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## Turin Hill, Angus

[NO 490 523], [NO 493 522], [NO 494 535], [NO 514 534], [NO 520 537], [NO 507 543], [NO 526 551], [NO 538 518], [NO 528 537]

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### Introduction

In the north-eastern part of the Midland Valley of Scotland, about 5 km east to ENE of Forfar, lie the group of quarries that together form this composite site (Figure 2.22). Turin Hill is the most prominent topographical feature in the small area covered by these outcrops, and this place-name was often used from at least the mid-nineteenth century onwards to indicate the provenance of fossil material from localities on the hill itself and its general vicinity. As described in the present volume, the site takes in Turin Hill quarries, Pitscandly Quarry, Wemyss Quarry, Mirestone Quarry (Figure 2.23), Aberlemno Quarry, Tillywhandland Quarry, Carsegowrie Quarry and Balgavies Quarry. The strata in all these exposures belong to the Lower Old Red Sandstone, Devonian, around 411 million years old, and their working for paving stones in the eighteenth and nineteenth centuries (Mackie, 1980) led to the discovery of fossils from them.

The general geology, palaeontology and tectonics of the Old Red Sandstone in this part of the Midland Valley has been discussed by Hickling (1908, 1912), Mykura (1991), Armstrong and Paterson (1970), Bluck (2002) and Trewin and Thirlwall (2002) amongst others. A stratigraphical framework for the Old Red Sandstone was provided by Browne *et al.* (2002). Aspects of the sedimentology, biofacies and palaeoenvironment have received more detailed coverage most recently from Trewin and Davidson (1996), Bluck (2000), Browne and Barclay (2005a) and Browne (2005a,b). Also, various localities that are included in this composite Turin Hill site were described in the field guide to accompany the 1978 international symposium on the Devonian System (Armstrong *et al.*, 1978).

Several authors have documented the arthropods from Turin Hill and associated Midland Valley localities. Page (1856a,b, 1859), Agassiz (1844), Salter (1859a), Woodward (1864b, 1865a, 1866, 1872), Waterston (1962, 1964, 1975) and Braddy (2000) have discussed the eurypterids, much of the finest material of which was recovered in the nineteenth century by James Powrie. Page (1856b, 1859), Peach (1882, 1899), Rolfe (1980), Almond (1985, 1986) and Wilson and Anderson (2004) have documented millipede and kampecarid myriapods. The arthropods from here are associated with fluvial and lacustrine settings and, significantly, some are implicated with the terrestrialization of the group.

Sites on and around Turin Hill that have been included in other GCR volumes include Aberlemno Quarry, in the volumes for fossil plants, fossil fish and the Old Red Sandstone (Cleal and Thomas, 1995; Dineley and Metcalf, 1999; Barclay *et al.*, 2005); Tillywhandland Quarry, in those for fossil fish and the Old Red Sandstone; and Clocksbriggs (also known as 'Wemyss') Quarry, which was described with Aberlemno Quarry under the site name Turin Hill' in that for fossil plants.

### Description

The quarries comprising this site belong to the Arbuthnott–Garvock Group of Lower Devonian, Lochkovian and Pragian age (Browne and Barclay, 2005a). Only some of them have been logged in modern times and most have been abandoned for decades, if not a century, or more.

Undifferentiated quarries and exposures under the name 'Turin Hill' [NO 514 534] and [NO 520 537] have produced numerous fine specimens of *Pterygotus anglicus* Agassiz, 1844 (Figure 2.24) and (Figure 2.25), a eurypterid much celebrated in 19th century works, and estimated (Kjellesvig-Waering, 1964) to reach up to 1.75 metres in length from the anterior of the carapace to the end of the telson. 'Turin Hill quarries' also represent the type locality for *Stylonurus ensiformis* Woodward, 1864, which has recently been regarded as a junior synonym of *Stylonurus powriensis* Page, 1856 (Agassiz, 1844; Hickling, 1912; Woodward, 1864b, 1866; Salter, 1859a; Kjellesvig-Waering, 1964; Waterston, 1964; Braddy, 2000). In addition the kampecarid *Kampecaris forfarensis* Page, 1856 has been recorded from here (Peach,

1882; Hickling, 1912).

**Tillywhandland Quarry** [NO 528 537] exposes beds of the Dundee Flagstone Formation of early early Lochkovian age (Richardson and MacGregor, 1986). According to Trewin and Davidson (1996) it was the main source in the nineteenth century of fossil specimens in laminite lithologies labelled 'Turin Hill'. The sequence here includes a fish bed, one of eight recognized in the Strathmore region and between which correlation is uncertain (Armstrong and Paterson, 1970; Armstrong *et al.*, 1978; Trewin and Davidson, 1996; Dineley, 1999c; Browne, 2005b). About 3 m of medium to coarse-grained sandstones, in part trough cross-bedded and in part parallel-laminated, and with two pebble-lined erosion surfaces, form the base of the section. Above this is the fish-bearing laminite, which is about 1.3 m thick, with sandstone dykes penetrating upwards into its basal 0.5 m, and with a 6 cm thick bentonite 1 m above its base. Succeeding the fish bed there is an 11 m coarsening upwards sequence of silt-stones and fine sandstones with minor laminites. The sandstones below the fish bed indicate high-energy fluvial channel deposits, the fish bed laminites represent phytoplankton-based lacustrine deposits, and the overlying siltstones and sandstones indicate the infilling and shallowing of the lake. The fish bed has yielded plant and eurypterid material in addition to early vertebrates, and it shows evidence of burrowing. The eurypterids recorded from the quarry are *Pterygotus anglicus* and *Parahughmilleria* sp. (Hickling, 1912; Armstrong *et al.*, 1978; Braddy, 2000). *Archidesmus macnicoli* Peach, 1882, a very rare millipede, has been recovered from the fish bed and from laminites in the overlying siltstones (Wilson and Anderson, 2004; (Figure 2.26)).

**Pitscandly Quarry** [NO 490 523] showed some 40 m of strata when it was logged in the late 1970s (Armstrong *et al.*, 1978). The lower 20 m comprises indifferently exposed conglomerates and arkosic sandstones. Above these are about 10 m of grey, horizontally laminated, fine-grained sandstones interbedded with grey, green and red mudstones. The genesis of these beds has been interpreted as fluvial/lacustrine, and the mudstones have yielded *Kampecaris forfarensis*. Up-section, overlying the essentially lacustrine deposits, there are about 10 m of braided fluvial conglomeratic deposits that have an erosion surface or channelling at their base. Pitscandly is the type locality for *Stylonurus powriensis* (Page, 1856; see also, for example, Woodward, 1865a, 1872b; Hickling, 1912; Kjellesvig-Waering, 1966; Braddy, 2000).

**Wemyss Quarry** [NO 493 522], adjacent to Pitscandly Quarry, and Mirestone Quarry [NO 494 535], on the north side of Pitscandly Hill, are possible sources of some 19th, century arthropod material.

**Aberlemno Quarry** [NO 526 551] exposes some 9.5 m of strata along a 300 m face (Armstrong *et al.*, 1978; Dineley, 1999c; Browne, 2005a). The lowest 2 m of sediments are largely fine sandstones and laminated siltstones and mudstones of the Dundee Flagstone Formation, interpreted as those of a shallow lake ((Figure 2.27) and see (Figure 2.29)). They have yielded a fauna of fish, plants, and arthropods, the latter including (Armstrong *et al.*, 1978) the eurypterids *Pterygotus* and *Erieopterus* (though note that Braddy, 2000, has dismissed British records of the latter genus), and the enigmatic *Dictyocaris*. The highest 7.5 m comprises trough-bedded sandstones belonging to the Scone Sandstone Formation, which are thought to have formed in a braided stream complex. The Aberlemno fish bed within the Dundee Flagstone Formation here has been correlated on palynological grounds with a lower Lochkovian horizon in the Anglo-Welsh Basin (Richardson *et al.*, 1984).

**Carsegowrie (or Carsgowrie) Quarry** [NO 507 543] has yielded *Pterygotus anglicus* (see Hickling, 1912; Armstrong and Paterson, 1970).

**Balgavies Quarry** [NO 538 518] is probably the type locality for the stylonurid eurypterid *Tarsopterella scotica* Woodward, 1865 (see Woodward, 1865a, 1872b; Hickling, 1912: his 'Montreathmont'; Waterston, 1975; Braddy, 2000; (Figure 2.28)).

Other Arbutnott–Garvock Group, Midland Valley fossil localities that have also yielded arthropods (see Armstrong and Paterson, 1970, fig. 1; Braddy, 2000, fig. 1) include the following:

**Montreathmont Muir, 12 km ENE of Forfar**, for eurypterids (Armstrong and Paterson, 1970; Braddy, 2000).

**Canterland Den, 30 km NE of Forfar**, from where *P. anglicus* and *Kampecaris forfarensis* have been listed (Peach, 1882; Hickling, 1912).

**Carmyllie quarry complex, 12 km ESE of Forfar**, is probably the type locality for the stylonuroid *Pagea sturrocki* Waterston (1962) and *Pterygotus anglicus* is also recorded from here (Hickling, 1912; Waterston, 1962). One of these quarries also yielded a syntype specimen of *Archidesmus macnicoli* (Peach, 1882; Wilson and Anderson, 2004).

**Kelly Den, 18 km south-east of Forfar** is the type locality of the monotypic *Erieopterus brewsteri* Woodward, 1864, a species recently considered to be based on a juvenile specimen of *Tarsoptereella scotica*, but which, note, has priority over the latter species (see Woodward, 1865a; Kjellesvig-Waering, 1958; Braddy, 2000). The stream section here is also possibly the type locality of the chasmataspid chelicerate *Forfarella mitchelli* Dunlop, Anderson and Braddy (1999; see also Braddy, 2000). Chasmataspids are known from just five species globally, one from Ordovician rocks of the USA, two from the Devonian strata of Scotland (the other is *Achanarraspis reedi* Anderson, Dunlop and Trewin, 2000 from the Middle Devonian of Caithness), and two from the Lower Devonian of Germany.

**Farnell is a locality 16 km ENE of Forfar** from where *Pterygotus anglicus* and *Pterygotus minor* Woodward, 1864 have been recorded. The latter species, however, based on a small juvenile specimen with more dorsally placed eyes than the former, has recently been re-interpreted as a junior synonym of *P. anglicus* (Woodward, 1864b; Hickling, 1912; Braddy, 2000).

**Whitehouse Den, 11 km SSW of Forfar**, has yielded the hughmillerid eurypterid *Nanahughmilleria pygmaea* Salter (1859b; see Braddy, 2000).

**Balmashanner Quarry, 1 km south of Forfar**, has yielded eurypterid material that probably belongs to *N. pygmaea* (Salter, 1859b; see Braddy, 2000).

**Balruddery, 22 km south-west of Forfar**, has yielded *P. anglicus* (Agassiz, 1844; Hickling, 1912; Salter, 1859a; Kjellesvig-Waering, 1964; Braddy, 2000) and *Kampecaris forfarensis* (Peach, 1892; Hickling, 1912).

## Interpretation

The laminite deposits and associated fish/arthropod fauna of the Dundee Formation, Arbutnott–Garvock Group, represent those of 'Lake Forfar', which is speculated to have formed as a result of drainage impediments to the south-west caused by local volcanic activity, together with progradation of synsedimentary fault-controlled alluvial fans in the north-west (Trewin and Davidson, 1996). Annual, varve-type deposits of the Tillywhandland fish bed laminites are reckoned to have formed over about 2000 years.

The eurypterid fauna of the Lower Old Red Sandstone, Devonian, of the Midland Valley numbers about seven species, and comprises two main facies assemblages: a clastic fluvial sequence and a finer-laminated lacustrine sequence (Braddy, 2000; (Figure 2.29)). The benthic stylonuroids (*Pagea*, *Stylonurus*, *Tarsoptereella*) are thought to have inhabited river channel systems surrounding Lake Forfar. The pterygotids (*Pterygotus*) and hughmillerids (*Hughmilleria*, *Parahughmilleria*, *Nanahughmilleria*), together with the chasmataspid *Forfarella*, are believed to have lived primarily in the lake shallows. The occurrence, incidentally, of pterygotids in this freshwater lacustrine setting suggests that the tripartite eurypterid biofacies model of Kjellesvig-Waering (1961), in which the Carcinomatidae–Pterygotidae phase was interpreted as the most open marine of the three, is open to question (Braddy, 2000). Myriapods occurred with plants on the lake margins. The kampecarids perhaps favoured freshwater aquatic habitats (Almond, 1985). Marine faunas are absent. Various faunal elements, including eurypterids and millipedes, were washed into the deeper parts of the lake (Trewin and Davidson, 1996; Wilson and Anderson, 2004). The pterygotids, the most common of the arthropods, are preserved as near complete exuviae or as fragments, ranging in size from about 15 cm to 1.8 m.

The morphology of *Pterygotus* and *Hughmilleria* in general indicates that they were active, nektonic predators, whereas that of the stylonuroids suggests that they were part of the benthos (Størmer, 1934). Various aspects of the morphology of the 'Turin Hill' stylonuroids were related by Waterston (1979) to maintaining stability in a relatively high-energy environment. Additionally, the excellent preservation of the Balgaves Quarry type material of *Tarsoptereella scotica* has been used to interpret the nature of its gill tracts as essentially extensions of the body wall, thus confirming that the eurypterid gill is more comparable with the respiratory structures in scorpions rather than those of xiphosurans

(Waterston, 1975).

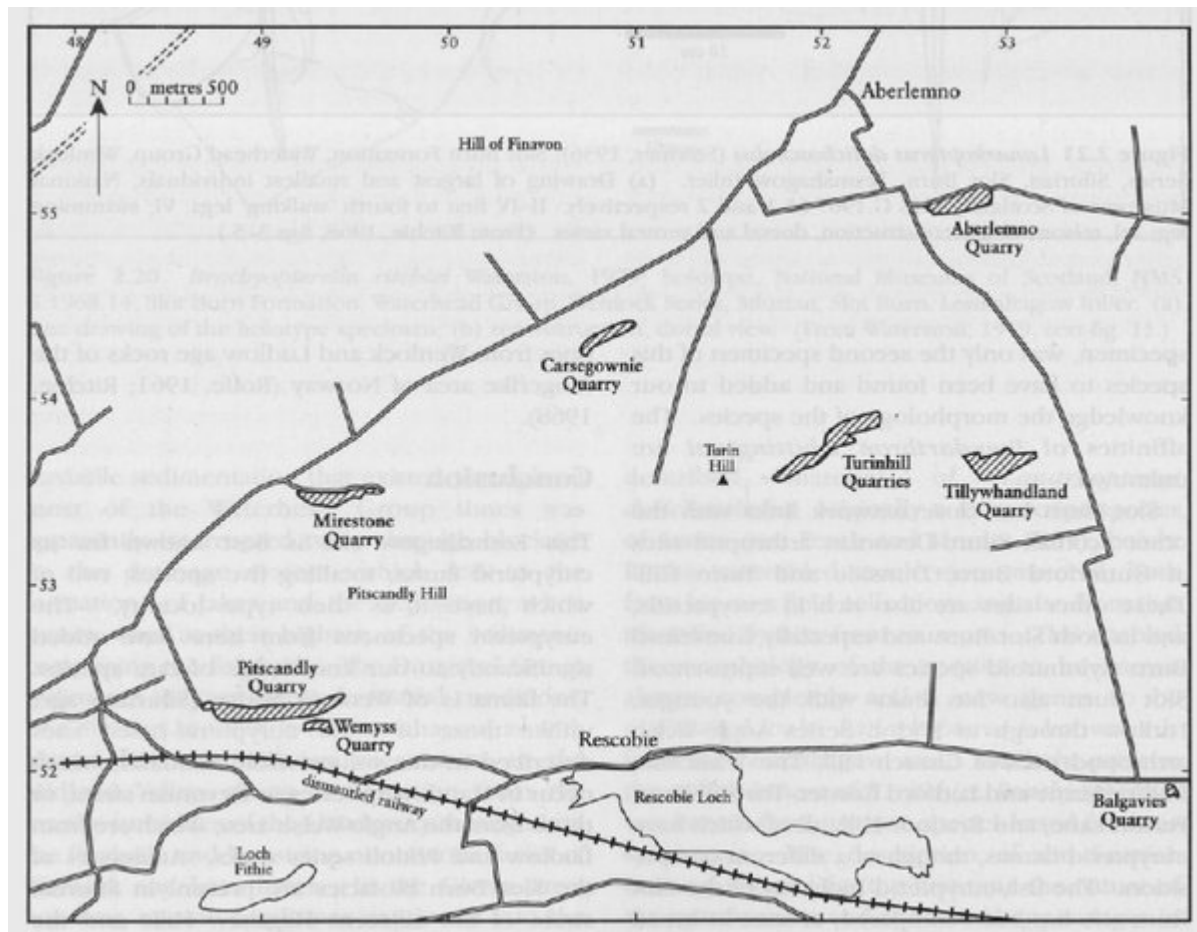
This Turin Hill site has close arthropod network links with the other Scottish Siluro-Devonian arthropod sites of Gutterford Burn, Dunside, Slot Burn, and Rhynie, especially the first three, which are also essentially eurypterid-based. It also has links with the Ludlow through to Pídolí Series Anglo-Welsh arthropod sites of Church Hill, The Whitcliffe, Ludford Lane and Ludford Corner, Tin Mill Race, Perton Lane, and Bradnor Hill, all of which also have important eurypterid faunas, but ones that contrast in composition with those from Turin Hill. Stonehaven (upper Wenlock—?lowermost Ludlow series), Ludford Lane and Ludford Corner (upper Silurian) and Rhyme (Lower Devonian) are other arthropod networked GCR sites yielding myriapods.

In terms of palaeogeography, between early and late Devonian times Scotland moved north from around 30° south to 20° south. The Iapetus Ocean had perhaps finally closed and Scotland had become part of the Old Red Sandstone continent of Euramerica, sandwiched between Greenland and Scandinavia. However, the presence of extensive volcanism in the Lower Old Red Sandstone from the Lorne Province, north-west of the Highland Boundary Fault through the Midland Valley and across the Southern Uplands Fault to the Cheviot Hills, might indicate continuing subduction in this region (Thirlwall, 1981).

## Conclusion

This composite Lower Devonian site has yielded excellent fossil material of *Pterygotus anglicus* and other eurypterids, notably stylonuroids, most of which was collected and first investigated during the course of classic 19th century studies of this major, extinct arthropod group. Some of the quarries comprising the site represent the type localities for some of the eurypterid species found there. Very rare millepede and kampecarid myriapods also occur, the aforementioned, at least, being potentially important in helping to assess the nature of arthropod terrestrialization.

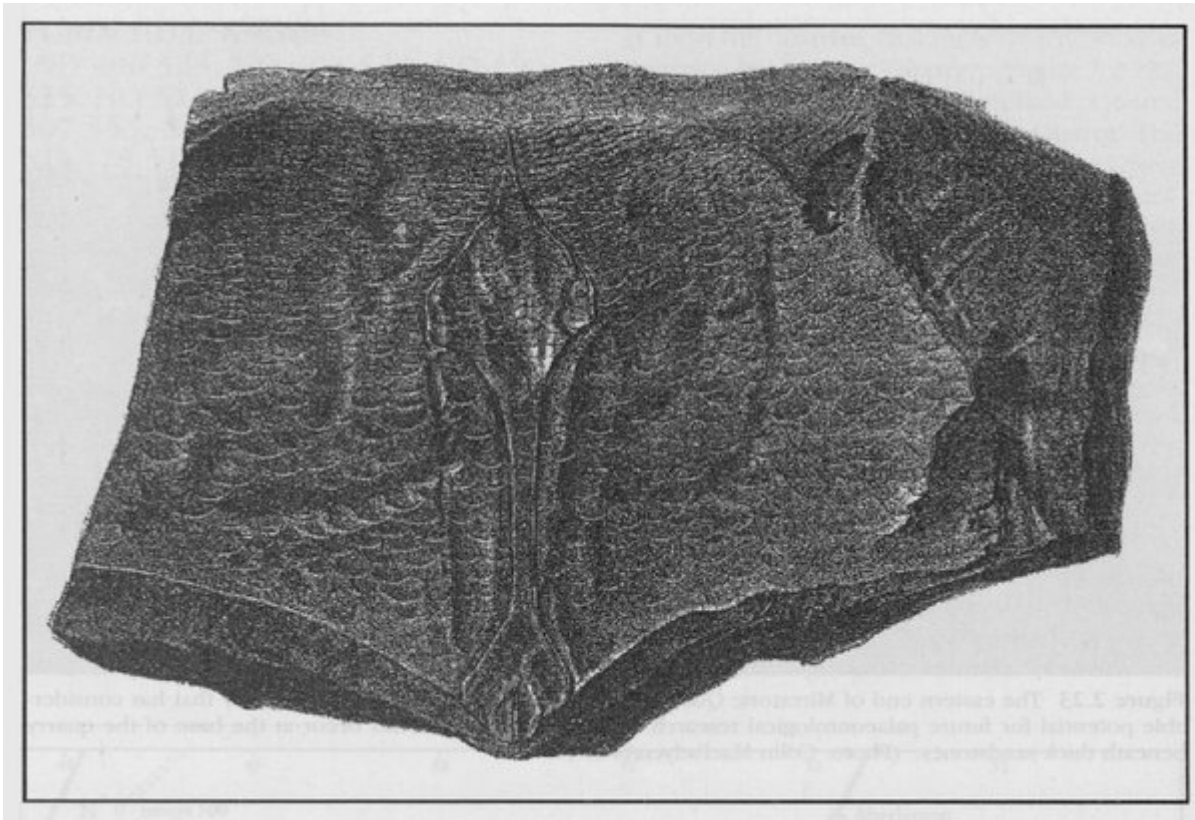
## References



(Figure 2.22) Location of quarries comprising the Turin Hill GCR site.



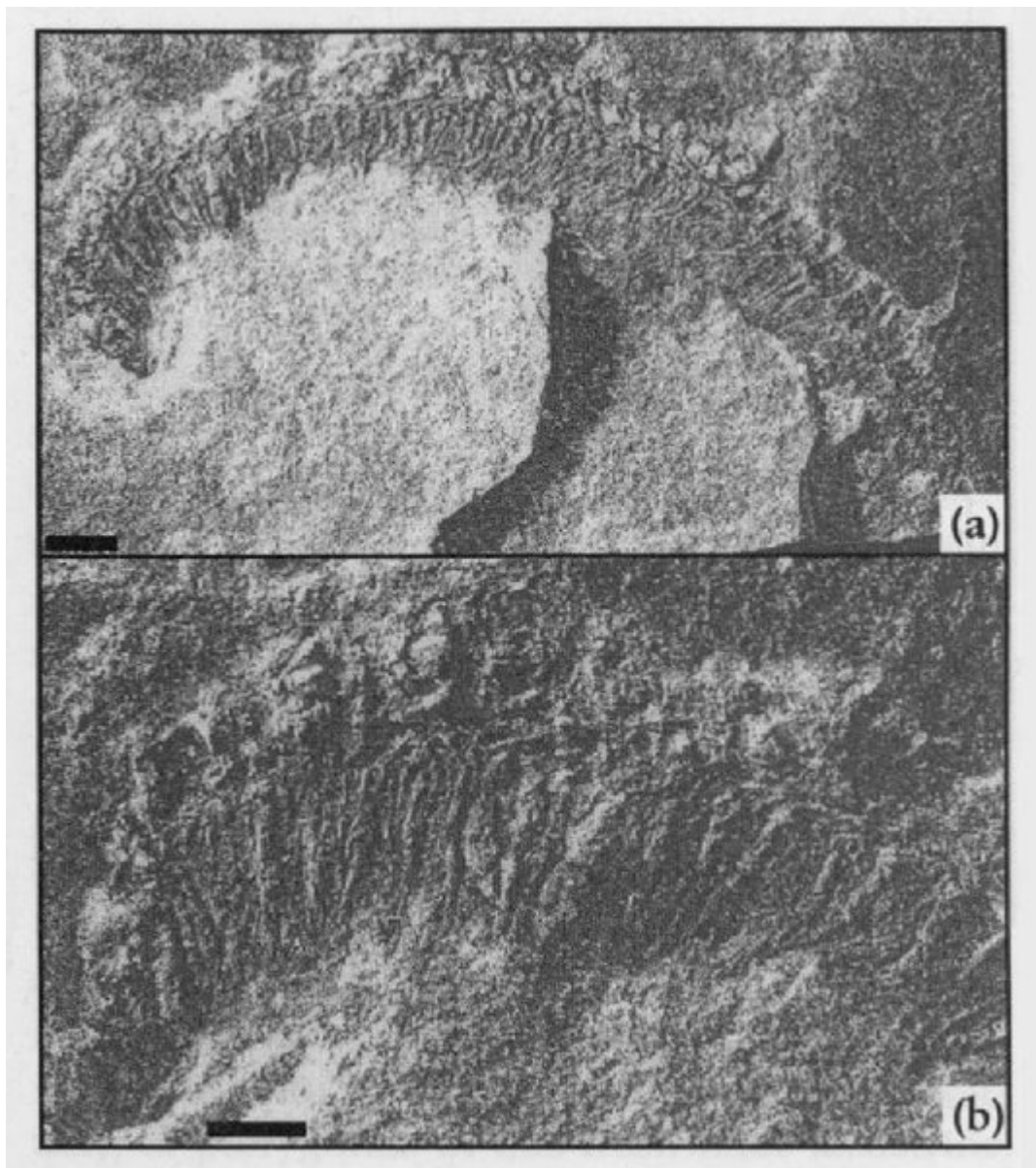
(Figure 2.23) The eastern end of Mirestone Quarry, Turin Hill. A long-disused stone quarry that has considerable potential for future palaeontological research. Fossiliferous mudstones occur at the base of the quarry beneath thick sandstones. (Photo: Colin MacFadyen/SNH.)



(Figure 2.24) *Pterygotus anglicus* Agassiz, 1844; National Museums of Scotland, Kinnaird Collection 49, Lower Devonian, Balruddery. Opercular plates with the median appendage attached. (Lithograph, from Agassiz, 1844.)

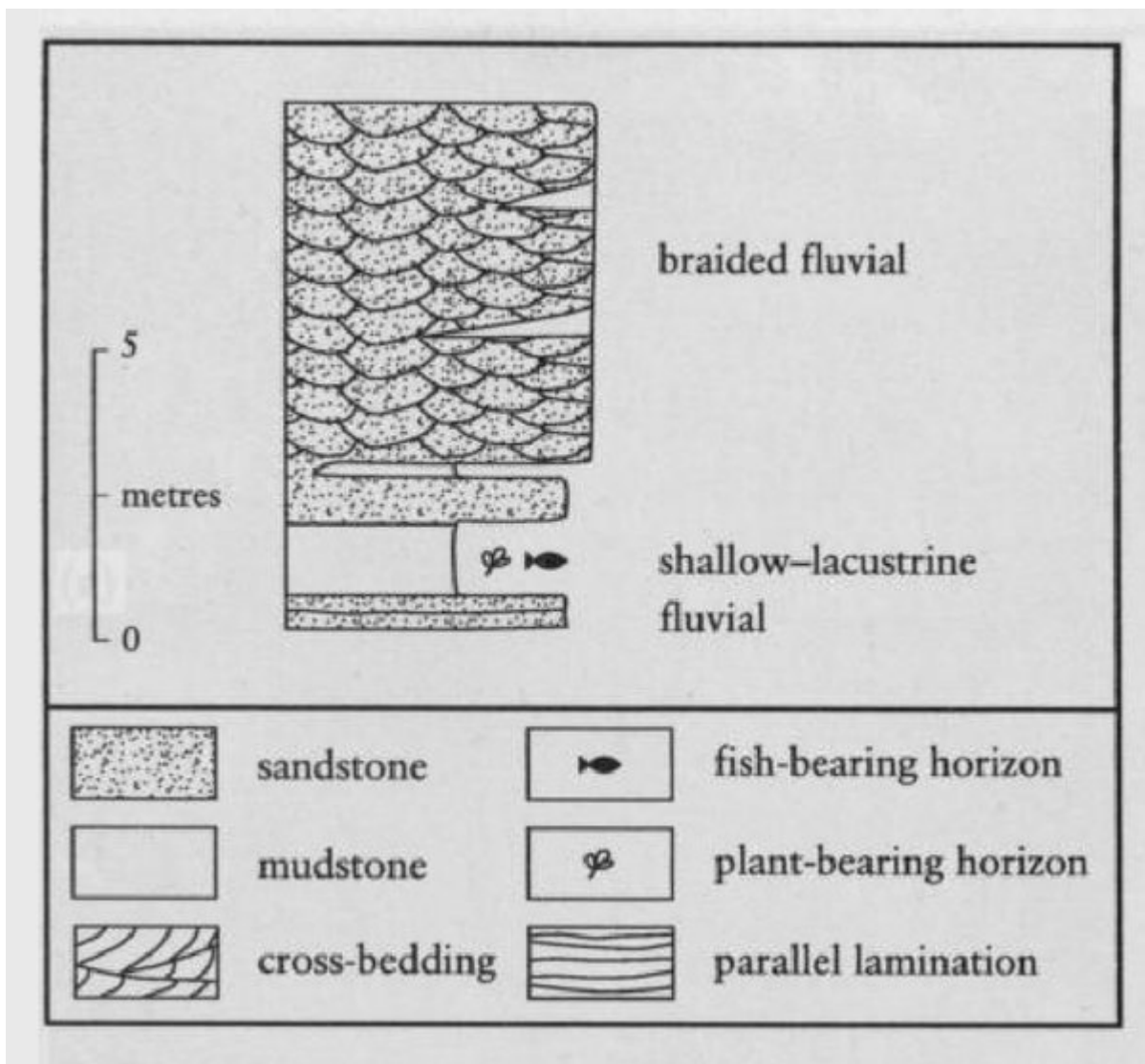


(Figure 2.25) *Pterygotus anglicus* Agassiz, 1844; From Indurated shale overlying the Arbroath Paving-stone', Turin Hill Range, near Forfar. One of the most entire specimens obtained. From the Museum of James Powrie, Esq., F.G.S., Reswallie, Forfar. 1-5, appendages; C, antennae; i, small triangular plate; O, oval marginal eyes; P, metastoma or post-oral plate.' (Lithograph, x 0.5, from Woodward, 1866, plate 2, fig. 1.)

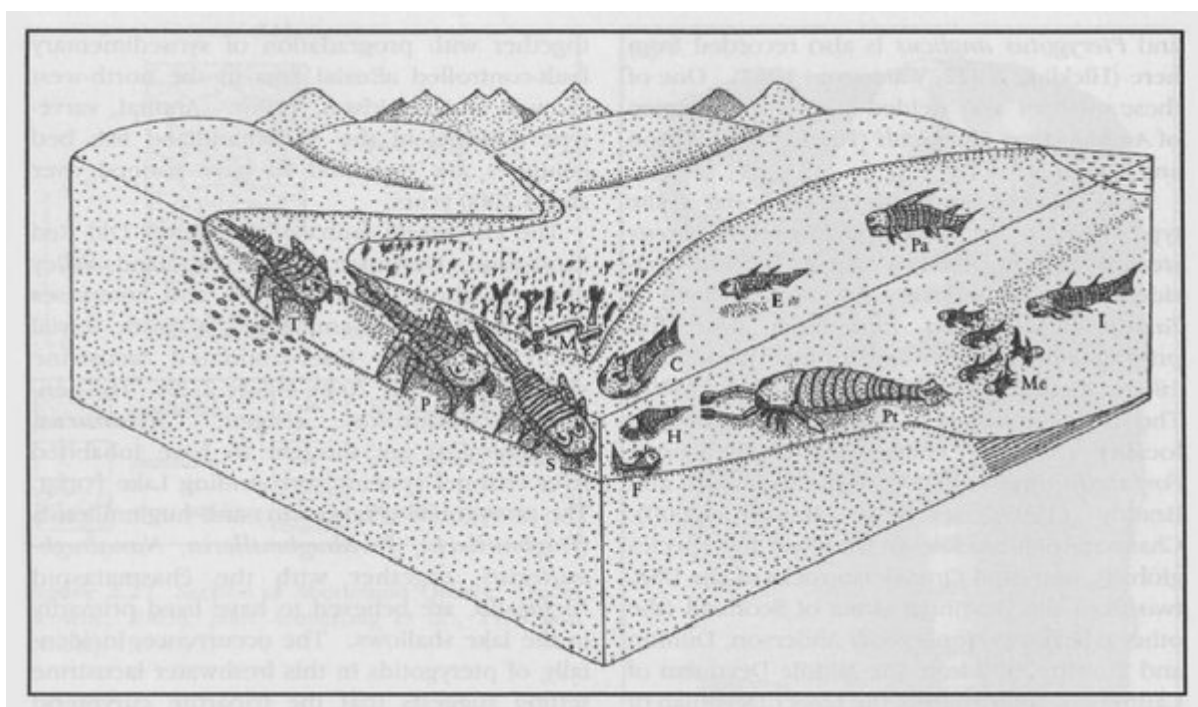


(Figure 2.26) *Archidesmus macnicoli* Peach, 1892; University of Aberdeen, Department of Geology, AUGD 12302b; Fish bed, Dundee Formation, Arbuthnott–Garvock Group, Lower Devonian, Tillywhandland Quarry, 8 km ENE of Forfar, Midland Valley of Scotland. Scale bar in (a) = 2mm, (b) = 1mm. (Photographs from Wilson and Anderson, 2004, figs 4.1 and 4.2.)





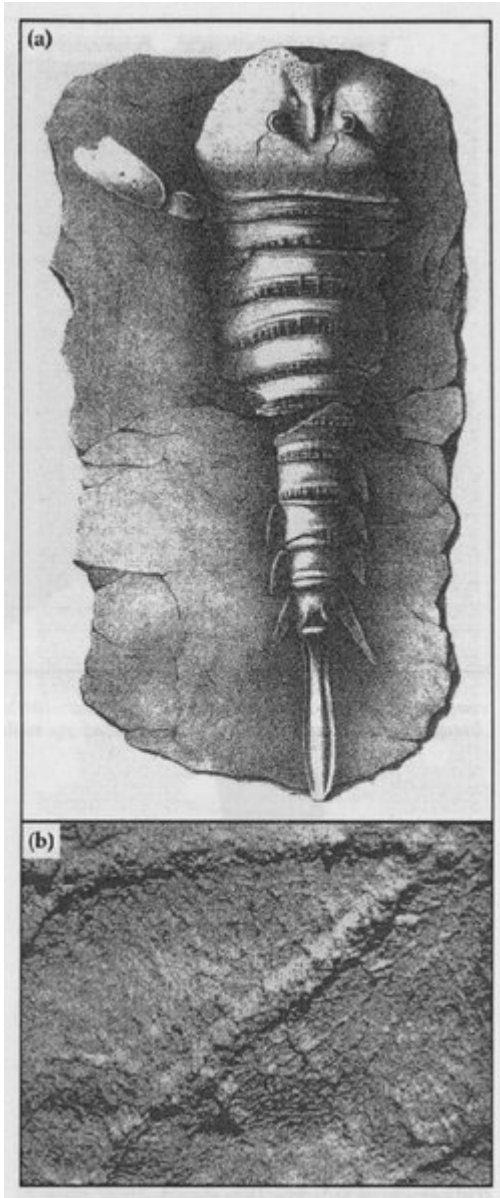
(Figure 2.27) Section of Aberlemno Quarry. (From Browne, 2005a, after Armstrong et al., 1978 and Dineley, 1999c.)



(Figure 2.29) Palaeoecological reconstruction of Turin Hill arthropod assemblage, including elements of the associated vertebrate fauna. A myriapod (M) is within the terrestrial flora (largely hypothetical) on the lake margins. Pterygotids (Pt), hughmillerids (H) and the chasmataspid Forfarella (F) inhabit the shallow lake margins. The stylonurids Pagea (P),



*Stylonurus* (S) and *Tarsopterella* (T) inhabit the river channels surrounding the lake. The cephalaspids (C) live in the shallow lake margins. The acanthodians inhabit open water —*Ishnacanthus* (I) chases a shoal of *Mesocanthus* (M), *Euthacanthus* (E) searches the substrate, and *Parexus* (Pa) patrols for prey. (From Braddy, 2000.)



(Figure 2.28) *Tarsopterygia scottica* Woodward, 1865; lectotype, National Museums of Scotland, NMS G.1891.92.103; Arbutnott–Garvock Group, Lower Devonian, probably from Balgavies Quarry, 7 km east of Forfar. Found in 1863 by James Powrie. This specimen is just over one metre long. (a) Entire specimen. (Lithograph, from Woodward, 1872b, plate 23.) (b) Photograph, latex cast of gill tract of the second mesosomal segment, x 6. (From Waterston, 1975, plate 2, fig. 5.)