

BOGHOLE, MUCKLE BURN

OS Grid Reference: NH972549

Highlights

Several sites along Muckle Burn in Highland have been the source of a rich fauna of up to 17 species of fossil fishes. Boghole, on the Muckle Burn, is the unique source of specimens of the osteolepiform sarcopterygian *Eusthenopteron traquairi*, a form close to the ancestry of the tetrapods.

Introduction

The Muckle Burn, near the village of Whitemire, exposes a section of Upper Old Red Sandstone (yielding *Asterolepis maxima*; Watson *et al.*, 1948) between Glenshiel and Earlsmill. Quarries at Whitemire and Boghole nearby have in the past supplied famous collections of fossil fishes. A stream section near Whitemire has also yielded fossils. Altogether, these localities present a good series of exposures yielding different faunas that illustrate a change from uppermost Middle Devonian at Boghole and Tarrywarrant, to lowermost Upper Devonian at Whitemire and above (House *et al.*, 1977, pp. 80–2).

Tarrywarrant Quarry (NH 970536) is almost completely filled in, with no exposure today. Boghole (NH 972549) is now an overgrown indentation in the steep bank of Muckle Burn with no exposure, although rock cannot be far below the soil cover. Whitemire (NH 972540) is a large quarry which is partially filled and very overgrown. Sandstone crops out along the east wall of this quarry in a steep overgrown face 8 m high (Figure 8.9). It is not known when the Muckle Burn fossil beds were discovered. Malcolmson knew of them in 1839, and he was the first to describe the threefold division of the vertebrate-bearing strata in the Moray and Nairn area (Malcolmson, 1842, 1859), based on early work at Tynet Burn (q.v.), Dipple Brae (q.v.) and Scaat Craig (q.v.).

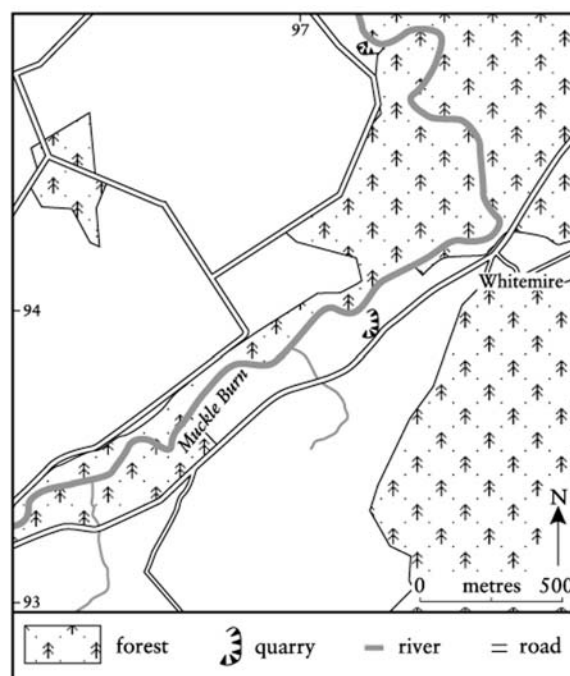


Figure 8.9: Sketch map of Muckle Burn–Whitemire GCR site area.

Most of the extant fossil material was collected from Boghole and Whitemire Quarries, neither of which are in a condition to yield fossils today. Fishes may still be found on the Muckle Burn, in the east bank below Boghole Quarry (Watson *et al.*, 1948), where mottled red and yellowish gritty sandstones and fine conglomerates were once exposed, and the more famous locality on

the Muckle Burn below Whitemire Quarry where coarse, pebbly, pink- and grey-coloured grits and grey-coloured sandstones are interbedded with flags and shales, the 'Boghole Beds'.

Description

The Upper Old Red Sandstone lies unconformably upon Middle Old Red Sandstone rocks that also contain fishes. Malcolmson (1842, 1859) and Gordon (1859) could immediately separate the Upper Old Red Sandstone fish beds from the Middle Old Red Sandstone fish beds because of the very different forms that they contained; Louis Agassiz (1833–1845) identified the fossil fishes.

The Upper Old Red Sandstone in the area may be about 450 m thick (Peacock *et al.*, 1968), but this is difficult to confirm because exposures are limited. Most of the rocks are sandstones, rarely red, and more commonly grey, pink, yellow, buff or reddish brown, and sometimes with green reduction mottling. Some beds are pebbly, and conglomerate occurs locally in lenses. Here and there are thin greenish mudstones, and red, brown and green mudstone intraclasts are common. Cross-bedding indicates transport generally south-east and south-west from the Highlands. Pedocals ('cornstones') commonly occur, these being ancient calcrete soil horizons indicating emergent conditions in a tropical climate.

A stratigraphical sequence has been established through the Upper Devonian of Highland based on fish faunas (Traquair, 1897a, 1905a, 1905b; Westoll, 1951, *in* House *et al.*, 1977; Figure 8.10). The Nairn Sandstones are

Moray–Nairn Area	Fauna	Greenland	Belgium	Baltic Province
Rosebrae Beds	<i>Phyllolepis</i> sp., <i>Bothriolepis alvesiensis</i> , <i>B. cristata</i> , <i>B. laverocklochensis</i> , <i>Phaneropleuron</i> sp., <i>Rhynchodipterus elginensis</i> , <i>Conchodus</i> sp., <i>Eusthenopteron</i> ?, <i>Glyptopomus elginensis</i> , <i>Holoptychius nobilissimus</i>	Phyllolepis Series	Upper part	'Post-Psammosteus-Stufe'
Alves Beds and Scaat Craig Beds	<i>Psammosteus taylori</i> , <i>Bothriolepis alvesiensis</i> , <i>B. gigantea</i> , <i>Conchodus</i> sp., <i>Rhizodonts</i> , <i>Holoptychius nobilissimus</i> , <i>H. giganteus</i> <i>Psammosteus</i> cf. <i>falcatus</i> , <i>Traquairosteus pustulatus</i> , <i>Bothriolepis paradoxa</i> , <i>Coccosteomorph arthrodire</i> , <i>Cosmacanthus malcolmsoni</i> , <i>Conchodus ostreiformis</i> , <i>Rhizodonts</i> , <i>Holoptychius nobilissimus</i> , <i>H. giganteus</i>		Lower part	e Stage
Whitemire Beds (= Edenkillic Beds)	<i>Bothriolepis taylori</i> , <i>Psammosteus taylori</i> , 'Coccosteus', <i>Cosmacanthus</i> sp., <i>Conchodus ostreiformis</i> , <i>Holoptychius nobilissimus</i> , <i>H. giganteus</i>			e–d Sheldon-limen
(Boghole Beds)	<i>Psammosteids</i> (indet), <i>Asterolepis alta</i> , <i>Eusthenopteron traquairi</i> , <i>Plourdosteus magnus</i> , <i>Polyplocodus leptognathus</i> , <i>Holoptychius decoratus</i> , <i>H. nobilissimus</i>			b' Snetogor
Nairn Sandstones	<i>Asterolepis maxima</i> , <i>Psammolepis tessellata</i> , <i>Plourdosteus magnus</i> , <i>Polyplocodus leptognathus</i> , <i>Holoptychius decoratus</i>	Spitsbergen ↑ Fiskekløfta Formation ↓ ?		a' Amata
				a' Gauja

Figure 8.10: Suggested correlation of the Upper Old Red Sandstone of the Moray–Nairn area with the successions in Greenland, Spitsbergen, Belgium and the Baltic Province (after Miles, 1968; Westoll, 1977).

characterized by *Asterolepis maxima* and the absence of *Bothriolepis*. The overlying Alves and Scaat Craig Beds include *Bothriolepis*

major and other species, and *Holoptychius*. Traquair's highest unit, the Rosebrae Beds,

contains *Phyllolepis concentrica* and *Glyptopomus minor*, among others. The two lower units appear to coalesce in the Elgin–Forres area, since *Asterolepis* and *Bothriolepis* are found

together at Boghole (Muckle Burn), as well as at Whitemire and on the Findhorn, a unit termed by Westoll (1951) the Boghole Beds.

These divisions were further discussed by Tarlo (1961a), Miles (1968), Peacock *et al.* (1968) and Westoll (*in House et al.*, 1977), and the chronostratigraphical situation appears somewhat complex. The Rothes and Heldon Hill faults separate three outcrops of Upper Old Red Sandstone in the Elgin–Nairn area. The uppermost unit, the Rosebrae Beds, rests with minor unconformity directly on the Alves Beds in the west, and on a new unit, the Cornstone Beds, in the east. The Cornstone Beds overlie, and interdigitate with, the Scaat Craig Beds. Hence the Scaat Craig Beds and the Cornstone Beds together, in the east, are approximate lateral equivalents of the Alves Beds in the west. Below these are the Boghole Beds, and below them, in the farthest west of the area, the Nairn Beds. These two lower units seem to merge in the Elgin–Forres area: Miles restricted the term Boghole Beds to the lower part of Westoll's (1951) usage, the units that lack *Bothriolepis*. He also introduced the term Edenkillie Beds for the upper part, with *B. taylori*, and terminating at the base of the Alves Beds where *B. gigantea* makes its appearance.

Stratigraphical relationships in the Muckle Burn area (Miles, 1968) are:

Edenkillie Beds

Lower limit marked by the first appearance of *Bothriolepis*

- Whitemire Quarry
- Muckle Burn section below Whitemire
- Boghole Quarry

Nairn Sandstone (upper Givetian or lowermost Frasnian)

Characterized by *Asterolepis maxima* and the absence of *Bothriolepis*

- Tarrywarrent Quarry

An excellent section on the Muckle Burn below Whitemire is given in Horne, (1923).

Fauna

The faunal assemblages from each of the sites, based on Miles (1968), are listed below. Abbreviations are: T, Tarrywarrant; B, Boghole; M, Muckle Burn below Whitemire; W, Whitemire Quarry; N, Nairn Sandstones; E, Edenkillie Beds.

AGNATHA

Heterostraci: Psammosteiformes: Psammostiidae

Psammosteus taylori Traquair, 1897 W, N, E

Psammosteid indet. B, M, N

GNATHOSTOMATA

Placodermi: Antiarcha: Bothriolepidae

Bothriolepis taylori Miles, 1968.

Type locality W, E

'*Asterolepis maxima*' Agassiz, 1845 T, N

'*A. alta*' Traquair, MS. ?Only locality B, N. A. sp. M, N

Placodermi: Arthrodira: Coupteidae *Plourdosteus magnus* (Traquair, 1895)

B, M, N *P. sp.* (cf *magnus*) W, E

Arthrodira indet.

Cosmacanthus sp. W, E

Osteichthyes: Sarcopterygii: Dipnoi: Dipterida

Conchodus sp.

Conchodus ostreiformis M'Coy, 1848 W, E Osteichthyes: Sarcopterygii: Osteolepiformes

Psammolepis ? sp. T, N *Polyplocodus leptognathus* Traquair, 1923

B, N *Polyplocodus ?* M, N *Eusthenopteron traquairi* Westoll, 1937

Type and only locality B, N

Osteichthyes: Sarcopterygii: Porolepiformes: Holoptychidae *Holoptychius nobilissimus*
 Agassiz, 1839

B, N, E *H. decoratus* Eichwald, 1846 B, N *H. giganteus* Agassiz, 1845 W, E

The occurrence of the heterostracan *Psammosteus taylori* Traquair was given by Traquair (*in* Horne, 1923), but no material was described and Miles (1968) could trace none.

Stensiö (1948) predicted that the *Bothriolepis* remains from Whitemire, usually referred to *B. major*, would prove to be a new species, and indeed Miles (1968) established the species *B. taylori* for this material. It is the oldest bothriolepid from the Moray Firth area, and probably also from Scotland. It is closely related to *B. gigantea*, which is found at many sites in the overlying Alves Beds.

The holotype of *Asterolepis maxima* Agassiz, 1845 is said to come from Boghole, although all other specimens are from Kingsteps, Nairn. There are no obvious differences between the asterolepids from these two places, although Traquair (MS) erected the new species *A. alta* on the basis of specimens from Boghole. Miles (1968) retained '*A. alta*' to distinguish this species from those more usually called *A. maxima*, and a more formal solution to this problem is still required.

Plourdosteus magnus (Traquair, 1895) was named as a species of *Coccosteus*, for material from Kingsteps, Nairn. The genus was founded by Ørvig (1951) on Upper Devonian fossils from Escuminac, Canada, and it also occurs in the Upper Old Red Sandstone of the Baltic region.

The arthrodire *Cosmacanthus sp.* was recorded by Traquair (*in* Horne, 1923), but has not been confirmed (Miles, 1968).

The osteolepiform sarcopterygian *Polyplocodus leptognathus* was identified by Traquair (*in* Horne, 1923), but Miles (1968) states that the name *Polyplocodus* should not be applied to this particular form.

Eusthenopteron was established by Whiteaves (1881, 1886) for *E. foordi* Whiteaves, 1881 from the Upper Devonian of Escuminac Bay, Canada. *Eusthenopteron traquairi* Westoll, 1937 is a new species based on a single fronto-ethmoid shield and fragments of head bones in the RSM. Boghole is the type, and possibly only locality. Westoll (1940) described *E. cf. traquairi* from the Rosebrae Beds, but Jarvik (1952) suggested that this specimen might be similar to *E. dalgleysiensis* (Anderson) from Dura Den, Fife (Anderson, 1859). The dipnoan *Conchodus ostreiformes* is present amongst specimens in the RSM.

Interpretation

Westoll (1978) argued that the Nairn and Boghole beds were late Givetian in age, and hence

latest Mid-Devonian. However, the Boghole Beds are usually dated as early Frasnian, and hence basal Late Devonian (Westoll, *in* House *et al.*, 1977; Friend and Williams, 1978), close to the Mid–Late Devonian boundary (Marshall and Allen, 1982), and perhaps equivalent in age to the Sumburgh Head (q.v.) and Bressay fish beds in the Shetland Middle Old Red Sandstone Basin.

Eusthenopteron appears in the succession at the same time as *Bothriolepis*, not only in Scotland, but also in Escuminac Bay, Canada, and the Baltic area. Westoll (1937) suggested that this assemblage might represent a zonal index. *Bothriolepis* is useful biostratigraphically since it occurs in late Devonian continental deposits of ancient Laurasia and all the Gondwana continents (Denison, 1978) and has over 100 species (Dineley and Loeffler, 1993).

Andrews and Westoll (1970a) suggested that *Eusthenopteron traquairi* resembled the pike (*Esox*) in its aquatic mode of life, and that it may also have been capable of short journeys 'walking' overland using the pectoral fins as limbs. They averred that in *Ichthyostega* the paired limbs developed to manoeuvre in confined spaces in water, and also to move about on land for short periods of time, possibly while searching for new waters. Locomotion out of the water was perhaps prompted by reasons such as drying up the pools, anoxia in the waters or predator pressure.

The vertebrate fauna of the Upper Old Red Sandstone is typified in the sites mentioned above and others support a correlation with areas in Greenland, Spitsbergen and mainland Europe (Figure 8.10). The late Devonian vertebrate (fishes) fauna was effectively cosmopolitan throughout the Euramerican Province, and generally similar worldwide.

Conclusions

The fish-bearing bands exposed in the Boghole Beds at Boghole have yielded an important earliest Late Devonian (Frasnian) fauna. The conservation value lies in the diversity of the fauna with over 15 species of placoderms, acanthodians and sarcopterygians. Specimens have come to light from many quarries and stream sections in the area. Unfortunately, the quarries are no longer extant, but the stream exposures still produce specimens, and could be excavated for more substantial studies.

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