 2.1) the precise correlation of these strata with the other fossil beds of the Bradgate Formation is uncertain. The beds dip steeply to the south-west and are intruded by the South Chainwood Diorites (Figure 2.19); this relationship has important implications for the maximum age of the Bradgate Formation and other parts of the Charnian Supergroup, as discussed in the introduction to Chapter 2. A single bedding plane has yielded several discoid impressions, which are ovoid with an outer wide depression around a raised central boss. Although the lack of internal detail raises doubts, Boynton and Ford (1995) have referred them to *Cyclomedusa cliffi*, the type specimen of which is now at Leicester Museum. Most occurrences have been quarried away or are hidden in quarry debris.

## **Interpretation**

The fossils of Charnwood Forest occur in turbidite-facies volcanoclastic strata, which are generally devoid of structures attributed to tidal or storm-influenced wave or current action and thus were probably deposited in moderate to deep waters. As discussed in the introduction to Chapter 2, the dominant sedimentation mechanism involved sediment gravity flowage, which was in part driven by tectonic and/or volcanic events. The beds with fossil impressions seem to represent relatively quiescent periods, characterized by the settling out of suspended fine-grade material, and commonly occur at the very tops of major graded sedimentary packages. This type of environment has been recognized in a minority of the other Ediacaran fossil occurrences around the world, and is regarded as representative of a deep-water slope or sedimentary fan environment (Jenkins, 1992; Narbonne, 1998). It is in contrast to the shallow shelf, tide-or storm-dominated conditions in which the faunas described from the Ashes Hollow (Long Mynd) and Coed Cochion (Camarthenshire) sites evidently flourished.

When simple frondose fossils such as *Charnia masoni* were first discovered at the North Quarry locality, their assignation to some form of complex seaweed was considered (Ford, 1958). They were later interpreted as probably the traces of organisms comparable with the present-day Pennatulacea, which are primitive colonial cnidarians, broadly comparable with the modern sea-pens (Glaessner and Wade, 1966; Glaessner, 1979, 1984). Some of the fronds possess basal discs, which may represent holdfasts or floats; these when detached may appear at certain of the fossil localities at which the frondose forms were not found (see below).

The complex frondose colonies, such as *Bradgatia linfordensis*, are regarded as having been composed of clusters of fronds radiating from a central attachment. The varied style of preservation of these specimens means that they are regarded as several forms of preservation or growth stages of the same organism described by Boynton and Ford (1995). These organisms may either have been sessile bush-like organisms as shown diagrammatically by Jenkins (1985; Jenkins and Gehling, 1978), or were floating colonies that settled on to the sea floor in quiet conditions (Boynton and Ford, 1995). They do not seem to have been taken into account by Seilacher (1992) in his discussion of his proposed taxonomic category, the *Vendobionta*.

Both the simple and complex frondose fossils have been assigned to the extinct phylum 'Petalonamae', Class Rangeomorpha (Pflug, 1972; Boynton and Ford, 1995), Family Charniidae. Frondose organisms comparable to some of those seen in Charnwood Forest have been recorded in several localities in Newfoundland, Russia, China and Namibia, all in Neoproterozoic strata.

A possible interpretation of certain of the disc-like fossils to which no species name has been given is that they may be detached holdfasts from *Charniodiscus concentricus*.

The supposed medusoid fossils, such as *Cyclomedusa cliffi*, *Cyclomedusa cf. davidi* and possibly *Ivesheadia lobata*, *Shepshedia palmata*, *Blackbrookia oaksii*, have been placed as Phylum Cnidaria, ?Class Cyclozoa (Fedonkin, 1983), Family Cyclomedusidae (Runnegar, 1992; Runnegar and Fedonkin, 1992). Comparable modern examples of these

cnidarians are the sea anemones, corals and jellyfish. Narbonne (1998) suggests that the Ediacaran fossils may well have some affinity with the first two, but doubts whether any could be ascribed to a 'jellyfish' type of organism.

So little detail is visible of the possible stems and branches of 'Problematica' that it is not possible to assign them to any biological group. Similarly, the apparently segmented form *Pseudovendia charnwoodensis* is only very tentatively suggested to be a primitive arthropod.

The Charnwood fossil assemblages are broadly comparable to the late Precambrian Ediacaran fauna found worldwide although there are some differences; for example, complex frondose fossils such as *Bradgatia linfordensis* and *Bradgatia aff. linfordensis* do not appear to be represented elsewhere (Boynton, 1999). It should be noted that Norris (1989) and Runnegar (1995) doubted the assignment of the Ediacara fauna to the Cnidaria though neither had any sound alternative proposal. Based on an alleged photosynthetic symbiosis, Retallack (1994) suggested that the Ediacara fossils might be large lichens. However, Seilacher (1992) has argued a case for the Ediacaran fossils belonging to a novel group of organisms based on a pneumatic quilt-like body structure and obtaining their nourishment by absorption through the integument. He proposed that this category could be a new kingdom or a new phylum, the Vendobionta. Neither the lichen nor the Vendobionta interpretations are supported herein.

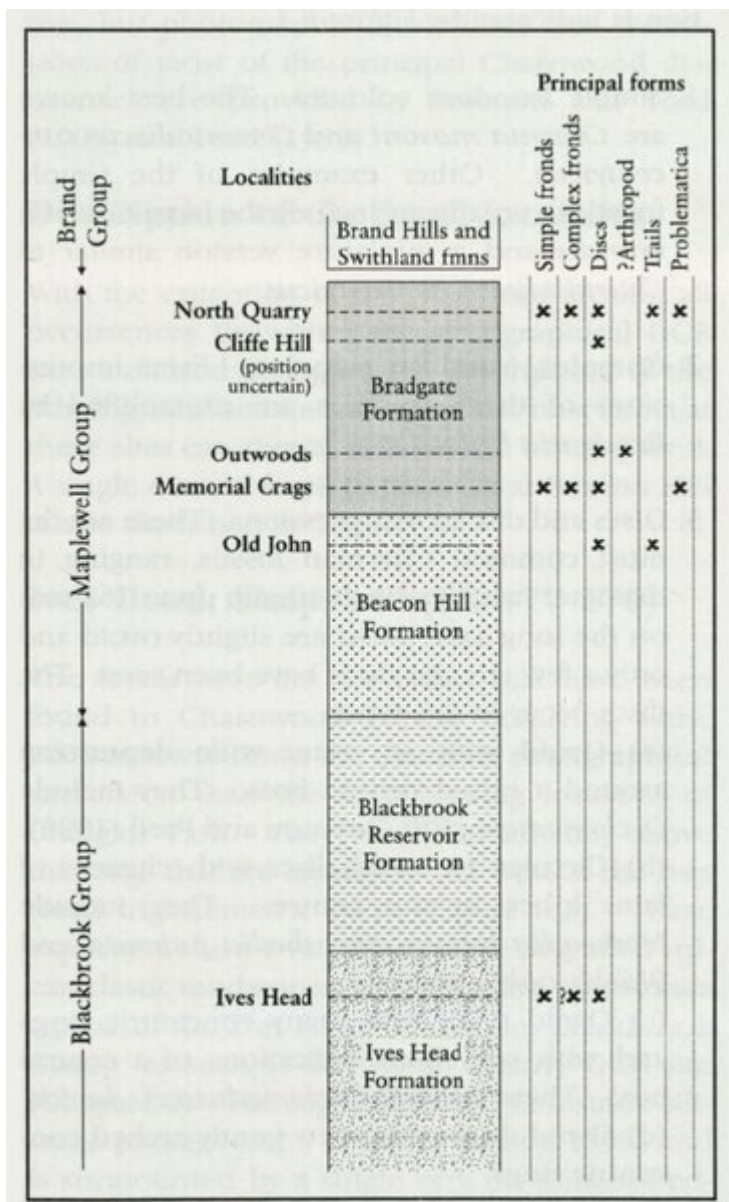
## Conclusions

The fossils of Charnwood Forest are rare examples of a diverse late Precambrian fauna that was preserved within deep-water, turbidite-dominated environments, and they consequently represent a unique insight into the early history of life on Earth. Fossil discoveries have been made at six levels in the Charnian Supergroup, encompassing some 3500 m vertical thickness of strata. The stratigraphically youngest horizons comprise four fossiliferous beds, near the top of the Maplewell Group in the Bradgate Formation. The two most important are at the North Quarry and Memorial Crags localities, and these show the most highly differentiated and diverse faunas yet found in Charnwood Forest. The oldest known fossils are those in the Ives Head Formation, near the base of the exposed Charnian sequence.

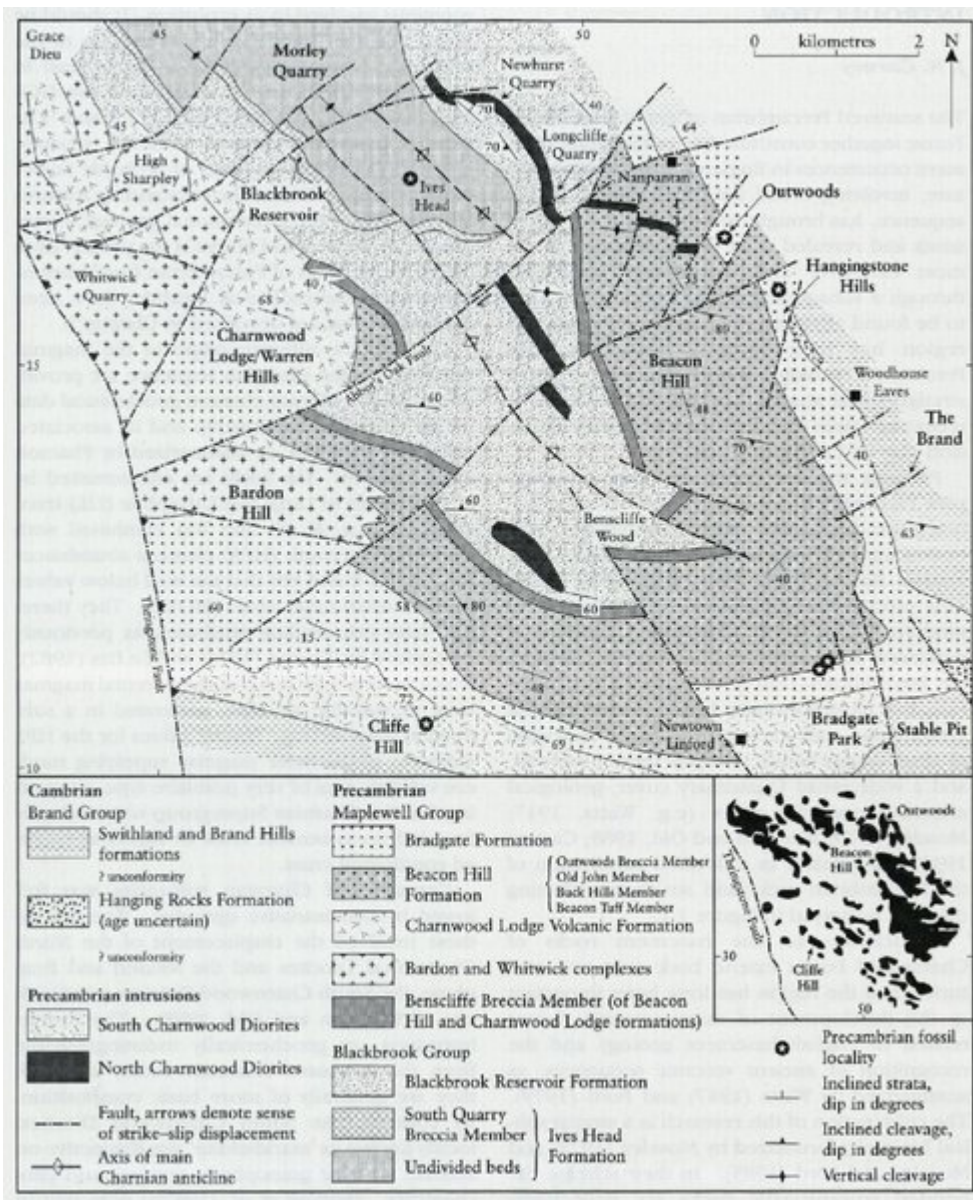
Six types of fossil and trace fossil have been found at localities in the Charnwood Forest, of which three proved amenable to taxonomic classification. Primitive colonial fossils, interpreted as sea-pens and placed in the extinct phylum 'Petalonamae', are represented by simple and complex frondose colonies exemplified by *Charnia masoni* and *Bradgatia linfordensis* respectively, with *Charnia grandis* considerably larger than *C. masoni*. Some disc-like fossils possessing a complex internal structure, or having frond-like attachments, are medusoid (jellyfish-like) organisms placed in the phylum Cnidaria; they include forms such as *Cyclomedusa cf. davidi* and *Cyclomedusa cliffi* and maybe some of the oldest fossils, from Ives Head, such as *Shepshedia palmata*. In addition, possible worm trails, problematic branch or stem-like fossils and an arthropod-like fossil *Pseudovendia charnwoodensis* have been found in the rocks of the Charnwood Forest.

These fossils have commonly been equated with the Ediacaran faunas of the late Precambrian found worldwide, and while there are many obvious similarities there also appear to be some differences. It is noteworthy that the age of the Charnian Supergroup has not yet been precisely constrained (see introduction to Chapter 2), but on the basis of present knowledge it is possible that its fossils may be somewhat older than the Ediacaran faunas found elsewhere.

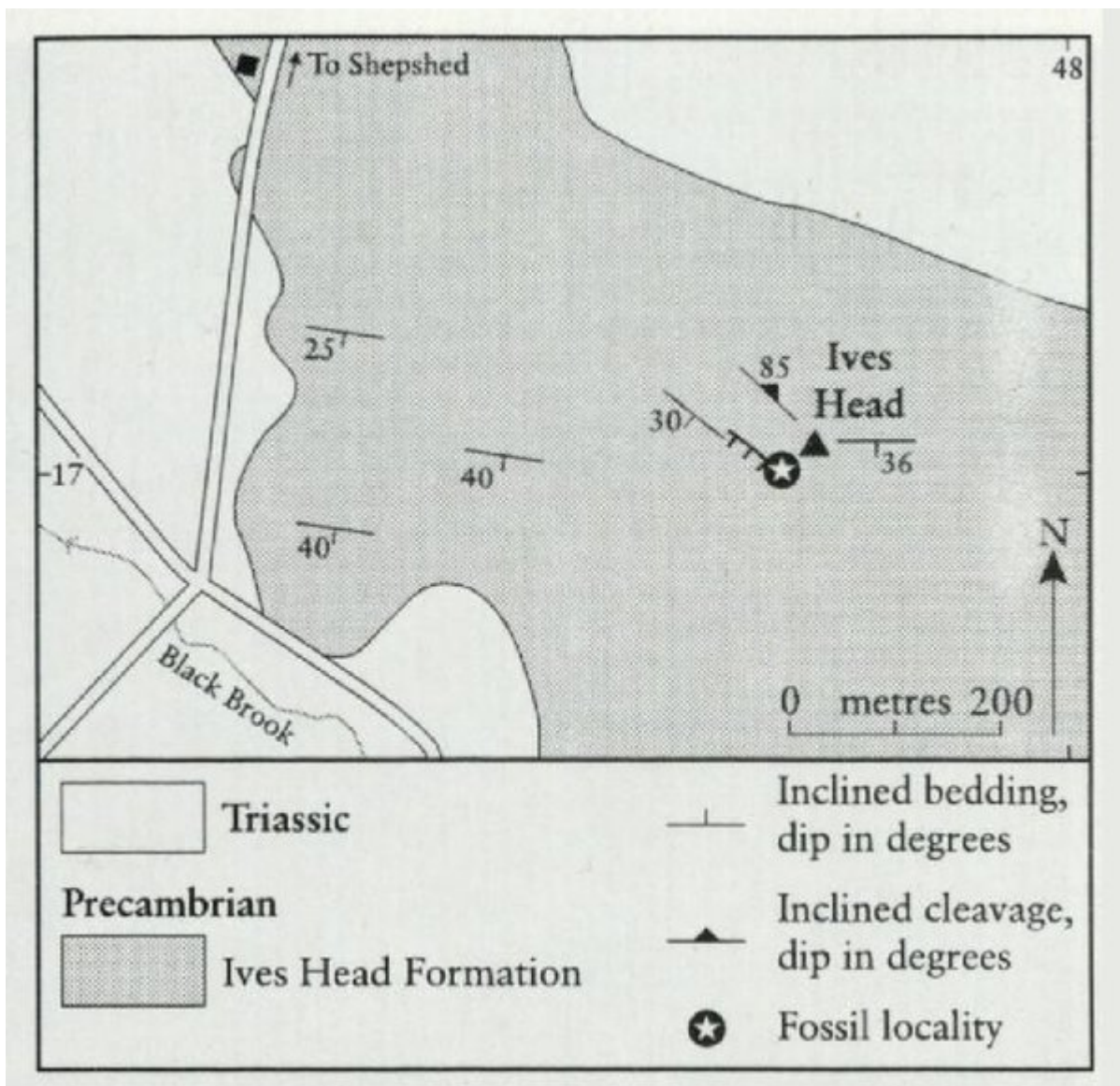
## [References](#)



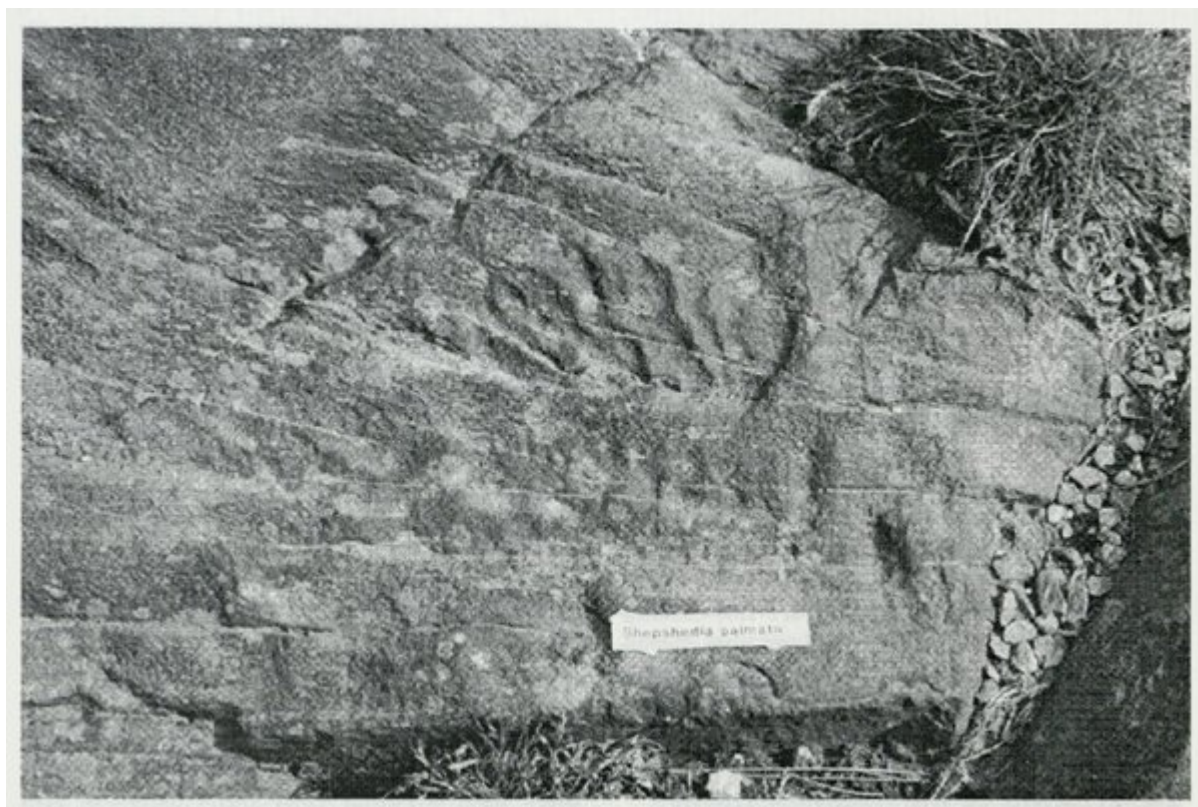
(Figure 8.1) The range and stratigraphical distribution of fossil forms in Charnwood Forest (the stratigraphical thicknesses shown are not to scale).



(Figure 2.1) Geological map of Precambrian and Cambrian rocks in Charnwood Forest, showing the locations of the GCR sites (in bold lettering). Note that younger rocks are omitted for clarity. The inset shows the actual extent of the 'basement' inliers (dark shading) between this younger cover. The latter mainly consists of Triassic strata, with Coal Measures included to the west of the Thringstone Fault; extensive veneers of Quaternary drift are also present (modified from Worssam and Old, 1988).

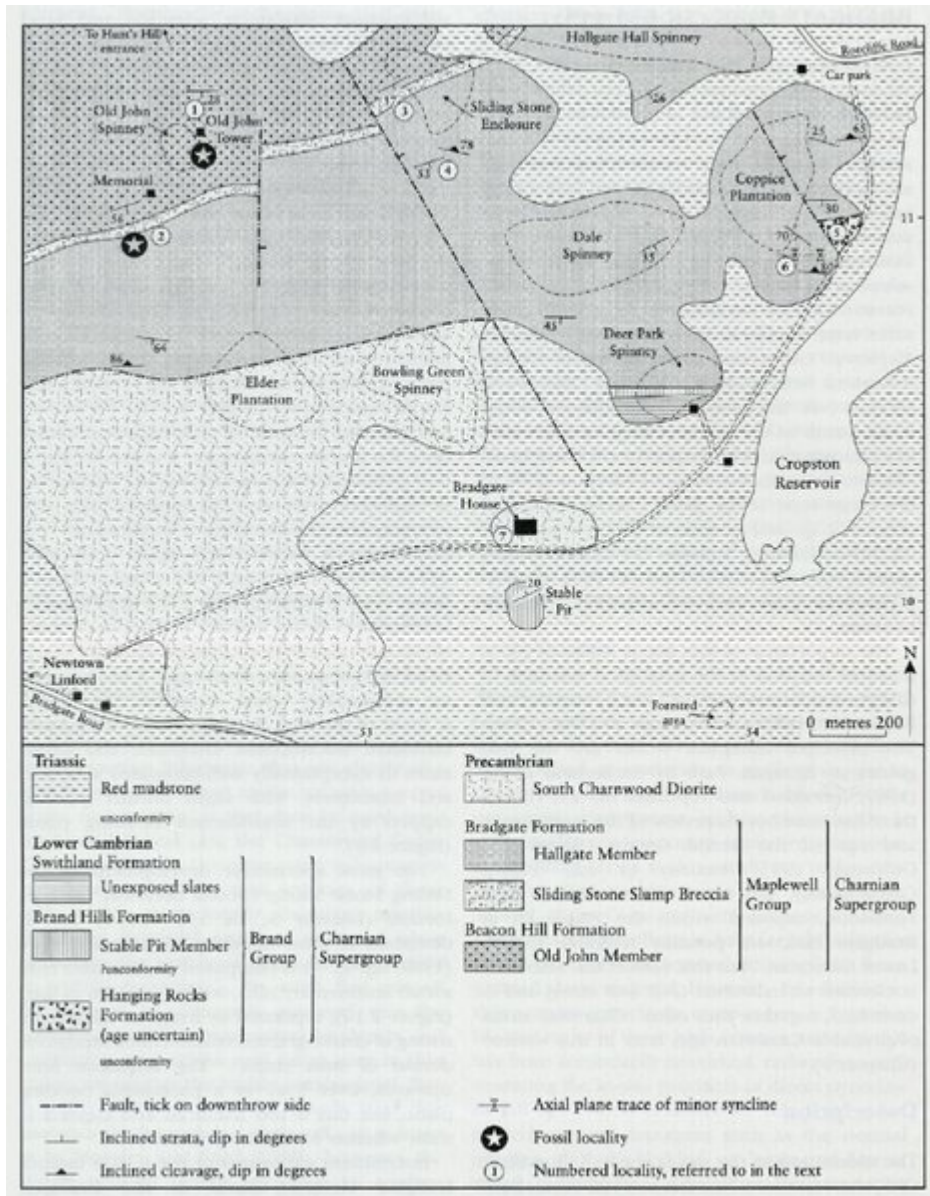


(Figure 8.2) Simplified geological map of the Ives Head fossil locality.

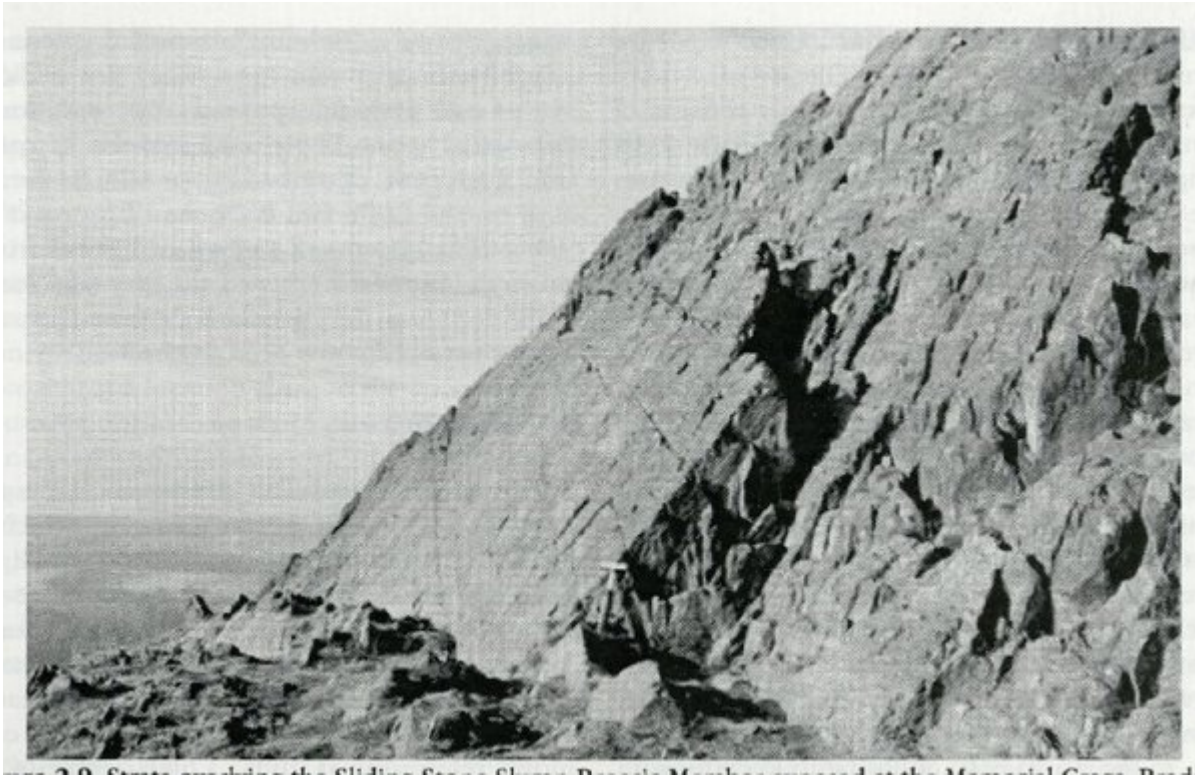




(Figure 8.3) The possible medusoid fossil, *Shepshedia palmata* at Ives Head. The impression is about 120 mm wide.  
(Photo: T.D. Ford.)



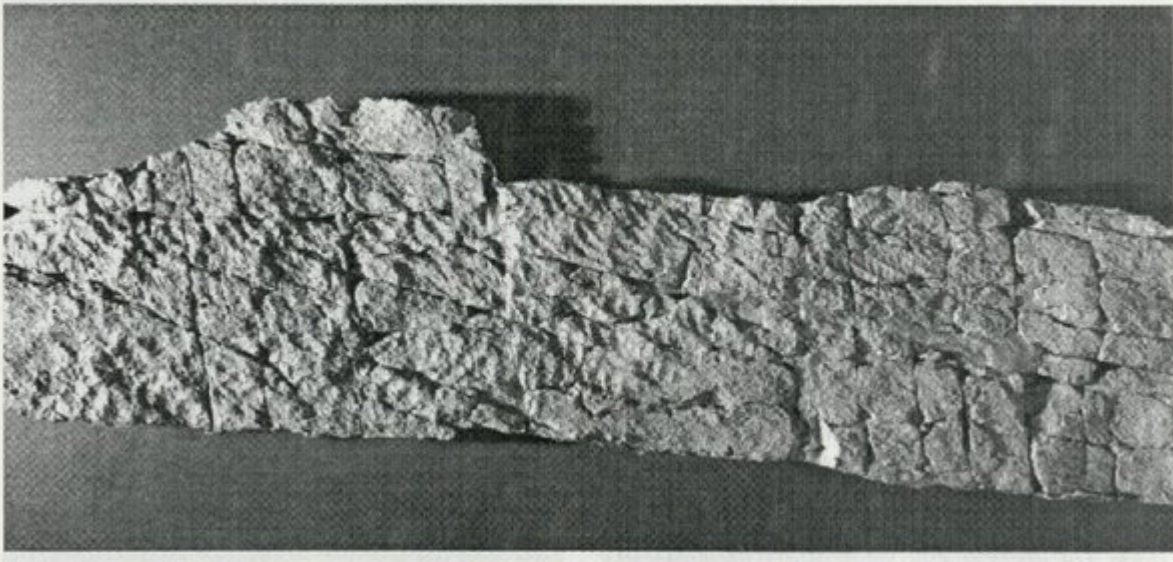
(Figure 2.8) Geological map of the Bradgate Park site, adapted from Sutherland et al., (1994) and Kelk and Old (1982).



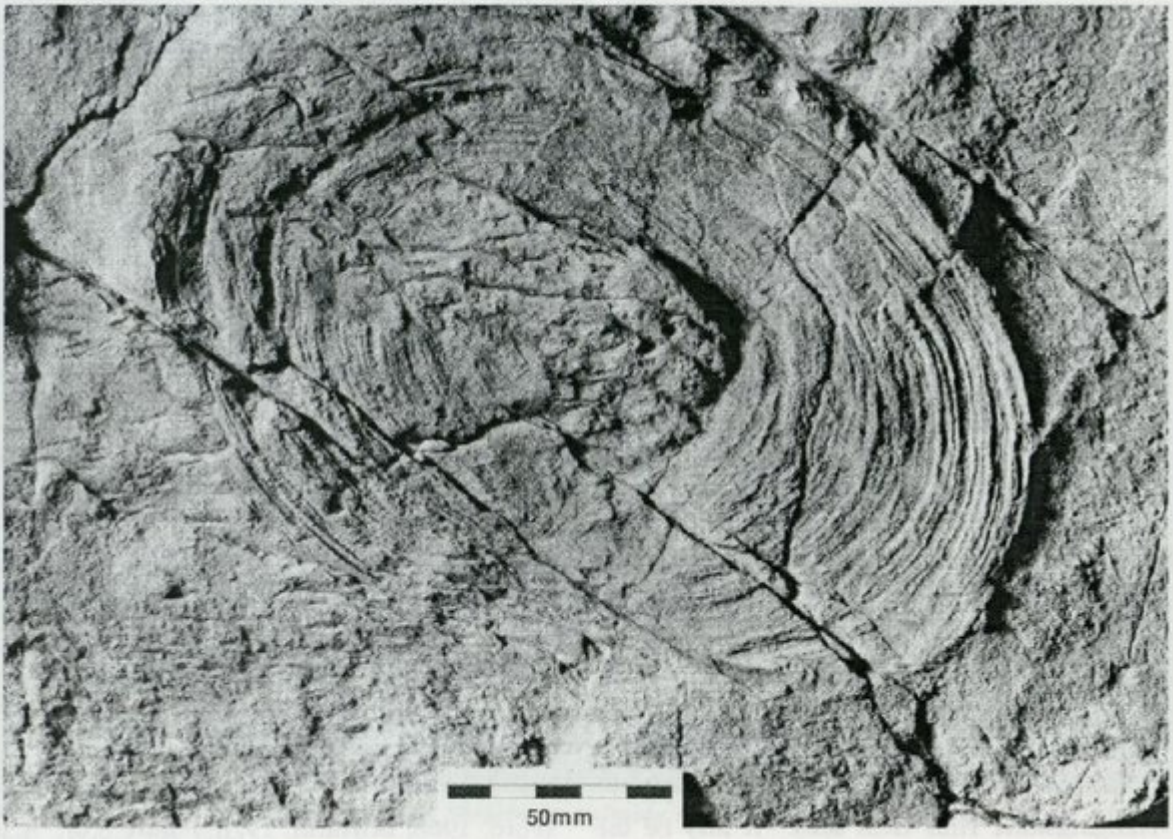
(Figure 2.9) Strata overlying the Sliding Stone Slump Breccia Member exposed at the Memorial Crags, Bradgate Park, showing the prominent bedding plane (to left) on which occur fossil impressions (see also, Chapter 8). (Photo: J.N. Carney)



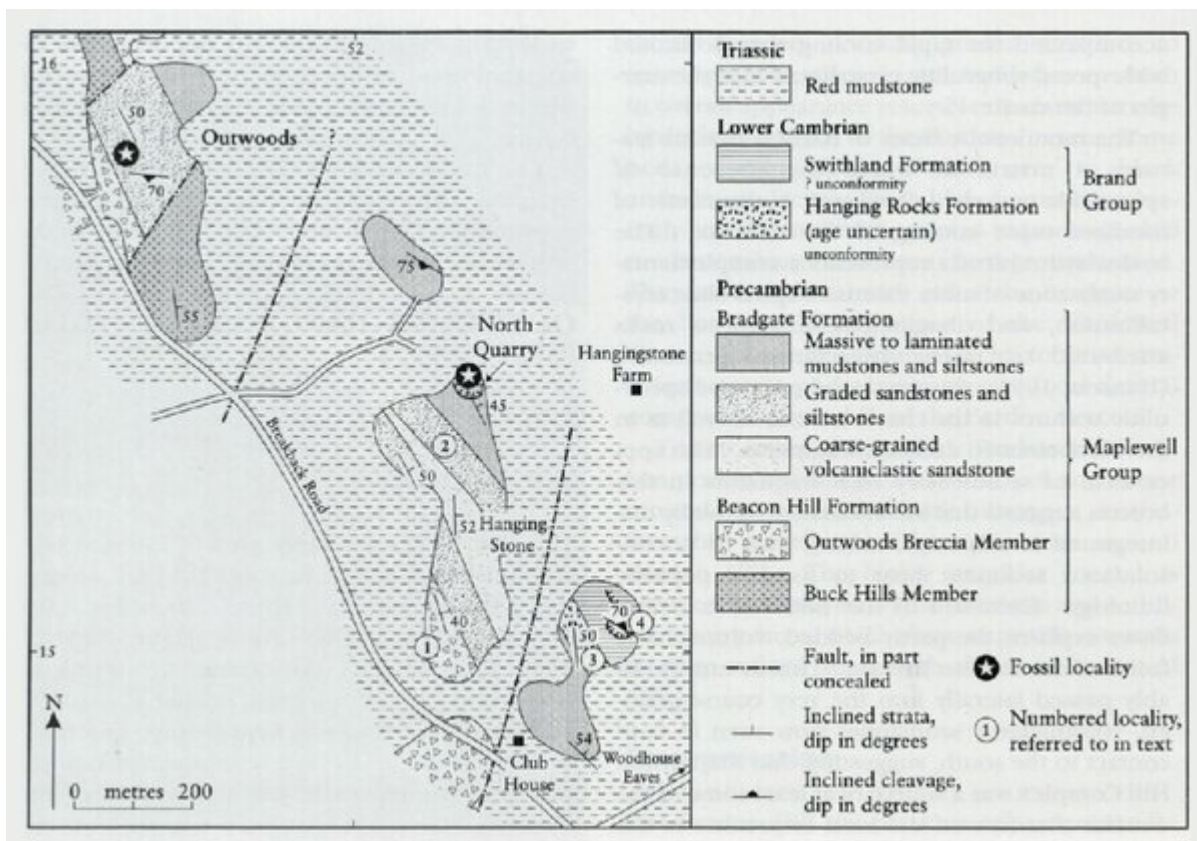
(Figure 8.4) Impression of the complex frondose organism, *Bradgatia linfordensis*, at the Memorial Crags locality. This specimen is about 100 m wide. Note also, the small ovoid disc-like impression on the left of the photo. (Photo: T.D. Ford.)



(Figure 8.5) Incomplete specimen of a large simple frond, *Charnia grandis*, from a cast taken at Memorial Crag. The specimen is 600 mm long. (Photo: T.D. Ford.)



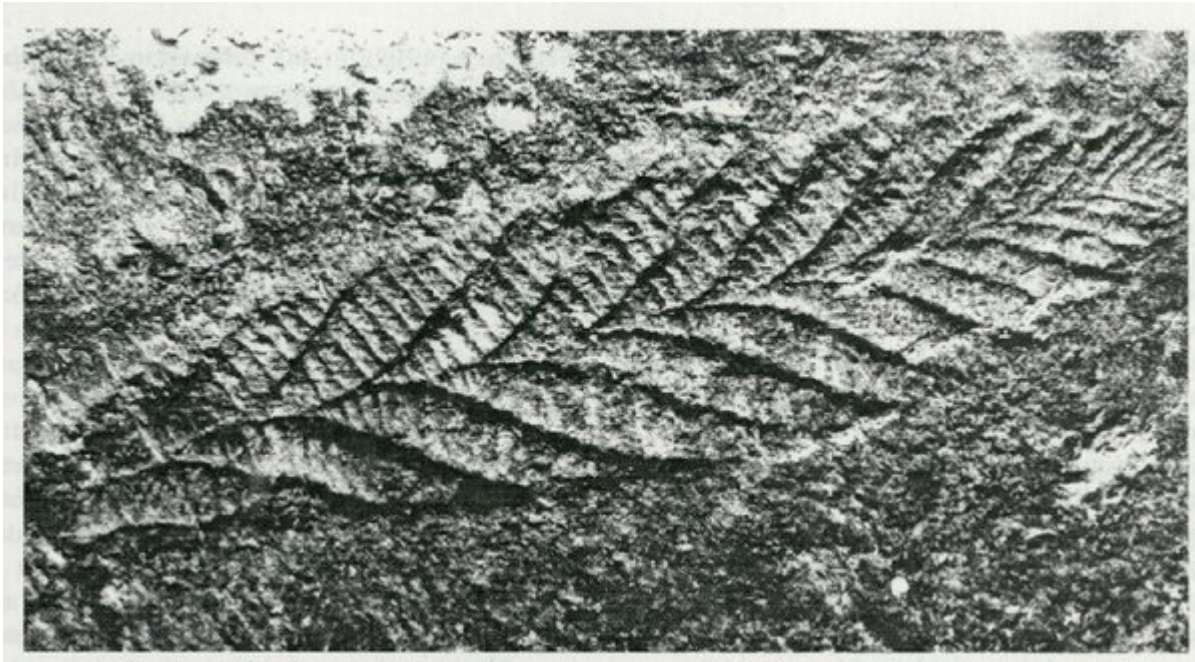
(Figure 8.6) Specimen of the possible medusoid fossil, *Cyclomedusa cf. davidi*, from the Outwoods locality. The fossil measures 220 x 160 mm. (Photo: T.D. Ford.)



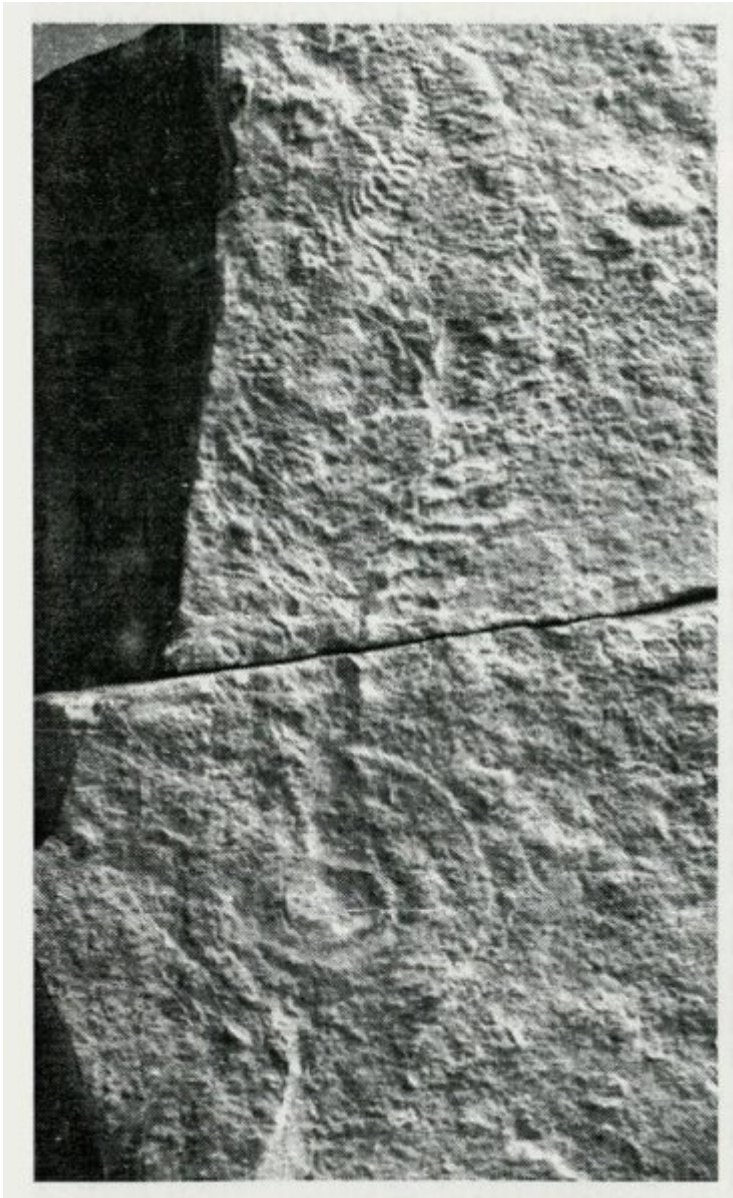
(Figure 2.15) Geological map of the Outwoods–Hangingstone Hills GCR site



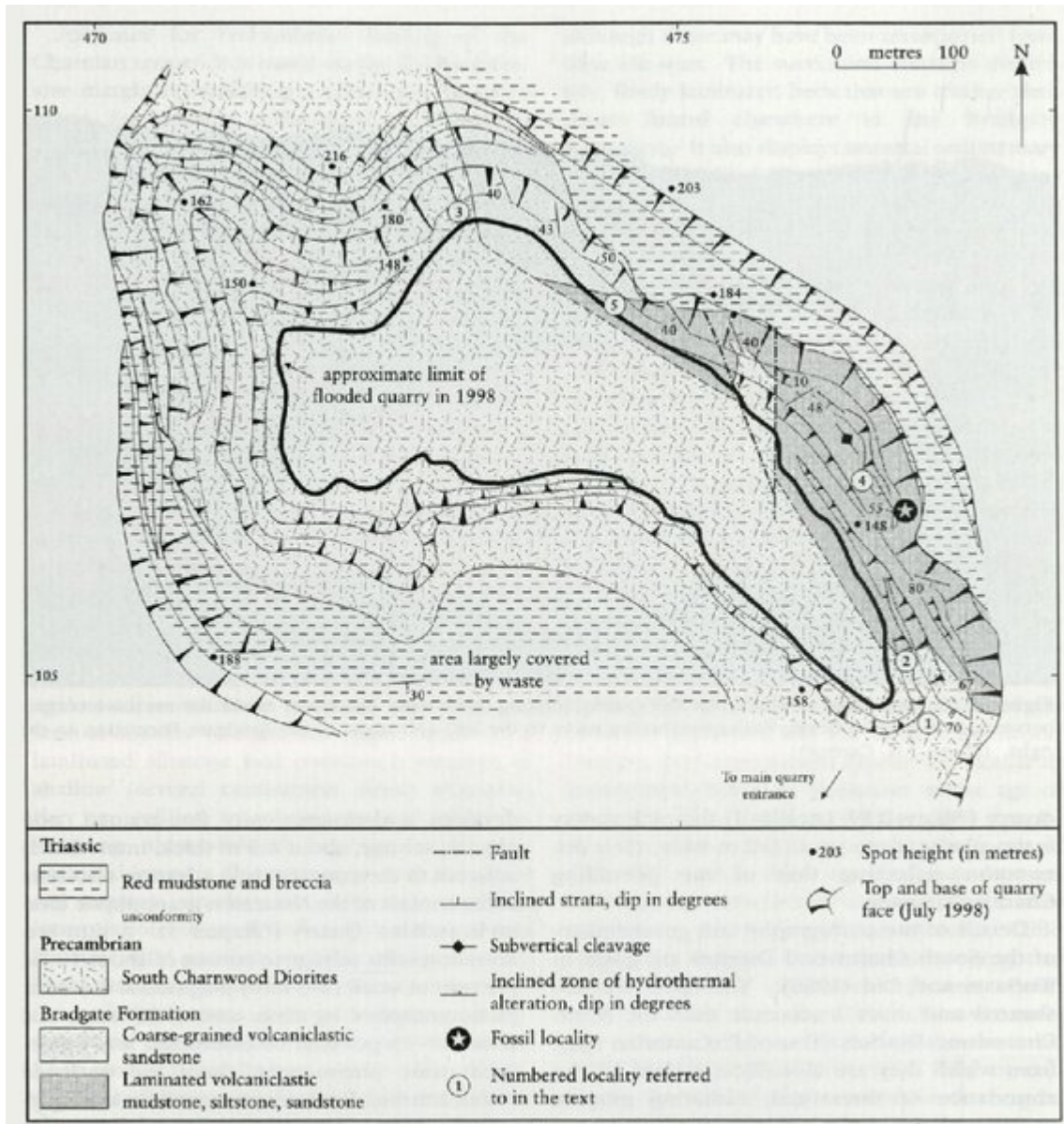
(Figure 2.17) Exposures at North Quarry in laminated, volcanoclastic siltstones near the top of the Bradgate Formation. The roped-up figure on the bedding plane is examining Precambrian fossil impressions (see Chapter 8). (Photo: T.D. Ford.)



(Figure 8.7) The simple frondose organism, *Charna masoni* at North Quarry on Charnwood Forest Golf Course. The specimen is 210 mm long. (Photo: T.D. Ford.)



(Figure 8.8) *Charniodiscus concentricus* from North Quarry. It shows a frond attached to a basal disc, which may either be a 'holdfast' or a float. This specimen is 250 mm long and the disc is 64 mm in diameter. (Photo: T.D. Ford.)



(Figure 2.19) Geological map of Cliffe Hill Quarry