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# Cruaday Quarry

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## Highlights

Cruaday Quarry, in the Orkney Islands, provides an exposure of the Sandwich Fish Bed, a famous source of fossil fish specimens. The fish fauna is rich here, including 14 or 15 species, and the site has provided crucial evidence for comparisons with the network mainland fish sites of the same age.

## Introduction

Cruaday Quarry (Figure 6.10) is a comparatively recent excavation. There is a long history of quarrying in the area for flagstones and roofing tiles, but most of the localities mentioned on the labels of old museum specimens, collected during the 19th century, no longer exist. The exact provenance of material labelled 'Sandwich Fish Bed' is vague. Fossil fishes have been known from the Sandwich area, probably since long before their first published mention — in the First Annual Report of the Orkney Natural History Society, which states that about 100 specimens of fossil fish were exhibited in Stromness Museum in 1837 (in *Orcadian Papers*, 1905, p. xi).

A key figure in the Cruaday story is Professor T.S. Trail of Edinburgh University, who collected many fossil fishes from northern Scotland, particularly Orkney. He corresponded with Agassiz, and in 1832 or 1833 sent him drawings of fossils, and a map showing localities at Skaill, Quoyloo and Breckaness near Stromness (Andrews, 1982). Traill (1834, 1841) described the geology of Orkney and its fossil fishes. The material that he collected, and managed to convey to Edinburgh without loss (see Traill, 1834, p. 646), was sent to Agassiz, who figured type material of new species of fish from Trail's collection from Orkney (Agassiz, 1833–1845), but that material is now lost, presumably because Trail sold his collection to unknown purchasers in 1843 (Andrews, 1982). Clouston (1845) mentioned fossil fishes and plants from several localities in Orkney, and hoped that they would prove the identity of beds with those in Caithness and the Moray Firth. Reference is made to fossil fishes from Ramna Geo on the Admiralty Chart for the Orkney Isles for 1850. It was from here that W. Watt obtained most of the fossil fishes which Hugh Miller saw during his visit to the island in 1848 (Wilson *et al.*, 1935). M'Coy (1854) also wrote about material from Orkney, confirming that the Stromness Flagstones were equivalent to the Caithness Flagstones. Many eminent geologists visited the islands and described the geology and palaeontology (Murchison, 1859a, 1859b; Geikie, 1878; Peach and Horne, 1880). Traquair (1894) showed that the fauna of the Achanarras Limestone in Caithness was very similar to that of Stromness, Cromarty and the Moray Firth, and Flett (1898) introduced a stratigraphical scheme for the Orkney Flagstones on the basis of the fish faunas.

## Description

Cruaday Quarry is a large excavation on the eastern brow of Cruaday Hill, and exposes 20 m of dark grey calcareous siltstones. The Sandwich Fish Bed is exposed along the western, then north-western, right-angled faces, with a continuous exposure of 450 m (Figure 6.11; Trewin, 1976, p. 206). It lies between the Lower and Upper Stromness Groups, of late Eifelian age, and is correlated with the Achanarras Fish Bed of Caithness (Weston, *in House et al.*, 1977), on the basis of a nearly identical faunal assemblage.

The Sandwich Fish Bed (Figure 6.11) occurs in the Sandwich area of Orkney within a series of faulted outcrops that trend roughly north and south (Wilson *et al.*, 1935). Further south, other fault blocks cause the fish bed to outcrop near the Loch of Stenness, and in the south of the mainland at Billia Croo. In 1848 several cliff-top quarries yielded a prolific Sandwich Fish Bed fauna (Miller, 1858, pp. 440–5). The fish bed at Cruaday Hill Quarry is divided into two layers, separated by 1.5 m of dark grey laminite with occasional fish fragments in its upper part. The lower band is 0.5 m thick, and unimportant as a source of fossil fishes, with only occasional *Dipterus valenciennesi* and osteolepids. The upper band is 1 m thick and highly fossiliferous. This upper layer also shows a three-fold division of sedimentary laminae,

similar to that seen at Achanarras Quarry (Rayner, 1963).

## Fauna

Acanthodii: Climatiiformes: Diplacanthidae

*Diplacanthus crassisimus* Duff, 1842 *D. sp.*

*Rhadinacanthus longispinus* Agassiz, 1844 = *D. perarmatus* M'Coy, 1848

Acanthodii: Acanthodiformes: Acanthodidae

*Cheiracanthus murchisoni* Agassiz, 1835

*Mesacanthus sp.*

Placodermi: Antiarcha: Pterichyodidae

*Pterichthyodes milleri* Miller, 1841

Placodermi: Arthrodira: Coccosteidae

*Coccosteus cuspidatus* Miller, 1841

Placodermi: Arthrodira: Homosteidae

*Homosteus milleri* Traquair, 1888

*Incertae sedis*

*Palaeospondylus gunni* Traquair, 1890

Osteichthyes: Actinopterygii

*Cheirolepis trailli* Agassiz, 1835

Osteichthyes: Sarcopterygii:

Osteolepidiformes: Osteolepididae

*Osteolepis macrolepidotus* Agassiz, 1835

?*Osteolepis sp.* (a large form)

*Gyroptychius agassizi* Trail, 1841

*Glyptolepis leptopterus* Agassiz, 1844

Osteichthyes: Sarcopterygii: Dipnoi: Dipteridae

*Dipterus valenciennesi* Sedgwick and Murchison, 1828

*Osteolepis macrolepidotus* is common as complete, well-preserved specimens (Figure 6.13), unlike the situation at Achanarras, where it is rare. *Coccosteus cuspidatus* is also very common, and at Cruaday Quarry some bedding planes are covered with complete specimens. Other bedding planes have dense concentrations of acanthodians upon them, particularly *Mesacanthus sp.* (Figure 6.12). The relative abundances of fishes nevertheless vary through the vertical section in the quarry.

Trail (1834) was the first to mention the subdivision of the fauna in the Sandwich fish bed. In a quarry near Skail, 'about 100 ft above the level of the sea' he observed that the lower part of the fish bed contained a diverse fauna, whereas the upper part contained mainly fishes 'of a flattened form, with a granular skin, which appear to belong to the family Raja' (i.e. *Coccosteus cuspidatus*; see also Agassiz, 1835, Tome II, p. 118). Miller (1858) distinguished a three-fold division in the Sandwich Fish Bed, noting 'the lower layer consisting almost exclusively of Diptherians, chiefly osteolepids, the middle layer of acanthodians, of the genera *Cheiracanthus* and *Diplacanthus*, and the upper layer of coccosteids, mostly of one species, the '*Coccosteus decipiens*'.

Recent studies confirm these ideas in more detail. Trewin (1976) presented a detailed log of the relative abundances of genera through the upper part of the fish bed at Cruaday, relating the pattern and composition of lacustrine varves in museum specimens to a varve by varve section taken from the quarry. He showed that *Dipterus* is abundant at the base, followed by osteolepids, then acanthodians, and at the top of the fish bed *Coccosteus* is abundant. *Osteolepis* and *Dipterus* do not overlap in distribution with *Coccosteus*.

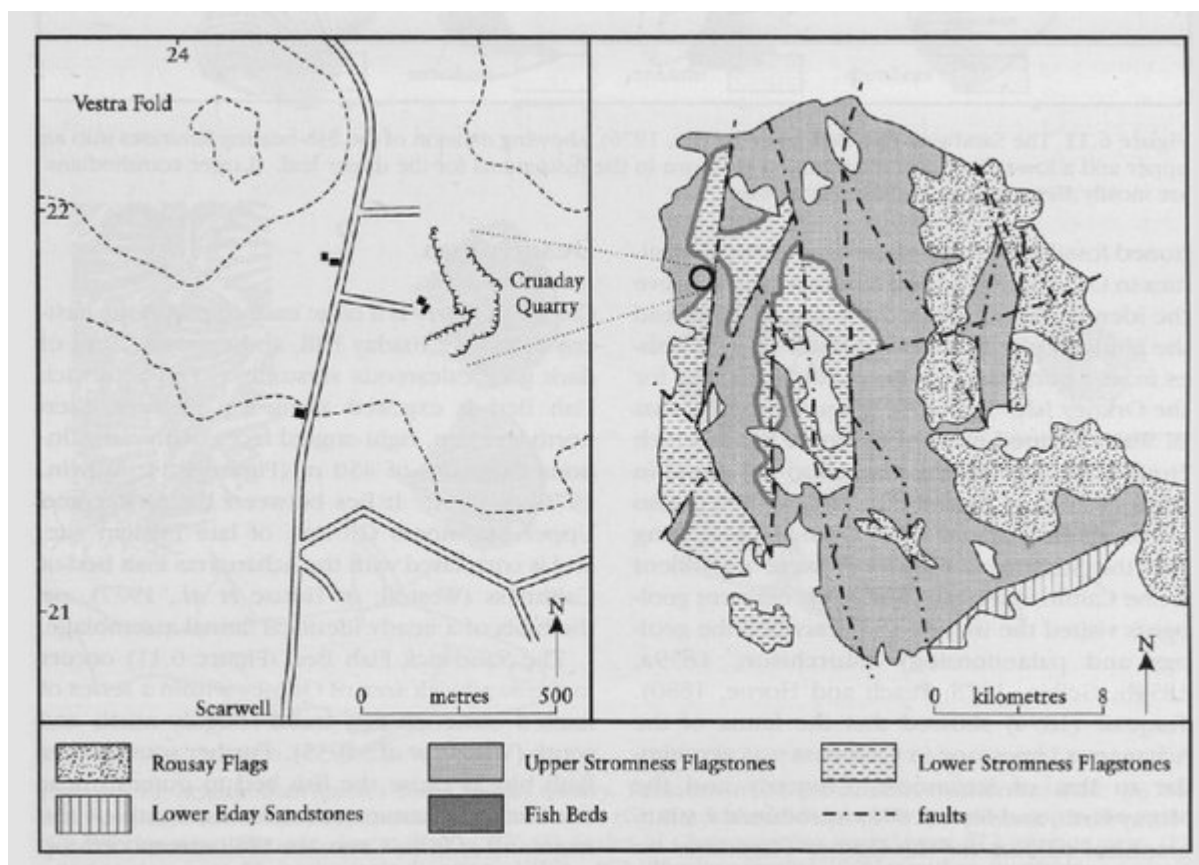
## Interpretation

Most authors correlate the Sandwich Fish Bed with the Achanarras Fish Bed. The diversity and abundance of the vertebrates must indicate high productivity of the lake waters with annual variations in salinity and organic (algal) productivity; upset on occasion to produce toxic conditions in the lower layers of water with catastrophic consequences for any vertebrate entering. Preservation in such an environment with little physical disturbance was excellent. Large museum collections of fossil fishes have been obtained in the past from other localities in the Cruaday area, Quoyloo, Instabillie, Hooveth and a small quarry on the south side of the Hill of Cruaday. Ramna Geo, a nearby coastal exposure, no longer yields the prolific quantity of material which was found there in the 1840s and 1850s. Less prolific quarries in the Sandwich Fish Bed occurred at Gairsty Farm near Tronston, Glebe Quarry, and at the crossroads near Roadside. 'A small quarry, about  $\frac{1}{4}$  mile south-west of Bryameadow, on the south of the Burn of Cruaday' was the most productive locality in 1935 (Wilson *et al.*, 1935). All of these localities confirm the areal extent of the conditions described above (see also Jarvik 1950b, 1950c).

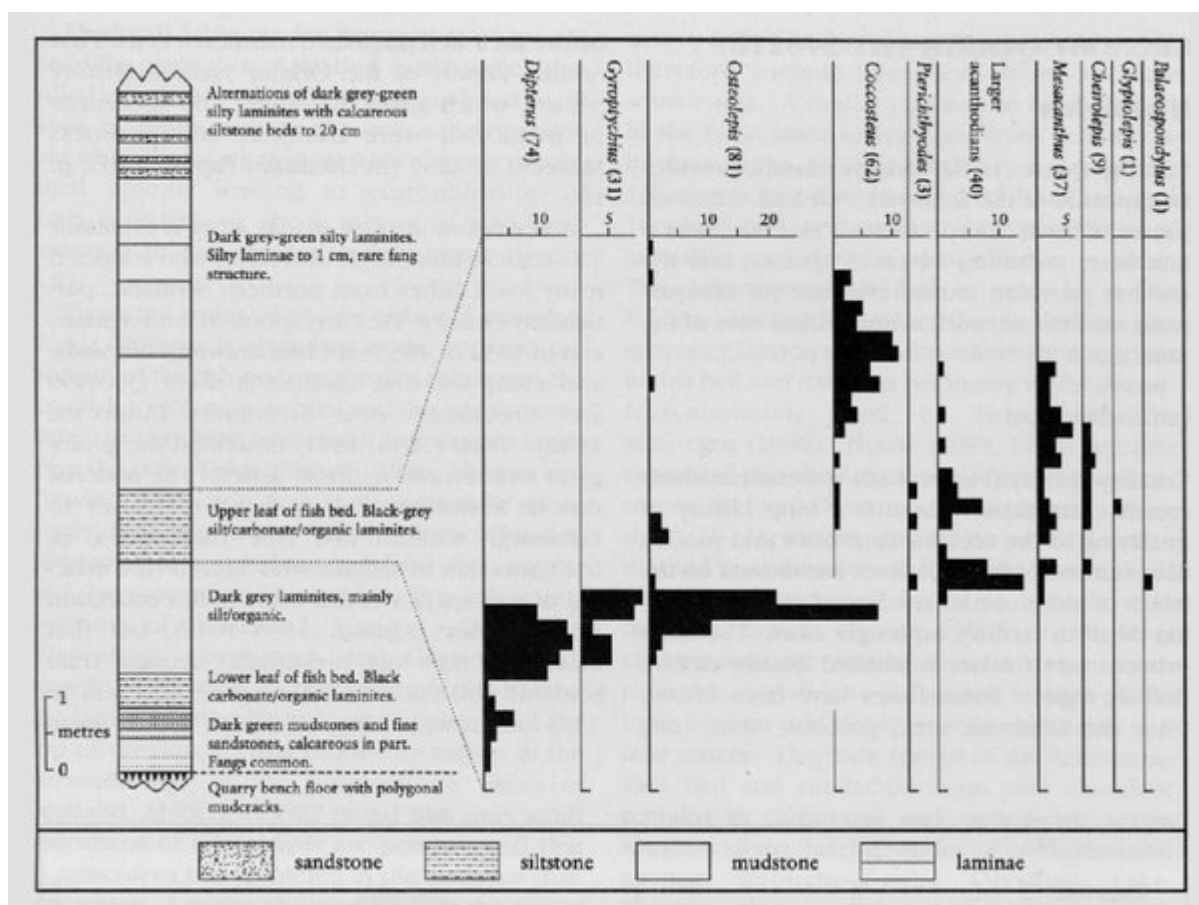
## Conclusion

Cruaday Quarry is the best site on Orkney showing an Achanarras horizon fish assemblage hence its conservation value. The fauna, consisting of 14 or 15 species of acanthodians, placoderms and osteichthyans, is closely comparable with the fauna from Achanarras itself. Cruaday Hill Quarry has the added advantage, like Achanarras, of recent detailed sedimentological and palaeoenvironmental studies, which enhance understanding of the nature of the great Orcadian Lake. At present, Cruaday Hill Quarry is the only site in the Sandwich area where a diverse fish assemblage can still be collected. All other sites that were productive in the past are no longer accessible.

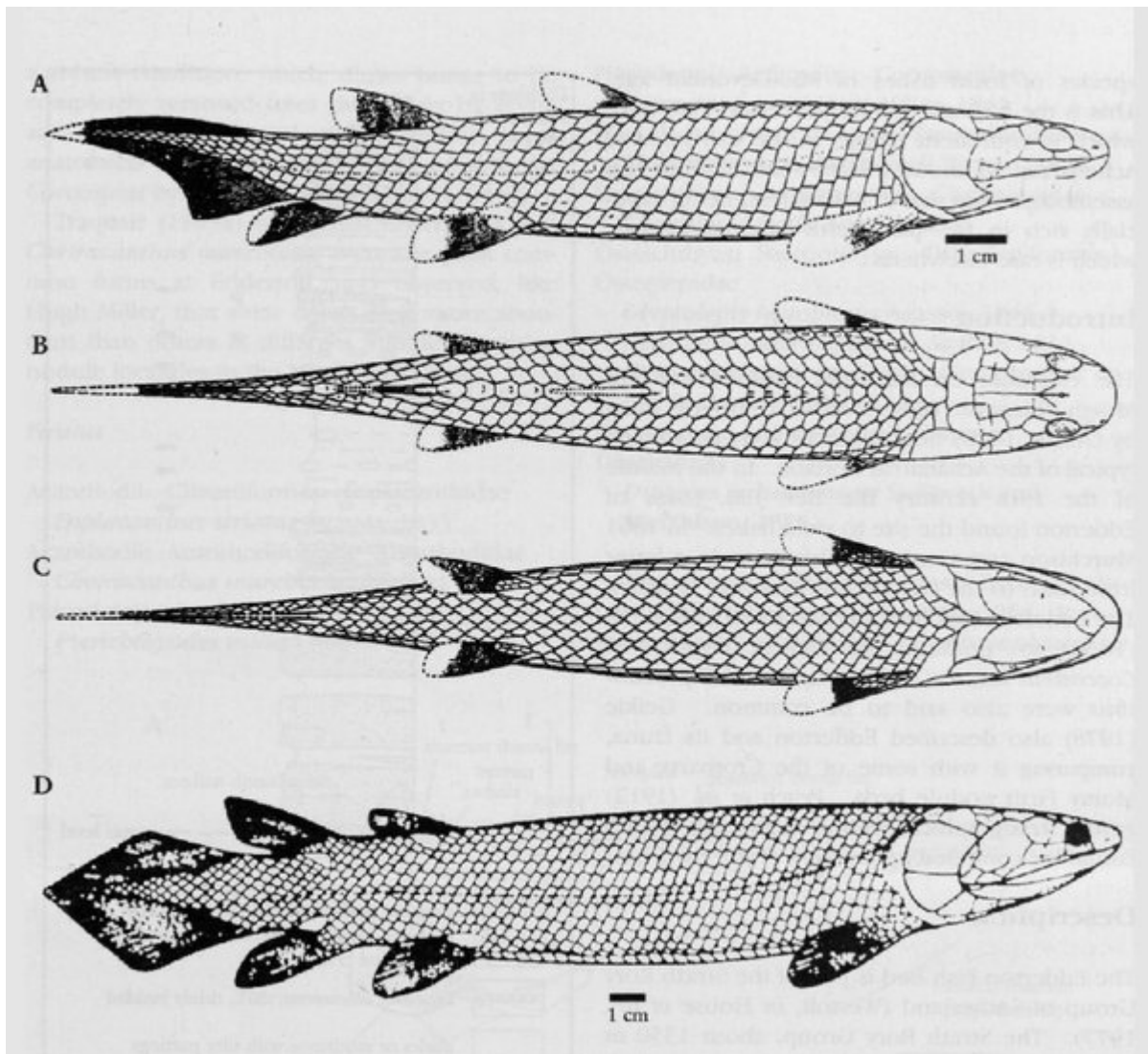
## [References](#)



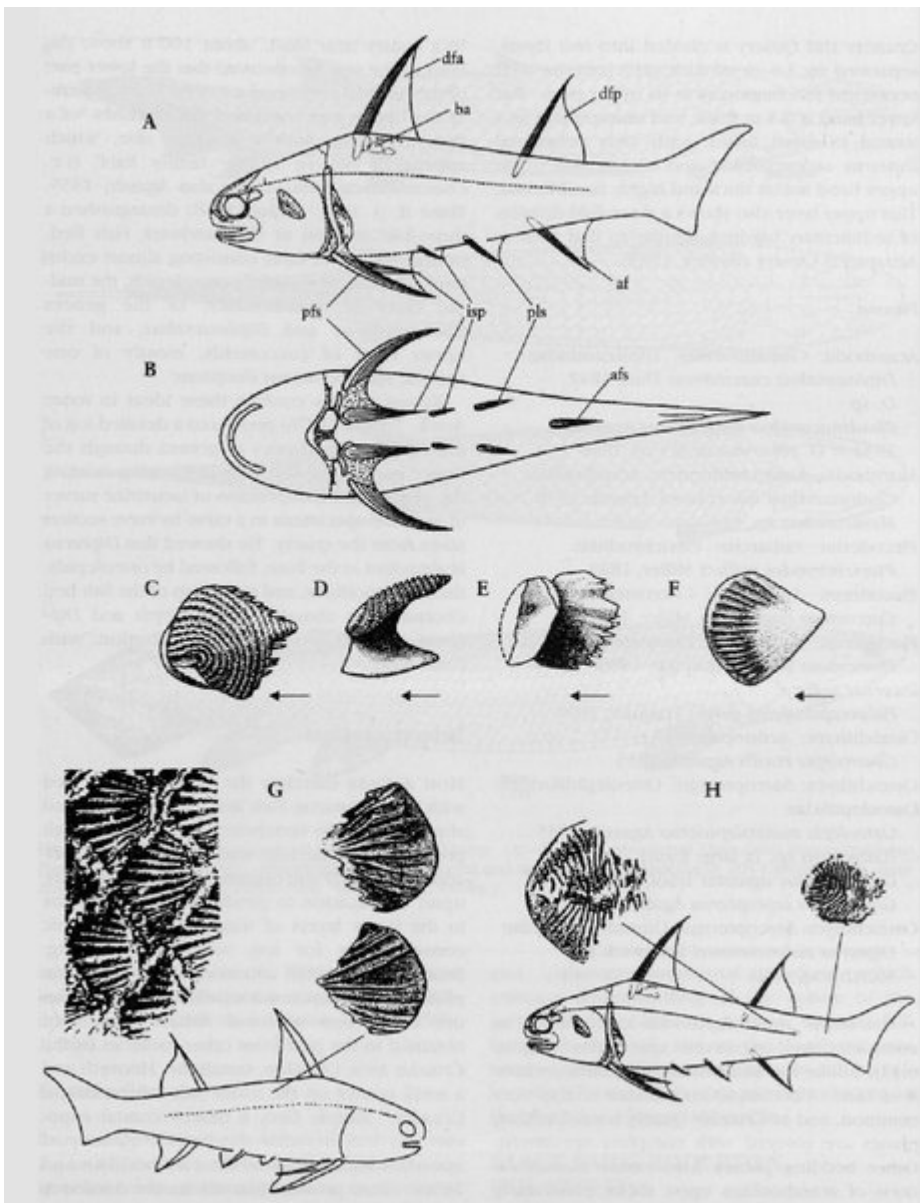
(Figure 6.10) Geological sketch map of GCR Site Cruaday Quarry, Mainland, Orkney, based on the Geological Survey Orkney sheet.



(Figure 6.11) The Sandwich Fish Bed (after Trewin, 1976), showing division of the fish-bearing laminites into an upper and a lower leaf. Fish distribution is shown in the histograms for the upper leaf. 'Larger acanthodians' are mostly *Mesacanthus* and *Cheiracanthus*.



(Figure 6.13) Osteichthyan species from Cruaday Quarry (A)—(C) The osteolepid *Osteolepis macrolepidotus* (Sedgwick and Murchison), restoration in lateral, dorsal and ventral views respectively; (D) *Gyropterychius agassizi* Traill, restoration in lateral view. (After Jarvik, 1948a.)



(Figure 6.12) Acanthodian species from Cruaday Quarry. Restoration of *Diplacanthus crassissimus* Duff: (A) lateral view; (B) ventral view, approximately natural size. (C), (D) Scales of *D. crassissimus*, posterior to the right: (C) exterior view; (D) side view, c. x 60. (E), (F) Scales of *Cheiracanthus murchisoni*; (E) interior view; (F) exterior view, c. x 55 (scales from Denison, 1979). (G) 'Rhadinacanthus' *Diplacanthus longispinus* Agassiz scales with well-defined ribs and scalloped posterior margin; (H) *Diplacanthus striatus* Duff, scales with fine transverse grooves, (G) and (H) c. x 50 (courtesy of V.T. Young).