Dob's Linn - an excursion

From Earthwise


Figure 32.1. Locality map and geological succession of Dob's Linn (after Williams 1980, fig. 1).

Figure 32.2. Ranges of some characteristic genera of the Moffat Shale: dotted line indicates rare occurrence or range recorded from elsewhere (after Williams 1980, fig. 2). All drawings approximately x1 unless otherwise stated.

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Figure 32.3. Schematic figures illustrating some of
the characteristic Upper Ordovician graptolites found at Dob's Linn.

Figure 32.4. Schematic figures illustrating some of the characteristic Upper Ordovician and Lower Silurian graptolites found at Dob's Linn.

Figure 32.5. Sketch showing geology and structure of the northern side of the Linn Branch gorge (reproduced from Williams 1988, fig. 3, by permission of the Trustees of the British Museum, Natural History).
Figure 32.6. Sketch of Linn Branch trench (reproduced from Williams 1988, fig. 4, by permission of the Trustees of the British Museum, Natural History).

Figure 32.7. Geological sketch map showing localities and approximate positions of Lower Silurian graptolite zones in the sides and stream bed of the Linn Branch burn.
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Figure 32.9. Illustrations of some characteristic Lower Silurian graptolites
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Key details

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Themes
Upper Ordovician and Lower Silurian graptolites and the international stratotype section of the Ordovician-Silurian boundary.

Features

Maps
O.S. 1: 50 000 Sheet 79 Hawick & Eskdale B.G.S. 1: 63 360 Sheet 16 Moffat 1: 50 000 Sheet 16E Ettrick (dri ft)

Terrain
Steep grassy and scree-covered slopes plus a few narrow stream crossings. Care should be taken on unstable, slippery rock if venturing up to the higher localities.

Distance and Time
A short walk (approximately 1 km): 2 hours minimum on exposure.

Access
Dob's Linn is on National Trust land and is also part of the Moffat Hills SSSI.

Although collection of a few specimens, particularly from scree, poses no problem, permission should be sought before extracting large amounts of material.

Historical background

The name "Dob's Linn" is derived from a 17th Century covenanter named Dobson, who used a ledge by the waterfall in the Linn Branch to hide from government forces. Graptolites were first recorded from Dob's Linn over one hundred years ago, although the earliest publications describing species
from the Moffat Shale Group paid little or no attention to their potential stratigraphic importance. Furthermore, despite attempts by several eminent scientists of the day, the structurally complex region of the Southern Uplands still defied satisfactory geological interpretation. In 1864 Charles Lapworth was offered a teaching post connected with the Episcopal Church at Galashiels. He had no formal geological training, but soon developed an interest in the local geology of the Southern Uplands. Over the following years he mapped large tracts of land, and made detailed collections of graptolites from the Moffat Shale at a number of critical localities. The classic summary of Lapworth's work was published in 1878; in this article he established beyond doubt the precise, ordered change in graptolite assemblages through the sequence of black and grey shales, and demonstrated unequivocally the value of graptolites in understanding the geology of a complex succession of Lower Palaeozoic strata. Lapworth's work in southern Scotland, both in the Moffat region and at Girvan, received widespread recognition: in 1875 he was appointed Assistant Master at Madras College, St. Andrews; then in 1881 was elected to the Chair of Geology at Mason College, Birmingham, which subsequently became the University of Birmingham.

Most of Lapworth's new species were first described by Elles and Wood (1901–18), whose work he supervised. Following this major publication, no taxonomic or stratigraphic work was done at Dob's Linn for half a century, with the exception of Davies (1929) who included material from the locality in his revision of certain Upper Ordovician and Lower Silurian graptolites.

The dearth of publications was broken by Packham in 1962, who utilised specimens from the Birkhill Shale in an evolutionary study of Lower Silurian diplograptids. Following this, Toghill published several papers listing revised zonal assemblages for the Birkhill Shale (1968 a & b), and giving taxonomic descriptions and illustrations of graptolites from the top Lower Hartfell Shale and Upper Hartfell Shale (1970). Following several years of critical study, Ingham published a completely new geological map of Dob's Linn in 1979. Ingham's mapping permitted intensive collecting of the graptolite fauna from continuous sections: a series of papers was published by Williams which included taxonomic descriptions of the late Ordovician and earliest Silurian faunas, and biostratigraphic revision of the top Lower Hartfell to basal Birkhill Shale (Williams 1982a, 1982b, 1983; Williams and Ingham 1987). This work confirmed Lapworth's faith in graptolites as a critical biostratigraphic tool, and resulted in more precise definition of the zonal boundaries.

Geological setting

Dob's Linn lies within the central part of the Southern Uplands. This region is dominated by a monotonous series of mostly Silurian greywackes referred to the Gala Greywacke. These are underlain by the Upper Ordovician and Lower Silurian Moffat Shale Group, which is exposed in a series of elongate, E–W faulted inliers formed by imbricate thrusting. Owing to the relatively soft nature of the shale, the inliers normally form steep-sided gorges, the most spectacular in the Moffat region being those at Hartfell Spa and Craigmichan Scaurs. Although slightly less impressive, the section at Dob's Linn preserves the most complete succession through the Moffat Shale, and is more readily accessible than the other inliers. Strangely, the base of the Moffat Shale is nowhere seen in the central Southern Uplands, although older strata, including Lower Ordovician cherts and pillow lavas, are exposed to the north.

The Moffat Shale Group is composed of a black shale-dominated sequence, now generally considered to have been deposited within the Iapetus Ocean which separated England and Wales from Scotland during the Ordovician before closing in the Silurian. It is interesting to note that shales, greywackes and graptolites almost identical to those of the Southern Uplands are found in central Newfoundland in eastern Canada, providing evidence that the two areas were once in close proximity before the opening of the present day Atlantic during the Mesozoic.
The Moffat Shale Group is divided into four formations: the Glenkiln Shale, Lower Hartfell Shale, Upper Hartfell Shale and Birkhill Shale. The Glenkiln Shale is composed of an unknown thickness of pale grey and black, commonly siliceous, shales and cherts. At Dob’s Linn the formation is poorly exposed and generally unfossiliferous, even the black shales rarely yielding identifiable graptolites. Better, more fossiliferous sections are present at Glenkiln Burn and Craigmichan Scaurs. The lower part of the Glenkiln Shale belongs to the Llandeilo–Caradoc *Nemagraptus gracilis* Zone, while the upper part has traditionally been assigned to the *Climacograptus peltifer* Zone. Many graptolite workers now consider it doubtful whether this second zone may be distinguished faunally from the following *Climacograptus wilsoni* Zone of the Lower Hartfell Shale, and the two are often combined into one *Diplograptus maltidens* Zone in the U.K. outside of southern Scotland. The Glenkiln Shale apparently passes gradationally into the almost continuously black Lower Hartfell Shale, which yields a far more abundant graptolite fauna and is over 20 m thick. The amount of chert decreases upwards thoughout the unit which is made up predominantly of black shale in the top 5 m. Following the *C. wilsoni* Zone, the *Dicranograptus clingani* and *Pleurograptus linearis* zones are represented, the Caradoc–Ashgill boundary probably falling within the latter.

The overlying Upper Hartfell Shale is composed mainly of nongraptolitic, pale grey-green shales and mudstones 28 m thick. Its lower boundary is marked by a transitional 3 cm interval of alternating pale grey and black shale laminae. Three groups of graptolitic black shale bands occur within the formation, named the *Complanatus*, *Anceps* and *Extraordinarius* Bands after their diagnostic zonal assemblages, indicative of the *Dicellograptus annplanatus*, *Dicellograptus aniceps*, and *Climacograptus extraordinarius* zones respectively. The *D. aniceps* Zone has been divided recently into two subzones, namely the *Dicellograptus complexus* and *Paraorthograptus pacificus* subzones, which have proved useful in international correlation. The 43 m of Birkhill Shale is composed almost entirely of black, continuously graptolitic shale and mudstone in the lower part. The shales become progressively siltier, less fissile and paler towards the top of the formation, culminating in a transition to coarse turbidites of the overlying Gala Greywacke Group. The lowest part of the Birkhill Shale belongs to the uppermost Ordovician *Glyptograptus persculptus* Zone, while the base of the *Parakidograptus acuminatus* Zone of the earliest Silurian falls at 1.6 m above the boundary with the Upper Hartfell Shale. The significance of this boundary is discussed in the next section. The remainder of the Birkhill Shale is divided into a number of graptolite zones, the boundary with the Gala Greywacke falling within the *Rastrites maximus* Zone.

**The Ordovician-Silurian boundary stratotype**

The Ordovician System was introduced by Lapworth in 1879, in a successful attempt to solve the mid-19th Century debate between Sedgwick and Murchison; Lapworth established his stratigraphy primarily through the use of graptolites. During the 1960’s it was recognised that despite most systems of the Geological Time Scale having been in international use for the past century, none had been properly defined.

In order to rectify this situation, the International Union of Geological Sciences (IUGS) established a Commission on Stratigraphy, who in turn set up a number of working groups to study the system boundaries and make recommendations regarding an international stratotype section for each. It was considered that any boundary stratotype should include an unbroken, continuously fossiliferous section across the relevant interval, have ease of access and the potential for palaeomagnetic, geochemical and radiometric studies. Once a stratotype had been decided, an imaginary "golden spike" would be placed at the exact horizon and locality marking the defined, internationally-accepted boundary. The Ordovician-Silurian Boundary Working Group was established in 1974 to formally define the stratigraphic level and boundary stratotype location for the base of the Silurian System. During the next decade it received over fifty reports from geologists around the world (see
Cocks and Rickards 1988); following much discussion, the choice for stratotype was narrowed down to two sections, namely Anticosti Island in eastern Canada, with a boundary based on conodonts, and Dob's Linn in southern Scotland, with a boundary defined using graptolites. Although both were well studied, richly fossiliferous and relatively complete, neither section provided a perfect candidate for the boundary stratotype. The succession on Anticosti Island is an essentially undeformed, shallow-marine limestone sequence rich in shelly macrofossils (e.g. trilobites and brachiopods) and conodonts, but with few graptolites. Dob's Linn is an oceanic shale sequence rich in graptolites, but with only rare examples of other fossils, and is structurally complex. Objections to choosing Dob's Linn as stratotype included the sparsity of nongraptolitic faunas (with only rare conodonts, trilobites and inarticulate brachiopods), and inadequacy for palaeomagnetic studies, while those against Anticosti Island included the likely presence of undetected breaks in a shallow marine sequence and difficulty of precise correlation with many Ordovician-Silurian boundary sequences. Following a series of formal ballots, Dob's Linn was finally ratified as the stratotype by the IUGS in 1985.

The Ordovician-Silurian boundary had historically been considered to lie at the base of the Birkhill Shale. This was, however, considered to be an unsuitable horizon at which to place a chronostratigraphic boundary, owing to a lithological change from unfossiliferous grey mudstone to graptolitic black shale and lack of major evolution in the graptolite fauna. The "golden spike" was thus placed at the base of the *P. acuminatus* Zone, 1.6 m above the base of the Birkhill Shale in the Linn Branch section. This horizon is recognised by the first occurrence of *Akidograptus ascensus* and associated species, an event which may be correlated accurately in many sections around the world. A summary paper on Dob's Linn as stratotype was published by Williams (1988).

**Itinerary**

To get to Dob's Linn, travel to Moffat via the A74, then take the A708 Selkirk road from the town centre. The road travels along the side of the glaciated and U-shaped valley of the Moffat Water; the present small stream is a misfit which meanders around the broad valley floor, sometimes splitting and rejoining to give a braided pattern. There are also hanging valleys, the most famous and spectacular being at the Grey Mare's Tail with its lofty waterfall. Proceed 1 km beyond the Grey Mare's Tail car park, which is 16 km (10 miles) from Moffat, to a double lay-by on the left-hand side of the road, (NT 196154) from where the gorge in black shale and greywacke is clearly visible. If time allows, it is worth making a "pilgrimage" to Birkhill Cottage, another 0.5 km (500 yds) further at the highest point of the road. This is where Lapworth stayed during his fieldwork, and a plaque commemorating his work has been erected on the cottage wall.

From the lay-by, follow the poorly-defined sheep track into the bottom of the valley, then northwards for about 150 m (Figure 32.1). The first black shale scree slope traversed is derived from faulted Birkhill Shale.

**Locality 1. Glenkiln Shale**

Proceed to a small but prominent bluff which the track crosses after dividing; just to the left of this, under a thin cover of scree, is the only fair-sized exposure of Glenkiln Shale at Dob's Linn. It is not, however, recommended to stop here before visiting the other localities, as graptolites are difficult to find and poorly preserved due to the rather pale, cherty lithology. It might be worth collecting from this stop after seeing the other outcrops, when specimens of *Dicellograptus*, *Dicranograptus*, *Climacograptus* and *Orthograptus* may be found (Figure 32.2).
Locality 2. Main Cliff

Lower Hartfell Shale. The first recommended stop is at the Main Cliff. Before studying the shales in detail, follow the track over to the right-hand bank of the stream and look across at the exposure, largely hidden by scree on the lower slopes. Note how the black Lower Hartfell Shale at the base, and Birkhill Shale at the top are separated by the paler grey Upper Hartfell Shale. At this locality the strata are dipping at about 45° and are the correct way up, while at all other parts of Dob's Linn the strata are dipping at a high angle and are inverted. The explanation is that the whole of the Main Cliff slumped and rotated during the Pleistocene; it is not a tectonic feature as assumed by early workers. The succession is heavily faulted, so detailed measured sections may only be constructed with extreme care. Now proceed to the lowest bluff just above the stream. This belongs to the Dicellograptus clingani Zone of the Lower Hartfell Shale and contains a fauna including Dicellograptus (D. caduceus, D. flexuosus, D. moffatensis), Dicranograptus (D. clingani, D. nicholsoni, D. rarnosus), Climacograptus (C. caudatus, C. spiniferus), Orthograptus (O. amplexicaulis, O. calcaratus) and the strange graptolite genus Corynoides (C. calicularis). (Figure 32.3).

Just above this is a second, slightly hollowed-out exposure. This belongs to the upper part of the Pleurograptus linearis Zone, and contains P. linearis, Leptograptus (L. capillaris, L. flaccidus macer), Dicellograptus (D. carruthersi, D. elegans, D. morrisi, D. pumilus), Climacograptus (C. mohawkensis, C. tubuliferus) Orthograptus (O. amplexicaulis, O. calcaratus basilicus, O. pauperatus, O. quadrimucronatus) and Plegmatograptus nebula, but no Dicranograptus or Corynoides (Figure 32.4).

Locality 3. Main Cliff

Anceps Bands. Climb the scree to the exposure of black shale and cream metabentonites in the top of the Upper Hartfell Shale. These are the five groups of Anceps Bands of the Dicellograptus anceps Zone, numbered A to E, and contain abundant Dicellograptus (D. anceps, D. complexus, D. minor), Climacograptus (C. latus, C. longispinus supernus, C. miserabilis), Orthograptus (O. abbreviatus, O. fastigatus) and Pseudoplegmatograptus craticulus. The three upper groups of bands C to E additionally contain Paraorthograptus pacificus, while the top band E yields rare specimens of Dicellograptus ornatus and Climacograptus ? extraordinarius (Figure 32.4). These and other species have permitted the division of the D. anceps Zone into a lower Dicellograptus complexus Subzone (Bands A and B) and an upper Paraorthograptus pacificus Subzone (Bands C to E). This allows accurate correlation of this part of the succession with that of the Soviet Union, North America, China and Australia. The occurrence of metabentonites indicates the presence of volcanic activity during deposition of the shales. The top Anceps Bands are repeated by strike faulting before the Birldnll Shale is entered. Only the Glyptograptus persculptus and Parakidograptus acuminatus zones are easily accessible on the Main Cliff.

The basal 1.6 m. of Birkhill Shale belong to the latest Ordovician G. persculptus Zone. It yields a low-density fauna consisting entirely of diplograptids, including Glyptograptus (G. avitus, G. cf. persculptus " G. venustus"), and Climacograptus (C. augustus, C. normalis), but no Dicellograptus or any of the other genera present in the D. anceps Zone (Figure 32.2). The following basal Silurian P. acuminatus Zone contains a similar fauna to that of the G. persculptus Zone, but is distinguished by the incoming of Akidograptus ascensus, Parakidograptus acuminatus and the earliest monograptid (Atavograptus ceryx). (Figure 32.4).

Locality 4. Main Cliff Complanatus Bands

Now cross the scree of the Main Cliff without descending to the bottom. If a little time is spent, it should be possible to find the two black Complanatus Bands of the Dicellograptus complanatus Zone,
bounded by pale grey shale.

These contain *Dicellograptus* (*D. complanatus*, *D. minor*), *Climacograptus* (*C. miserabilis*, *C. tubiliferus* and *Orthograptus socialis* — (Figure 32.4), together with a relatively common inarticulate brachiopod *Barbatulella lacunosa* in both the black and grey shale. The bands are seen more easily in the Linn Branch (Locality 5), but at that locality are almost impossible to collect.

### Locality 5. Linn Branch

Proceed to where the main stream divides and turn into the left hand tributary, the Linn Branch. The first exposures of black shale in the hollow on the left bank of the stream belong to the *D. clingani* and *P. linearis* zones and contain similar faunas to those seen at Locality 2. Just upstream from this, the two Complanatus Bands seen at Locality 4 may be observed at the back of an excavation in the stream bank. These should not, however, be collected owing to their very limited outcrop.

### Locality 6. Junction of the Linn Branch and Long Burn

Climb up the track to the trench visible from the junction of the Linn Branch and Long Burn (see (Figure 32.5)). This Linn Branch trench is the least tectonically disturbed section through the top of the Upper Hartfell Shale and basal Birkhill Shale, and is the stratotype section for the Ordovician-Silurian boundary (Figure 32.6). The Anceps Bands contain the same fauna described from Locality 3. Midway between the top Anceps Band and the base of the Birkhill Shale (remember that the strata are inverted and young upstream) is a narrow dark brown band. Rare diplograptids occur on one lamina of this *Extraordinarius* Band, including *Climacograptus? extraordinarius* (Figure 32.4), indicating the *Climacograptus? extraordinarius* Zone; no other graptolites are present. The late Ordovician graptolite mass extinction, which almost resulted in the complete extinction of the group, therefore occurred sometime between the deposition of Anceps Band E and of the *Extraordinarius* Band. Just below the *Extraordinarius* Band, in a conchoidally-fracturing calcareous mudstone, rare fragments of a blind mucronaspid trilobite have been found. The lack of eyes presumably indicates a mode of life in deep water below the photic zone. Following along the trench upstream, the basal Birkhill Shale is encountered, beginning in the *G. persculptus* Zone. The base of the *P. acuminatus* Zone, marking the "golden spike" for the Ordovician-Silurian boundary, occurs at 1.6 m above the base of the Birkhill Shale, with a faunal assemblage as described for Locality 3. The full thickness of the *P. acuminatus* Zone (about 5 m of black shale with thin metabentonites or "claystones") occurs here and should be searched thoroughly for the small and slender proximal ends of the zone fossil (Figure 32.4). The *Cystograptus vesiculous* Zone follows, but is only 1.3 m thick and difficult to distinguish; it is worth looking for the zone index fossil (Figure 32.8), but otherwise this interval is best considered with the *Coronograptus cyphus* Zone and studied in the stream below. The general evolutionary changes in the Silurian graptolite fauna discussed here and in localities 7 to 10 are summarised in (Figure 32.2), while some of the most characteristic species are shown in (Figure 32.8) and (Figure 32.9). A more detailed stratigraphical description of the Lower Silurian interval with species ranges is provided by Toghill (1968a, 1968b).

### Locality 7. cyphus Zone

The Linn Branch burn provides a continuous section from the *P. acuminatus* to *R. maximus* zones, but most zonal boundaries are not easily recognisable. It is wisest, therefore, to collect from the central body of each zone at the numbered localities (Figure 32.7).

The graptolite assemblages from Locality 7 in the *C. cyphus* Zone (7.3 m of black shale) display the general characteristics of the *C. vesiculous–C. cyphus* interval, i.e. the common occurrence of monograptids with simple thecae (e.g. *C. typhus*) and some with gently sigmoid thecae (e.g.
Atavograptus atavus). The distinctive dimorphograptids with their short uniserial portion occur at this level but are not easy to find, although examples of the diplograptid genus Climacograptus are relatively common.

**Locality 8. gregarius and convolutus Zones**

The general characteristics of the middle Llandovery Coronograptus gregarius and Monograptus convolutus zones can be discussed together in terms of their general characteristics. The C. gregarius Zone comprises 7.9 m of black shale with thick nodular claystones and is best collected at Locality 9. The M. convolutus Zone is 5.35 m thick, and is represented by two intervals of richly fossiliferous black shale separated by barren grey mudstones; it can be seen at Locality 10 and on the opposite side of the gully. Monograptids with triangulate thecae (e.g. Monograptus triangulatus in the C. gregarius Zone, and M. convolutus in the M. convolutus Zone) become common in these strata. Petalograptus appears at this level and is relatively abundant on some bedding planes. At the base of the M. convolutus Zone, monograptids with lobate thecae (e.g. Monograptus lobiferus and M. clingani) appear and are fairly common. Climacograptus specimens are noticeably rarer than in previous zones, (Figure 32.9).

**Locality 9. sedwickii and maximus Zones**

The youngest characteristic graptolitic interval present at Dob’s Linn comprises the Monograptus sedwickii and Rastrites maximus zones. The M. sedwickii Zone is 8.4 m thick, with 2 m of black shale sandwiched between lower and upper units of barren, grey mudstones. The R. maximus Zone is 6.55 m thick, composed mostly of grey mudstones and fine greywackes with a number of fossiliferous black shale bands. Locality 9 in the M. sedwickii Zone shows the main characteristics of this division. Monograptids with hooked thecae (mostly M. sedwickii become common, although triangulate forms still occur in the basal layers and monograptids with simple thecae (e.g. Pristiograptus regularis) persist (Figure 32.9).

**Locality 10. Gala Greywacke**

Here the gradational transition from the Birkhill Shale to the Gala Greywacke occurs. It falls within the R. maximus Zone, the black shale bands yielding hooked, triangulate and simple monograptids, together with species of Rastrites which have long, isolate thecae.

**Locality 11. North Cliff trench Lower Hartfell Shale**

If time and energy allow, it is worth visiting the final two localities, although care must be exercised on the rather steep slopes. Locality 11 may be reached by climbing up the scree-filled gully on the down-stream side of the Linn Branch trench, or via the scree and grass-covered slopes above the junction of the Lunn Branch and Long Burn (see (Figure 32.5)). The North Cliff trench exposes the only unfaulfed section through the P. linearis and top D. clingani zones, with faunal assemblages as described for Locality 2. The boundary between the two zones is approximately marked by the line of a possible old trench excavated along strike.

**Locality 12. Long Burn: Anceps Bands**

This is another trench cut through the Anceps Bands, and is situated above a scree slope in the Long Burn. At this locality the succession is more than twice as thick as that in the Linn Branch (Locality 6). This apparently rapid change in depositional thickness is more easily understood when realising that the localities are separated by a major thrust (the Main Fault, see (Figure 32.1)), and were probably deposited tens or even hundreds of kilometres apart. The greater thickness of graptolitic
shale means that scree-scramblers visiting this locality will be rewarded by a more abundant and better preserved *D. anceps* Zone fauna than at Localities 3 and 6.

**Identification of characteristic graptolite species**

Graptolites were originally colonial, planktonic animals, which belonged to the invertebrate phylum Hemichordata. Their organic external skeletons, originally a series of tubes, are all that remain of the original animal. Identification of graptolites relies on:

1. The overall form of the complete fossil (rhabdosome), including features such as number of branches (stipes), stipe attitude, width, etc.

2. The nature of early development of the colony (seen at the proximal, normally spinose, end).

3. The outline and spacing of the tubes (thecae).

In earlier publications, much emphasis was placed on the overall form and thecal outline when identifying genera. It is now believed that these features are often unreliable, partly because they are frequently affected by deformation caused during flattening of the cylindrical thecae, and partly because of tectonic stretching. More emphasis is therefore placed on proximal development, including position of thecae, nature of spines, etc. Unfortunately, such features are often difficult to observe in flattened, deformed specimens as normally found at Dob's Linn and in other black shale sequences, and many genera are currently being revised.

When identifying graptolite species, first look for overall form and distinctive proximal features, then finally check the thecal outlines. Remember that graptolite colonies grew continuously by budding, and while large specimens might have several hundred thecae, others may have died after growing only three or four, or with only the conical sicula present (which housed the first individual). Also be careful not to identify a single, broken-off stipe of a *Dicellograptus* as a *Monograptus*, and watch out for two or more rhabdosomes overlapping to give the false appearance of a different graptolites (e.g. two *Monograptus* stipes resembling a *Dicellograptus*). Good luck!

**Dob's Linn for the amateur geologist**

The amateur geologist should not be discouraged by the detailed biostratigraphy of the foregoing account, or by the difficulties encountered when identifying graptolites. Although not perhaps the most prepossessing of fossils, graptolites have proved to be of worldwide importance in establishing contemporaneity of strata in the older Palaeozoic rocks owing to their rapid evolution and diversification. Many of the species and zones at Dob's Linn can be recognised over much of the world; particularly close comparisons have been made recently with China, Siberia and Newfoundland.

Many sections yield graptolites slowly and reluctantly, but at Dob's Linn you cannot fail to find them in abundance and variety. Remember, however, that most professional geologists need to send their specimens to a very limited number of experts for accurate identification of species. Nevertheless, it is not difficult to recognise the more distinctive genera and the main thecal types of monograptids; a knowledge of these enables one to instantly distinguish between Ordovician rocks of Llandeilo, Caradoc and Ashgill age, and Silurian strata belonging to various divisions of the Llandovery Series.
These cover a time span of about 30 million years in just over 90 in (300 feet) of strata–100 000 years for every foot you cover!

Most of the specimens you find will not be readily identifiable because of fragmentation, distortion or poor preservation. Look for specimens which are as large as possible but still show the early stages (sicula and proximal thecae), and use an elementary text book.

Refer to the foregoing account and start at Locality 2 at the base of the Main Cliff in the Lower Hartfell Shale. The graptolites tend to occur in bands with differing species components, so examine the black shales layer by layer. The abundant diplograptids can mostly be identified as Orthograptus or Climacograptus, but are not helpful unless identified to species level. The stratigraphically significant genera are, unfortunately, less common and reward patient search.

These Caradoc rocks are characterised the world over by the presence of slender, gently or strongly curved, two-branched Leptograptus, the slender but stiff Pleurograptus with side branches, the V-shaped Dicellograptus, and the Y-shaped Dicranograptus. The latter genus is easier to find at the more precarious Locality 11.

Ascend the Main Cliff to Locality 3, or move to Locality 6 above the Linn Branch to collect from the Anceps Bands in the Upper Hartfell Shale. Although the fauna at this level is dominated by Climacograptus and Orthograptus, specimens of Dicellograptus with complex thecae are not uncommon (mostly D. anceps). D. complanatus with more simple thecae can be found at Locality 3. These rocks belong to the Ashgill Series at the top of the Ordovician; although Dicellograptus has persisted. Dicranograptus and Leptograptus have disappeared; again a worldwide pattern.

At Locality 6, study the Ordovician-Silurian boundary. Note that it is not now taken in the formerly accepted position at the base of the Birkhill Shale where continuous black shale deposition began, but 1.6 m above where Akidograptus ascensus and Parakidograptus acuminatus appear; reasons for this change are discussed earlier in the text. Now descend to the stream and collect from the C. cyphus Zone at Locality 7 (Figure 32.7). Note the common occurrence of monograptids with simple thecae. Search for the rarer dimorphograptids characteristic of this level. Diplograptids are still common.

On both sides of the gully at Locality 8, collect from the C. gregarius Zone which yields an abundant and varied fauna. Monograptids with triangulate thecae are now common in addition to the simple forms. Isolate forms (Rastrites) and the distinctive Petalograptus are less common and need to be looked for carefully. Lobate monograptids appear in the higher layers. The small ridge with bedding planes exposed at Locality 9 is within the M. sedgwickii Zone, notable for the appearance of hooked monograptids, particularly the zone fossil. The transition from the Birkhill Shale into the overlying Gala Greywacke is visible at Locality 10.

Acknowledgements

(Figure 32.5) and (Figure 32.6) are reproduced from Williams (1988), (British Museum (Natural History) publication), while (Figure 32.8) and (Figure 32.9) of Silurian graptolites are based on illustrations in Webb, Rushton and White (British Geological Survey publication, in press). We thank these individuals and organisations for their permission to employ diagrams in the excursion guide. S.H.W.’s study of the late Ordovician and early Silurian graptolites was made for a Ph.D. thesis at Glasgow University, supervised by J.K. Ingham and supported financially by NERC.
References


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