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# Bryn-Ilin-Fawr

[SH 7904 3068]

## Introduction

The forestry road section by Afon Bryn-Ilin-fawr is the best place in Britain to identify the Merioneth–Tremadoc series boundary and the base of the Cressagian Stage. Mudstones at the top of the Dolgellau Formation containing a fauna of the *Acerocare* Zone pass up into silty mudstones at the base of the Dol-cyn-afon Formation that contain early subspecies of *Rhabdinopora flabelliformis*. The faunas include taxa known from many other regions (Scandinavia, North and South America and China), making this a key site, regionally and internationally, for the correlation of the base of the Tremadoc Series in the graptolitic and olenid biofacies and for the evidence it contributes to the definition of the Cambrian–Ordovician boundary. A volcanoclastic sandstone lying at the base of the Tremadoc can be dated radiometrically.

Faunas of the *Peltura* Zones are widely recognized in Britain (Thomas *et al.*, 1984, fig. 6), and the early Tremadoc *Rhabdinopora flabelliformis* is even more widely distributed (Erdtmann, 1982, p. 19). The contacts described by Stubblefield (1956) between units containing these faunas indicate a non-sequence, because the faunas of the uppermost Cambrian *Acerocare* Zone, known to lie above the *Peltura* Zones and below *Rhabdinopora flabelliformis* in Scandinavia, were unknown in Britain. However, the British Geological Survey detected faunas of the *Acerocare* Zone at several places east and north of Rhobell Fawr (Allen *et al.*, 1981) and identified two sections, Bryn-Ilin-fawr and Dol-cyn-afon (see site report below), where a passage up into the *flabelliformis* Zone could be seen. Whereas Dol-cyn-afon displays the lithological succession well and provides the basal stratotype of the Dol-cyn-afon Formation, the faunal succession at Bryn-Ilin-fawr provides the more satisfactory correlation with the Cambrian–Ordovician boundary as recognized in Scandinavia and includes a number of taxa identical with, or closely related to, those known from North America (Newfoundland, New Brunswick, Vermont, Mexico), South America (Argentina) and northern China (Nei Monggol).

## Description

The Bryn-Ilin-fawr section occurs by the forestry road on the south side of Afon Bryn-Ilin-fawr, 9.5 km south-east of Trawsfynydd. After early studies had shown its potential, the Nature Conservancy Council arranged for excavation over about 500 m of the roadside to improve exposure (Figure 7.3), especially at the critical Merioneth—Tremadoc boundary interval (Rushton *et al.*, 1979). The section was measured by reference to an arbitrary datum and fossils collected systematically at intervals of about 0.5 m. The faunal succession was described by Rushton (1982), with revisions in Fortey *et al.* (1991). The section was sampled for microflora, and poorly preserved acritarchs are known to be present, but they have not yet been studied in detail. Further details of the geology are given by Allen *et al.* (1981) and Allen and Jackson (1985). The succession is illustrated in (Figure 7.4).

**162–165 m from datum:** The lowest beds in the principal part of the section are cleaved but have nevertheless yielded numerous fossils, including the conodont *Cordylodus proavus* Møller (*sensu lato*), *Parabolinella contracta* Lu and Zhou and several fragments of *Hysteronotus* sp.. These beds terminate at a small fault trending at 160°.

**165–177 m:** These weakly cleaved strata contain abundant fossils, including the conodont *Phakelodus tenuis* (Møller) and ten species of trilobites, among which *Parabolina heres heres* Brögger ranges through much of the unit and *Parabolina* (*Neoparabolina*) *frequens* occurs near the top.

**177–180 m:** Here occur pale beds in which fossils are scarcer, though a fragment of *Parabolina acanthura* (Angelin)? was found near the top. At 180 m two sandstone beds about 30 cm apart dip eastwards at 74°. They are pyritic tuffaceous sandstone with euhedral quartz grains (Allen *et al.*, 1981, p. 313). Each bed is 10 cm thick, but within the space of about 1 m the upper one is seen to thin out. For about 0.4 m above the upper sandstone bed the shales are

disturbed and slightly brecciated, suggesting minor faulting.

**180.4–184 m:** These strata consist of black mudstones with *Phakelodus* and fragmentary trilobites including *Parabolina heres*, followed by more massive siltstone. The siltstone has been taken as the local base of the Dol-cyn-afon Formation.

**184–187.5 m:** These beds comprise grey mudstones, in which a 15-cm ochreous-weathering bed 20 cm above the base has yielded a fragmentary *Rhabdinopora flabelliformis* (subsp. indet.). A bed 2 m above the base (185.80–186.20 m) yields several *Rhabdinopora flabelliformis* (Eichwald), including specimens compared by Prof. Ph. Legrand (unpublished report, 1980) with the subspecies *desmograptoides* (Hahn), *parabola* (Bulman) (Figure 7.5) and *socialis* (Salter). Rushton (1982) took the base of the Tremadoc Series at 184.20 m, i.e. the base of the ochreous-weathering mudstone.

**187.5–195 m:** Striped silty mudstone with sparse trilobites occurs here; *Boeckaspis birsuta* (Brögger) was collected at the base of this unit, and the brachiopod *Eurytreta sabrinae* (Callaway) appears near the top. This unit terminates at a fault.

**195–199 m:** These are massive beds, sparingly fossiliferous, dipping southwards and cleaved at a high angle to bedding.

Above this unit the section is less well-exposed, but collections were made at several places and include *Euloma* (*Proteuloma*) cf. *geinitzi* (Barrande) at [SH 7908 3074], *Boeckaspis mobergi* (Wiman) and *Anacbeirurus*? at [SH 7915 3081], and *Rhabdinopora flabelliformis flabelliformis*, identified by Prof. Legrand as transitional to *R. f. anglica* (Bulman), at [SH 7917 3083].

## Interpretation

The importance of Bryn-llin-fawr is primarily as a representative section for the base of the Tremadoc Series in North Wales. However, the recommendation to place the base of the Ordovician in the Green Point section in northwest Newfoundland (Webby, 1998), at the level at which a species of *Iapetognathus* appears and immediately below the first appearance of *Rhabdinopora flabelliformis* subspecies, makes the corresponding level at Bryn-llin-fawr valuable as a parastratotype for the base of the Ordovician in Europe, especially in the historical type-area of the Ordovician. It is *de facto* the base of the Cressagian Stage (Fortey *et al.*, 1995).

The passage, at about 182 m, from dark mudstones to lighter-coloured laminated silty mudstones, which occurs at a level close to the Merioneth–Tremadoc boundary as determined by the faunas, corresponds to that seen at Dol-cyn-afon (see site report below). It is considered to represent a change to higher levels of oxygenation in the sea water and an increase in sedimentary input.

The correlation of the faunal succession at Bryn-llin-fawr with that of the Oslo area (Bruton *et al.*, 1982) depends on the successive appearances of species of *Parabolina*, *Rhabdinopora* and *Boeckaspis*. The part of the section between 165 m and 180 m is clearly referable to the *Acerocare* Zone of the Scandinavian succession: *Parabolina heres heres* occurs only in this Zone, is not found in the underlying *Peltura scarabaeoides* Zone and does not extend as high as the first appearance of the *Rhabdinopora flabelliformis* group. Rushton (1982) discussed the fauna and its correlation and later added some details and revisions (in Fortey *et al.*, 1991).

The part of the section between 184 m and 188 m that contains early forms of *Rhabdinopora flabelliformis* and *Boeckaspis hirsuta* is considered to be basal Tremadoc (Rushton, 1982; in Fortey *et al.*, 1991, p. 8). *Rhabdinopora* subspecies identified by Legrand (unpublished report, 1980) have not yet been described, but the example shown in (Figure 7.5) is one of the taxa that correspond closely with those from near the base of the Ordovician in the section at Naersnes, Oslo region (Bruton *et al.*, 1982).

Later subspecies of *Rhabdinopora*, occurring higher in the section together with *Boeckaspis mobergi*, indicate correlation with the *flabelliformis* Subzone, Etage 2e $\beta$  or 2e $\gamma$  of the Norwegian succession (Bulman, 1954) and with Erdtmann's (1982) informal 'Zone D'.

Certain genera of trilobites that occur in the *Acerocare* Zone at Bryn-llin-fawr and in neighbouring localities are more generally associated with the Tremadoc Series: *Araiopleura*, *Beltella*, *Niobella* and *Shumardia* (*Conophrys*) are examples

(cf. Webby *et al.*, 1988, p. 930). The Bryn-Illin-fawr section shows that they existed before the beginning of Tremadoc time, confirming Westergård's (1909) report of *Niobella* and *Euloma* from the *Acerocare* Zone. The pre-Tremadoc occurrence of these genera of trilobites shows that it is unsafe to assign such assemblages to the Tremadoc Series only on the basis of their generic constitution. In contrast to the assumptions of Webby *et al.* (1988, p. 930), the genus *Hysteroenus* is present in the *Acerocare* Zone, represented by several fragments at Bryn-Illin-fawr and also by *Hysteroenus* cf. *toernquisti* farther south [SH 7947 2873], at 'Locality B' of Rushton (1982, fig. 1B and p. 44).

Zircon crystals in the beds of volcanoclastic sandstone that lie just below the lowest *Rhabdinopora* are being dated radiometrically. When their age has been determined it will constrain the base of the Ordovician chronometrically more closely than anywhere else in the world.

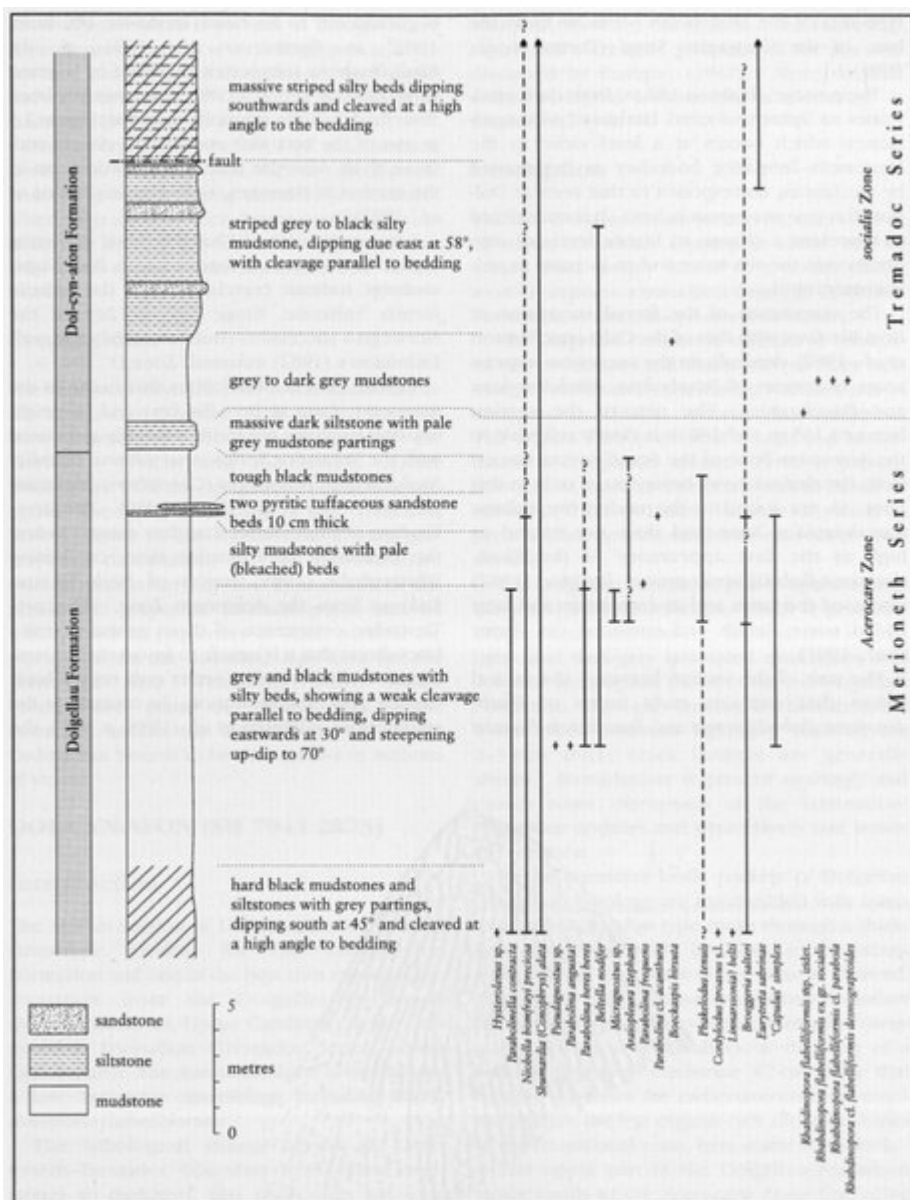
## Conclusions

The section at Bryn-Illin-fawr is a key site nationally and internationally. The fossils recorded here characterize the highest zone of the Cambrian System and the lowest of the Ordovician. It is the best place in Britain to recognize the basal boundary of the Tremadoc Series. Some of the fossils have a wide geographical distribution, so that this boundary, marked particularly by the appearance of the planktonic graptolite *Rhabdinopora*, can be related both to sequences in other parts of the world and to the historical type area for the Tremadoc near Tremadog, North Wales. Furthermore, grains of volcanic rock at the boundary enable the age of the base of the Ordovician System to be determined in millions of years.

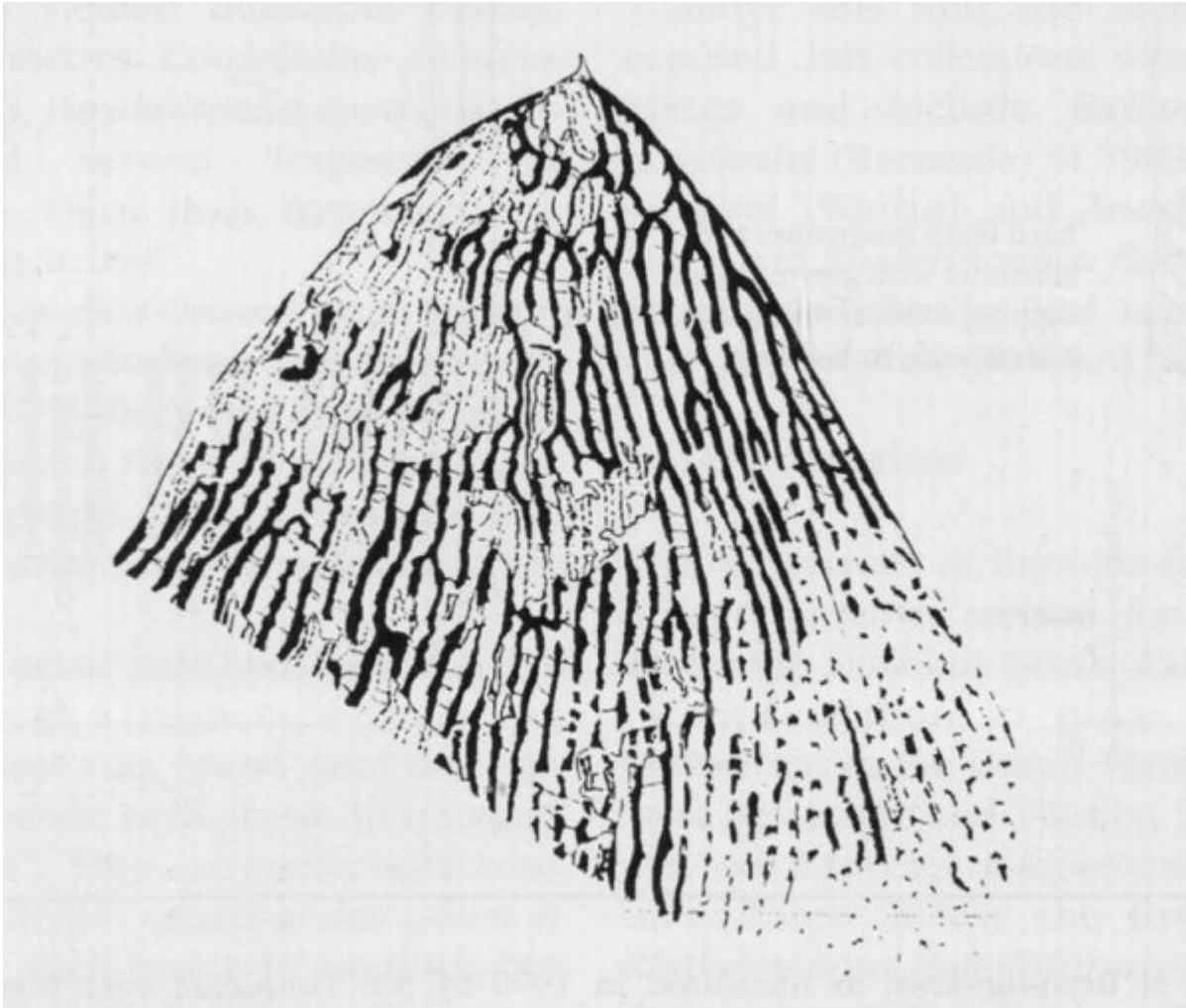
## References



(Figure 7.3) Bryn-Illin-fawr, as excavated in 1978, looking south. The figure on the left is working at the *Rhabdinopora* beds at the base of the Dol-cyn-afon Formation which dip to the left and strike towards the viewer. The next figure stands near the volcanoclastic sandstone beds that lie close to the boundary between the Merioneth and Tremadoc series. The other figures stand near the top of the Dolgellau Formation, on the beds with the *Acerocare* Zone fauna. (Photo: A.W.A. Rushton.)



(Figure 7.4) Section at Bryn-llin-fawr, as measured in 1978 by S.F. Tunnicliff, with fossil distribution from Rushton (1982, fig. 3) and Fortey et al. (1991, fig. 1).



(Figure 7.5) *Rhabdinopora flabelliformis* cf. *parabola* (Bulman), X 2. This taxon, from the basal beds of the Dol-cyn-afon Formation at Bryn-llin-fawr, is characteristic of the lowest Tremadoc. (Drawing by Dr P Legrand, published with his permission.)