



Nature in Avon

Volume 83

Bristol Naturalists' Society

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The Bristol Naturalists' Society aims to stimulate a greater awareness of natural history and geology in the Bristol area. It is a thriving and friendly Society with something of interest for everybody, young or old, professional or amateur. It is actively involved in a long term programme of education, research and conservation. Each year its talks, trips and publications are enjoyed by hundreds of people wanting to find out more about our natural world.

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Nature in Avon

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CONTENTS

Editorial	1
Correlations within the Clifton Down Limestone, Bristol Area A. Kirkham	2
Making Geology field work accessible, a case study in Bristol Richard Arthur	27
The biostratigraphy and palaeoecology of the Lower Cornbrash, Woolverton Simon Carpenter and Deborah Hutchinson	41
The Redcliffe Sandstone: Great Outcrops at Stapleton Maurice Tucker and Mark Howson	59
Dandelions of the Bristol Region Dylan Peters	69
Studying obscure fungi on obscure plants - bryophilous fungi in the molecular age George R. L. Greiff	95
Wildlife Surveying and Recording at Watercress Farm, Wraxall, North Somerset Bob Fleetwood <i>et al</i>	105
Avon Needs Trees: The Evolution of a Tree Planting Charity Cathy Bedford	129
Invertebrate Report 2023 Ray Barnett	139
Weather Report 2023 Barry Horton	152
Society Annual Report 2023	172
Society Accounts for 2023	184

Editorial

Welcome to Nature in Avon Volume 83. It has been another busy and productive year for our Society as you will see from our Annual Report and Accounts.

This year we begin again with geology and a study by Tony Kirkham of arguably our most famous local rock sequence, the Clifton Down Limestone (CDL), for which he offers new correlations to aid study. Richard Arthur provides a guide to the CDL in the Observatory area of Clifton, Bristol, with special consideration for those with restricted mobility. Simon Carpenter and Deborah Hutchinson have been examining temporary exposures in the Lower Cornbrash and making new discoveries to add to its already diverse benthic fauna. Finally, Maurice Tucker and Mark Howson describe the Redcliffe Sandstone at Stapleton. These attractive red exposures are obvious to all who pass by; this piece encourages us to stop and take a closer look.

We have a ground-breaking report on the dandelions of our region by Dylan Peters. He became interested in this critical group during the COVID lockdowns and has increased the local list from around 40 to – well, I'll let him tell you. He provides the details of his studies here and offers a guide to getting to grips with Taraxacology.

George Greiff has benefitted from a grant from the Society towards his research into bryophilous fungi – an intriguing group that is rarely noticed, let alone studied. He has been developing methods to study their DNA which he shares with us here.

It is very exciting to be able to report on efforts in our area (and the wider Avon valley) to bring back nature and we have two articles describing different approaches. Bob Fleetwood and a dedicated team of surveyors give us a fascinating and detailed account of the biodiversity of Watercress Farm, an ordinary piece of modern farmland just south of Bristol, at the very beginning of a major new re-wilding scheme. Great changes are afoot here and this glimpse of the earliest stages already offers an insight into what nature can do when given the chance as well as acting as a baseline study for future comparison. We also have a piece by Cathy Gray about the relatively new charity Avon Needs Trees, how it was conceived and how it has evolved to become what it is today – a significant force capable of creating on a large scale the woodlands which our grandchildren's grandchildren will be exploring.

We have our usual informative round up of a year of invertebrates by Ray Barnett, including yet more new records, and a weather report from Barry Horton who is faithfully chronicling the local evidence of our warming climate.

I want to say a big thank you to all our contributors. I feel very lucky to live in this lovely part of the world and these varied papers highlight the diverse features of our region so beautifully. It is also important to record our changing biodiversity with regards to the warming climate which is progressing increasingly rapidly.

Dawn Lawrence

Correlations within the Clifton Down Limestone, Bristol Area

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Abstract The Lower and Middle Cromhall Sandstones, which form the lower and upper stratigraphic limits to the Clifton Down Limestone north of Bristol, pass into shale packages which, as a whole, provide approximate correlative markers for the southerly stratigraphic positions of the Cromhall clastics where sandstones are absent or poorly developed. More specific lithological correlative markers are provided by stratified ferroan dolomites, micro-spherulitic thrombolites and chert beds'. Palaeontological support for the lithostratigraphical correlations is provided by rare occurrences of the brachiopod, *Davidsoninia carbonaria*, and by concentrations of a cerioid coral, *Lithostrotion*. Microfossil dating, mainly using foraminiferids, assisted in establishing the Arundian-Holkerian substage boundary. All illustrations copyright of author.

1 Introduction

The Clifton Down Limestone (CDL) is a term introduced by Kellaway and Welch (1955) as part of the Clifton Down Group and arguably constitutes the most varied part of the Lower Carboniferous Limestone succession in the Bristol-Mendip area in terms of facies variation, MacQuown and Bloxam (1972). Field geologists would therefore benefit from being able to recognise conspicuous lithological markers within the CDL or its laterally equivalent formations and so one objective of this paper is to identify some as a basis for correlation. A second objective is to confirm a substage boundary within the CDL using index fossils.

Lower Carboniferous Limestones are exposed in the limbs of Hercynian (Variscan) folds including the *en echelon* periclinal folds of the Mendip Hills, the Broadfield Down pericline, the Clevedon-Westbury anticline and the Tytherington-Cromhall-Chipping Sodbury syncline (**Fig. 1**). Detailed sampling localities included the abandoned Great Quarry in Avon Gorge, Bristol, and the natural outcrops of Burrington Combe at the northern edge of the Mendip Hills. Others were at working quarries including those at Elberton (ST 60 88), Failand (ST 53 71), Flax Bourton (ST 503 684), Backwell (ST 492 678), Dial (ST 527 667), Arnold's Quarry at Chipping Sodbury (ST 725 825) and Wick (ST 712 732). Additional sampling was done at the small, abandoned Church Quarry, Tytherington (ST 675 885) and Henley Quarry, Yatton (ST 442 652). The only location that had significant gaps in the measurable succession due to vegetation overgrowth causing poor exposure was at Burrington Combe.

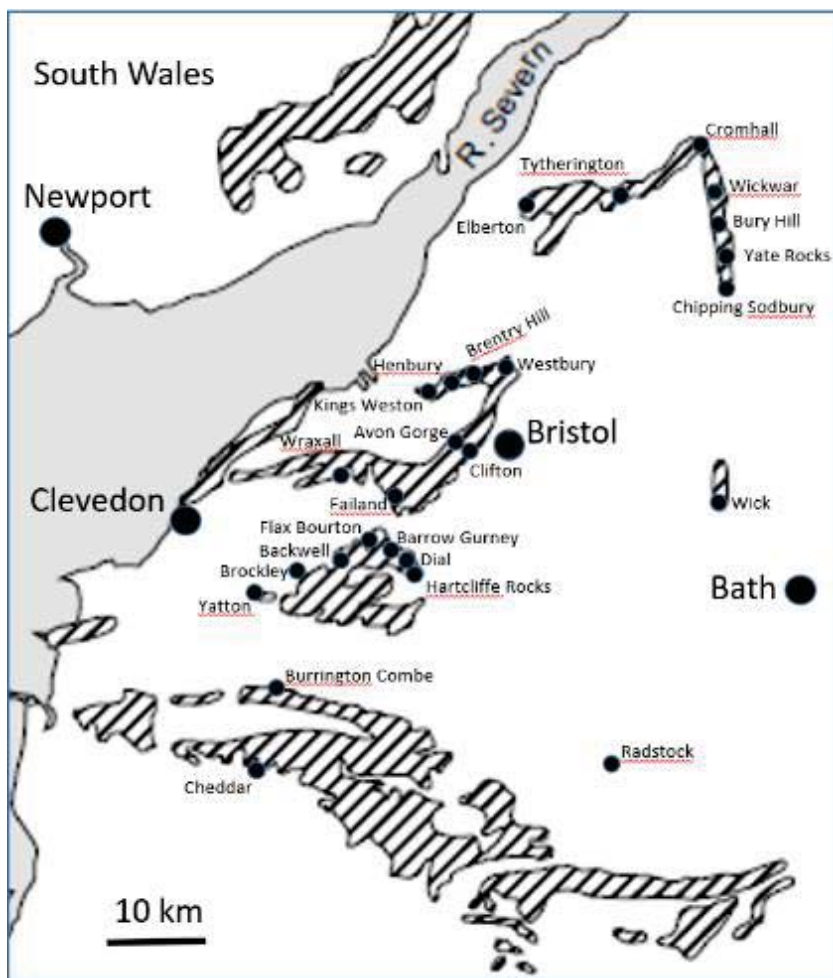


Fig. 1: General location map. Lower Carboniferous Limestone outcrops indicated.

Reconnaissance sampling visits were made to Wickwar (ST 713 900) and Hartcliffe Rocks (ST 533 662) quarries. The Chipping Sodbury, Elberton and Yatton quarries have since been infilled under waste disposal schemes. Minor control was afforded by Kellaway's (1967) description of the Ashton Park Borehole located 2 km south of the Great Quarry, Avon Gorge, and which reached total depth in only the uppermost layers (Concretionary Beds) of the CDL.

		Bristol to Cromhall	Broadfield Down-North West Mendips (and South & East Mendips)		Great	Britain
Vaughan 1905	Reynolds 1921	Kellaway & Welch 1955	Waters et al. 2009 & 2011 and Green & Welch 1965		Ramsbottom 1973	George et al. 1976
D2 & D3	D2	Upper Cromhall Sandstone	Pembroke Limestone Group	Upper Cromhall Sandstone	6 (group)	Brigentian
D1	D1	Hotwells Limestone Fm.		Oxwich Head Limestone Fm.	5 (group)	Asbian
		Middle Cromhall Sandstone				
		Concretionary Beds		Concretionary Beds (calcite-mudstones)		
				(Cheddar Oolite Mbr.)	4	Holkerian
S2	S2	Seminula Oolite		Clifton Down Limestone Fm.		
		Clifton Down Limestone Fm.		(Cheddar Limestone Mbr.)		
	S1	Fluorite-rich Band		Dolomite Rib		
S1		Lower Cromhall Sandstone		Burrington Oolite Subgroup	3	Arundian
		Clifton Down Mudstone Fm.		(Vallis Limestone Fm.)		
	C2	Goblin Combe Oolite Fm.		Goblin Combe Oolite Fm.		
C2		Clifton Down Mudstone Fm.		High Tor Limestone Fm.		
				Caswell Bay Mudstone Fm.	2	Chadian
				Gully Oolite Fm.		
C1	C1	Gully Oolite Fm.				
		Sub-oolite Bed				
Z2	Z2					
		Black Rock Group	Black Rock Subgroup			
Z1	Z1					
				1	Courseyan	
K2	K2					
		Lower Limestone Shales	Avon Group			
K1	K1					

Table 1: Summary of historical chronostratigraphy and lithostratigraphy. Blue shaded parts are historical non-sequences. Vaughan's and Reynold's onations did not include the Cromhall Sandstones. The Arundian-Holkerian boundary is changed at the type locality, Avon Gorge,

This paper	Belgium			NW Europe Index	Foraminiferal biozones
				Waters et al. 2011	
Brigantian	V3c	Viséan	Mississippian		
				Cf6	<i>Neoarchaediscus</i>
Asbian	V3b				
	V3a			Cf5	<i>Koskinotextularia</i> - <i>Pajarkavella nibelii</i>
Holkerian					
	V2b				
	V2a			Cf4	
Arundian					<i>Eoparastaffella</i>
	V1b				
	V1a				
Chadian					
	Tn3	Tournaisian	Cf3	<i>Tetrasis</i> - <i>Eotextularia diversa</i>	
Courceyan	Tn2		Cf2	<i>Paraendothyra</i>	
	Tn1		Cf1	<i>Chernyshinella</i>	

(cont.) to be lower than originally picked base of the Seminula Oolite. Ramsbottom (1973) picked the top of his Cycle 3 at the Dolomite rib in Burrington Combe.

N.B. The table reads across the double page spread.

2 General Stratigraphy

Vaughan (1905, 1906) provided the first serious attempt at zoning the Lower Carboniferous Limestones using combinations of brachiopods and corals. His type locality was the Avon Gorge, Bristol, and the limestones became known as the Avonian. He referred to the Lower Avonian as Clevedonian (his K, Z and C zones) and the Upper Avonian as the Kidwellian (his S and D zones), but such terms quickly fell out of favour. In later years, effort focussed with limited success upon refining the KZCSD zonation throughout the Southwest Province (**Table 1**; Reynolds 1921) and elsewhere in the UK and Western Europe. The Belgian Lower Carboniferous limestones were classified as Dinantian (now Mississippian; Waters *et al.*, 2011) which was subdivided into the Tournaisian (Lower Avonian) and Viséan (Upper Avonian) stages.

Kellaway and Welch (1955) introduced a lithostratigraphical nomenclature for the Bristol-Mendip (- Forest of Dean) area including the Clifton Down Group comprising the Gully Oolite, Clifton Down Mudstone (CDM), Goblin Combe Oolite, Lower Cromhall Sandstone and the CDL. The CDL falls within Vaughan's (1905–1906) S1 and S2 zones. Other important units of the Group include the Seminula Oolite and Concretionary Beds of Vaughan (1905) within the CDL (**Fig. 2**).

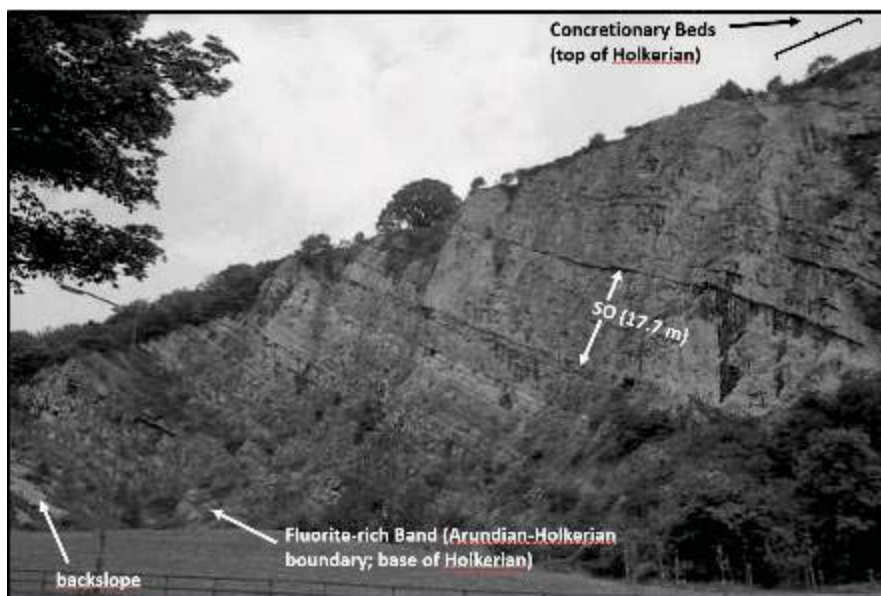


Fig. 2: Clifton Down Limestone at the northern end of Great Quarry, east side of Avon Gorge. SO = Seminula Oolite.

In the southern Mendips, Green and Welch (1965) and Waters *et al.* (2009) further subdivided the CDL into the lower Cheddar Limestone Member, the middle Cheddar Oolite Member and the upper calcite-mudstones. Those calcite-mudstones are equivalents of the Concretionary Beds.

Any CDL oolites in Vaughan's S-zone were routinely referred to as Seminula Oolite by early workers but it is sometimes unclear whether they regarded them as connected to the Seminula Oolite at its type locality of the Avon Gorge. Kellaway and Welch (1955) preferred to group all oolites within the CDL as the Clifton Down Oolite. They also argued for southerly merging of the main oolitic facies in Avon Gorge (Gully Oolite; Goblin Combe Oolite and Seminula Oolite) and possibly the Brockley Oolite of Broadfield Down to form the Burrington Oolite which directly underlies the CDL in the Mendips at Burrington Combe (Green, 1971). Although the Burrington Oolite is dominated by grainstones, it is not particularly oolitic at Burrington Combe.

Mainly to the north of Bristol, the Lower and Middle Cromhall Sandstones underlie and overlie the CDL respectively. Vanstone (1991) introduced the term 'Chipping Sodbury Member' to include shales and palaeosols within the Lower Cromhall Sandstone just north of Chipping Sodbury. The Middle Cromhall Sandstone may be overlain by the Oxwich Head Limestone Formation (the Hotwells Limestone Formation of Kellaway and Welch (1955)) which directly overlies the CDL south of the Middle Cromhall Sandstone limit.

The term 'High Tor Limestone' was introduced by Walters *et al.* (2011) to represent an open marine sequence between the CDM and Goblin Combe Oolite in the vicinity of Broadfield Down and Weston-super-Mare. Riding and Wright (1981) had interpreted equivalent limestones as an open marine subtidal inner shelf facies with migrating bars in South Wales. The High Tor Limestone Fm. substitutes for what Kellaway and Welch (1955) regarded as the southern extension of the CDM.

The boundary between the CDM and CDL occurs near the northern end of the Great Quarry in Avon Gorge where, according to Kellaway and Welch (1955), the uppermost CDM consists largely of thinly bedded or lenticular limestone, dolomite, mudstone and shales with stromatolites and ooliths whereas the lower part of the CDL contains more regularly bedded splintery calcite- and dolomite-mudstones which pass upwards into more massive fossiliferous limestones. Alternatively, the CDM-CDL boundary has been picked at the base of a sandy limestone (Waters *et al.* (2009) which Kellaway and Welch (1955) interpreted as part of the Lower Cromhall Sandstone.

The boundary needs further investigation according to Waters *et al.* (2009). The CDL is characterised by the coral *Siphonodendron*, previously also referred to as a fasciculate *Lithostrotion*; Murray (1992) and the brachiopod *Composita (Seminula) ficoidea*. The term 'fasciculate' is applied to a compound coral in which the corallites are spaced far enough apart to avoid mutual interference during growth; they may be linked by connecting processes Allaby (2013). The former coral indicates relatively

open marine conditions whereas the latter indicates more lagoonal settings not too different from the CDM. The CDM is not developed further south in the Mendips such as at Burrington Combe.

Murray and Wright (1971) studied the facies development within the CDL (Vaughan's upper C₂, S₁ & S₂ ones Reynold's S₁ & S₂) of Chipping Sodbury and Wick and identified a transgressive-regressive cycle starting with peritidal-lagoonal sediments succeeded by open marine carbonates which were in turn succeeded by more peritidal-lagoonal carbonates. MacQuown Jr. and Bloxam (1972) subdivided the CDL and upper CDM on the basis of colour, scratch frequency and microfacies in the Avon Gorge and correlated them with South Wales but later workers have not replicated their approach. Ramsbottom (1973) defined six major, eustatically induced, transgressive-regressive cycles in the entire Lower Carboniferous throughout the UK with each cycle ideally ending with peritidal-lagoonal facies. He assigned the single Murray and Wright cycle in the CDL to the upper part of his cycle 3 and entire cycle 4 both of which he extended to Avon Gorge and Burrington Combe. In modern parlance Ramsbottom's (1973) cycles are sequences comprising systems tracts.

George *et al.* (1976) assigned formal Stage names to Ramsbottom's (1973) cycles, later modified by Conil *et al.* (1977) and Ramsbottom & Mitchell (1980) who subdivided the Tournaisian into Hastarian and Ivorian which, although acknowledged by Waters *et al.* (2009), were ignored for the British Isles by Waters *et al.* (2011) who restored the Courceyan and reclassified the original Stage names as Substages. Ramsbottom's (1973) cycles 3 and 4 were assigned to the Arundian and Holkerian which in turn were later correlated respectively with the V1b-V2a and V2b-V3a subzones of Belgium. Those subzones were superseded by a Cf1-Cf7 foraminiferal zonation for Belgium which was established as the standard for NW Europe (Conil *et al.* 1980, 1990; Riley 1993; Waters *et al.* 2011a) although the original Belgian subzones nomenclature is adhered to in this paper as defined by Conil in 1976 because it provides greater correlation fidelity.

Within the Clifton Down Group, Ramsbottom (1973) and George *et al.* (1976) assigned all strata below the Goblin Combe Oolite (*i.e.* Gully Oolite and lower part of the CDM) to the Chadian and regarded them as the regressive phase at the top of their second eustatic cycle. This was later supported by Whittaker and Green (1983) who reported Chadian foraminifera from the CDM just below the Goblin Combe Oolite in Avon Gorge. However, the entire CDM (together with its equivalent Caswell Bay Mudstone in South Wales) including the Goblin Combe Oolite is now regarded as: 1) transgressive (Riding and Wright, 1981), 2) part of a third eustatic cycle, and 3) Arundian in age (Waters *et al.* 2011). The top of the Chadian is now picked at the palaeokarstic unconformable top of the Gully Oolite in the Avon Gorge, Chipping Sodbury, and elsewhere in South Wales (Riding and Wright, 1981). Ramsbottom (1973) and George *et al.* (1976) picked the top of the Arundian-

Holkerian boundary at the base of the Seminula Oolite in Avon Gorge but is now thought to be too high in the CDL as discussed below.

3 Depositional setting

The Lower Carboniferous sediments of the South West Province (South Wales-Bristol area-Mendips) display a general northerly thinning onto the contemporaneous St George's Land. Within the Province, (Wright (1987) argued for a Courceyan-Holkerian ramp evolving into an Asbian uniform, shallow, relatively flat, shelf-like configuration lacking sign of a shelf edge. Adams *et al.* (2004) interpreted the Holkerian CDL of Chipping Sodbury as a mid-ramp deposit. Courceyan Waulsortian reef mounds are known to have accumulated in the Cannington Park area 30 km southwest of Burrington Combe (Lees and Hennebert 1982) and calciturbidites and debris flows in the Chadian-Brigantian Westleigh Limestone Formation of northeast Devon (Thomas 1963; Matthews and Thomas, 1974; Waters *et al.* 2011). Reef mounds and turbidites are typically associated with platform slope beyond a platform rim or shelf edge, but Wright (1987) viewed the resedimented deposits containing very shallow water grains such as ooliths and dasycladacean grains (from Dasycladales an order of green algae, Allaby (2013)) as indicative of a ramp shallow water shoals sourced probably from the east, rather than being sourced by shedding of shallow water sediment southwards across a shelf edge. Leeder (1992) illustrated Late Dinantian submarine fans with calciturbidites transported southwards into NE Devon.

4 Lithological Markers

4.1 Sandstones and shales

The CDL interfingers northwards between the fluvio-deltaic Lower and Middle Cromhall Sandstones which provide loose correlation control and are regarded as siliceous wedges originating from the northerly St George's Land. Without noting a thickness, Kellaway and Welch (1955) interpreted a slightly sandy hard grey limestone with a well-defined and regular base at the contact between the CDM and CDL near the northern end of the Great Quarry, Avon Gorge. This is perhaps a very weak representation of the Lower Cromhall Sandstone which is more conspicuously represented by numerous, laterally equivalent, relatively thick shales in the same part of the succession. As in the Avon Gorge, shales alone occur near the base of the CDL at Wick and are again interpreted as distal extensions of Lower Cromhall Sandstone pulses. Lower Cromhall Sandstone with accompanying shales and palaeosols underlies the CDL at Chipping Sodbury where Vanstone (1991) incorporated them in the Chipping Sodbury Member of the CDM at Southfields Quarry (Grid Reference ST 724 843) north of Arnold's Quarry and regarded them as a combination of braided and meandering stream deposits.

The Lower Cromhall Sandstone was also encountered at Elberton during commercial quarry drilling. Reynolds (1920) described a sandy development (previously identified as Devonian Old Red Sandstone) in S₁ one near King's Weston House (ST 543 775) 4 kms to the northwest of the Great Quarry on the northern end of the Clevedon-Westbury anticline and Reynolds (1937) recorded another grit unit below what he interpreted as the Seminula Oolite near Wraxall. Both of these instances may represent western tongues of the Lower Cromhall Sandstone which by-passed the Avon Gorge.

Middle Cromhall Sandstone and shales occur above the CDL at Chipping Sodbury and Wick. They are absent from the Great Quarry, Avon Gorge, where the CDL is directly overlain by the Asbian Oxwich Head Limestone but about 1.25 m of sandy limestone occurs within the top of the Concretionary Beds in the Ashton Park borehole 2 km south of the Great Quarry (Kellaway 1967).

Neither of the Lower and Middle Cromhall Sandstones or related shales are recorded from Broadfield Down, Burrington Combe or elsewhere in the Mendips. Unfortunately, there are no specific lithological markers in the Lower or Middle Cromhall Sandstones which can be used for correlation but at least the two gross siliciclastic incursions provide general indicators of proximity to the lower and upper CDL boundaries respectively.

Other sandstones and sandy limestones occur within the CDL between the Lower and Middle Cromhall Sandstone wedges but they have proven difficult to correlate. The 'Firestone' is the thickest (2.75 m) of such developments. It is essentially oolitic calcareous sandstone with quartz grains acting as oolith nuclei. Quartz content increases upwards and quartz grains are etched but may have thin outer pellicles of hematite which give the Firestone its patchy red colouration. Perhaps the quartz was fluvial-derived from the Devonian Old Red Sandstone exposed on St. George's Land, but possibly also sourced by aeolian processes. Oolith formation requires slightly raised salinities and so their abundance in the Firestone argues against penecontemporaneous nearby fluvio-deltaic activity. The Firestone is known to thin locally even within the confines of Tytherington village where it is currently best exposed (**Fig. 3**). It extends further north along the strike of the Tytherington Ridge to the vicinity of Cromhall and may be correlative to Wickwar (Wallis 1924a and b). Tuck (1925) recorded the Firestone at Yate Rocks, but such an observation must be viewed with caution because other unrelated sandstones occurred in the CDL at Arnold's quarry, Chipping Sodbury.



Fig. 3: Firestone bed, ≤ 2.5 m thick and patchily hematite stained. Clifton Down Limestone of Tytherington Church Quarry. Geologist resting on basal bedding plane.

4.2 Ferroan dolomite beds

Dolomitization is common within the CDL and tends to increase northwards within certain depositional facies (Kirkham, 1977). Most dolomitisation was late diagenetic and formed during burial but two conspicuous penecontemporaneous ferroan dolomites occur. One of those is the Dolomite Rib (top 25 cm of a 70 cm thick bed; **Fig. 4A**) which is a finely crystalline ferroan dolomite with fenestrae perhaps representing intertidal birds-eyes. It is exposed near the top of the Burrington Oolite in Burrington Combe. Vague stromatolitic laminae occur within the Rib and a stromatolitic limestone forms the lower part of the bed. Reynolds and Vaughan (1911) discovered fluorite in the vicinity of the Dolomite Rib and they compared it with what later became known as the Fluorite-rich Band (Loupekin, 1951) of the Great Quarry, Avon Gorge, 18 km to the north.



Fig. 4A: Buff coloured Dolomite Rib (arrowed), Burrington Combe. 40 cm of buff colouration is due to high content of finely crystalline ferroan dolomite. View is to the east and the steeply inclined beds either side are Burrington Oolite dipping north.



Fig. 4B: Fluorite-rich Band, Great Quarry, Avon Gorge. 0.45 m thick. Buff colour is due to very high finely crystalline ferroan dolomite content. White calcite nodules are probably replaced anhydrite nodules.

The Fluorite-rich Band outcropping at the northern end of the Great Quarry, Avon Gorge, is the other most conspicuous dolomite in the CDL (**Fig. 4B**). It is 40 cm thick with a stylolitic basal bedding plane and a planar top. As in the case of the Dolomite Rib it is almost entirely composed of finely crystalline ferroan dolomite. It caps a thin peritidal-lagoonal sequence and is distinctively yellow ochre. Elliptical calcite nodules with dimensions up to 16 by 7 cm are aligned parallel to bedding mainly along the approximate middle of the Band. The nodules may be linked by calcite veins, which occur throughout the bed.

The calcite of both the nodules and veins is coarsely crystalline. The nodules are interpreted as former supratidal sabkha anhydrite nodules completely or partially leached and replaced or later cemented by the coarsely crystalline calcite. The fluorite is concentrated in the nodules and veins but also occurs in the underlying and overlying beds.

Regarding the conditions under which these ferroan dolomites formed, high salinities leading to rapid dolomite formation are suggested by: a) the stromatolitic content of the Dolomite Rib; b) the formerly anhydritic content in the Fluorite-rich Band; c) association with calcite pseudomorphs after gypsum at Dial (**Fig. 5**) d) the fine dolomite crystallinity suggesting rapid crystallization; e) sparsity of fossils. As the

ferroan dolomites are bed-restricted it is clear that they did not form as a result of a groundwater reflux process. Wright *et al.* (1997) and Barnett *et al.* (2012) demonstrated with the aid of isotopes that ferroan dolomites can form under the influence of sulphate-reducing bacteria in paludal brackish waters of coastal marshes that developed landward of a shoreline. Perhaps, therefore, salinities varied during the formation of these deposits. Rapid finely crystalline dolomite precipitation in the anaerobic beds of saline lagoons as a result of sulphate-reducing bacteria acting on dissolved or precipitated sulphates such as in the Coorong Lakes of southern Australia is a process whereby ferrous ions could be incorporated in the dolomite (Wright and Wacey 2004).

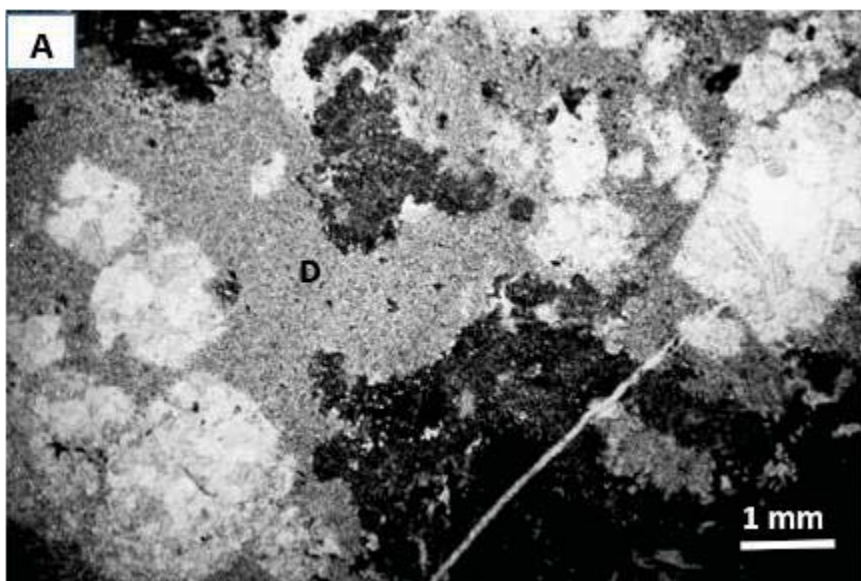


Fig. 5: Calcite pseudomorphs after gypsum. A) White pseudomorphs set in a matrix of finely crystalline ferroan dolomite (D). Holkerian, Dial Quarry. B) In the original rock sample the white pseudomorphs were arranged with their long axes vertical or sub-vertical suggesting the original gypsum formed in a salina. Holkerian, Wick Quarry.

The Dolomite Rib of the Burrington Oolite and the Fluorite-rich Band of the CDL were dated as S_1 zone and thought to be correlative by Reynolds and Vaughan (1911). Kellaway and Welch (1993) correlated the two beds as representing the diagenetically modified top of Vaughan's S_1 unit. Unfortunately, the present study has not incorporated any outcrops from that part of the sequence between Avon Gorge and Burrington Combe although fluorite associated with dolomite has been recorded at the same general stratigraphic level near Wraxall. Kellaway and Welch (1993) identified the Fluorite-rich Band at Lawrence Weston, 5 km northwest of the Great Quarry. If correlative, they represent a very unusual, early diagenetic, reducing

peritidal-lagoonal environment extending over a large area for a very restricted time period to encourage Fe to be incorporated in the dolomitisation process.

The thin ferroan dolomite horizon encountered at Dial (Fig. 5) remains uncorrelated, as also does another near Tytherington, which had been deformed by tepee construction typical of beach rocks and shallow lagoon hardgrounds.

4.3 Concretionary Beds and Thrombolites

The origins of the term 'Concretionary Beds' and their characteristics (**Figs. 6A and B**) were discussed in detail by Kirkham (2021). They comprise a facies association rich in microbial horizons including stromatolites, oncolitic horizons and thrombolites (Kirkham, 2005, 2018; Kirkham and Tucker, 2018). The general lagoonal aspect of the Concretionary Beds is quite distinctive and their almost blanket distribution across the study area renders them useful for approximate correlation as first suggested by Vaughan (1906) although he did not understand their origin. However, within the Concretionary Beds the only conspicuous potential markers are packages of early lithified, biostromal thrombolites. Macroscopically they display a mottled, clotted, pseudobreccia or arborescent structure, but microscopically they constitute a mass of spherulitic calcite fabrics. There is evidence that they developed under variable salinities including brackish or coastal marsh conditions. Thrombolites actually comprise a relatively small percentage of the Concretionary Beds and may occur as isolated beds at many localities but form potential correlation markers as packages of two or three stacked biostromes associated with undulatory erosional bedding planes or microkarsts at Avon Gorge, Flax Bourton, Backwell, Yatton and Burrington Combe.

At Avon Gorge, thrombolites with the same distinctive characteristics also occur near where Kellaway and Welch (1955) picked the CDM-CDL boundary although Kirkham (1977) placed them within the CDM and correlated this same lower thrombolite development to Wick where it occurs within what Murray and Wright (1971) interpreted as the CDM and which they may have misidentified as pseudobreccias. If correct, there is facies diachroneity. At Chipping Sodbury these lower thrombolites occur just above the Lower Cromhall Sandstone within the CDL. The Avon Gorge contains a third, very weak micro-spherulitic thrombolite development immediately below the ferroan dolomite of the Fluorite-rich Band but no correlative thrombolites have yet been discovered elsewhere in the area. Their association with the Fluorite-rich Band is in keeping with the possible coastal marsh setting considered for its ferroan dolomite precipitation.



Fig. 6A: Thrombolite outcrops, Concretionary Beds. From Backwell. The matrix is reddened perhaps due to pyrite oxidation, car keys for scale. (After Kirkham, 2021).



Fig. 6B: Thrombolite outcrops, Concretionary Beds. From Flax Bourton. Thrombolitic mesoclots are the irregular darker grey patches at both localities. Car keys for scale. (After Kirkham, 2021).

4.4 Chert ‘Beds’

Whilst silicification (beekitization) of bioclasts is fairly common throughout the CDL, the distributions of nodular cherts seems to have been stratigraphically controlled since they are restricted to bed-parallel horizons in the CDL. Reynolds and Vaughan (1911) quoted Hinde who implied that the silica in the CDL cherts of Burrington Combe originated from sponge spicules and radiolarians which were dissolved and re-precipitated. The silica of the chert is unlikely to have had a volcanic origin as the only local volcanic activities occurred earlier during accumulation of the Black Rock Group and lower CDM (Reynolds 1917; Kellaway and Welch 1955; Green 1992).

Conspicuous, individual, 9 – 10 cm thick chert ‘beds’ rather than nodules occur in the CDL at Flax Bourton and Backwell localities which are 1.25 km apart (**Fig. 7**). A detailed comparison reveals a very precise correlation between bedding planes and shaly partings above and below the chert ‘beds’. There is no doubt, therefore, that the chert ‘beds’ of these two localities are the same. Chert ‘bed’ correlations were therefore extended 4 km from Flax Bourton to Failand and 2.75 km to Dial quarries again with support from consideration of the vertical distributions of the associated carbonate facies.



Fig. 7: White coloured chert bed, Flax Bourton. It is 10 cm thick and probably formed from lateral coalescence of chert nodules. Correlative to Backwell, Failand and Dial Quarry. Hammer for scale.

Chert nodules, but no chert beds', also occur in the CDL at Burrington Combe and Avon Gorge. Those of Avon Gorge occur just beneath the Seminula Oolite. Neither of those two chert nodule groups are easy to correlate elsewhere. No cherts occur in the CDL at Chipping Sodbury and Wick.

5 Palaeontological controls

Vaughan's zonation by coral-brachiopod assemblages.

Although Vaughan's (1905) coral-brachiopod zonation scheme for the Mississippian limestones was an important geological contribution, its fallibility is recognised even within the Bristol area and South Wales. The presence of index fossils varies noticeably across the South West Province and there is a strong possibility that some species are facies controlled. For example, *Composita (Seminula) ficoidea* which is diagnostic of the CDL favoured lagoonal facies. Ramsbottom (1973) cast considerable doubt upon the ability of Vaughan's scheme to identify discontinuities in the Mississippian Limestone succession not only throughout Britain, but even within the Avon Gorge which is the type section that Vaughan used to formulate his zonation. Whilst there is no denying their historical value in the field for general stratigraphic positioning, the use of these assemblages does not provide the precision required for correlation within the limited but highly variable stratigraphic succession of the CDL.

5.2 *Davidsoninia carbonaria* (formerly *Cyrtina*)

The brachiopod, *Davidsoninia carbonaria*, first appears at the base of the Holkerian cycle of sedimentation (Ramsbottom, 1973) although it is arguably an unreliable index fossil in the Bristol district since it also occurs in the Asbian Oxwich Head Limestone in the Ashton Park borehole and may be facies controlled (Kellaway, 1967). Nevertheless, its occurrence does at least indicate an upper limit for the Arundian stage at any one locality.

It was described as extremely rare in the Bristol area by Wallis (1922a and b) who recorded small fragments of *D. carbonaria* at Dial Quarry. Tuck (1925) and Vaughan & Reynolds (1935) found it to be very abundant at Wickwar. It is noticeable for its absence from the CDL in Avon Gorge (Reynolds 1937; Ramsbottom 1973).

D. carbonaria has been identified within the CDL at Tytherington (Wallis 1924a and b) and just above the Dolomite Rib in Burrington Combe (Mitchell and Green, 1965). Ramsbottom (1973) found it at the top of the Burrington Oolite in Burrington Combe, *i.e.* again a few metres above the Dolomite Rib.

5. 3 Cerioid corals (*Lithostrotion*)

Lithostrotion basaltiforme, *L. bristoliense*, *L. aranea* and *L. portlocki* are names used by previous workers in referring to a cerioid coral occurring within the S-zone of the Bristol area. The term 'cerioid' is applied to those corals in which the individuals comprising the colony are packed together and corallites are polygonal in section, each individual corallite retaining its own wall Allaby (2013). The name *L. vorticale* takes priority according to Nudds (1975). Poty (1981) viewed *L. aranea* as being very restricted to the lower Cf5 zone whereas *L. vorticale* was restricted to much higher in the upper Cf6 zone in Belgium.

In the Avon Gorge, *L. basaltiforme* was previously identified as *L. aranea* within the so-called aranea bed (Vaughan 1905 Conil *et al.* 1976). Amongst the CDL localities studied in detail, such cerioid corals were found to occur at Elberton, Tytherington, Avon Gorge and Chipping Sodbury. They have also been found at Wickwar Quarry and at disused quarries southwest of Alveston (ST 632 881; Reynolds and Innes 1914); at Durdham Park (ST 574750; Reynolds, 1920) and at Failand (ST 506 724). Impressive developments with colony diameters >1 m occurred on an exposed bedding plane at Arnold's quarry, Chipping Sodbury where Murray and Wright (1971) identified the CDL cerioid corals as *L. portlocki* although Vaughan (1905) limited that form to the D-zone, especially D₂).

The cerioid form has been considered to be an adaption by fasciculate *Siphonodendron martini* to subtle environmental conditions adverse to fasciculate growth (Poty, 1981), though in the Avon Gorge and near Westbury it is found associated with abundant *S. martini* debris (Reynolds 1920) and so such adaptations are questionable.

A cerioid *Lithostrotion* is known in S₁, S₂ and D₁ throughout the UK which suggests that its correlation potential is low. However, as in the case of many other coral bands in N. Wales and N. England, its occurrence can locally provide a useful marker. Concentrations of cerioid corals occur within an extremely limited stratigraphic range in the CDL. Vaughan (1905) revealed that *L. basaltiforme* extended from his mid-S₁ zone to the lower part of S₂ zone but was at its maximum near the top of S₁ in the Avon Gorge. In most localities they are confined to a single bed but, in the Avon Gorge and at Chipping Sodbury, cerioid colonies are concentrated within two beds <=4 m apart. One cannot therefore automatically assume that all the horizons containing cerioid corals at the various localities are exact time equivalents. However, one of these horizons at Chipping Sodbury is underlain by an undulating bedding surface. So also are the cerioid coral horizons 8 km to the west at Tytherington and Elberton. Such surfaces may have been storm effects or perhaps even palaeo-karstification. Whatever the exact nature of these undulating surfaces, their coincidence with cerioid coral colonies at three localities strongly suggests that these colonies are contemporaneous. The combination of limited stratigraphic range

locally, relative abundance of colonies, ease of identification, and conspicuous mode of weathering (due to total intra-skeletal calcite cementation it weathers white and is easily visible) provides a much greater potential as a marker horizon than is possible from using the coral-brachiopod assemblages. Reynolds (1920) correlated its occurrences between Avon Gorge and Westbury.

Though Wallis (1922a and b) discovered rare specimens of what he interpreted as *L. basaltiforme* at unknown locations in what he regarded as Vaughan's S₂ zone on Broadfield Down, no specimens have ever been recorded from Burrington Combe or Wick. It is unfortunate therefore that it cannot be used for correlation over the whole of the study area. Sibly (1906) recorded *L. basaltiforme* outside the study area at eastern Mendips.

5. 4 Foraminifera and Calcified Microbes

Table 2 summarizes the relative abundances of key microfossils used for dating according to the Belgian subzone nomenclature. More detailed microfossil identifications and specific sampling points are presented in Kirkham (1977). The V2a-V2b boundary was of particular interest because it coincided with the Arundian-Holkerian boundary which separated the eustatic cycles 3 and 4 of Ramsbottom (1973).

	Tn3c	V1		V2a	V2b a β-γ		V3
<i>Tetraxis</i>	*	*	*	()	*	*	*
<i>Plectogyransopsis</i> sp.		()	()	*	**	**	**
<i>Archaediscus primitifs</i>			**	**	()	()	()
<i>Archaediscus</i> (<i>Archaediscus</i>)			*	*	**	**	**
<i>Girvanella densa</i>		*	*	*			
<i>Spiroendothyra</i>	()	*	*	*	()		
<i>Dainella</i>		*	*	*			
<i>Lituotubella magna</i>					*	*	*
<i>Pojarkovella nibelis</i>					*	*	*
<i>Koskinotextularia</i>					*	*	*
<i>Koninkopora</i>				*	*	*	*
<i>Nodosarchaediscus</i>				()	()	()	()

Table 2: Listing of index microfossils: () sparse, * relatively abundant, ** common.
N.B. *Pojarkovella nibelis* was initially identified as *Quasiendothyra* (?) *nibelis*.

Foraminifera, especially, are extremely abundant at some horizons. *Spiroendothyra*, *Dainella* and the microbial form, *Girvanella densa*, have been used as indicators of V2a and older. *Girvanella densa* occurs in V1-V2a but a V2a age is indicated if accompanied by *Koninkopora*. *Pojarkovella nibelis* (previously identified as *Quasiendothyra* (?) *nibelis*), *Koskinotextularia* and an abundance of *Lituotubella magna* were regarded as good indicators of V2b-V3a, although *L. magna* also occurs in the upper Arundian (Cózar *et al.*, 2020). The formal foraminiferal zonation for Belgium (Cf1-Cf7) was established as a standard for NW Europe and applied to British Isles by Conil *et al.* (1980) and modified by Riley (1993) and Poty *et al.* (2006) Cf4 and Cf5 equated to the Arundian and Holkerian respectively. Cózar *et al.* (2020) offered modifications to the lower Cf5 but *Pojarkovella nibelis* and *Koskinotextularia* are still regarded as good indicators of the Holkerian (Cf5 Zone) and so the V2a-V2b boundary is unaffected. Most of the Holkerian samples analysed were dated as V2b – V3a. No definitive V2b (-) assemblages were identified.

6 The Arundian-Holkerian (V2a-V2b) Boundary

Ramsbottom (1973) and George *et al.* (1976) picked this boundary immediately below the Seminula Oolite in the Avon Gorge and regarded it as a considerable non-succence accounting (in their view) for the lack of *D. carbonaria* at that locality. The current study revealed a V2b – V3a (Holkerian) microfossil assemblage 24 m below the Seminula Oolite in the Avon Gorge and so the original boundary pick was too high in the succession.

Also in 1976, for this study, Conil interpreted a V2a (Arundian) age from a sample 7.5 m below the cerioid *Lithostrotion* horizon in the Avon Gorge (Kirkham, 1977). Conil *et al.* (1976) placed the boundary below the aranea (cerioid *Lithostrotion*) horizon which they dated as V2b. Mitchell (1989) stated that cerioid *Lithostrotion* is not recorded below the base of the Holkerian, Green (1992) placed the Arundian-Holkerian boundary at the first appearance of cerioid corals. Surprisingly, Waters *et al.* (their Figure 20, 2011) drew the boundary deeper in the Avon Gorge succession - at the base of the Lower Cromhall Sandstone (top of their CDM) which, as already discussed, was not developed at that locality. In summary, the cerioid corals are potentially good approximate markers for the boundary although their occurrence in two beds at Avon Gorge and Chipping Sodbury leaves room for error in the pick because these corals may appear at even more horizons and it may be impossible in the field to ensure that the boundary correlations are correct. There is also the problem that cerioid corals have neither been observed at Wick nor Burrington Combe.

An additional complication stems from the fact that the tops and bases of Ramsbottom's eustatic cycles are characterised by peritidal lagoonal facies but no such sediments accompany the cerioid corals. It is therefore proposed that the conspicuous Fluorite-rich Band be regarded as the boundary in the Great Quarry, Avon Gorge, where it is 7 m above the cerioid corals, and interpreted as having

originally contained sabkha anhydrites. As already discussed, it has previously been correlated with the Dolomite Rib of the Burrington Oolite, Burrington Combe, and to other localities north of Bristol. Acceptance of such a marker for the boundary obviously conflicts with micro-palaeontological data which perhaps is more fallible than one would wish.

Such a conclusion is supported by diagnostic microfossils especially at Elberton and Tytherington. V2a? and *cf*V2a ages were identified 8 m above the cerioid coral horizon at Elberton and a more definite V2a age was identified immediately above it at Tytherington. At Elberton, the V2a-V2b boundary is picked at the top of a thin development of lagoonal facies that comprises highly ferruginised lenses of oomoldic dolomite and probable karstic solution features. At Tytherington, the boundary is drawn 3 – 5 m below the Firestone at the undulating bedding plane from which Wallis (1924a & b) collected his *D. carbonaria*. The position of the boundary was impossible to define on Broadfield Down and at Failand owing to non-exposure of V2a sediments in any of the studied localities.

At Burrington Combe, *Davidsoninia carbonaria* occurs just above the ferroan Dolomite Rib (Mitchell and Green 1965) which is taken as the top of the terminal Arundian regressive phase or the base of the Holkerian transgressive phase. At Wick a horizon containing calcite pseudomorphs after gypsum (Fig. 5) first identified by Murray and Wright (1971) denotes the same event. At Chipping Sodbury it is taken at a stromatolitic horizon 10.7 m above the upper cerioid coral bed. Notwithstanding the historical confusion associated with the boundary in the Avon Gorge, at all three of these localities the boundary coincides with the levels indicated by Ramsbottom (1973). Accordingly, there is agreement with Ramsbottom (1973) who re-interpreted the single transgressive-regressive cycle of Murray and Wright (1971) at Chipping Sodbury and Wick as including the upper part of his Cycle 3 (ie. upper Arundian) plus his entire Cycle 4 (Holkerian).

7 Conclusions

The following lithological markers of varying precision and extent are identified within the uppermost Clifton Down Mudstone and Clifton Down Limestone: 1) shale pulses associated with the Lower and Middle Cromhall Sandstones, 2) penecontemporaneous ferroan dolomites, 3) micro-spherulitic thrombolites, 4) chert 'beds'. Conspicuous occurrences of the cerioid rugose coral, *Lithostrotion*, provide an imprecise palaeontological marker across the northern part of the study area.

Microfossil datings confirm that the Clifton Down Limestone spans the Upper Arundian-Holkerian Substages and therefore includes elements of two eustatic cycles. The Arundian-Holkerian boundary is picked significantly lower than originally at the Lower Carboniferous type locality, Avon Gorge, where it is moved from the base of the Seminula Oolite to the top of the finely crystalline, ferroan dolomite of the

distinctive Fluorite-rich Band. That in turn is correlated with the finely crystalline, ferroan Dolomite Rib of the reference locality, Burrington Combe. This correlation needs to be verified at Broadfield Down where there was lack of suitable Arundian outcrop during the study.

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Making Geology field work accessible a case study in Bristol

Richard Arthur

Introduction

Following requests to have any compulsory element of field work removed from university geology courses (in order that they might be more inclusive), I began to wonder how much real geology could be done from a wheelchair and began to look for easy access sites with accessible rocks to see if such a wheelchair user could perhaps examine those rocks. I appreciate the need to be inclusive but also know that field work to be absolutely vital to put geology in context.

Near to Christmas 2021 I put on a special BNS field trip, which was attended by a geologist friend who is a wheelchair user. The all-weather paths on the approach to the Clifton Suspension Bridge and the nearby playground provide good easy access to rocks exposed in adjacent low faces. The rocks are mainly Carboniferous Limestone, of the Clifton Down Limestone Formation often referred to as the Concretionary Beds. What is revealed in these strata follows on well from Tony Kirkham's work on microbial limestones recently printed in *Nature in Avon*, *The Proceedings of Bristol Naturalists' Society* Vol. 80 page 46. In addition, some excellent fossils, a variety of joints and minerals, and unconformable rocks of Triassic Age can also be seen.

Detailed Itinerary

Figure 1, see below, shows a suggested tour of the accessible exposures and features in the Observatory area and a brief description of the localities.

Localities a and b (Plate 1)

a: after passing small well exposed bedding planes showing true southerly dips arrive at the start of the 2–3 metre high rock face. Notice the predominant jointing pattern and apparent dip in the seemingly uniform and uninteresting grey limestone well exposed in this section leading up to the bridge foundations. At 'a' look for a narrow near vertical open 10cm fissure that cuts the bedding and is partly eroded out to form a slot. It is seen to be filled with a vivid bright red mud and a sample of this loose material was collected and washed. Although no bone or teeth fragments were recovered some noticeably dense centimetre sized chips revealed black hematite and good quartz crystals, in effect minute Bristol Diamonds. Please leave any larger lumps present for others to feel how noticeably heavy they are but beware - this oxidized iron minerals stains skin and clothes deep red.

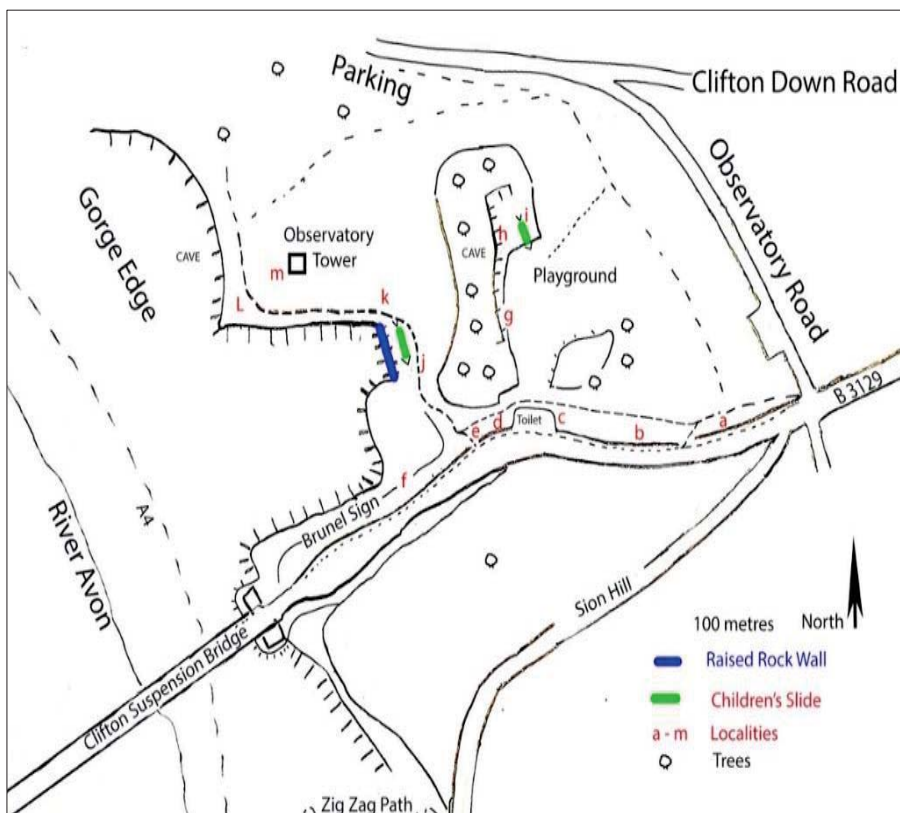


Figure 1: A suggested tour of the accessible exposures and features in the Observatory Area.

Localities a-f are at the foot of a small cliff face beside the level footpath from where it begins 50m from the junction of Observatory Road and Sion Hill to the bridge pier some 500m west.

Localities g- i are accessed from the semi all weather surface of the playground reached either by taking the sloping path behind the aforementioned cliff face, or using a new path under construction from the junction of Observatory Road and Clifton Down Road. There is a linking path but this is quite steep.

Localities j – m are on good paths but up a very steep slope, and better accessed from the path running from the junction of Observatory Road and Clifton Down Road.

b: Approximately halfway along the face to the toilet block notice high up faint convex concentric indentations. These are stromatolite fossils, they are not much to look at but the micro-organisms that trapped the sediment and made the convex shapes were alive billions of years ago and provided the oxygen that kick started animal life on the planet – they are also found in younger rocks (e.g. Cotham Marble) and living stromatolites are still to be found today making similar shapes in Shark Bay, Australia. A little further west a triangular block protruding from the face is a good place to point out the difference between true and apparent dip.



Plate 1: Localities a and b: looking north – the toilet block is just left of picture.

Locality c (Plates 2 and 3)

c: Next is another obvious narrow near vertical parallel sided slot (another weathered out mineral vein or mini cavern). At the corner in the embayment for the toilet block, and in the set-back face look for totally different kinds of mineral veins. Notice one with fine branching sinuous orange/red mineralised alteration veins with low dip but also observe linear veins filling tectonic fissures and wider cracks filled with coarse calcite crystals.

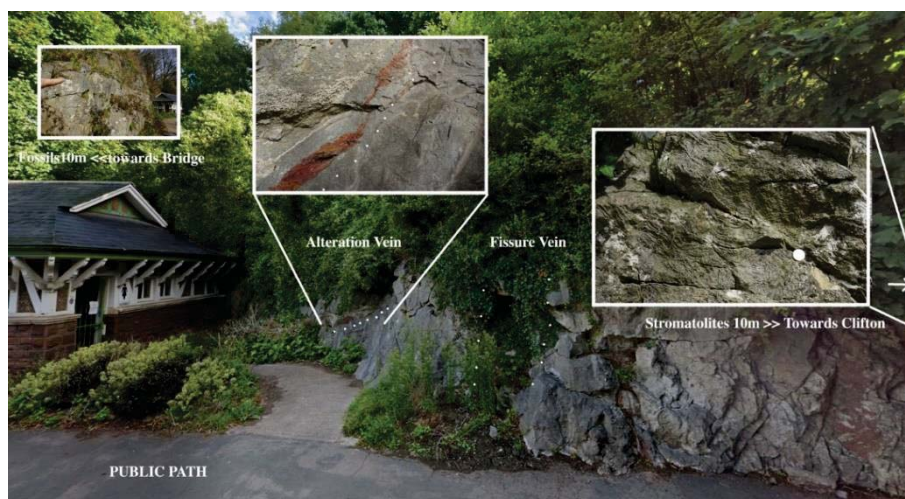


Plate 2: Locality c. View of the rock embayment accommodating the Victorian Toilet block.



Plate 3: Locality c: thin red vein spreading out and mineralizing the limestone on either side of a sinuous line, on N-S Toilet block face. The adjacent calcite vein is stained black from years of pollution. The torch pointing to the vein is 20cm long.

Locality d (see Plates 4 and 5)

d: on the face west of the toilet block, about half-way to the Bridge Toll Booth, look for beds with nests of brachiopods and, partially hidden by the netted off face, a large colonial coral and beautifully preserved if small stromatolites.



Plate 4 (left) : locality d: Concentric growth lines of Stromatolite fossils, finger for scale.

Plate 5 (right): locality d: Colonial coral almost obscured by rock netting 2mm wire for scale

Locality e

e: where the path goes through a gap in the face look for a wide fissure with mineral and fill deposit. This side path is steep and has a step and is unsuitable for wheelchairs.

Locality f (Plates 6 and 7)

f: near the seat and the plaque to Brunel try to find an unconformable junction with overlying Triassic Dolomitic Conglomerate (now called Mercia Mudstone Marginal Facies or MMMF for short!) sadly this exposure is rather disappointing. Far better examples are exposed further north but in generally rather dangerous places. A small

garden, created by staff of the University of Bristol Botanical Garden, is given over to plants typical of the rich Limestone flora of the gorge.



Plate 6: Sarah Arthur pointing to an area packed with fossils - oval brachiopods and circular rugose corals. She is pointing to a particularly good coral (see Plate 2 below). The true dip is $\sim 30^\circ$ SSE towards the camera but her arched back also echoes a possible antiformal structure.



Plate 7: Enlarged portions of the area pointed to in Plate 1 showing, left, Longitudinally sectioned (L.S.) tubes with close spaced stripes = vertical septal vertical walls in the life position of 10mm coral seen - many more crowd the whole rock face: and, right, Transverse sections (TS) across circular coral tubes showing clear septal walls, which have been differentially eroded. The depressions are where the coral polyp would have sat in life (fossula), not the most comfortable of homes! Oval marks are cross sections through brachiopods (we know these are not lamellibranch bivalves from the shell symmetry) most likely *Seminula* (now *Composita*). Several beds nearby are crowded with these shells.

From here it is a good idea to loop across the bridge and upon the return, try to look over the parapet wall to gain a view of the full face of the Avon Gorge – You may need help to stand because the wire safety netting all but obscures the view from a wheelchair. Looking from across the river the face shows an excellent section of the dipping massive beds of the Clifton Down Limestone and also some surfaces which at first may appear to be bedding planes but are in fact thrust fault planes, although many thrusts migrate to become bedding plane slides. There are also very noticeable near vertical surfaces that are red stained. It is tempting to try to reconstruct the time before these faults moved and a paper in *Nature in Avon* Vol 80 by R Arthur suggests that one possible reconstruction would return all the separate thrust surfaces as one if the slip on the vertical faults were reinstated prior to the off-set. It will probably take a rock climber to confirm if this theory is correct. Also, a very noticeable drag fold is described in the same article but is only seen if the light is right and this may be the reason that prior to this the fold does not seem to have been recorded.

Return to the start but if time, and gentle slopes, permit, take the sloping path to the Playground or use the path from Observatory Road.

Locality g (see Plates 8 and 9)

g: The playground is sited between a small rocky bluff with indistinct bedding and an old quarry face with massive beds clearly dipping south i.e. from right to left. A bed crowded with 'nests' of the brachiopod *Seminula* (now called *Composita*) in places comprises almost all of the rock. This is best seen at some height in the face, which is not ideal for our easy access tour, but the same bed reaches ground level some 5 metres to the right of the bricked up old 'adit'. It is my intention to seek permission to clean this bed sufficiently well to show the fossils clearly.



Plate 8: locality g, the brachiopod *Seminula*, now *Composita* Vaughan 1903. Note on the Corals and Brachiopods obtained from the Avon Section and preserved in the Stoddart Collection. *Proc. Bristol Naturalists' Society* NS 10(2), pp. 90-134, 2.



Plate 9: Polished block from a bed 50m north of the bricked up adit in the quarry face near the playground. Note that it is crowded with articulated 'bi valved' shells with a brachiopod not lamellibranch symmetry set in a very fine-grained limestone matrix notably not Oolitic or Pisolitic. These are presumed to be *Seminula*, now *Composita*, but their classic stratigraphic position near the Base of the Clifton Down Limestone is far older.

Locality h

h: The north face of the quarry is formed by a series of distinct single bedding planes, the surfaces of which shows some eroded/weathered out weaknesses mostly orientated north–south. These are joints but there is also perhaps some faulting. These weaknesses are in the same orientation as those exploited to create the gorge.

Locality i (see Plate 10)

i: Two stepped bedding planes rise from the ground and these are more accessible although traversing them is not really possible for the able bodied, especially the older of the two surfaces which has a polished depression (a smaller version of the famous children's slide nearby). The slope is useful for describing true dip (the steepest slope). Crossing this polished surface is a fine example of mineral filled en-echelon tension gash veins. These are a series of thin lozenge shaped white marks in a staggered line. This structure (which is very rare for the area) is caused by a shearing action producing a staggered line of cracks.



Plate 10: Locality i. A very rare occurrence for the region of En-echelon tension veins. Here they cross a prominent bedding plane polished by the children's slide at an angle of about 30° to the steepest slope – the true dip direction. A barren joint lies sub-parallel to this trend. A second set of sub parallel joints and indistinct un-thickened thin veins are orientated in the opposite direction defining the classic and very common X shape of typical of 60/30 brittle fracture. This is the same orientation and pattern of scratch marks seen deep in Aveline's Hole often attributed to Neolithic art. Were these people inspired by geology or are the marks actually geological in origin?

Shearing opens these up to oval slits which are later in-filled by a mineral, usually quartz or, as here, calcite. The feathered out ends of these slits are often dragged by further movement and this structure is very useful in calculating the stress fields from the Variscan compression.

From here return to the start or the fit and those wheelchair users who can summon two strong pushers can tackle the short but very steep path to the Observatory Tower.

Localities j, k, l and m

j: Half way up the slope is a good view of the main children's slide. On dry days it is just possible for the fit to walk up the slide and observe the superb polished fossils. Nearby is a generally undisturbed calcicole (lime-loving) flora. Between the slide bedding planes and the gorge is an upstanding wall with many interesting features but only seen close up and therefore outside the scope of this paper.

k: At the top of the slope near a telegraph pole (a left over from a wartime barrage balloon) one can get a view of the wall between the slide and the sheer gorge drop. I came across this upstanding wall of rock some time ago and discovered a fascinating texture. There is also a very similar upstanding wall just south of the peregrine viewing area near the circular walk. Although essentially a hardened rib of limestone related to mineralization along a major joint/fault it has a very unusual texture as yet not fully understood.

l: a good view of the bridge and gorge from where the path is close to the edge.

m: Probably the best place in the area to see fossils is in the building stones of the Observatory.

Return to the start or take the path to the parking on Clifton Down Road.

Further information

One of the biggest drawbacks to studying rocks is getting through weathered surfaces but there are many times when hammering is not permitted, and hammering often reveals little more information. One issue is in limestones where fresh surfaces usually fracture across calcite cleavage. This may show some internal texture but more often hides it so that all we see is a crystalline sparkle. Thin sections are needed but these are expensive to obtain.

Acetate peels are an option for limestone where a polished surface can be etched with dilute acid and thin acetate film stuck onto the uneven surface with acetone. Once dry the plastic film can be peeled away and this provides a good substitute for a thin section. However, as we will see from the photographs a good deal can show up on just simple polished surfaces.

Samples can be polished using wet or dry paper or better still proprietary diamond pads, and this simple cheap technique reveals a lot of hidden information, for example the presence of clear ooids and paired shell valves seen in the **Plate 11** below of a sample taken from the Great Quarry from a bed aptly named *Seminula Oolite*.

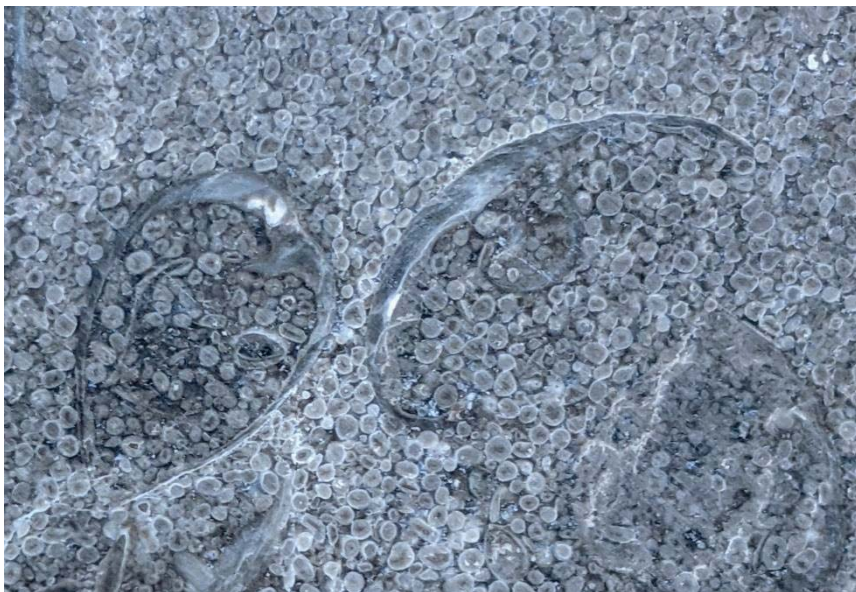


Plate 11: *Seminula* Oolite from the Great Quarry Brachiopod shells in section are 20mm across. Note a trace of internal structure in the shells which were clearly open when infilled (Unlike Lamellibranchs, Brachiopod shells usually remain closed when the animal dies. Ooliths are well size sorted but show little concentric growth.

Arthur Vaughan used key fossils such as *Seminula* to develop a scheme of fossil zones based on the Carboniferous Limestone succession in the Avon Gorge. He hoped that these zones could be used to correlate the Carboniferous Limestone succession across the Bristol region and beyond. Sadly, because the fossils used in Vaughan's classic zones are not sufficiently constrained in time these zones cannot be used for detailed stratigraphic correlation beyond the Bristol area. The Lower Carboniferous rocks are now divided on lithological grounds although this has its limitations. Perhaps in the future micro fossils may represent a better alternative. Vaughan used the brachiopod *Seminula* to delineate two horizons in the lower part of the Clifton Down Limestone referenced in the BGS Bristol District memoir (page 31, Kellaway and Welch, 1993). These are the *Seminula* Oolite beds and the older *Seminula* Pisolite immediately below. These were widely used in the last millennium and are still fairly good indicators of stratigraphy.

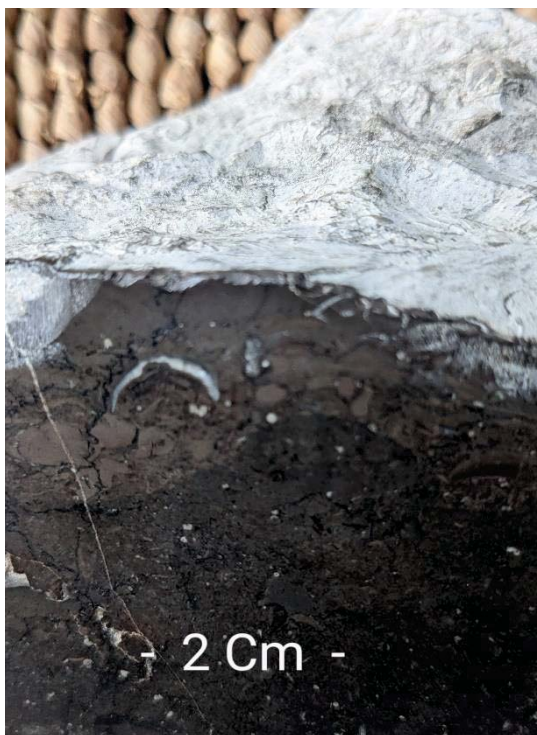


Plate 12: *Seminula* Pisolite from the Great Quarry - showing two faces one weathered and one part polished. This shows large rounded (but irregular edged) pisolite texture light brown in the polished part and a white texture in the grey weathered part of the sample. The depth of surface weathering extending into the rock is clear. Stratification, bedding and sorting can be seen. The white arc is a brachiopod (*Seminula*) shell fragment with a notch for the pedicle attachment.

An idea of the problems with Vaughan's ones is seen from the *Seminula* brachiopod nests found at the back of the playground. These are in rocks of a much higher stratigraphic position and we know this because we can follow the stratigraphic sequence bed by bed. It took little digging in the literature to sort out this anomaly but just one diagram in the memoir mentions bands of oolite and *Seminula* pisolite in the upper part of the Clifton Down Limestone a little below the concretionary beds, as a tiny label on a column figure 8 page 22 but does not appear to be described in the accompanying text. So, this is one example where Vaughan's ones are ill constrained – however in the absence of good clear lithological markers I still maintain that Vaughan's fossils are a useful broad guide.



Plate 13: Assorted irregular fragments, including nodules showing concentric growth or internal granularity and hook like sections, which are probably shell fragments. Most fragments are separated from the next by some matrix or more often by a thin winding sinuous line, and some of these lines can be traced from one side of the rock to the other. These are stylolites where much limestone has been dissolved away by pressure solution and areas where a good deal of material has been lost resulting in structures seeming to be truncated or offset.

As for whether there is any texture to be seen in the concretionary beds – the rocks seen on our trip - a sample from the Playground was polished (see **Plate 13**). I think you will have to agree that the polishing exercise has been an unqualified success, especially where no obvious concretions can be seen. It now is beholden on the next generation to see if this simple inexpensive polishing method can reveal detail leading to clear improved correlation of rocks across our area. The great thickness of the concretionary beds examined in the road section show almost no texture. However, polishing reveals that the rock consists of a variety of striking fragmented textures and growth formations that are far from dull. It is now perhaps clearer why these beds are generically called concretionary beds but perhaps this explains even better the term Pseudo-Breccia. However, the exact nature of formation of the fracturing of pseudo-breccia is a matter for further research.

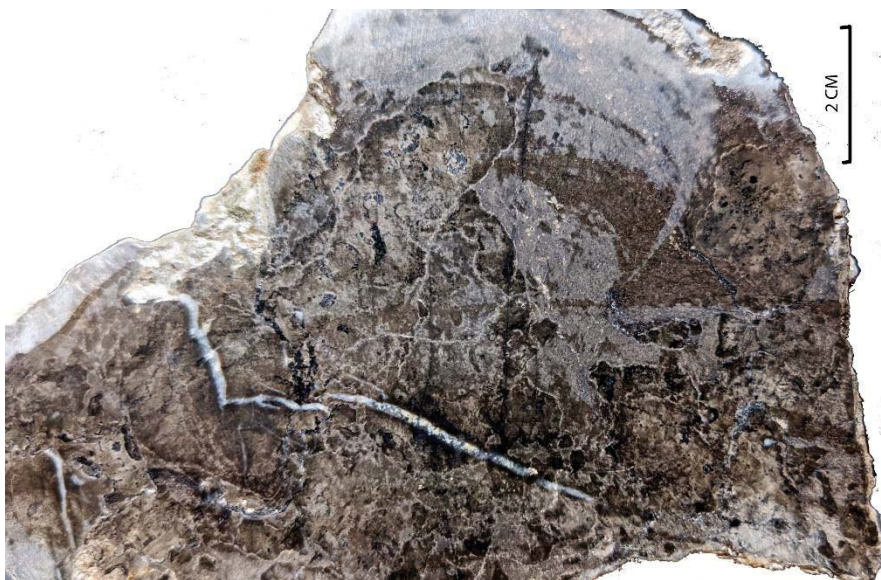


Plate 14: Polished Clifton Down Limestone from Cheddar Gorge from the beds which lie at the top of the Clifton Down Limestone just below the Hotwells Limestone (now Oxwich Head Limestone OWHL). Thrombolitic or mottled texture produced by microbial growth. An irregular white calcite vein crosses the middle with a non-linear trace.

Trying to correlate these beds which lie at the top of the Clifton Down Limestone and just below the Hotwells Limestone (now Oxwich Head Limestone OWHL) to those in the Cheddar Gorge area is not easy but again polishing of a sample here revealed a lot more than is apparent in the rock face (see **Plate 14**). Good foot paths, in the lower half of Cheddar Gorge (up as far as the narrows) represent another good opportunity for a field trip where there is easy access. Perhaps this could be the focus of a future paper. However, traffic makes the narrows far too dangerous and further up the gorge the paths are sporadic. As with all fieldwork awareness of the risks presented by falling rocks, traffic and other hazards must be accounted for and suitable precautions taken.

In conclusion

The trip was a great success and it was clear that a great deal of valuable work can be done from a wheelchair, albeit with some help regarding the steeper paths. I hope this gives some idea of what can lie hidden in plain sight and the value of taking a closer look at our amazing local rocks, especially the Carboniferous Limestone, and how a close study of geology can be achieved by the less physical fit or indeed by wheelchair users. All photographs and samples are by the author.

The biostratigraphy and paleoecology of the Lower Cornbrash at Lower Chatley Farm, near Woolverton, Somerset

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Abstract The excavation for a lake on farmland in March 2023 at Lower Chatley Farm, north of Woolverton, Somerset, exposed a section through the Lower Cornbrash (the Berry Member of the Abbotsbury Cornbrash, Middle Jurassic, 167-165 million years old). The Lower Cornbrash at Chatley had previously been recorded by Douglas & Arkell (1928) and Arkell (1933), but their shallow quarries have long been filled and there have been few, if any, notable excavations in the area since. The temporary exposure at Lower Chatley Farm provides a wealth of new information on the diversity and abundance of fossils and the character of the lithology at Chatley. The Chatley fieldwork will be used here to appraise and re-describe the biostratigraphy and palaeoecology of the Lower Cornbrash at Lower Chatley Farm. Fossil evidence at this site suggests a greater diversity of benthic animals than had previously been recorded and undescribed fossil species have now been added to the Lower Cornbrash ecology. The discovery of the rare ammonite *Delecticeras delectum*, a *Clydoniceras* microconch from this site, as well as a belemnite fragment are also discussed.

Key words: Lower Cornbrash, Chatley, *Delecticeras*, *Clydoniceras*, palaeoecology, bioturbation biostratigraphy, bund, invertebrate.

1 Introduction

In March 2023, Simon Carpenter visited Lower Chatley Farm near Woolverton, Somerset (ST 788547) to examine the Lower Cornbrash exposed during the development of a lake-side holiday park complex (**Figure 1**).

Permission for access and collecting was granted by the landowner, Richard Holdway. At the time of the first visit, the lake had already been excavated with *in situ* rock exposures lost below the water level as the lake filled with water from a local stream. All excavated material had been retained on site and tipped to form a series of low spoil bunds positioned along the boundaries of the lake development.

The numerous fossil-rich spoil bunds (**Figure 2**), were the source of all fossil collecting over several months in 2023 (**Table 1**).



Figure 1: The lake excavation at Lower Chatley Farm, near Woolverton, Somerset.
Image: Simon Carpenter, 2024.



Figure 2: One of several fossil-rich spoil bunds spread across Lower Chatley Farm.
Bristol Naturalists' Society and Bath Geological Society field trip: 3rd September 2023.
Image: Simon Carpenter.

The Lower Cornbrash is seldom, if ever exploited as a building material. The rock is too thin, poorly consolidated and rubbly for this use. It is occasionally dug in shallow pits by local farmers, where the soft and crumbly limestone is used as a cattle-friendly aggregate for farm tracks.

Fossil collecting was greatly aided by the wet weather in 2023, particularly the frequent pulses of rain that drenched the land at Lower Chatley Farm. The successive rain showers washed the finer clay sediments from the surface of the spoil and exposed new fossils continuously (**Figure 3**). Small matrix-free fossils, many of them incomplete and fragmentary, were picked directly from the surface of the spoil, then bagged and labelled. With so many of the smaller fossils under a few millimetres in size, it was often necessary to search close up, on hands and knees, so as not to miss anything.



Figure 3. Numerous fossils weathering out on the spoil including the benthic bivalves *Ceratomya* and fragments of *Meleagrinella*. Image: Simon Carpenter, 2024.

A large collection, upwards of 20-30 fossils were made during each visit and these were washed and screened at home before a small number (usually 6, if they were numerous) of each fossil species was retained. The retention of 6 specimens of each fossil species provides, at a glance, an opportunity to study the variation in shape and form that occurs naturally in all related extant and extinct species. In circumstances where fossils are damaged and incomplete, having more than one specimen may be the only way of understanding the complete animal. Fossils were only cleaned under running water, so as to preserve encrusting animals, particularly bryozoans, serpulids and oysters. In total, over 20 visits were made to the Chatley site during the 2023 research period and over 400 fossils retained, representing a wide range of marine animals. Benthic invertebrates dominate the palaeo-environment, with pelagic (sea-going) invertebrates restricted to shelled cephalopods. Marine vertebrates were

present but their remains were scarce and fragmentary. The palaeo-fauna, how they interact with each other and their environment will be discussed in greater detail in the forthcoming pages.

2 The Lower Cornbrash

The word ‘Cornbrash’ was first used as an agricultural term to describe the brashy and stony soils in Wiltshire that were suited for growing corn. It was then adopted as a geological term by William Smith in 1812 and first used in a publication a year later by Joseph Townsend (Woodward, 1894). The Cornbrash Formation, which ranges in age from Late Bathonian to Early Callovian (between 167-165 million years old), forms part of the Great Oolite Group of the Middle Jurassic (Figure 4). It is divided lithologically and faunally into the Lower and Upper Cornbrash.

PERIOD	STAGE	FORMATION	MEMBER
MIDDLE JURASSIC PERIOD	CALLOVIAN	Kellaways Formation	
		Cornbrash Formation	Upper Cornbrash
			Lower Cornbrash
	BATHONIAN	Forest Marble Formation	
		Frome Clay Formation	
		Fullers Earth Formation	
	BAJOCIAN	Inferior Oolite	

Figure 4: The position of the Lower Cornbrash Member, Cornbrash Formation within the Upper Bathonian Stage, Great Oolite Group of the Middle Jurassic Period.

Lower Cornbrash ammonites such as *Clydoniceras discus* and *Homeoplanulites homeomorphus* indicate the Upper Bathonian discus Zone and Subzone, whereas ammonites in the Upper Cornbrash are different and indicative of the Lower Callovian Herveyi (formerly *macrocephalus*) Zone (Cope et al., 1980b; Page, 1989). Fig. 4 shows the position of the Lower Cornbrash within the Upper Bathonian Stage of the Middle Jurassic Period. This area is farther south than the maximum extent of the Chalfield Oolite Formation, which is a feature of the Bathonian from Bradford on Avon north to Bath and east towards Box and Chippenham. It is represented by the Frome Clay Formation here.

The Cornbrash and underlying Forest Marble Formation are dominated by relatively shallow, bioclastic limestones representing a time of transition to an increasingly more offshore depositional environment in Late Bathonian and Early Callovian times. A warm shallow sea, tens of metres deep, was established, surrounded by islands and larger landmasses that supplied abundant organic matter. This culminated in the deposition of offshore mudstones and clay during Kellaway Formation times (Hesselbo, 2008; Bristow et al, 1999).

The Jurassic (201 – 145 million years ago) has often been portrayed as a warm ‘greenhouse’ period. Global geological records show, when compared to the present, that ocean depths were warmer, perhaps by 8 degrees centigrade than the present. Recent research, (Korte, Hesselbo, Ullmann *et al.* 2015) however, suggests that there were also periods of cooling. They postulate that a Middle Jurassic, mid-latitude cooling of sea water by as much as 10 °C occurred in the north–south Laurasian Seaway, a marine passage that connected the equatorial Tethys Ocean to the Boreal Sea. This contrasts with the Early Jurassic (182 million years ago) when our planet experienced temperatures 5 to 10 degrees centigrade warmer than the present. Reefs dominated by corals, sponges and microbialites grew 10 degrees of latitude further north and south than at the present time (Leinfelder, 2002).

In the South West of England the Cornbrash is a highly fossiliferous, bioclastic carbonate limestone composed of sand-grade shell debris. Thin argillaceous (clay) partings and interbeds of calcareous mudstone also occur. In their unweathered state, the limestones are bluish grey in colour but become a warm olive or yellowish brown when weathered (Tucker, 2023). The rocks are intensely bioturbated due to the infaunal and epifaunal activities of marine animals. As a consequence there are few signs of bedding.

In the Lower Cornbrash two brachiopod biozones are established (Arkell, 1933), represented by *Cerethyris intermedia* and *Obovothyris obovata*. The Cornbrash has the greatest geographical extent of any Middle Jurassic formation in the UK, its outcrop extending from Dorset to the Yorkshire coast. From Wiltshire to Yorkshire it is generally only a few metres thick or less and facies and faunal changes can occur rapidly over a short distance. The Lower Cornbrash is thickest in the Wessex Basin

where it is up to about 10.5 metres thick (Page, 1989). Non-sequences may also occur and locally some of the Lower Cornbrash may be missing (Bristow et al, 1999).

The fauna at Lower Chatley Farm corresponds precisely with the rocks at the same stratigraphical level in Dorset, Wiltshire and Oxfordshire, as described by Douglas & Arkell (1928) and Page (1988), indicating uniformity of seafloor conditions over a wide area, despite the obvious rolled and disturbed condition of many of the fossils. Douglas & Arkell (1928) were the first authors to recognise that localized faunas in the Lower Cornbrash were often associated with particular lithological facies and were not evidence of the complete obliteration of biozones elsewhere as had been assumed by Buckman (1854).

3 The Lower Cornbrash at Lower Chatley Farm

Arkell (1933) recorded a number of Lower Cornbrash exposures north of Frome including Chatley. The name Chatley refers to the former estate of Chatley House of which Lower Chatley Farm would have been part. His description is included here:

At Chatley (a Sowerbyan type locality), Tellisford and Rode, a short distance north of Frome, shallow pits expose Lower Cornbrash, in which the faunas of the intermedia and obovata zones are mingled in a single bed of rubble. These exposures are somewhat to the north of the line of the Mendip Axis, and in view of the more regular development of the beds in the Frome cuttings, the admixture of faunas which they show can scarcely be attributed to the influence of the axis.

The rubbly nature of the Lower Cornbrash and the mixing of the Intermedia and Obovata Beds at Chatley suggest that intermittent seafloor elevation and/or the lowering of the wave base had played a significant part in reworking and removing some of the seafloor sediments.

Adult macroconchs of the zonal and subzonal ammonite, *Clydoniceras discus* were commonly found although often incomplete and poorly preserved. During a visit in late September 2023, a much smaller and rarer ammonite, *Delecticeras delectum* was discovered by a member of Bath Geological Society, Graham Hickman during a field trip to Lower Chatley Farm and identified by geologist, Mr Alan Bentley. This is the mature microconch of *Clydoniceras*. It is rarely found complete and there are only a handful of museum specimens where the inner whorls are preserved (**Figures 5 a and b**). At the Chatley site, over 25 fragments of the larger adult macroconchs were found, compared with just the one solitary microconch. This specimen has been donated to Bristol Museum & Art Gallery (BRSMG Cg3177).



(a)

(b)

Figure 5: An *ex-situ* specimen of *Delecticeras delectum* (BRSMG Cg3177) found at Lower Chatley Farm. Scale bar cm. Image: Bristol Museum & Art Gallery

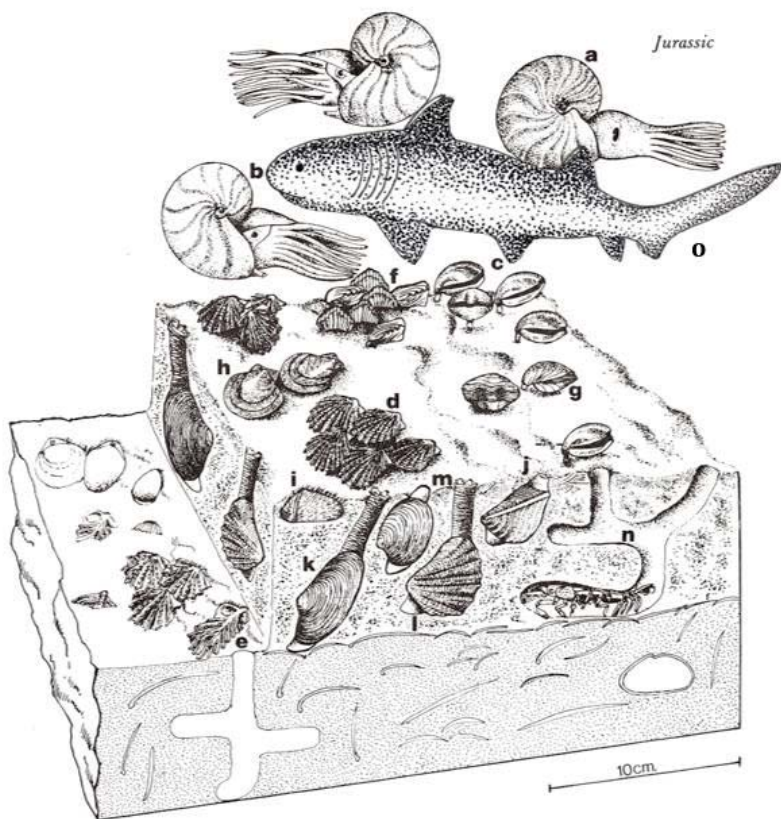
The Upper Cornbrash is missing from this location. The lower part of the Upper Cornbrash, called the Siddingtonensis Beds (Douglas and Arkell, 1928), contains the distinctive brachiopod *Microthyridina siddingtonensis*. No examples of this brachiopod were found at Lower Chatley Farm.

A section of weathered, grey/brown silty unfossiliferous clay seen above the Lower Cornbrash at the lake edge was identified as modern sediments, based on the discovery of *in-situ* shells of the juvenile lymnaeid pond snails, *Radix auricularia* or *Ampullaria balthica* (Rowson, 2023). These modern sediments are associated with a historic water course that flows west of the farm and supplies the lake with water.

4 The palaeoecology of the Lower Cornbrash at Lower Chatley Farm

An extensive collection of fossils (over 400) was made from the Lower Cornbrash at Lower Chatley Farm (Table 1) over 20 visits. These include benthic animals such as brachiopods, bivalves, echinoids, gastropods, crinoids, serpulids, corals and bryozoa as well as a smaller number of pelagic animals represented by fish, ammonites and nautilus. The ecology of the fossils during Lower Cornbrash times has been visualized below, after McKerrow (1978) (**Figure 6**).

The incomplete, disarticulated and poorly preserved fossils at Chatley are the result of sea bed conditions during Lower Cornbrash times. Turbulence, predation and bioturbation all had a significant part to play. As turbulence increased, the unconsolidated seafloor sediments at Chatley were reworked and mixed, as noted by



- a. *Clydoniceras* (Mollusca: Cephalopoda: Ammonoidea)
- b. *Cenoceras* (Mollusca: Cephalopoda: Nautiloidea)
- c. *Ornithella* (Brachiopoda: Articulata: Terebratulida)
- d. *Meleagrinella* (Mollusca: Bivalvia: Pterioidea)
- e. *Lopha* (Mollusca: Bivalvia: Pterioidea - oyster)
- f. rhynchonellids (Brachiopoda: Articulata: Rhynchonellida)
- g. *Cererithyris* (Brachiopoda: Articulata: Terebratulida)
- h. *Entolium* (Mollusca: Bivalvia: Pterioidea - pectinid)
- i. *Nucleolites* (Echinodermata: Echinozoa – sea urchin)
- j. *Trigonia* (Mollusca: Bivalvia: Trigonoida)
- k. *Pleuromya* (Mollusca: Bivalvia: Anomalodesmata)
- l. *Pholadomya* (Mollusca: Bivalvia: Anomalodesmata)
- m. *Astarte* (Mollusca: Bivalvia: Veneroida)
- n. *Thalassinoides* (trace fossil) with burrowing *Glyphaea* (Crustacean) inside
- o. *Strophodus* (Vertebrata: Chondrichthyes)

Figure 6: The ecology of Cornbrash fossils (taken from McKerrow,1978)
with added *Strophodus* (Illustration by Simon Carpenter)

Arkell (1933). The seafloor was also a habitat for a wide range of benthic invertebrates that used the unconsolidated sediments for feeding, burrowing, reproduction and concealment. The intense reworking of sediments by animals (bioturbation) is strongly developed in the bioclastic limestones of the Lower Cornbrash across the UK. Bioturbation resulted in the destruction of bedding structures and the chaotic burial of fossils, with few, if any, preserved in life position. Many of the animal groups were present in different stages of growth and size suggesting healthy, self-sustaining populations.

As the abundant fossils at Lower Chatley Farm clearly show, fossilisation preferentially preserves hard remains of animals particularly their shells, teeth and bone. Some benthic animals such as crinoids and ophiuroids whose skeletons were composed of small calcite plates, fell apart shortly after death as the tissues holding them together decayed. Only in exceptional conditions are these animals preserved intact. The disassociated calcite plates are easily overlooked in hand samples because of their small size and this may suggest the absence of the species altogether from the seafloor ecology. Analysis of the micro-fossils can provide evidence of a more complete palaeofauna.

The microfossils from the Lower Chatley farm site have been studied by Brian Ottway, a micro-fossil specialist. His analysis Lower Cornbrash sediment collected from the Lower Chatley site shows that virtually all material is fragmentary and abraded (Ottway, 2024). This should not be a surprise as many of the macro-fossils are similarly affected by bioturbation and current activity. The incomplete and weathered condition of the micro-fossils made identification very difficult and, in some cases, impossible (Ottway, 2024).

Samples were disaggregated, then wet sieved through a 1 mm and then a 63 μm sieve, before samples were dry sieved through 500 μm and 250 μm sieves. Analysis of the various fractions identified a number of micro-fossils not represented in the collection of macro-fossils from the site (Table 1). These include rare fragmentary ossicles of ophiuroids (brittlestars), scarce Holothurian (sea cucumber) remains and possible fragments of plates from an unidentified barnacle. At least two species of ostracods were seen as well as 9 species of foraminifera, all of which were fragmentary and heavily abraded.

Rare fragments of charcoal were also recognised. Lignite occurs in some abundance in the underlying Forest Marble Formation and to a lesser extent in the lowest beds of the Lower Cornbrash. Two notable absences were a lack of sponge spicules and no agglutinated foraminifera. Agglutinated foraminifera have tests made up of mineral particles held together by a cement, most commonly calcite. Forams are present but no agglutinates; these may have been broken into unrecognizable pieces by the high-energy environment, whereas the forams with solid walls survived better (Ottway, 2024). No sponge macro-fossils were recorded from the site and their absence may be down to unfavourable seafloor conditions. The remaining sieved fractions

contained elements of crinoids, echinoids, gastropods, bryozoans and serpulids, all present as macro-fossils from the site. Details of all the micro-fossils are included in Table 1.

In life, the majority of living animals inhabiting the Lower Cornbrash sea had either calcite or aragonite shells. Ammonites and nautilus had aragonite shells in life, but in the examples from the Chatley site, the shells were seldom preserved. Aragonite does not preserve beyond a few hundred to 2000 metres of water depth (Tucker, 2011). Many of the bivalves also had aragonite shells originally, but these have lost their shells during diagenesis, either as a result of subaerial exposure or burial. However, some of these casts were exhumed on the seafloor and were encrusted by serpulids and bryozoans. This would indicate that their shells dissolved away very early, during shallow sub-seafloor diagenesis, when acidic-reducing conditions were established, probably as a result of decomposition of organic matter (also see Tucker, 2023). The calcite shells of the epifaunal bivalves such as *Meleagrinella echinata* and *Radulopecten vagans* and all the brachiopod species have retained their shells. An example of the bivalve, *Meleagrinella echinata* was found with its original colour banding preserved. Although most gastropods were preserved as casts, a few species were found with remnants of shells and very rarely with shell ornamentation.

The diversity of infaunal and epifaunal animals suggests very variable rates of turbulence and sedimentation on the seafloor during the Cornbrash. As the sediments became more stable, so the diversity of the epifauna showed a marked increase, encouraging more sensitive infaunal suspension feeders such as *Pholadomya* and *Pleuromya* to flourish. These deep-burrowing bivalves, which were extremely abundant in the Cornbrash at Lower Chatley Farm, had long siphons and would have been excluded previously by high rates of deposition (McKerrow, 1978). It is likely that these deep burrowing bivalves chose this lifestyle to evade predators.

Epifaunal bivalves, such as *Meleagrinella*, *Radulopecten* and *Entolium* lived and fed on the sediment surface and were all common elements of the Lower Cornbrash at the Chatley site. Bysally attached *Meleagrinella* were anchored to shell particles on the seafloor and its low, flattened profile was ideal to withstand strong currents sweeping across the seabed. *Entolium* may have been free-living, clapping their valves together to swim short distances across the seafloor. The oyster, *Lopha*, which was present in small numbers, cemented itself to other oysters. Most bivalves were filter feeders extracting floating food from the seawater although a few extracted nutrients directly from the sediment.

The filter-feeding brachiopods, represented by the terebratulid brachiopods, *Obovothyris magnobovata* and *Cererithyris intermedia* were a very common element of the Lower Cornbrash fauna and like the less abundant rhynchonellid brachiopods, *Kallirhynchia yaxleyensis*, *Epithyris* and *Rhynchonella*, all favoured lower turbidity and sedimentation rates. The brachiopods also required, following their free-swimming larval stage, a hard substrate for attachment. This was achieved with a

fleshy ligament or pedicle, which was cemented permanently to the seafloor, commonly grouped together in large colonies. Included in the fossil assemblage at Chatley were a number of very small juvenile brachiopods suggesting that the rocks preserve brachiopods at all growth stages.

The echinoderms are well represented in the Lower Cornbrash at Lower Chatley Farm. Species of the irregular and infaunal echinoids, *Clypeus*, *Pygurus*, *Holactypus* and *Nucleolites* used their low profiles and fine spines to move through the substrate to feed and hide from predators. The regular echinoid, *Acrosalenia*, protected by robust spines, foraged on the seafloor and was part of the epifauna. Individual crinoid stem ossicles, tentatively identified here as *Isocrinus* occurred very rarely. In life these would have been attached permanently to the seafloor by a flexible stem.

The Lower Cornbrash includes a diverse bryozoan fauna with encrusting forms like *Stomatopora* and *Mesonopora* most abundant. These were seen attached to many other fossils and in particular, attached preferentially to large serpulid tubes, *Sarcinella* sp. preserved at the base of the Lower Cornbrash. Erect and self-supporting bryozoan colonies were present and represented by *Collapora* and *Mesenteripora michelini*.

Encrusters, such as bryozoans, serpulids and oysters favoured the shells of living and dead animals and very few organisms escaped their attention. Surfaces exposed to the sunlight and nutrient sources were preferred and commonly heavily encrusted. By contrast, the undersides of these same fossil shells were often free of any attachments, providing a clue to the final orientation of the fossil in the sediments. Many of the epifaunal encrusters were small, grew in low relief and were cemented firmly to their host, all adaptations for living in a high-energy environment.

The small, mobile solitary coral, *Chomatoseris porpites* was very common. It is the only scleractinian coral species present in the Lower Cornbrash at Chatley. These corals typically grow in shallow, well-lit, warm water with moderate to brisk turbulence and abundant oxygen. Mobility in corals allows them to flourish under circumstances unfavourable for sedentary forms. They are good indicators of loose, soft, sand substrates. Structural similarity leaves little doubt that *Chomatoseris* was a mobile coral with a mode of life comparable to that of the modern mobile coral, *Cycloseris*. Both species were capable of self-induced movement which allows escape from sediment smothering, unburial, righting and lateral migration (Gill and Coates, 1977).

In his monograph on the fauna of the Cornbrash, Blake (1907) described the remains of gastropods as uncommon. Whether he is referring to their general abundance or lack of diversity is unclear. The majority of fossil gastropods at Lower Chatley Farm were preserved as internal casts and the lack of shell character and ornamentation makes it more difficult to identify them. Many of the gastropod groups contain both fossil and recent members. At Lower Chatley Farm a number of gastropods were

observed and collected including those in the family Naticidae and Aplustridae (see Table 1). These represent small to medium-sized predatory sea snails. Some like *Hydatina* (Family: Aplustridae) are shallow burrowers in today's oceans, feeding on polychaete worms, mussels and sea slugs. We can assume that the recent and fossil gastropods behaved in similar way. If, as we have suggested, the fossil *Hydatina* was a predatory species then it is also likely that some of the prey species (with soft bodies) are missing from the fossil record because they had so few hard parts to preserve. The general abundance and diversity of the gastropods suggests that they were an important part of the seafloor environment, actively hunting down their prey.

Patrolling the warm, shallow seas above the sea floor would have been a variety of pelagic animals including marine reptiles, fish, ammonites and nautiloids. These animals were active predators, capable of swimming vast distances in search of food. Marine reptiles and fish were pursuit predators with an array of sharp, striated teeth with which they caught and subdued their prey. Others, like *Strophodus*, a durophagous shark, had a different tooth morphology suited to manipulating and processing hard-shelled prey (Stumpf et al., 2023) of which there were many in the Cornbrash environment. Several elongate and slender domed crushing teeth were found at Chatley and tentatively identified here as *Strophodus*.

Ammonites were the most prolific open-water carnivores at this time and used their speed and ingenuity to hunt down other cephalopods, crustaceans and fish. They likely bore a radula and beak, a marginal siphuncle and ten arms with hooked suckers (Landman, 1996).

The presence of belemnites in the Cornbrash Formation is questionable. Blake (1907) in his Cornbrash monograph states that the occurrence of belemnites in the Cornbrash appears to be doubted. The few belemnites he described had been drawn from the best private and public collections of the day but all have questionable provenance. Peter Doyle, a UK belemnite specialist (personal communication), describes belemnite occurrence in the Middle Jurassic as sparse with a reduction in taxa at the end Toarcian extinction and during the subsequent recovery. Local facies conditions may have also had an influence on their occurrence. It does seem odd that ammonites occur in some abundance and not belemnites, as they commonly occur together in other Jurassic Formations.

A small eroded and unidentified fragment of a belemnite guard was found *ex-situ* on the spoil at Chatley. It was found free of matrix so it cannot be confidently assumed to have come from the Cornbrash and may have its origins as a derived fossil, reworked from an earlier Jurassic formation. If it has come from the lower Cornbrash, it represents an exceptionally rare find, possibly the first record in the UK of a belemnite from the Cornbrash Formation.

5 In summary

The lake excavation at Lower Chatley Farm, near Woolverton, Somerset, provided an unrivalled opportunity to study an extensive exposure of the Lower Cornbrash. The occurrence of the zonal ammonites, *Clydoniceras discus* and *Homeoplanulites homeomorphus* confirms the Lower Cornbrash age for the rocks.

The rocks are highly fossiliferous, bioclastic limestones and formed on an extensive shallow platform during the Middle Jurassic Period, between 167-165 million years ago, when the climate was warmer than today by between 5 and 10 degrees centigrade. The rocks formed in a relatively shallow offshore depositional marine environment where very variable rates of turbulence and sedimentation occurred. The marine environment supported a diverse benthic assemblage of epifaunal and infaunal animals. During periods of intense turbulence and current activity, sediments and fossils were mixed, reworked and in some cases transported away to settle elsewhere. As a consequence, many of the fossils are incomplete, abraded and poorly preserved. The careful collection of fossils has revealed the rich diversity of invertebrates living on or within the seafloor sediments. Some pelagic animals such as fish, ammonites and nautiloids were present in the water column during life with their remains found on the sea bed when they died. Many of the fossils found at Lower Chatley Farm are familiar finds to other Cornbrash localities and their ecology has been described here using the approach of McKerrow (1978).

That said, the fossil collection made at Lower Chatley Farm includes a number of rarities and so increases the faunal list for the Lower Cornbrash. The discovery of *Delecticeras delectum*, the mature microconch of the ammonite, *Clydoniceras* was unexpected due to its usual rarity. The specimen, one of just a few well-preserved examples of this ammonite species, has been donated to Bristol Museum & Art Gallery. A fragment of a belemnite rostrum was also found at Chatley. As an *ex-situ* fossil found on the spoil, it cannot be confidently assigned as having come from the Cornbrash Formation. Had it been found *in situ*, the Chatley fossil would have been one of just a few specimens ever to be found in the Cornbrash of the UK.

The occurrence of the solitary coral, *Chomatoseris* with its preferences for shallow, well-lit, warm water with abundant oxygen and the presence of scavengers and predators above the seafloor suggests that the seawater was sufficiently normal to support a multitude of marine invertebrate and vertebrate animals (McKerrow, 1978). The sheer quantity of excavated spoil and fossils available at the site has allowed estimates to be made of the relative abundance and diversity of different animal groups. The most abundant and diverse of these benthic groups were the bivalves showing an abundant and rich diversity of infaunal and epifaunal species (Table 1).

Great care was taken during the collecting of fossils from the site to ensure a good representative collection was made and these along with accompanying field notes will be donated to Bristol Museum & Art Gallery.

Table 1: *Ex-situ* Lower Cornbrash fossils collected from Lower Chatley Farm

KEY: VC = Very Common

C = Common

R = Rare

Fossil type (macro and micro-fossils)	VC	C	R
Vertebrates			
Shark crushing tooth (cf. <i>Strophodus</i> sp.)			*
Ammonites			
<i>Clydoniceras discus</i> (Sowerby)		*	
<i>Choffatia</i> sp.			*
<i>Homeoplanulites</i> sp.			*
<i>Delecticeras delictum</i>			*
Nautiloids			*
<i>Cenoceras</i> sp.			*
Arthropods			
Unidentified (crustacean) appendage			*
Barnacles			
Micro-fossils: unidentified species (fragmentary plate)			*
Gastropods			
<i>Ampullospira</i> sp.		*	
<i>Hydatina</i> sp.			*
<i>Nirenea</i> sp.			*
<i>Alaria</i> sp.			*
<i>Cylindrites</i> sp.			*
Micro-fossils: At least 3 unidentified gastropod species			*
Bivalves			
<i>Lopha gregaria</i> (J. Sowerby)		*	
<i>Pholadomya fidicula</i> J. Sowerby		*	
<i>Meleagrinella echinata</i> (W. Smith)	*		
<i>Pholadomya lirata</i> (J. Sowerby)		*	
<i>Radulopecten vagans</i> (J. de C. Sowerby)	*		
<i>Pleuromya uniformis</i> (J. Sowerby)	*		
<i>Ceratomya</i> sp.	*		
<i>Pseudotrapezium cordiforme</i> (Deshayes)		*	
<i>Protocardia buckmani</i> Morris and Lycett		*	
<i>Pholadomya deltoidea</i> (J. Sowerby)		*	
<i>Modiolus imbricatus</i> (J. Sowerby)		*	
<i>Modiolus sowerbyanus</i> (d'Orbigny)		*	
<i>Trigonia crucis</i>		*	
<i>Pseudolinea duplicata</i> (J. de C. Sowerby)		*	
<i>Modiolus bipartitus</i> (J. Sowerby)		*	

Table 1 continued.			
Fossil type (macro and micro-fossils)	VC	C	R
<i>Homomya gibbosa</i> (J. Sowerby)			
<i>Tancredia</i> sp.		*	
<i>Pleuromya elongata</i> (Schlotheim)		*	
<i>Myophorella</i> sp.		*	
<i>Anisocardia</i> sp.		*	
<i>Pholadomya fidicula</i> J. Sowerby		*	
<i>Plagiostoma</i> sp.			*
<i>Nannogyra nana</i> (J. Sowerby, 1822)		*	
<i>Thracia depressa</i> (J. de C. Sowerby)		*	
<i>Entolium corneolum</i> (Young & Bird)		*	
<i>Liostrea</i> sp.		*	
Oyster (Indet sp.)			*
Brachiopods			
<i>Obovothyris magnobovata</i> S.S. Buckman	*		
<i>Cererithyris intermedia</i> (J. Sowerby)	*		
<i>Kallirhynchia yaxleyensis</i> (Davidson)		*	
<i>Rhynchonella</i> sp.		*	
<i>Epithyris</i> sp.		*	
Serpulids			
<i>Sarcinella</i> sp.		*	
Unidentified serpulid		*	
Unidentified serpulid		*	
<u>Micro-fossils</u> : 2 unidentified serpulid species			*
Echinoderms			
<i>Acrosalenia hemiscidaroides</i> Wright		*	
<i>Acrosalenia pustulata</i> Forbes, 1852			*
<i>Holectypus</i> sp.		*	
<i>Holectypus depressus</i> (Leske)		*	
<i>Clypeus ploti</i> Salter			*
<i>Pygurus michelini</i> Cotteau		*	
<i>Nucleolites clunicularis</i> (Llhwyd and Phillips)	*		
aff. <i>Isocrinus</i> sp. (individual stem ossicle)			*
<u>Micro-fossils</u> : unidentified echinoid species (spine and test fragments)		*	
<u>Micro-fossils</u> : unidentified crinoid species (brachial, pinnule and columnal ossicles)			*
<u>Micro-fossils</u> : unidentified ophiuroid species (ossicle fragments)			*

Table 1 continued.			
Fossil type (macro and micro-fossils)	VC	C	R
<u>Micro-fossils: unidentified holothurian species (4 sclerite types)</u>			*
Corals			
<i>Chomatoseris porpites</i>		*	
Bryozoa			
<i>Mesonopora</i> sp.		*	
<i>Collapora</i> sp.		*	
<i>Mesenteripora michelini</i> Blainville, 1830			*
<i>Stomatopora</i>		*	
<u>Micro-fossils: unidentified species (abraded fragments)</u>		*	
Ostracods			
<u>Micro-fossils: 2 unidentified species (total 315/100g)</u>			
Foraminifera			
<u>Micro-fossils: at least 9 unidentified species (total 1512/100g)</u>			
Plants			
<u>Lignite</u>		*	
<u>Micro-fossils: Charcoal</u>			*

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THE REDCLIFFE SANDSTONE: GREAT OUTCROPS AT STAPLETON OF BRISTOL'S HISTORIC AQUIFER AND SOURCE OF GLASS SAND

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Abstract The Triassic Redcliffe Sandstone (within the Mercia Mudstone Group, or MMG) occurs in the Bristol district, SW England, and historically was an important aquifer and source of glass sand. It is a well-sorted, sand-dominated fluvial deposit, up to 50 m thick, deposited in a braided stream environment. There are few useful exposures but one road cutting in line for engineering work in the Stapleton area has revealed well developed pedogenic features interpreted as ground water calcretes and a variety of burrows. These are briefly described and recorded before their access may be curtailed. All photographs are by Maurice Tucker.

1 Introduction

The Redcliffe Sandstone is a Triassic fluvial deposit occurring near-surface over a significant part of central Bristol and surrounding areas but with very few worthwhile exposures. The best known are those at the Redcliffe Wharf where, at the Redcliffe 'Caves', the red sandstone was once mined by the 'room-and-pillar' method. Entry to these old mines is not possible at this time. A small exposure can be seen nearby at the Quaker Burial Ground and it is also exposed, but difficult to access, along the banks of the 'New Cut', an artificial waterway excavated in 1804-9 to divert the tidal River Avon through south Bristol.

However, there are two excellent exposures in roadcuts located in Park Road and Frenchay Park Road (ST 622 766, the B4059), Stapleton, not far from the entrance to Stoke Park. These exposures were drawn to our attention by an application from Bristol City Council to undertake works to stabilise the outcrops and this came through to the Avon Regionally Important Geological Sites (RIGS) group for comment. Examination of the exposures, especially the one in Frenchay Park Road (**Figure 1**) has revealed numerous interesting features in the Redcliffe Sandstone, most not reported before, which are briefly described here. The Redcliffe Sandstone has played an important role in the development of Bristol: being the main aquifer for the city in medieval times, until it became polluted, and a source of sand for the famous Bristol glass (from the 16th to early 19th C especially); it is also a local building stone, as in the Redlands area, although it does decalcify easily.



Figure 1: Exposures of the Redcliffe Sandstone in Frenchay Park Road, Stapleton, Bristol. Cliff up to 5 metres high of bright red, massive to cross-bedded sandstone with nodular calcrete and trace fossils.

2 Stratigraphy

The Redcliffe Sandstone is generally regarded as occurring towards the base of the MMG in the upper Triassic, that is equivalent to the Sidmouth Mudstone Formation (Fm), above the Otter Sandstone Fm. (Howard et al. 2008; BGS website). However, there does not seem to be any definite biostratigraphic evidence for this (no pollen or other fossil data). One other possibility is that it is equivalent to the Arden Sandstone (attributed to the Carnian stage) which occurs in the middle of the MMG with the Branscombe Claystone Fm. above and the Sidmouth Mudstone Fm. below. The Arden Sandstone is a distinctive sandstone in the Midlands and Worcester Graben, within the mudstone-dominated MMG, which is equated with the Butcombe Sandstone south of Bristol and the North Curry Sandstone in the Taunton area. However, the Arden Sandstone is generally a mixed fine to coarse clastic unit of lenticular sandstones, some mudstone, and a variety of colours, from green, grey and buff, and generally around 10 m thick (Howard et al. 2008; Newell 2018). This contrasts with the Redcliffe Sandstone which is up to 50 m thick and consists of medium to coarse intensely red sandstone (Kellaway & Welch 1993). For the most part, the Redcliffe Sandstone rests directly on Coal Measures strata and passes laterally, basinwards, into 'classic' red marl (formerly Keuper) facies of the MMG. In this respect, the sandstone could be equivalent to the Dolomitic Conglomerate (DC), the basin-margin equivalent of the MMG marl, which also occurs in the Bristol-

Mendips area. However, the DC dominantly occurs where the local hilly-upland landscape was formed of Carboniferous limestone. The DC could also be Carnian in age.

3 Exposures at Park Road and Frenchay Park Road

There are two road cuttings here, one in Park Road and the other 500 m north in Frenchay Park Road on the B4058. The first is about 60 metres long and shows around 6 metres of section consisting of bright-red, metre-thick bedded sandstone with some internal large-scale planar cross-bedding, and rare muddy units. The sandstones are relatively uniform, medium-grained and well sorted. Apart from conspicuous low angle fractures, there are few other features of interest.

By way of contrast, the section in Frenchay Park Road, showing around 10 metres of strata in total, exhibits many interesting structures, especially on the western side of the road cutting. The bedding is not so well defined; there are some horizontal bedding planes and minor cross-bedding, some on a large scale, but generally there is a more massive appearance to the sandstone here, compared to the Park Road section. There are some curved basin'-shaped, metre-scale planes on the east side of the cutting which could reflect water escape/ soft sediment deformation. Conspicuous in the western exposure are areas of calcite concretions (**Figure 2**).



Figure 2: Exposure of Redcliffe Sandstone 4 metres high, showing quite massive, structureless sandstone in the lower part but with nodular, commonly tabular lenses of calcite in the upper part. Frenchay Park Road.

Some of these are near horizontal whereas others crudely follow a large scale low-angle to flat bedding (**Figure 3**). These nodules vary from spheroidal, a few cm across, to much larger structures, commonly tabular, some reaching 40 cm in length and up to 10 cm thick.



Figure 3: Outcrop 5 metres high showing mostly massive sandstone but with many nodules of calcrete in the upper part, some formed along low-angle dipping bedding planes, which would have originally formed by the migration of a sand bar in a braided stream before pedogenesis. Some more vertically oriented nodules (upper left) could be rhizocretions.

Others have a more vertical, elongate appearance and branch (**Figures 4, 5**). The concretions stand proud of the outcrop through differential weathering and being cemented by calcite. These features are interpreted as pedogenic and the vertical ones could well be rhizcretions, resulting from the calcification of plant roots. The near horizontal tabular nodules are likely to be groundwater calcretes, developing in the capillary-phreatic zone of the water table, notably along the bedding planes in some cases.



Figure 4: Outcrop 5 metres high with sub-horiz ontal and vertical nodular calcite concretions interpreted as groundwater calcrete and rhiz ocretions.



Figure 5: Vertical calcite concretions, likely to be rhizocretions, as well as horizontal nodular-tabular concretions. Field of view 60 cm across.

Also present at this outcrop, especially visible within the areas of more intense calcite cementation, are features interpreted as burrows. The burrows have a diameter of around 10 mm and curve and twist, almost knotted (**Figures 6, 7**).



Figure 6: An area of burrows within the more calcareous part of the sandstone. Burrow diameter 10 mm.



Figure 7: Cm-scale calcite-cemented burrows. Field of view 40 cm across.

In some cases, there are calcite cemented sand balls' or nodules, 10-20 mm in diameter within the sediment (**Figure 8**). These burrow – sand ball features tend to occur in clusters or clumps, extending over areas of several 10s of cm across.



Figure 8: Spheroidal calcite-cemented balls of sand, 10-20 mm diameter, and horizontal nodular calcrete. Field of view 40 cm across.

One curious large calcite-cemented mound', 50 cm across, 20 cm high, consisting of burrow structures and large sand pellets, is prominent at the northern end of the section (**Figures 9**). The burrows are likely to be the result of crustaceans or earthworms living within the sediment. Could individual spheroidal sand nodules be insect burrow/ nest fills? Such features are not uncommon in soils today. One wonders if the mound structure might be some form of colonial structure (nest'), as for insects. Further work is being undertaken on these intriguing structures.



Figure 9: An intriguing 'mound-like' structure composed of burrows and cm-scale sand 'balls'.

4 Environment of deposition

The features of the Redcliffe Sandstone, the colour and sedimentary structures, are typical of a sand-dominated braided-stream fluvial environment in an arid-zone climate. There are no mudstones in the sections indicating a relatively high-energy regime with channel and sand-bar deposition. Red sandstones are common in the Lower Triassic (Sherwood Sandstone) in the Wessex and Worcester-Cheshire basins and at different levels in the MMG (the so-called skerries) (Newell 2018). They mostly occur in locations marginal to upland areas, particularly where Coal Measure sandstones were being eroded. Periods of non-deposition and river abandonment are indicated by the nodular calcretes, with precipitation of calcite taking place around plant roots and at the capillary fringe of the groundwater table. The presence of the burrows is particularly exciting and indicates an environment where organisms could live or dwell within the sandy sediment, when river action was minimal or had ceased for a period of time.

5 Significance

With so few good outcrops of the Redcliffe Sandstone in Bristol, it is hoped that these two road cuttings in Frenchay will be preserved for all to see in the future. The burrows and pedogenic features in particular are wonderful examples and are well displayed here, likely the result of the sandstone surface being exposed to the

elements for several decades. Fresh surfaces of the sandstone show few structures. In terms of the origin of the Redcliffe Sandstone, such features as reported here are extremely significant and should form the topic of a more detailed study, including any other outcrops in the region, to describe fully the sedimentology and ichnology of this formation which has been important in the history of Bristol.

Representations have been made to Bristol City Council to request that if their contractors proceed with works to stabilise these two road cuttings, the removal of rock should be minimised and access to the rock face should be preserved. At the same time, these works could be an opportunity to obtain samples for research, especially into the nature of the burrow structures. A difficulty would be the friability of the rock; however, resin impregnation followed by Computed Tomography (CT) Scanning could be a way forward. The University of Bristol has a CT Scanner that is used for examining fossils within a rock without having to break or dissect it.

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Dandelions of the Bristol Region

Dylan Peters



Plate 1: Erect-bracted Dandelion *Taraxacum exsertiforme*. All photographs by Dylan Peters.

This is the first extensive account to ever be produced on the dandelions of the Bristol Region. Enjoy!

Introduction

It may come as a surprise to learn that dandelions are not a single species but in fact a collection of hundreds. In fact, we have around 260 of them in Britain. The true number cannot be stated because it keeps on growing. Last year five new species were added to the British list (three newly described and two new arrivals from the continent). However, the British list is dwarfed when you look at *Taraxacum* on a global scale. 2487 are currently recognised worldwide according to Kew (at the time of writing in spring 2024), most of which are concentrated around Europe, but some are native also to North Africa, Asia, Australia, parts of the Americas and introduced more widely elsewhere.

In Britain all dandelions bar one (*T. obtusifolium* - a rare and sporadic casual) are apomictic, meaning they produce clones - identical versions of themselves - through seed without the need of pollination: a process of asexual reproduction which evolved many thousands of years ago. Our *Taraxacum* flora today is thought to have developed from a process of hybridisation between pre-existing sexual plants and early apomicts until the sexual plants were hybridised out of existence, leaving behind

fixed apomicts which are incompatible with one another. On the continent in regions where sexual plants and apomicts meet, this process is still ongoing and new species continue to be formed this way. On a few occasions where *T. obtusilobum* has been recorded in Britain, so have putative hybrids.

The Ecological Value of Dandelions

Despite the fact that our dandelions no longer require pollen or nectar in order to reproduce, most of them still produce both in abundance because they are genetically stuck with it. A waste of energy for the dandelion perhaps but a perfect resource for others to take advantage of, particularly in early spring at a time when many insects are just emerging (especially Mining Bees - *Andrena*).



Plate 2: Many animals take advantage of dandelions. Top left, springtails such as this *Dicyrtomina saundersi* shelter beneath the foliage. Top right Ashy Mining Bees *Andrena cineraria* feed on the flowers. Bottom left, hoverflies such as this *Syrphus vitripennis* take nectar. Bottom right, House Sparrows *Passer domesticus* feed on the seeds.

Every part of a dandelion is used by something else. From my own observations, and others, the leaves and vegetative parts are: eaten by the larvae of a good number of moths (Lepidoptera - 46 species are mentioned in Henwood and Sterling); mined by 13 leaf miners (Agromyzidae flies, reference www.ukflymines.co.uk/index.php and

<https://influentialpoints.com/>); sucked by 25 species of aphid including three members of my favourite genus - *Trama* (Root Aphids); nibbled by numerous slugs and snails (Gastropoda) and other detritivores; infected by several species of fungi; and of course the seeds are eaten by small mammals and birds too, especially House Sparrow *Passer domesticus* and Goldfinch *Fringilla carduelis* in particular. Not to mention the shelter they provide to countless invertebrates. When rummaging I'm always amazed by the mini ecosystem to be found at the base of a single dandelion: springtails (Collembola); slugs and snails; money spiders (Linyphiidae); mites (Parasitiformes and Acariformes); pseudoscorpions (Pseudoscorpiones); beetles (Coleoptera) etc. It's where I make some of my best finds. Dandelions' versatility and ability to conquer virtually every terrestrial habitat from coastal dunes and woodland rides to roadside verges and pavements means they cater for a huge range of wildlife and are easily one of our single most important plants for biodiversity. Yet, for the very same reasons, the 'neat and tidy' approach has sadly labelled dandelions 'the weed of all weeds' and this needs to change.

The History of Dandelion Recording in the Bristol Region

In the early days of taraxacology the group had been divided into six or seven very broad species.' They included: *T. officinale*, *T. erythrospermum*, *T. laevigatum*, *T. palustre*, *T. udum* and *T. obliquum*. *T. officinale* would have covered any of the more robust species and could be loosely applied to what we call today section Taraxacum. *T. erythrospermum* and *T. laevigatum* were both part of what's now section (sect.) Erythrospermum, the former bunched together plants (in the words of White, 1912)

With outer phyllaries ovate, inner ones horned or gibbous at the tip, and pale brown or reddish-yellow fruit (which would include the likes of *T. fulviforme*, *T. fulvum* and *T. glauciniforme* for example). The latter was those of dwarf habit with deeply pinnatifid leaves; the outer phyllaries lanceolate, adpressed or patent, inner ones gibbous or appendaged at the tip; and bright red or reddish-brown fruit (which would cover most frequently *T. lacistophyllum*, *T. brachyglossum* and *T. rubicundum*). *T. palustre* is an easy one - sect. Palustria of which there's only two possibilities based on distribution - *T. palustre* itself and *T. anglicum*. Only *T. palustre* has been recorded in our area. This was the first dandelion microspecies to be described - back in 1798 as *Leontodon palustris* by the almost perfectly suited name of Lyons (if only his first name was Danny). *T. udum* is a bit more confusing and would have loosely covered plants with more or less appressed bracts without linear leaves (i.e. not sect. Palustria) - *T. nordstedtii* was probably the intended plant recorded under 'udum' in our region but other members of sect. Celtica may have been included such as *T. britannicum*, *T. berthae* and our sole member of sect. Spectabilia - *T. faeroense* could have been mixed in there too. And finally *T. obliquum* - sect. Obliqua which is not recorded from our region but was confusingly used in replacement for *T. laevigatum* in the Flora of Gloucestershire (Riddelsdell, 1948). *T. platyglossum* has been recorded once from Berrow Dunes (just outside the region) pre 1930 but it's not impossible

that it might occur within the region, such as at Sand Bay so I've added it to the list of plants which could occur at the end. The Flora of Gloucestershire is also the first local source to mention proper microspecies - 7 of which are named: *T. alienum* (now *T. cyanolepis*) from Highnam (outside our region), *T. brachyglossum* and *T. lacistophyllum* from Clifton and Durdham Downs, giving us our first hard records of the two, *T. exoniense* (no doubt a typo for *oxoniense*) from Tockington, *T. pectinatiforme* from Westbury-on-Trym, *T. polyodon* from Avonmouth and *T. sublacinosum* (now *T. subexpallidum*) - from Lechlade (outside our region). It's hard to know how accurate these old records are but I've now discovered them all anyway.

Prior to my findings only 40 odd species had been recorded in our region. The total now stands at 161/2 plus 5 mystery taxa which have been given nicknames for now until more light can be thrown upon them. However, the majority of my recording has been from the northern half of Bristol and the true number may surpass the 200 mark. There are certainly many incredible discoveries just waiting to be made.

Learning Dandelions

My interest in dandelions was sparked at the beginning of Lockdown (I was just 16) but it soon bloomed into something more of an obsession! Originally I just named my dandelions as sp. 1, 2, 3 etc. and it remained this way until I got the new Botanical Society of Britain and Ireland (BSBI) handbook (Richards, 2021) and I could finally put a name to all my finds. I suppose this was a good thing because I got to look at dandelions and find characteristics for myself before I was told what to look for. To make the daunting numbers easier to cope with, dandelions are split into sections but I don't find them very useful because there is so much overlap.

When looking at dandelions you should try to avoid plants that are trampled, mown, grazed, diseased, or in heavy shade. You should only look at them during the first flush of flowering from about March to May. Any later and you risk getting caught up in the range of heterophylly (various leaf-forms) many species possess.

In theory, dandelions being apomictic should be useful when it comes to identification because all plants of a single species should be genetically identical and all variation should be purely down to situation i.e. soil type, moisture levels, sun and wind exposure etc. but I'm afraid it's not much of a helping hand morphologically speaking. Plants of the same species growing side by side can look drastically different. The maturity of the plant is also a great factor - whether the plant is young and flowering for the first time (leaves are often less lobed and capitulas are often smaller) or old and well developed. Even the same plant can look very different from one year to the next or even from one month to the next depending on whether the plant is heterophyllous (with multiple leaf-forms) or not.

Everyone learns differently but it's best to just start off small and observe the dandelions in your local patch - your garden, street, and regular walking routes for

instance. Don't even attempt to identify them, just try to convince yourself that they are all very different! Look at all the different features e.g. petiole colouration, bract posture, whether pollen is present or not. When you've convinced yourself that they are all different, move on to focusing on individual plants which look good quality (as described above). Plants at the bases of walls are ideal. Take pictures, one of the whole plant, close ups of the leaves and petioles, flowers (capitula) side-on, from above (showing stamens), from below (showing ligule undersides and tips clearly) and compare to the handbook. Focus first on leaf characters flicking through the book just to see if they look like any and write down the names of any you think it might be, to come back to. Also try and key it out to see what you get that way. If there are any dichotomies (forks in the key) you're not sure on, attempt both routes and again write down what it comes to. Once you've narrowed the field down by elimination go back and read the descriptions of all the species you wrote the names of and look for features which make your plant an unlikely match. Does your plant have pollen when the account says that species doesn't Does your plant have pink petioles when that species should have them white? Much patience is needed! Consider joining the Dandelions (Taraxacum) of Britain and Ireland Facebook Group (private) and upload your photos, say what you think it might be, and describe the location - habitat type, Vice County and grid-ref. For example: at the base of a wall, Gloucester Rd, Bristol (vc34) at ST59137566 and await a comment. Don't despair if you're wrong, or if the verdict is 'not sure.'

It's a good idea to put your photos in some sort of organised collection. I created my own website but you don't have to be that extravagant. Something like a Flickr account would do or even printing them out and creating some sort of 'scrap book.' Over time you'll find the whole process becomes 'quicker and maybe a bit easier and you can start to be more adventurous exploring a wider range of habitats expanding the number of species you encounter. You will soon become familiar with the endless variation all species possess. You may even get to the point where you don't need to use the book as much. Good luck!

Eight Dandelions for Beginners

These are the most distinct and widespread species in our region and make a good place to start.

- 1 *T. britannicum* (British Dandelion) sect. Celtica**
- 2 *T. boeckmanii* (Böckman's Dandelion) sect. Hamata**
- 3 *T. pseudohamatum* (False Hook-lobed Dandelion) sect. Hamata**
- 4 *T. hamiferum* (Dark Hook-lobed Dandelion) sect. Hamata**
- 5 *T. densilobum* (Close-lobed Dandelion) sect. Taraxacum**
- 6 *T. pulchrifolium* (Beautiful-leaved Dandelion) sect. Taraxacum**
- 7 *T. speciosiflorum* (Beautiful-flowered Dandelion) sect. Taraxacum**
- 8 *T. atonolobum* (Recurved-lobed Dandelion) sect. Taraxacum**

1 *T. britannicum* (British Dandelion) Dahlst. sect. *Celtica*



Plate 3: The features of *T. britannicum*. (British Dandelion). See text below.

This is the first dandelion I got to know and seems to be the commonest dandelion in Bristol and likely the region as a whole; growing mostly in slightly damp soils with slight shade such as below parkland trees (including roadside trees on the Downs), bases of walls, road verges, grassland, gardens, churchyards etc.

Leaves small to medium, suberect, rather flat but often cucullate (laterally enrolled or cupped), homophyllous, dark bluish-green (sometimes purple-veined), lacking blotches and glabrous. Midrib purple or greenish distally. Petioles bright purple,

unwinged proximally. Lateral lobes 2-4, short, broad, recurved, convex on distal margin and entire except for most proximal. Terminal lobes short, obtuse, entire on outer leaves and larger on inner leaves.

Scapes equalling leaves, purplish but light green at the very apex (this is characteristic) and somewhat hairy.

Capitula deep yellow, up to 40 mm in diameter but very variable and generally about 30 mm (I have recorded it as small as 22 mm). Stigmas blackish, pollen present. Exterior bracts 7-10 x 2-3 mm, erect to appressed, pruinose-blackish and scarcely bordered to unbordered. Ligules striped grey-violet, inner florets with dark teeth.

Achenes pale brown, almost smooth, body = 3.2-3.5 mm, cone = 0.5-0.7 mm.

2 *T. boekmanii* (B kman's Dandelion) Bor y sect Hamata



Plate 4: The features of *T. boekmanii* (B kman's Dandelion).

A species of damp, shaded sites such as gardens, churchyards, lane-sides, hedge-banks, roadside verges, woodland edge etc. Fairly frequent throughout the region. A distinctive feature is beetroot-purple veining on the underside of the leaf.

Leaves medium, mostly ascending, dark green, oblanceolate, scarcely blotched and slightly hairy. Midrib bright purple to apex with red veining throughout (diagnostic). Petiole purple and narrowly winged at base. Lateral lobes 3-5, regular, rather shallow and deep, obtuse, the distal margin somewhat convex, filiform dentate on proximal lobes. Terminal lobes obtuse to rounded, entire, often more or less waisted.

Scapes equalling leaves, hairy above. Exterior bracts 10-12 x 2.5-3.5 mm, spreading-arcuate, dark blackish-green and pruinose outside, paler inside, unbordered.

Capitula deep yellow, 40 mm in diameter. Stigmas dark yellow, pollen plentiful. Ligules striped grey-violet with yellow teeth.

Achenes straw-coloured, body = 4 mm, cone = 0.5 mm.

3 *T. pseudohamatum* Dahlst. (False Hook-lobed Dandelion) sect. *Hamata*

A medium-sized to robust plant with slightly olive-green leaves and evenly recurved, hamate (hook-shaped) but slightly alternating lateral lobes, purple petioles, winged and leading into the midrib with interwoven strands. Large capitula with very grey-white, spreading-arcuate exterior bracts which often have strongly enrolled margins.



Plate 5: The features of *T. pseudohamatum* (False Hook-lobed Dandelion).

4 *T. hamiferum* Dahlst. (Dark Hook-lobed Dandelion) sect. *Hamata*

A neat medium-sized plant with glossy mid to dark-green leaves with 4-5 pairs of narrow recurved lateral lobes - often well-spaced in between with interlobes parallel and tinged black, giving it a rib-bone effect. The terminal lobe is small and triangular with a slight mucronate (nipple-like) apex. Petioles unwinged at the base, purple and continuing but fading in colour along the length of the midrib which if seen under a lens appears to be interwoven with strands (characteristic of sect. *Hamata*). Exterior bracts are spreading-arcuate and grey-white above with the inner bracts (involucre) uneven in width - some often half the width of others (a distinctive feature of this species).



Plate 6: Features of *T. hamiferum* (Dark Hook-lobed Dandelion) sect. *Hamata*. Widespread and locally frequent throughout the region.

5 *T. densilobum* Rail. (Close-lobed Dandelion) sect. *Taraxacum*

A widespread and well distributed species of disturbed grassy places such as gardens, roadside verges, wasteland etc. A squat plant early on in the season, becoming very different later on but remains recognisable by the broad-winged petioles, lateral lobes often (sometimes not) with a large 'tooth' on the distal margin causing it to look 'double' or forked and terminal lobes often with a 'tooth' on the 'shoulder.' The exterior bracts are recurved, usually sigmoid (the tip turns upwards) and relatively neat.



Plate 7: Features of *T. densilobum* (Close-lobed Dandelion)

6 *T. pulchrifolium* Markl. ex Lindb. (Beautiful-leaved Dandelion) sect. *Taraxacum*

This is quite a frequent dandelion (in Bristol at least) and very distinctive even early in the season before flowering when only leaf rosettes are available. It seems to be a really good coloniser and favours disturbed places such as roadside verges, bases of street trees, pavements, grassy banks, wasteland and at the base of walls but also seems to be a constituent of limestone grassland such as the Downs.

Identified by the distinctively shaped light-green slightly glossy leaves - the terminal lobes of which taper from the base into a fine prolonged point with the base often forward-directed so that the outline almost creates a shallow, squashed diamond-shape to almost trilobate (3-lobed) at its extreme. The petioles are unwinged at the base and pinky-purple but green on the midrib and the exterior bracts are spreading-suberect (at least towards the base) but sometimes becoming more recurved with age.



Plate 8: *T. pulchrifolium* (Beautiful-leaved Dandelion)

7 *T. speciosiflorum* M.P. Christ. (Beautiful-flowered Dandelion) sect. *Taraxacum*

Nationally rare but locally frequent on pavements around Bristol. Told by its dark-green, deep-cut and acutely pointed lobes, rich purple petioles & midribs, messy reflexed bracts and most importantly lack of pollen.



Plate 9: Features of *T. speciosiflorum* (Beautiful-flowered Dandelion)

8 *T. atonolobum* Hagend., Soest & Zevendb. (Recurved-lobed Dandelion) sect. *Taraxacum*

A national rarity, previously with only a handful of records. But in 2023 I found it to be well-established and reasonably frequent in Bristol, mainly along pavements at the bases of walls and roadside verges. A distinctive species when well-grown. Leaves mid-green with long recurved narrowly triangular acute lobes, orange-red tipped ligules and stiff, green messy recurved bracts.



Plate 10: *T. atonolobum* (Recurved-lobed Dandelion)

Dandelions of the Bristol Region: the current list (161/2 + 5?)

The following list comprises all known dandelions of the Bristol area. One or two notable species from each section have been picked out for comment here. More information will be available in the new edition of the Flora of the Bristol Region (Wild Plants of the Bristol Region), which will also, no doubt, contain further additions to the list. All records below are my own unless otherwise noted and all my determinations have been confirmed by A.J. Richards.

Abbreviations are as follows: FH, listed in Richards, 2021, Field Handbook; NBN is a record from the National Biodiversity Network database; whilst Glos. Flora refers to a record in Riddelsdell. See references for details.

Section *Erythrosperma* (19)

T. lacistophyllum (Dahlst.) Raunk. (**Cut-leaved Dandelion**) Scattered and scarce but very locally frequent on well-drained, sparsely vegetated often skeletal soils in calcareous districts such as rocky outcrops, headlands, dunes, old quarries, short unimproved grassland etc. I only know it occurring in small populations in the Avon Gorge and on Sand Point but existing records have it from Bleadon Hill, Sand Bay and Durley Hill near Keynsham.

T. brachyglossum (Dahlst.) Raunk. (**Purple-bracted Dandelion**) Same status and distribution as for *T. lacistophyllum* and often grows with it but less restricted to calcareous soils and 'natural' habitats. At Castle Park and along the floating harbour towards Bathurst Basin, parts of the Avon Gorge (both sides) and Trooper's Hill.



Plate 11: *T. brachyglossum* (Purple-bracted Dandelion)

- T. argutum* Dahlst. (**Sharp-toothed Dandelion**) FH.
- T. rubicundum* Dahlst. (**Ruddy Dandelion**)
- T. parnassicum* Dahlst. (**Parnassus Dandelion**) FH.
- T. dunense* Soest (**Dune Dandelion**) FH.
- T. haworthianum* Dudman & A.J. Richards (**Haworth's Dandelion**) FH.
- T. proximum* Dahlst. (**Umber-fruited Dandelion**) FH.
- T. pseudoproximum* Soest (**Essex Dandelion**) Very rare.
- T. disseminatum* G.E. Haglund (**Golden-fruited Dandelion**) Rare.
- T. oxoniense* Dahlst. (**Oxford Dandelion**) NBN, FH.
- T. fulviforme* Dahlst. (**Green-bracted Dandelion**) FH.
- T. fulvum* Raunk. (**Cinnamon-fruited Dandelion**) FH, NBN. Very rare.
- T. scoticum* A.J. Richards (**Scottish Dandelion**). FH, very rare.
- T. glauciniforme* Dahlst. (**Many-toothed Dandelion**). FH, NBN. Very rare.
- T. retzii* Soest (**De Retz's Dandelion**) Very rare.

T. wallonicum Soest (**Belgium Dandelion**) Very rare.

T. degelii G.E. Haglund (**Degelius's Dandelion**) FH, very rare.

T. acutum A.J. Richards (**Violet-striped Dandelion**) NBN, very rare.

Sect. Palustria (H. Lindb.) Dahlst. (1)

T. palustre (Lyons) Symons (**Fen Dandelion**) Very rare. Discovered in 1918 at Yate Common and in a few other spots close by soon after. It should still occur here and in suitable spots elsewhere in the region. It is one of the few dandelions known in White's time and he mentions..."The rather strongly marked *T. palustre* DC. has not come under notice, but should be found in bogs and damp places."



Plate 12 : *T. palustre* (Lyons) Symons (Fen Dandelion)

Sect. Spectabilia (Dahlst.) Dahlst. (1)

T. faeroense Dahlst. ex Henry H. Johnst. (**Faeroes Dandelion**) - FH, NBN, rare.

Sect. Naevosa M.P. Christ. (6 + 1?)

T. "Laundry Lane Naevosa" Like a very small *T. longisquameum* but with spots.

T. euryphyllum (Dahlst.) M.P. Christ. (**Wide-stalked Dandelion**) – FH, very rare.

***T. ronaë* Margetts var. *ronaë* (Ronaë's Dandelion)** Very rare. A few plants at Weston-super-Mare in 2023 extending its previous known range in England from its nearest known site at West Somerset by a good few miles.



Plate 13: *T. ronaë* Margetts var. *ronaë* (Ronaë's Dandelion)

***T. cornubiense* A.J. Richards (Cornish Dandelion)** Very rare. Two locations in Bristol. Endemic to Cornwall, likely introduced with gravel from a Cornish quarry.

***T. pseudomarklundii* Soest (False Marklund's Dandelion)** Very rare.

***T. hamiferum* (Dark Hook-lobed Dandelion).** See above.

***T. richardsianum* C.C. Haw. (Richard's Dandelion)** – FH, very rare.

Sect. *Celtica* A.J. Richards (12 + 2?)

***T. gelertii* Raunk. (Gelert's Dandelion)** – FH, rare.

***T. bracteatum* Dahlst. (Dark-green Dandelion)** One of our commonest dandelions. It has a liking for growing at the foot of walls but is just as happy in more rural situations on hedgebanks and along lanes.



Plate 14: *T. bracteatum* Dahlst. (Dark-green Dandelion)

***T. britannicum* (British Dandelion)** (see above).

***T. subbracteatum* A.J. Richards (Dark-bracted Dandelion)** Widespread.

***T. duplidentifrons* Dahlst. (Double-toothed Dandelion)**

***T. hesperium* C.C. Haw. (Western Dandelion)** FH.

***T. excellens* Dahlst. (Purple-blotched Dandelion)** Scattered and local.

T. tamesense A.J. Richards (Thames Dandelion) Very rare, in wet places.
T. haematicum G.E. Haglund ex H. Øllg. & Wittzell (Blood-red Dandelion)
T. nordstedtii Dahlst. (Nordstedt's Dandelion) Rare, locally frequent N. Somerset.
T. 'Berkeley Road Celtica'
T. 'Broadway Rd Celtica'
T. ostenfeldii Raunk. (Ostenfeld's Dandelion) FH.
T. unguilobum Dahlst. (Claw-lobed Dandelion) FH.

Sect. *Hamata* H. Øllg. (13)

T. hamatum Raunk. (Hook-lobed Dandelion) Widespread.
T. hamatulum Hagend., Soest & Zevenb. (Slender Hook-lobed Dandelion)
T. subhamatum M.P. Christ. (Large Hook-lobed Dandelion) Widespread and fairly frequent throughout the region.



Plate 15: *T. subhamatum* M.P. Christ. (Large Hook-lobed Dandelion)

T. marklundii Palmgr. (Marklund's Dandelion) Widespread.
T. quadrans H. Øllg. (Fleshy-lobed Dandelion) Rare but can be locally frequent.
T. pseudohamatum (False Hook-lobed Dandelion). See above.
T. boekmanii (Bökman's Dandelion). See above.
T. atactum Sahlin & Soest (Narrow-bracted Dandelion) Rare and localised.
T. sahlinianum Dudman & A.J. Richards (Sahlin's Dandelion).

T. pruinatum M. P. Christ. (Pruinose Dandelion)
T. hamatiforme Dahlst. ex Lindm. (Asymmetrical Hook-lobed Dandelion)
T. lancidens Hagend., Soest & Zevenb. (Spear-toothed Dandelion)
T. lamprophyllum M. P. Christ. (Lustrous-leaved Dandelion)

Sect. *Taraxacum* (formerly sect. *Ruderalia* Kirschner, H. Øllg. & t ne) (0 8) : Alata Group: (10)

T. alatum H. Lindb. (Green Dandelion)
T. densilobum (Close-lobed Dandelion). See above.
T. dilaceratum Dahlst. (Lacerate-leaved Dandelion)
T. pallescens M.P. Christ. (Pink-stalked Dandelion)
T. pannucium Dahlst. (Green-stalked Dandelion) Very rare.
T. subexpallidum Dahlst. (Tongue-lobed Dandelion)
T. laeticolor Dahlst. (Pale-stalked Dandelion) Widespread and locally frequent.
T. sublaeticolor Dahlst. (Small-headed Dandelion) Scattered and rare.
T. leucopodium G.E. Haglund (White-stalked Dandelion)
T. macrolobum Dahlst. (Incise-lobed Dandelion)

Sect. *Taraxacum* continued: Undulata Group: (3)

T. undulatum H. Lindb. & Marklund (Wavy-leaved Dandelion)
T. corynodes G.E. Haglund (Dense-lobed Dandelion) Very rare.
T. tenebricans Dahlst. (Shiny-leaved Dandelion)

Sect. *Taraxacum* continued: *Croceiflora* Group: (11)

T. insigne Ekman ex M.P. Christ. & Wiinst. (Remarkable Dandelion)
T. pannulatiforme Dahlst. (Tar-blotched Dandelion)
T. laticordatum Markl. (Decumbent Dandelion)
T. subhuelpersianum M.P. Christ. (Light-green Dandelion)
T. necessarium H. Øllg. (Dark-leaved Dandelion)
T. lepidum M.P. Christ. (Pruinose-bracted Dandelion)
T. expallidiforme Dahlst. (Broad-stalked Dandelion)
T. pallidipes Markl. (Grey-bracted Dandelion)
T. croceiflorum Dahlst. (Orange-flowered Dandelion) FH, NBN.
T. lacerifolium G.E. Haglund (Jagged-leaved Dandelion)
T. lunare M.P. Christ. (Lunar-lobed Dandelion) Very rare.

Section *Taraxacum* continued: *Stenacra* Group: (4)

T. stenacrum Dahlst. (Linear-lobed Dandelion) Very rare.
T. porrigens Markl. ex Puol. (Hump-lobed Dandelion) FH.

T. undulatiflorum M.P. Christ. (Dull-leaved Dandelion)

T. chloroticum Dahlst. ex Florstr. (Spiky-leaved Dandelion) Very rare.

Section *Taraxacum* continued: *Piceata* Group: (10)

T. piceatum Dahlst. (Leaden-bracted Dandelion)

T. cyanolepis Dahlst. (Bluish-bracted Dandelion) Recorded as *T. alienum* Glos. Fl.

T. curtifrons H. Øllg. (Variable-leaved Dandelion)

T. acutifrons Markl. (Acute-leaved Dandelion)

T. sublongisquameum M.P. Christ. (Roadside Dandelion)

T. chrysophaenum Rail. (Orange-toothed Dandelion)

T. tumentilobum Markl. ex Puol. (Swollen-lobed Dandelion) Very rare. Recorded only once at Weston-super-Mare but it will occur elsewhere.



Plate 16: *T. tumentilobum* Markl. ex Puol. (Swollen-lobed Dandelion)

T. intumescens G.E. Haglund (Red-tipped Dandelion) Very rare.

T. ancistrolobum Dahlst. (Few-lobed Dandelion)

T. sellandii Dahlst. (Selland's Dandelion) Widespread.

Sect. *Taraxacum* continued: *Maculata* Group: (9)

T. multicolorans Hagend., Soest & Zevenb. (Many-coloured Dandelion) FH, NBN

T. nitidum Hagend., Soest & Zevenb. (Shining Dandelion)

T. longisquameum H. Lindb. (Elongate-bracted Dandelion)

T. scotiniforme Dahlst. ex G.E. Haglund (Deltoid-lobed Dandelion)
T. maculatum Jord. (Yellowish-green Dandelion)
T. fasciatum Dahlst. (Dense-bracted Dandelion) FH.
T. subxanthostigma M.P. Christ. ex H. Øllg. (Purple-stalked Dandelion)
T. melanthoides Dahlst. ex M.P. Christ. & Wiinst. (Bluish-leaved Dandelion)
 Very rare. One to look out for on wet ground.



Plate 17: *T. melanthoides* Dahlst. ex M.P. Christ. & Wiinst. (Bluish-leaved Dandelion)

T. severum M.P. Christ. (Severed Dandelion)

Sect. *Taraxacum* continued: Dilatata Group: (11)

T. aequisectum M.P. Christ. (Equal-lobed Dandelion) Very rare.
T. lacinosifrons Wiinst. ex Raunk. (Hairy-stemmed Dandelion)
T. edmondsonianum H. Øllg. (Edmondson's Dandelion) Very rare.
T. latens H. Øllg. (Cut-lobed Dandelion)
T. obtusifrons Markl. (Obtuse-leaved Dandelion) Scattered and rare.
T. lucidum Dahlst. (Large-bracted Dandelion) Rare.
T. vastisectum Markl. ex Puol. (Crowded-lobed Dandelion). NBN.
T. dilatatum H. Lindb. (Grassland Dandelion) Scattered and locally frequent.



Plate 18: *T. dilatatum* H. Lindb. (Grassland Dandelion)

- T. diastematicum* Markl. (Bulbous-lobed Dandelion) Very rare.
T. hepaticum Rail. (Regular-lobed Dandelion)
T. fusciflorum M.P. Christ (Beautiful-flowered Dandelion) Fairly frequent.

Sect. *Taraxacum* continued: *Stenoglossa* Group: (12 + 1?)

- T. pulchrifolium* (Beautiful-leaved Dandelion). See above.
T. subundulatum Dahlst. (Complex-leaved Dandelion)
T. exacutum Markl. (Imbricate-bracted Dandelion) NBN.
T. adiantifrons E. Ekman ex Dahlst. (Pretty-leaved Dandelion)
T. retroflexum H. Lindb. (Reflexed-lobed Dandelion)
T. stenoglossum Brenner non Dahlst. (Dahlstedt's Dandelion, Glossy Dandelion)
 1 unconfirmed record NBN, Field Handbook
T. 'Cotham Rd *Stenoglossa*'
T. sinuatum Dahlst. (Sinuate-lobed Dandelion)
T. caloschistum Dahlst. (Brilliant-stalked Dandelion)
T. mimulum Dahlst. ex H. Lindb. (Sharp-lobed Dandelion)
T. valens Markl. (Reflexed-bracted Dandelion)
T. leptodon Markl. (Yellow-styled Dandelion) Scarce.
T. incisum H. Øllg. (Incise-leaved Dandelion)

Sect. *Taraxacum* continued: *Trilobata* Group: (4 +1?)

- T. trilobatum* Palmgr. (Three-lobed Dandelion)
T. planum Raunk. (Diverse-leaved Dandelion)
T. aurosulum H. Lindb. (Tailed Dandelion) FH.
T. ochrochlorum G.E. Haglund ex Rail. (Winged Dandelion)
T. 'Spotted Ochrochlorum' Rare, in parts of North Bristol. It might be an established introduction but it could easily be an undiscovered native.



Plate 19: *T. 'Spotted Ochrochlorum'*. See also Plate 23 below.

Sect. *Taraxacum* continued: Pannulata Group: (7/8)

T. latisectum H. Lindb. (Broad-lobed Dandelion)

T. pannulatum Dahlst. (Brown-ribbed Dandelion) FH, NBN

T. blandum G.E. Haglund. - previously *T. remanentilobum* Soest. (Falcate-lobed Dandelion) NBN - probably a mistake for the previous.

T. fagerstroemii Sältin (Fagerström's Dandelion)

T. interveniens G.E. Haglund. (City Dandelion)

T. rhamphodes G.E. Haglund. (Robust Dandelion)

T. procerisquameum H. Øllg. (Large-headed Dandelion) FN, 1 unconfirmed record according to NBN.

T. exsertiforme Hagend., Soest & Zevenb. (Erect-bracted Dandelion) Scattered and locally common, Horfield Common and Nightingale Valley, Leigh Woods etc.



Plate 20: *T. exsertiforme* Hagend., Soest & Zevenb. (Erect-bracted Dandelion)

Sect. *Taraxacum* continued. Ekmania Group: (17)

T. ekmanii Dahlst. (Ekman's Dandelion) FH.

T. coartatum G.E. Haglund. (Irregular-bracted Dandelion)

T. angulare Hagend., Soest & Zevenb. (Angular-lobed Dandelion)

T. latissimum Palmgr. (Broad-leaved Dandelion)

T. aequilobum Dahlst. (Twisted-bracted Dandelion)

T. cordatum Palmgr. (Entire-lobed Dandelion)

T. xanthostigma H. Lindb. (Ochre-styled Dandelion)

T. pachymerum G.E. Haglund. (Dirty-leaved Dandelion)

T. lingulatum Markl. (Long-bracted Dandelion)

T. pseudoretroflexum M.P. Christ. (Spur-lobed Dandelion)

T. dudmanianum inedit. (Dudman's Dandelion) FH.

T. altissimum H. Lindb. (Tall Dandelion)

T. obliquilobum Dahlst. (Orange-tipped Dandelion)

T. pectinatiforme H. Lindb. (Pectinate-leaved Dandelion) Glos. Flora.

***T. polyodon* Dahlst. (Common Dandelion)** Glos. Flora.

***T. hexhamense* A.J. Richards (Hexham Dandelion)**

***T. amplum* Markl. (Toothed Dandelion)**

Scattered along pavements, sometimes locally frequent; occasionally in more natural places such as grass and hedgebanks.



Plate 21: *T. amplum* Markl. (Toothed Dandelion)

Sect. *Taraxacum* Acutifida Group: (11)

***T. exsertum* Hagend., Soest & Zevenb. (Pale-green Dandelion)**

***T. acroglossum* Dahlst. (Broad-bracted Dandelion)**

***T. semiglobosum* H. Lindb. (Hairy-ribbed Dandelion)**

***T. huelphersianum* G.E. Haglund. (Hülphers's Dandelion)** NBN.

***T. nigridentatum* T. Edm. (Black-toothed Dandelion)** FH.

***T. angustisquameum* Dahlst. ex H. Lindb. (Multilobed Dandelion)** Locally frequent in the more species-rich parts of the Downs and also at Inglestone Common.

***T. stereodes* Ekman ex G.E. Haglund. (Hairy-stalked Dandelion)** Rare.

***T. sagittipotens* Dahlst. & Ohlsen ex Haglund (Smooth Dandelion)**

Rare but likely scattered and locally plentiful.



Plate 22: *T. sagittipotens* Dahlst. & Ohlsen ex Haglund (Smooth Dandelion).

T. atonolobum (Recurved-lobed Dandelion). See above.
T. oblongatum Dahlst. (Oblong-leaved Dandelion)
T. cophocentrum Dahlst. (Rounded-lobed Dandelion)

Additional predicted species for the Bristol Region

The following 42 species could be expected to also occur in our area. I have no doubt that most if not all of these will be discovered one day in the Bristol region and the full tally should surpass the 200 mark.

T. inopinatum C.C. Haw. (Unexpected Dandelion)
T. arenastrum A.J. Richards (Sand Dandelion)
T. commixtum G.E. Haglund (Sociable Dandelion)
T. proximiforme Soest (Straw-fruited Dandelion)
T. falcatum Brenner (Narrow-lobed Dandelion)
T. platyglossum Raunk. (Tongue-leaved Dandelion)
T. anglicum Dahlst. (English Dandelion)
T. naevosiforme Dahlst. (Wetland Dandelion)
T. maculosum A.J. Richards (Spotted Dandelion)
T. pseudolarssonii A.J. Richards (Spreading-bracted Dandelion)
T. subnaevosum A.J. Richards (Pale-bracted Dandelion)
T. stictophyllum Dahlst. (Stiff-leaved Dandelion)
T. atrocollinum A.J. Richards (Hill Dandelion)
T. oellgaardii C.C. Haw. (Ollgaard's Dandelion)
T. porteri C.C. Haw. (Porter's Dandelion)
T. celticum A.J. Richards (Celtic Dandelion)
T. inane A.J. Richards (Pollenless Dandelion)
T. fulgidum G.E. Haglund (Bright Dandelion)
T. akteum Hagend., Soest & Zevenb. (Hampshire Dandelion)
T. landmarkii Dahlst. (Landmark Dandelion)
T. chlorofrugale Oosterv. ex A.J. Richards (Greenish-yellow Dandelion)
T. pietii-oosterveldii H. Øllg. (Piet-oosterveld's Dandelion)
T. berthae C.C. Haw. (Bertha's Dandelion)
T. cambricum A.J. Richards (Welsh Dandelion)
T. lancastriense A.J. Richards (Lancashire Dandelion)
T. palustrisquameum A.J. Richards (False Fen Dandelion)
T. amicorum A.J. Richards (Friend's Dandelion)
T. fulvicarpum Dahlst. (Brown-fruited Dandelion)
T. luteum C.C. Haw. & A.J. Richards (Pure Yellow Dandelion)
T. subericinum Hagend., Soest & Zevenb.
T. fusciflorum H. Øllg. (Brown-striped Dandelion)
T. prionum Hagend., Soest & Zevenb. (Saw-leaved Dandelion)
T. spiculatum M.P. Christ. (Sagittate-lobed Dandelion)

T. kernianum Hagend., Soest & Zevenb. (Kern's Dandelion)
T. horridifrons Rail. (Prickly-leaved Dandelion)
T. margettsii C.C. Haw. (Margetts's Dandelion)
T. cherwellense A.J. Richards (Cherwell Dandelion)
T. pachylobum Dahlst. (Thick-lobed Dandelion)
T. tanyphyllum Dahlst. (Spreading-lobed Dandelion)
T. macranthoides G.E. Haglund (Large-flowered Dandelion)
T. sundbergii Dahlst. (Sundberg's Dandelion)
T. acutifidum M.P. Christ. (Pointed-lobed Dandelion)

References and Resources

If you want to be brave and take up the sport of Taraxacology there are some superb resources available. If you would like to get into recording dandelions or just marvel over other people doing it then you could join the Dandelions (Taraxacum) of Britain and Ireland Facebook Group (private) where you can obtain lots of help and advice.



Plate 23: *T. Spotted Ochrochlorum*'.

References for this paper

Dudman, A.A. and Richards, A.J. 1997. *Dandelions of Great Britain and Ireland*. BSBI Handbook 9. Botanical Society of the British Isles. (outdated but still useful)
 Barry Henwood and Phil Sterling, 2020: *Field Guide to the Caterpillars of Great Britain and Ireland*. Bloomsbury Publishing.
 Richards, A. J. 2021. *Field Handbook to British and Irish Dandelions*. B.S.B.I. Handbook no. 23. Botanical Society of Britain and Ireland.

Riddelsdell, *et al.* 1948. *Flora of Gloucestershire*. Out of print.
Clive Stace, 2019 *New Flora of the British Isles*. Fourth edition. C & M. Floristics.
(for identification to section level)
White, J.W. 1912. *The Flora of Bristol*. Out of print. Good for historical records.

Online Resources

For photos, check-lists and other information:

Wildbristol.uk - <https://wildbristol.uk/> (My Website!)
UK Vascular Plants - <https://www.vascularplants.co.uk/>
Somerset Rare Plants Group - <https://www.somersetrareplantsgroup.org.uk/>
The Dandelions of Cardiff -
<https://museum.wales/curatorial/biosyb/vascular/collections/taraxacum/cardiff/>

Foreign resources:

Taraxacum Nederland - <https://www.taraxacumnederland.nl/>
BOTANY.cz - <https://botany.cz/cs/>
PhotoFlora - <http://www.photoflora.fr/TaxTrouv.php>

For an introduction to dandelions:

BSBI Dandelions - <https://bsbi.org/identification/taraxacum>
BSBI Plant Crib - <https://bsbi.org/plant-crib>
BSBI News & Views, Tim Rich, The Dandelion ID Bug -
<https://bsbipublicity.blogspot.com/2020/03/the-dandelion-id-bug-tim-says-its.html>
A Botanical Journey mostly from Kent & SE England -
<https://barbus59.blogspot.com/2021/05/taraxacum-section-erythrosperma-in-kent.html>

For distribution and taxonomy:

Kew - Plants of the World Online - <https://powo.science.kew.org/>
GBIF (Global Biodiversity Information Facility) - <https://www.gbif.org/>
Euro+Med PlantBase - <https://europlusmed.org/>
NBN (National Biodiversity Network) - <https://nbnatlas.org/>

Studyin o scure fun i on o scure lants ryo hilous fun i in the molecular a e

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Introduction

Bryophytes are a group of generally small land plants comprising mosses, liverworts and hornworts. While mosses, in particular, are widely known to have extremely high levels of desiccation tolerance, most bryophytes cannot live away from a source moisture, either avoiding summers by having annual life cycles, growing in the cooler, wetter times of year, or by growing in permanently damp, sheltered habitats all year round. There are over 1000 bryophyte species in Britain and Ireland, a significant proportion of which are rare and threatened, confined to hyper-oceanic climates, mountains, and temperate rainforests (Callaghan, 2023).

Bryophytes are important in natural habitats, with the well-known genus *S. hagnum* playing fundamental ecosystem engineering roles in Holarctic bogs and wet heath, and multiple other species contributing to the ground cover in woodland, heathland and tundra. The diversity of epiphytic bryophytes and lichens has long been appreciated to indicate air quality, with multiple species being extremely sensitive to pollutants (e.g., Pescott et al., 2015). While these little plants are starting to be better appreciated for their ecological functions, very little is known about the way they interact with other organisms, particularly fungi.

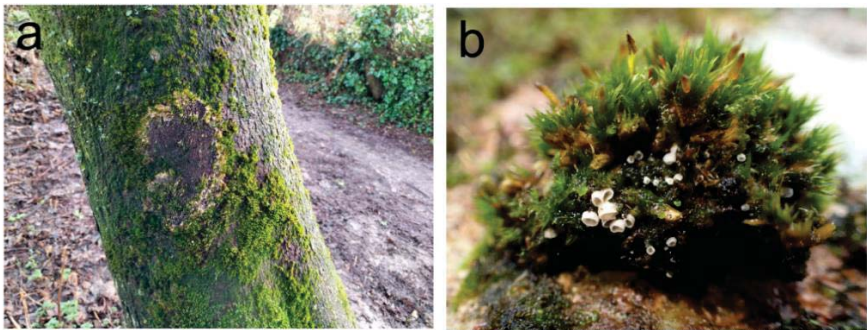


Fig. 1: The bryophilous basidiomycete, *Thromocyella muscicola*. a) Radiating necrotic patch with whitish borders caused by the fungus. B) Fruitbodies of *Thromocyella muscicola* on *Callunella dilatata* and *Calluna* sp. Photos by the author (Greiff, 2024).

Much of the bryological literature makes no mention of fungi. One report mentions the general viewpoint that bryophytes are hardly attacked by invertebrates and other micro-organisms (Ando & Matsuo, 1984), which remains pervasive among

bryologists. This may well be true to some extent in the case of basidiomycetes, as relatively few fruitbody-forming, specifically bryophilous species are known. Examples include the widespread necrotroph *hromocy hella muscicola*, and various species of *Arrhenia*, *Rim achia* and *Ric enella*. I have seen the former species in woodland across Britain, often forming conspicuous necrotic rings in epiphytic moss patches. One may see these, and the tiny white basidiocarps, in woodlands around Bristol, including Leigh Woods NNR (Fig.1).

Ascomycetes (sac-fungi), on the other hand, successfully and frequently interact with bryophytes, with many forming fruitbodies that permit morphological identification. Multiple species have evolved to exploit bryophyte hosts in all manner of ways, from generalist saprophytes to extremely host specific, biotrophic parasites (D bbeler, 1997). Many species are very common, with some bryophytes almost guaranteed to be infected and house fruitbodies, e.g., the sea urchin-like *i ryon interlamellare* on *Polytrichum commune* and *P formosum* (Fig.2).

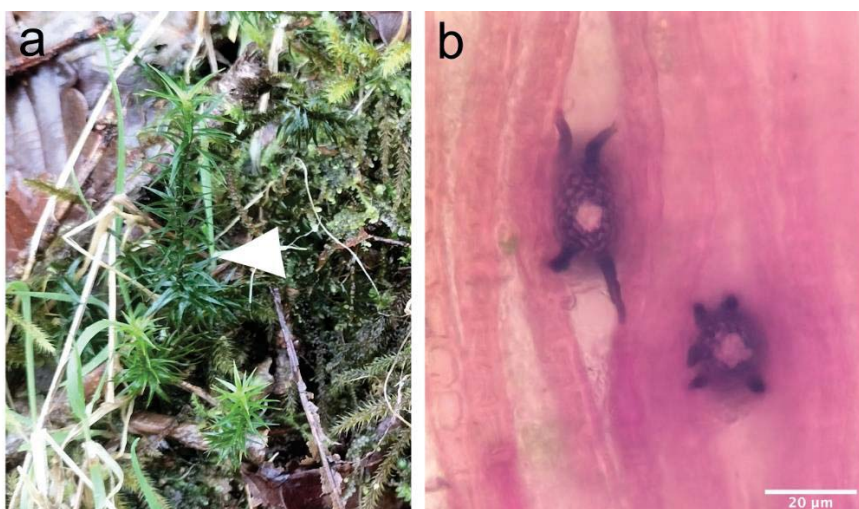


Fig. 2: *i ryon interlamellare* on *Polytrichum formosum*. a) Infected host plant, *Polytrichum formosum*, without any visible symptoms infected leaf arrowed (fungus invisible in the field). B) Fruitbodies of *i ryon interlamellare* arising from between the photosynthetic leaf lamellae of the host plant. Scale bar 20 micrometres (1 50 mm). Photos by the author.

Most of these species are minute, barely or not visible in the field unless a good hand lens is used, generally with a strong light, which is why they are under-studied and overlooked. Some species, such as *Bryonectria callicar a*, are, in my experience, impossible to spot in the field and need to be screened for under a dissecting microscope (e.g., Greiff 2021). There are still many new things to discover about these fungi.

2 Bring bryophilous fungi into the molecular age

While one group of bryophilous fungi, the Pezizales, is being actively studied (e.g., Janoušek et al., 2023), most of the diversity remains underexplored, particularly at a molecular level. This means that we do not know the natural relationships between a great deal of species. Morphological information is not sufficient to make judgement calls on this because many groups of the smaller fungi have experienced similar evolutionary selection pressures to become small and relatively simple in structure. As such, similar-looking fungi may actually be very distantly related, often being in different classes and sharing common ancestors hundreds of millions of years ago. A good example would be the species above *Cladonia interlamellare* (Eurotiomycetes Fig.2b), which strongly resembles the genus *Niesslia* (Sordariomycetes), which is parasitic on vascular plants. Both genera produce tiny blackish, sea-urchin-like fruitbodies with spines and often 2-celled ascospores, but these morphologies arose convergently.

Stenroos et al. (2010) conducted the first broad phylogenetic study of bryophilous ascomycetes and showed that *Cladonia* was in the class Eurotiomycetes rather than Dothideomycetes, as was previously thought. This is a notable result, as several fungi important to humans are also in this group, including *Penicillium* and *Aspergillus*. It is possible that bryophilous fungi may also have hitherto unknown applications, but this cannot be explored or realised until the fungi are known (morphologically), named, sequenced, and cultured.

There are two main barriers to sequencing bryophilous fungi, operating together to limit the ability to generate data. These are over and above the fact that very few people know they exist and can find and identify them. Firstly, it was previously necessary to use a large number of the small fruitbodies to extract enough DNA for sequencing. Due to the aforementioned convergent evolution, multiple fungi may be present on a single host plant and could look largely indistinguishable under a stereomicroscope. So, even the most careful dissections could result in mixed species samples, which means that traditional Sanger sequencing approaches will not work as these require single, clean samples. Furthermore, many samples lack enough fruitbodies to use up for sequencing, perform the detailed morphological analysis under the compound microscope required to identify and document the species, as well have enough material left for an herbarium specimen. There are two ways around this limitation. The first is to find a method to reliably obtain sequence data from smaller amounts of fungal material, and the second is to use next-generation sequencing approaches, such as Nanopore, to sequence all the fungi present in mixed samples.

The second barrier is contamination, which works in hand with the material problem above. The more material dissected, the higher the chance that other fungal structures, not necessarily bryophilous, may contaminate the extract. Additionally, in my

experience, any bryophyte tissues harvested alongside fungal fruitbodies generally result in contamination, as fungus-specific primers used to amplify the molecular barcoding genes sometimes manage to amplify bryophyte DNA. Collecting practices also influence this point. If a collection is kept in a damp, dark collection box or bag for too long, it becomes mouldy and this mould could be sequenced instead of the target fungus. Since I cannot employ next-generation sequencing and am limited to Sanger sequencing, what I needed was an approach that uses the least amount of fungal fruitbodies and carefully removes or excludes all potential contaminants.

After spending time in the Sainsbury Laboratory at the University of Cambridge in 2021, I was introduced to a commercial kit used to genotype plants in the lab, called Phire Plant Direct by Thermo Fisher. I should say that I am in no way affiliated with the brand or company, but I have found that a modification of the protocol in this kit is highly successful at amplifying barcoding genes from small amounts of tiny bryophilous fungi, with some caveats. Utilising this kit allows for multiple Polymerase Chain Reaction (PCR) experiments to be run relatively cheaply and with far fewer steps for introducing contamination than other approaches. It is also what is termed a 'direct PCR'-based approach, which means that a separate kit used to extract DNA from samples is not required, saving both time and money. Finally, the polymerase enzyme that is used to amplify the target DNA is robust, rapid, and has a high affinity to DNA, meaning that it is better able to successfully amplify targets without or before being degraded by inhibitors released from the target tissues than some other forms.

After some pilot studies, I obtained two small grants from the British Mycological Society and the Bristol Naturalists' Society to purchase reagents to try sequence a number of different bryophilous fungi. This has, for the most part, been incredibly successful. During the project, I managed to amplify barcoding genes from around 100 samples, from both recently-collected and decade-old, dried material. The approach was able to amplify genes successfully from all major groups of fruitbody-forming bryophilous ascomycetes, including Pezizales, Leotiomycetes, Dothideomycetes, Eurotiomycetes and Sordariomycetes, all from very small amounts of tissue.

I focussed on two specific groups of bryophilous fungi for my studies. The first is the genus *Bryocentria*, which currently contains 18 species. Until I began working on bryophilous fungi in 2017, only one species, *B. rongniartii* was known from Britain and Ireland, and only a couple of specimens of *B. rongniartii* and *B. metgeriae* had been sequenced globally (Stenroos et al., 2010). Since then, I have recorded *B. hyothallina* (Greiff, 2019), *B. metgeriae* and *B. octosorelloides* (Greiff, personal observations) in Britain, as well as an undescribed species provisionally named '*B. confusa*'. I successfully amplified the Large Subunit Ribosomal Nucleic Acid (LSU) molecular barcode from representatives of almost all British and Irish species, as well as from some samples from Belgium and Switzerland representing another novel species. These new species and sequences will be published from mid-2024 in

separate journal articles. The molecular data acts as a good character in addition to morphology that clearly separates closely related and or cryptic species.



Fig. 3: *Mniaecia nivea* on *Bryum caillare*. Photo by the author (Greiff, 2024).

The second group I have studied in more detail includes species in the class Leotiomycetes, which include many beautiful and conspicuous fungi like *Mniaecia nivea* (**Fig.3**) and *Roseodiscus formosus*. Some bryophilous Leotiomycetes are fairly large and conspicuous and have been studied by traditional mycologists since the 1800s. However, little molecular data exist for species in this group, and there is a plethora of undescribed but known species awaiting formal description. Here, DNA data is helping to clarify the relationships between the bryophilous species and higher taxa. It is becoming clear that the bryophilous habit evolved multiple times independently in several groups, and multiple species-rich genera, such as *Bryoscyphus*, appear to have radiated following the acquisition of a bryophilous lifestyle (e.g., see Döbbeler, 1997). The first manuscript of the Leotiomycetes work is in preparation, and we will soon be publishing a new species of *Bryoscyphus* found thus far in England and France, but which undoubtedly occupies a wider distribution.

Because of the rather long timeframes in which taxonomic work progresses, particularly writing the manuscripts, collating the data and going through the submission process (while working on this in my spare time), I am disappointed that I cannot share the results of the studies more explicitly at the point of writing.

However, I am keen to share the protocol I use to amplify DNA barcoding genes from these fungi. The method is likely applicable to a large number of organisms.

Although we have not tested animal tissues, this approach works well on fresh or recently collected bryophytes, vascular plants and ascomycete fungi. It will likely work for mushrooms and other basidiomycetes, and could be used to obtain sequence data from tricky, small species like powdery mildews or rusts. If combined with next-generation sequencing approaches, it could be utilised to understand the diversity of a target group within a mixed sample of organisms, something beyond the capacity of the Sanger Sequencing technology that is still generally used for DNA barcoding (but this is changing).

As natural history societies, especially mycological divisions, utilise molecular biology to help identify cryptic species and document local biodiversity, finding methods that cut costs and time while increasing reliability are highly desirable. It is hoped that this approach adds to the arsenal of developing tools used by naturalists to explore molecular biology.

3 protocol sampling, molecular biology, and caveats

3 Sampling

The Phire Plant Direct kit (Thermo Fisher Scientific: F160S) is used for direct PCR. 15 µL dilution buffer was aliquoted into labelled PCR tubes (1.5 mL Eppendorf tubes also work) and stored in a freezer until use. It is useful to use and stick to a simple code that is used both on the tubes and on a corresponding spreadsheet or notebook to keep track of samples as they go through the process. It should be noted that extracting good, clean samples of the fungi is far more time-consuming than setting up the PCR reactions, so it is worth taking care with this process.

Two small containers of fresh tap (or distilled) water and another containing a roughly 20% bleach tap water are to be made up. Recently collected or herbarium host bryophyte material is to be rehydrated in fresh tap water from one of the containers while the other two (20% bleach and the other water) are used for sterilising and washing dissection equipment – a pair of forceps and a dissecting needle. Gloves can be used from this point but are not necessary. The forceps are crudely washed under a running tap or in soapy water before the lower parts were placed in the bleach solution for up to a minute (usually shorter). They were then rinsed in the container of tap water not used for specimen hydration before being thoroughly dried on a piece of kitchen towel, especially the ends of the equipment to remove any sticky debris from previous dissections. This prevents cross contamination.

Under a dissecting microscope, regions of the host bryophyte containing fruitbodies can be detached and pooled together into a new clean drop of water on a clean Petri dish. A number of fruitbodies can then be carefully detached intact from the host

tissues. This should always be done with freshly sterilised, washed and dried dissecting instruments. The fruitbodies can be transferred between various drops of clean water until they are free of debris. It is very important to remove as much host material, if not all of it, as possible. Even tiny amounts of host tissue frequently result in contamination by lichens, other fungi, and even the DNA of the host plants themselves, which occasionally amplify even with fungus-specific primers.

The total number of fruitbodies required depends on the size of the fungus, how likely the fruitbodies are to contain spores (if they are overmature and without spores then they are not going to release DNA), and the number of spores usually produced in a given species. For example, the genus *Bryocentria* is very amenable to this method. One mature fruitbody (200–250 µm) produces an estimated 1000 8-spored asci. Each ascospore is 1-septate, so at least 16 000 cells have the capacity to release DNA. Since the ribosomal DNA used in DNA barcoding is present in high quantity in most fungal genomes, a single fruitbody of *Bryocentria* offers plenty of DNA for sequencing. Other species, such as *Bryochiton monascus*, usually produce a single ascus with eight 3-septate spores in minute fruitbodies rarely exceeding 40 µm diam. at maturity. A single fruitbody would release significantly less DNA than one of *Bryocentria*. I have not attempted to sequence *B. monascus*. A lower volume of dilution buffer could be used in this case, perhaps 5 µL with up to 10 fruitbodies, or a few fruitbodies could be added directly to a PCR reaction. For larger species, especially 'discomycetes' like *Bryoscypha* or *Clitocybe*, a single apothecium (> 300 µm) or small amount of hymenium (asci and spores) removed on the tip of a dissecting needle is usually sufficient. If dissecting whole fruitbodies, more dilution buffer can be added.

Always sterilise and wash the dissection equipment between sample extractions and ensure all specimens are appropriately numbered & labelled, both on the tubes and in a corresponding document. The golden rule for extracting from 'larger' fungi is that less is more. The end volume of dilution buffer should not be substantially altered by the addition of the sample fragment. If so, add more buffer. After sample extraction, the tubes can be stored in a freezer until it is time to set up the PCR reactions. This is useful because freeze-thaw cycles will help to disrupt the fungal tissue and released DNA into the dilution buffer. One may also heat the sample tubes up to 90°C for ten minutes to facilitate DNA release, but this does not seem to be necessary.

3.2.2. CR EXPERIMENTS

I usually set up 20 µL PCR, adding 10 µL of the Phire Plant Direct master mix, 1 µL of the forward primer, 1 µL of the reverse primer, 7.5 µL of water and 0.5 µL of template (i.e., the dilution buffer + fungus extracted previously). Prior to loading template from the sample tubes into the PCR tubes, I usually crudely disrupt the sample with the end of a 10 µL pipette tip before transferring material, just in case spores are still enclosed in fruitbodies. One may increase the template to 1 µL and

correspondingly reduce the water when dealing with fungi that produce few spores. The reaction volumes can also be scaled down to 14 μ L to conserve the master mix, though this usually requires pipetting less template. The PCR settings usually use a long initial denaturation of 5 min, with all other options following the manufacturer's instructions (see manual online and use it in conjunction with this section). Note that the T_m (annealing temperature) needs to be estimated using the Fisher T_m Calculator available online, as the Phire polymerase enzyme is different to regular Taq enzymes. The Phire polymerase operates rapidly, so PCRs usually take just over an hour. I recommend always checking PCR products on agarose gels to assess amplification and screen for contamination ahead of preparing the samples for sequencing. 3–4 μ L is usually more than enough to run on a 1–2% agarose gel (in Tris-Acetate-Ethylendiaminetetraacetic acid – TAE – buffer), leaving plenty of PCR product for purification and sequencing reactions.

Sequence analysis and processing follow general methods and will not be discussed here. It is very useful to 'BLAST' (using an online Basic Local Alignment Search Tool) any obtained sequences on the NCBI website to check that the species amplified matches what the target group is expected to be, e.g., using <https://blast.ncbi.nlm.nih.gov/Blast.cgi>. This simply compares sequences obtained to a library of existing sequence data produced by the community and is a first port of call for checking any sequence.

There are several factors to be aware of when using the molecular methods outlined above. It is imperative to run a negative control for each different marker gene amplified in a PCR run (i.e., those with all PCR components except for the template), as this method is highly sensitive and PCR product from past reactions can contaminate the extraction buffer, primers and Phire Direct master mix if the same pipettes are used to set up PCRs and deal with PCR products (e.g., loading gels). I highly recommend using separate pipettes pre and post PCR but realise that this is not always possible. It is then worth cooling PCR products on ice or in the fridge before running gels to limit potential vaporisation of PCR product into the barrels of pipettes used.

I have failed to get clean extracts from one fungus in particular, *Bryocentria octos orelloides* (see **Fig. 4**), despite multiple attempts from different collections at different times. This appears to be due to leprose lichens, including *Bacidina delicata* and *Psoroglaena* sp., growing on and with the host liverwort, *Myriocolea minutissima* in shared epiphytic habitats. A way to possibly circumvent this is to surface sterilise several fruitbodies in a weak bleach solution for a few seconds, wash them and then rupture them to release their spores in dilution buffer. I have not managed to attempt this troubleshooting yet. Simply washing the fruitbodies around in water has not been sufficient so far.

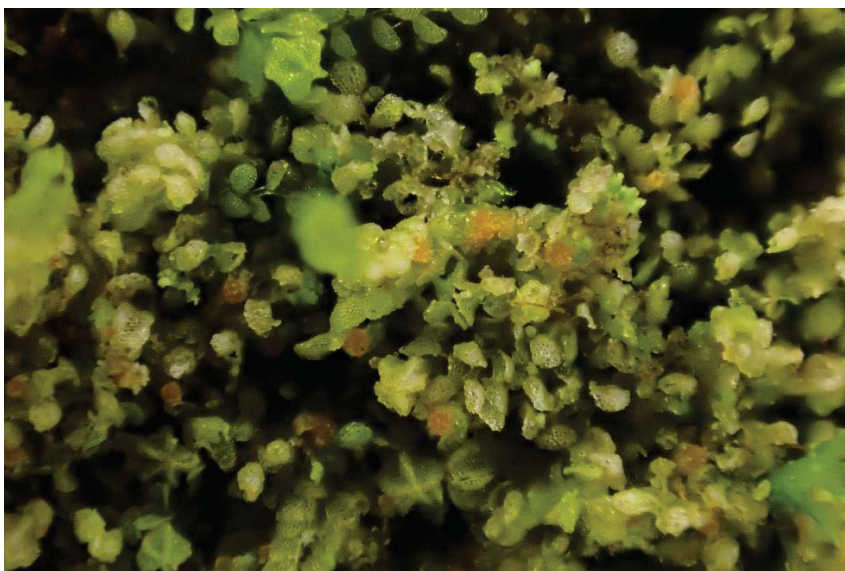


Fig.4. *Bryocentria octosporelloides* (orange spherical perithecia) on *Myriocoleopsis minutissima*. Photo by the author (Greiff, 2024).

The final caveat is that the polymerase enzyme used in this kit does not have the accuracy of other, more specialised and expensive enzymes, such as Phusion and 5 polymerases. This means that the enzyme may make errors when amplifying target DNA. In my experience, this seems rather rare, but it does occur. This is a limitation of many molecular methods, mitigated by the examination of sequence traces obtained following sequencing, the repetition of reactions, and the extraction of multiple different samples of the same fungus. The error rates are so low and spread-out that, even if errors were not to be detected, the vast majority of a sequence will still be correct. It should be noted, however, that errors can also occur during sequencing reactions, a factor generally out of the researcher's control.

Conclusions

The above method has allowed for many bryophilous ascomycetes to be sequenced for the first time, increasing our understanding of this neglected group of organisms.

utilising only a small amount of fungal material, about the same or less than would be used to microscopically determine a species, bypasses past requirements for large specimens, which are not always available and prone to contamination. Although contamination can be an issue to be wary of, it is not specific to this method. The data generated using this method, including several new species to science, will soon be published with all results publicly available.

Acknowledgements

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Wildlife Surveying and Recording at Watercress Farm, Wraxall, North Somerset

Bob Fleetwood *et al*

1 Introduction

1.1 General

Belmont is a regenerative estate just outside Bristol with a mission of environmental restoration and the reconnection of people with nature, food, and themselves, as described more fully at <https://belmont.estate>.

Belmont is delivering natural process restoration at their rewilding and rewetting project, Watercress Farm. This article documents the results of wildlife surveying and recording undertaken there by volunteers over the past three years. It is hoped that this, together with the more detailed records submitted annually to Belmont, Bristol Environmental Records Centre (BRERC) and specialist recording groups, will provide a baseline for comparison with the results of any future surveys. This, in turn, could provide evidence for the evaluation of the regenerative practices employed.

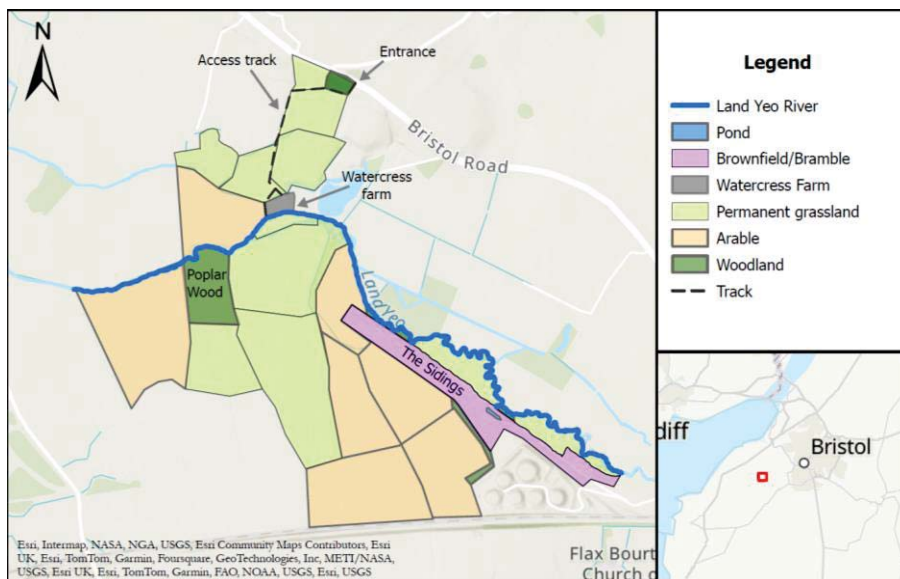


Figure 1: Map of Watercress Farm to show location and main vegetation types at time of purchase in 2019. Courtesy of Luke Ramsay of Nature-based Insights.

1.2 Watercress Farm History and the Vision for the Future

Belmont acquired Watercress Farm in 2019 with the objective of restoring near natural vegetation types to the site which consisted mainly of farmed land. The aim was to restore the land through largely natural processes. The land was approximately 20 hectares of ecologically degraded arable plus 30 hectares of low-grade pasture, plus approximately 3 hectares of poplar plantation with 500 metres of river running in a straightened channel through the site from east to west (see **Figure 1**).

The site was chosen for several reasons, the first being that it was representative in size and ecological baseline of an average agricultural land holding in the UK. Secondly, the site provided an excellent opportunity to demonstrate the potential to transition the agricultural land holding into something nature-positive to combat the dual climate and biodiversity crises.

From the beginning the intention has been to let nature take the lead with only limited tree-planting being undertaken and seed sowing occurring only on the butterfly banks (see below). The only interventions have been designed to kick-start natural processes that can then be self-sustaining.

An important part of the rewilding process is the appropriate use of free-roaming animals to enable the land to regenerate naturally. To this end, 12 free-roaming Devon Red cattle and six Dartmoor Ponies have been used for their grazing and browsing behaviours and two Tamworth Pigs for their amazing ability to break up the grass roots and open up the soil to allow flowering plants to establish. The cattle and pigs are on site year-round and the ponies visit for the winter only. At present, the animals are free to roam in the fields north of the farmhouse and in Poplar Wood and all the fields that border it. They are excluded from the Sidings and the field adjacent to that strip of land. There have been temporary exclusion fences during the engineering works to create the new ponds, river re-alignment and butterfly banks.

In 2023, the next phase of restoration was initiated by creating a wetland. This project represented a significant milestone in the conservation efforts. The major part of the rewetting is in the field to the west of Poplar Wood (Figure 1), as shown in **Plates 1 and 2**. The project reconnected the Land Yeo to its former floodplain, restoring critical hydrological processes and creating a new, more sinuous river channel, ponds and seasonally wet scrapes. It is designed to filter and slow rainwater runoff, helping to reduce downstream flooding, limit pollutants and excess nutrients entering the river, and so transform an environmentally degraded landscape into a biodiverse wetland, supporting abundant wildlife. Subsoil from these works was used to create a series of butterfly banks across the site which were seeded with locally native grasses and herbs (see Plate 2 for the location of one of the groups of banks). The project will create a dynamic biodiverse habitat for wildlife and will provide opportunities for the local community to visit, learn from, be inspired by, and connect with the natural world.



Plate 1: Aerial photograph (June 2023) to show an area of the wetland creation scheme before work commenced. The edge of the Poplar Plantation is on the left-hand edge of the photograph.



Plate 2: Repeat photograph (September 2023) to show the wetland creation scheme after work had finished; a group of butterfly banks can be seen at the far corner, beyond the pools. Photographs are taken facing south-west, by Sam Ingles and Graham Scott, courtesy of Belmont Estate.

Equally important are the reconnection projects within the site, including nature-based education and community and corporate volunteering. Since 2021, Watercress Farm has become the backdrop for Belmont's nature-based education and volunteering programmes with more than 4000 people, from school children to families to local charities, accessing and connecting with nature free of charge. Watercress Farm also benefits from public footpaths allowing the local and wider community to visit and experience it for themselves.

Looking to the future, Belmont will soon be hosting guided tours around the wetland to educate communities and local businesses on their mission and the societal, environmental and ecological benefits projects like this can bring on a national scale.

The hope for the future is that with nature in the driving seat, Watercress Farm will deliver some of the ecological complexity that is often missing from our overly homogenised landscape in the UK.

1.3 Arrangement of Surveys

The wildlife surveying started in 2020 as a result of contact between Belmont Estate and Bristol Ornithological Club (BOC). This instigated regular transect surveys for birds and in the winter of 2021/22 Gil Martin, the Belmont Estates Land Manager, gave a Zoom talk for BOC about Watercress Farm and the aspirations for the future. Fortuitously, this talk was viewed by a number of individuals with wide natural history experience who subsequently visited the site and volunteered to undertake responsibility for recording groups of other taxa in which they had interest and experience.

Each of these groups has a species-lead, an experienced amateur, who is responsible for organising the surveys and compiling the records. All of the following species groups were surveyed using recognised techniques for the particular taxa. A number of records were also obtained by field sightings or photographs taken during visits. Such records were reviewed by the species lead prior to being included in the records.

2 Plants

2.1 Method

Rapid baseline assessment of vegetation was undertaken in 2022-23 by three surveyors with occasional help from others. All species encountered were listed and a few more records were contributed by volunteers surveying other groups. Walks were taken through each field and flowering plants and ferns were recorded from a total of 145 roughly representative 1x1m quadrats. Thirty more 1x1m quadrats were

placed to characterise the well-established secondary grasslands on the railway sidings, and ten 5x5m quadrats in woodland.

2.2 Results

To date, 240 species have been recorded. The most diverse vegetation is on the railway sidings, which comprise less than 10% of the site area. Many plants presumably arrived here before the recent wave of post-war agricultural intensification. There are pockets of species-rich sward with Red Fescue *Festuca rubra*, Crested Dog's-tail *Cynosurus cristatus*, Yellow Oat-grass *Trisetum flavescens* and Glaucous Sedge *Carex flacca* occurring on embankments and old trackways, alongside Common Bird's-foot-trefoil *Lotus corniculatus*, Wild Carrot *Daucus carota*, Grass Vetchling *Lathyrus nissolia* and Goat's-beard *Tragopogon pratensis* plus a little Corky-fruited Water-dropwort *Oenanthe pimpinelloides*, Fairy Flax *Linum catharticum* and Common Restharrow *Ononis repens*. Squirrel-tail and Rat's-tail Fescues *Vulpia bromoides*; *V. myuros* and, rarely, Distant Sedge *Carex distans* grow on thin, stony soils, while damp areas harbour tussocky Hard Rush *Juncus inflexus* interspersed by short grassy turf with Creeping Cinquefoil *Potentilla reptans*. Associated are stands of tall False Oat-grass *Arrhenatherum elatius*, with local anthills and occasional Meadow Vetchling *Lathyrus pratensis*; some invading brambles *Rubus fruticosus*, a little thorny scrub, and marginal tree saplings.

The site has many mature trees, some with veteran features. Thirty-five individuals were measured and described. Dozens of large Alders *Alnus glutinosa* overshadow the Land Yew and standard Oaks *Quercus robur* occur at woodland margins and in some fields. There is a copse of Sycamore *Acer pseudoplatanus*, a line of tall Aspens *Populus tremula*, some peripheral Hazel *Corylus avellana* coppice, plus a few Crack-type Willows *Salix* sp. and Ash *Fraxinus excelsior*. Field Maple *Acer campestre* occurs both as trees and in hedgerows alongside Hazel, Blackthorn *Prunus spinosa* and Hawthorn *Crataegus monogyna*, with occasional Spindle *Euonymus europaeus* and Dogwood *Cornus sanguinea*, and rare Holly *Ilex aquifolium*, Elder *Sambucus nigra* and Buckthorn *Rhamnus cathartica*.

The main stand of woodland is a close-ranked plantation of aging hybrid Poplars *Populus* sp., with some Beech *Fagus sylvatica*. Its relatively sparse understory includes spindly Hazel and rare Guelder Rose *Viburnum opulus*. The ground flora has frequent Common Nettle *Urtica dioica* but also includes Dog's Mercury *Mercurialis perennis*, Ramsons *Allium ursinum*, Wood Melick *Melica uniflora* plus a little Primrose *Primula vulgaris*, Hart's-tongue Fern *Asplenium scolopendrium*, Common Dog Violet *Viola riviniana* and Moschatel *Adoxa moschatellina*.

Plant diversity in the agriculturally improved pastures and abandoned arable fields is low. Cock's foot *Dactylis glomerata*, Perennial Rye Grass *Lolium perenne*, Yorkshire Fog *Holcus lanatus* and Bent grasses *Agrostis capillaris*; *A. stolonifera* dominate the

grasslands, while thistles *Cirsium arvense*; *C. vulgare*, Common Ragwort *Jacobaea vulgaris* and docks e.g. *Rumex obtusifolius* are currently flourishing widely. In the first year after cessation of cultivation, the arable hosted a colourful flush of willowherbs *Epilobium* spp., Field Poppy *Papaver rhoeas*, Field Pansy *Viola arvensis* and mayweeds *Matricaria chamomilla*; *Tripleurospermum inodorum*, among self-seeded crops, which quickly gave way to patchy grass swards with Rough Meadow Grass *Poa trivialis*, dandelions *Taraxacum officinale* agg. and Creeping Buttercup *Ranunculus repens*. Welcome early surprises have been pops-ups of a few Bee Orchids *Ophrys apifera*, plus a single Green-winged Orchid *Anacamptis morio*. However, vegetation succession is particularly lively in a corner between the river and the railway sidings. Many Alder saplings have sprung up here and herbs such as Wild Carrot, Square-stalked St John's-wort *Hypericum tetrapterum* and Hemp Agrimony *Eupatorium cannabinum* are gaining ground.



Plate 3: Bee orchid at Watercress Farm. Photograph by Robin Martin.

Aquatic and marginal species present on the site include Common Spike-rush *Eleocharis palustris*, Common Reedmace *Typha latifolia*, Common Club-rush *Schoenoplectus lacustris*, Gipsywort *Lycopus europaeus* and Brookweed *Samolus*

valerandi which grow in and around the sidings' pond. Fool's Watercress *Helosciadium nodiflorum* and Hemlock Water-dropwort *Oenanthe crocata* are locally frequent along watercourses.

2.3 Discussion

Opportunities for wetland and water plants have been vastly increased by the 2023 rewetting works. Unshaded habitats ranging from fast-flowing channels to shallow scrapes and banks of varying profiles now await natural colonisation. In addition, a series of butterfly banks created from the excavated nutrient-poor subsoils offer more hospitable conditions for plants that prefer unfertile ground. The mounds have been seeded with a mixture of grasses and traditional meadow wildflowers appropriate to the locality and the soil type. Over time, flower rich 'butterfly bank' flora should develop, but for the time being, the expected surge of ruderal species is well under way. First-year botanical monitoring of the rewetting zone is planned for 2024.

Elsewhere, changes in the flora have been most noticeable in parts of five ex-arable fields in the east of the site that have not yet had livestock introduced, particularly in the corner between the river and the Sidings where alder saplings and tall herbs have spread rapidly as noted in Results, above. Whips of hybrid willow *Salix x multinervis* and a little Buddleja *Buddleja davidii* are also appearing locally in some of these fields, while Blackthorn and brambles are beginning to spread from some boundaries and hedge-lines across the site more generally. A programme of photo-monitoring is documenting structural changes in the vegetation.

3 Moths

3.1 Methods

Moth recording started in June 2022. Some moths have been recorded in the daytime, sometimes with a hand-held net and sometimes with pheromone lures, but the vast majority have been recorded at night using light traps. The sessions have been between the beginning of April and the end of October with nine in 2022 and ten in 2023. The first attempts at trapping were in fields containing livestock and it soon became apparent that moth-trapping and two large, albeit friendly, Tamworth pigs do not mix well. Therefore, nearly all subsequent trapping has been in the railway sidings area, where livestock are excluded. There have also been several morning show-and-tell sessions for school children as part of the educational programme these have been held in a fenced-off area close to the farmhouse buildings.

For most trapping sessions five traps using 125W mercury vapour lights were deployed, run off two portable generators, spread along the embankment at approximately 100m intervals. The great majority of moths were identified as they were trapped and then released unharmed in the morning. A few were potted up and

taken home for both closer examination and photography in daylight before release. Dissection was undertaken for confirmation on a few difficult species.

3.2 Results

The total number of species recorded to the end of 2023 is 418, with 259 macro and 159 micro species. In both years, approximately 330 species were recorded. On two nights, 150 or more species have been recorded, being 28 July 2022 and 10 August 2023.

3.3 Discussion

Five species recorded were adventives (introduced species) being *Tachystola acroxantha*, *Blastobasis adustella*, *Blastobasis lacticolella*, *Epiphyas postvittana* and *Cydalima perspectalis* (first recorded in the region in 2013). Seven species recorded were migrants, being Rusty-dot Pearl *Udea ferrugalis*, Rush Veneer *Nomophila noctuella*, Vestal *Rhodometra sacraria*, Silver Y *Autographa gamma*, Delicate *Mythimna vitellina*, Dark Sword-grass *Agrotis ipsilon* and Hummingbird Hawkmoth *Macroglossum stellatarum*. However, over four hundred of the species were native residents. These represented a very wide range of different foodplants, many of which have been recorded on site. They also represented larval food sources of animal material, dead wood, leaf litter and fungi. Clearly, the mosaic of foodplants and habitats that exist on site will support high diversity.

Moth populations can be very dynamic and ten of the species recorded have colonised the Bristol region (the area previously known as 'Avon') in the last decade, being *Acleris umbrana*, *Neocochyliis moliculana*, *Metalampra italica*, Brussels Lace *Cleorodes lichenaria*, Jersey Tiger *Euplagia quadripunctaria*, Four-spotted Footman *Lithosia quadra*, Clifden Nonpareil *Catocala fraxini*, White-point *Mythimna albipuncta*, L-album Wainscot *Mythimna l-album* and Kent Black Arches *Meganola albula*. *Neocochyliis moliculana* was first recorded in Britain in 1993 and *Metalampra italica* was first recorded in Britain in 2003. In contrast, *Acleris umbrana*, Brussels Lace and Kent Black Arches are examples of longstanding national residents undergoing significant recent range expansions.

One species has been recorded that was new to the Bristol Region being *Triaxomasia caprimulgella* with two attracted to a lure primarily intended for the Lunar Hornet Moth. The association here is with dead wood and rot holes and is a species rarely recorded before the association with this lure became apparent. This species was confirmed by genitalia determination. This record suggests the likely presence of other dead wood and rot hole specialists on site.

Scrobipalpa ocellatella was notable as there was only one local record prior to 2022, being at Weston Moor in 1995. Normally restricted to feeding on Sea Beet (*Beta*

vulgaris ssp. maritima, not recorded at Watercress Farm) along the south and south-eastern coast of England its range began to expand in 2021 and it appeared to be exploiting other similar foodplants. Other species recorded with only a handful of previous local records are *Opostega salaciella* on Sheep's Sorrel, *Rumex acetosella*, *Metzneria lapella* on burdocks, *Arctium spp*, *Carpatolechia proximella* on birches, *Betula spp*, and Alder, *Coleophora alcyonipennella* on White Clover *Trifolium repens*, *Celypha aurofasciana* on mosses and liverworts again associated with rotten trees, *Catoptria margaritella* on mosses and Cotton-grasses (*Eriophorum spp*, not recorded at Watercress Farm) and Valerian Pug *Eupithecia insigniata*. The last feeds on Valerian, *Valeriana spp*, and one of the three records was confirmed by genitalia determination. An effort will be made to prove breeding by finding larvae.

Of the approximately 400 native resident species recorded so far, around 15% of them, over 60 species, are described as either local or thinly distributed in the updated 2023 version of 'Moths of the Bristol Region' (unpublished), reinforcing the importance of the site generally for moth diversity. With ongoing effort, the recorded diversity will increase.



Plate 4: Valerian Pug, *Eupithecia insigniata*. Photograph by Paul Chapman.

4 Butterflies, Dragonflies and Damselflies

4.1 Methods

Butterfly and Odonata monitoring started in 2022 and nine surveys were undertaken between late April and end of August that year. In consultation with Butterfly Conservation, two formal transects were developed for the 2023 season, as detailed below. The recording methodology requires weekly recording for 26 weeks between the start of April and end of September.

4.1.1 Poplar Wood Transect

This survey route covers the area north and south of the Poplar Wood. The Landeo River runs through from east to west. This transect covers much of the area that is now included in the rewetting or wetlands project and the route has had to be slightly modified to cover these developments. The wetland development also now includes extensive butterfly banks made of spoil from the workings and then seeded with a grass and wildflower mix. These and the diverted river with the numerous pools will be important habitat for both butterflies and Odonata in the future and the results for 2023 will be a useful baseline for future comparison.

Poplar Wood Transect - *Watercress Farm* (Permissive access owned by Belmont Estate)

ENTRANCE TO WATERCRESS FARM

Grid Ref: **ST 50194 70902**

What3Words: **taken.songs.amuse**

Address: **Bristol Road, Wraxall and Failand,
Bristol, North Somerset, BS48 1NE**

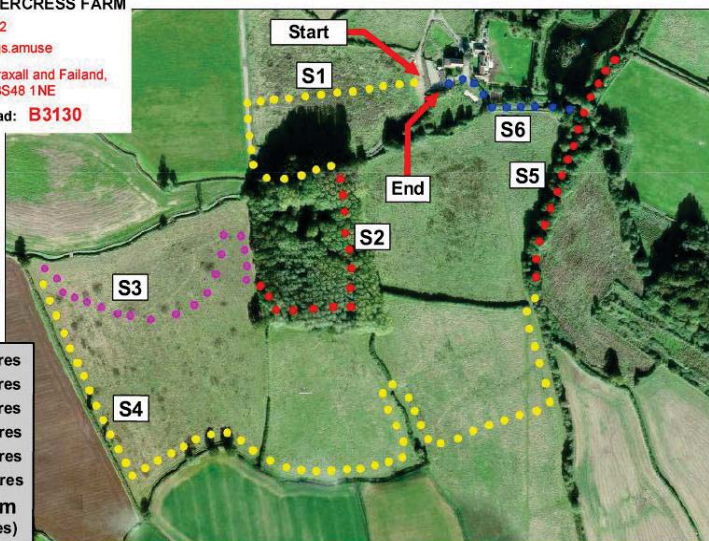
Access is on Bristol Road: **B3130**

From Nailsea
direction, the turning
is on your right.

From A38 direction,
it is on your left.

Enter the gateway and
head down the part-
made driveway for 500m
where there is obvious
car park to your right.

Section 1 - 395 metres
Section 2 - 313 metres
Section 3 - 396 metres
Section 4 - 1154 metres
Section 5 - 415 metres
Section 6 - 219 metres
TOTAL - 2.89 Km
(1.80 miles)



4.1.2 Railway Sidings Transect

This transect starts by crossing an old arable field that has been returned to nature for approaching three years. There has been no significant grazing of this area. The survey route then enters an enclosed area that used to be a railway siding and contains a raised embankment with a pond. This site has been disused for 30 years but has been grazed by sheep intermittently recently. The Landeo River runs along the northern edge of the railway sidings. There is also a field north of the sidings that is included in the transect and this is a waterside meadow with plenty of bramble scrub. The railway sidings itself is a brownfield site with mixed scrub and ephemeral wet areas.

Railway Sidings Transect - Watercress Farm (Permissive access owned by Belmont Estate)

TRANSECT START

Grid Ref:

ST 50143 70484

What3Words:

then.over.deflection

Cross over the wooden fencing and head towards the field. Entering the field is the start



CONTINUATION & END

Head diagonally across the field towards a gate entering a fenced area

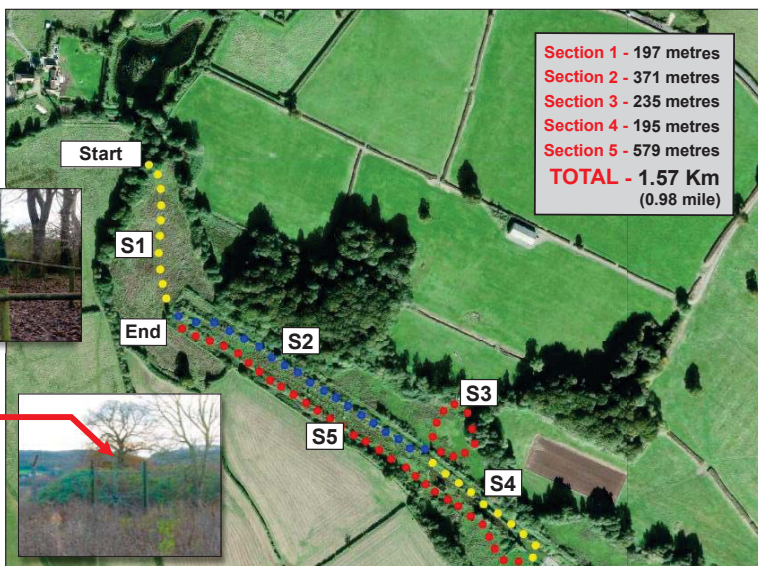
Grid Ref:

ST 50162 70297

What3Words:

then.agree.money

This gate will be the entry to Sections 2 to 5 and will also be the end of the Transect.



4.2 Results

4.2.1 Butterflies

4334 individuals of 24 species of butterflies have been recorded up to the end of 2023. The 24 species were: Small Skipper *Thymelicus sylvestris*, Essex Skipper *Thymelicus lineola*, Large Skipper *Ochlodes sylvanus*, Clouded Yellow *Colias croceus*, Brimstone *Gonepteryx rhamni*, Large White *Pieris brassicae*, Small White *Pieris rapae*, Green-veined White *Pieris napi*, Orange Tip *Anthocharis cardamines*, Small Copper *Lycaena phlaeas*, Brown Argus *Aricia agestis*, Common Blue *Polyommatus icarus*, Holly Blue *Celastrina argiolus*, Silver-washed Fritillary *Argynnis paphia*,

Red Admiral *Vanessa atalanta*, Small Tortoiseshell *Aglais urticae*, Peacock *Aglais io*, Painted Lady *Vanessa cardui*, Comma *Polygonia c-album*, Speckled Wood *Pararge aegeria*, Marbled White *Melanargia galathea*, Gatekeeper *Pyronia tithonus*, Meadow Brown *Maniola jurtina*, and Ringlet *Aphantopus hyperantus*.

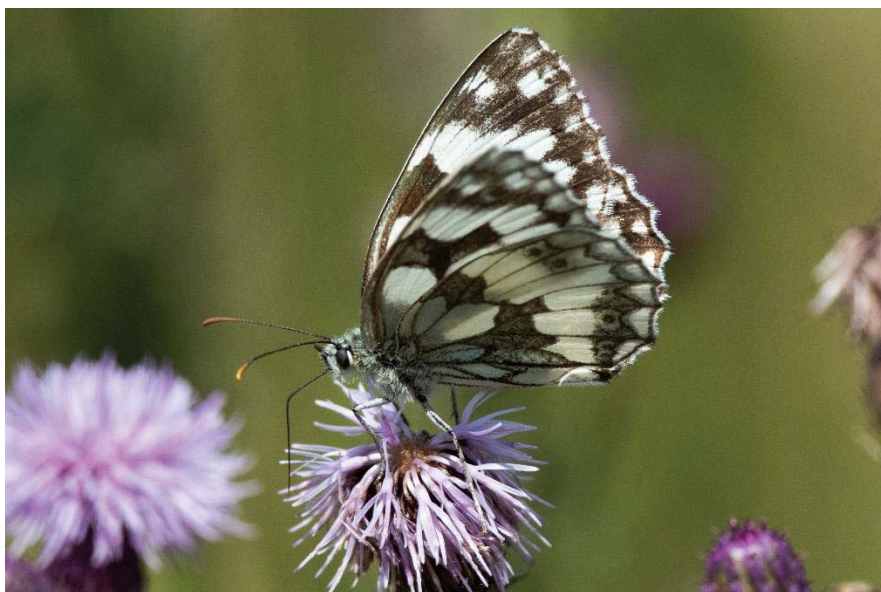


Plate 5: Marbled White *Melanargia galathea*. Photograph by Robin Martin.

Clouded Yellow was seen during the hot weather of 2022, but not during 2023. New species recorded in 2023 were Essex Skipper, Small Copper and Silver-washed Fritillary. Meadow Brown was by far the most numerous butterfly recorded (1810 records) and Gatekeeper was second (659 records).

4.2.2 Dragonflies and Damselflies

Over the two transects there were 2313 dragonflies and damselflies observed from 18 different species. The 14 species in 2022 were: Emerald Damselfly *Lestes sponsa*, Banded Demoiselle *Calopteryx splendens*, Beautiful Demoiselle *Calopteryx virgo*, Azure Damselfly *Coenagrion puella*, Common Blue Damselfly *Enallagma cyathigerum*, Blue-tailed Damselfly *Ischnura elegans*, Large Red Damselfly *Pyrrosoma nymphula*, Migrant Hawker *Aeshna mixta*, Emperor Dragonfly *Anax imperator*, Broad-bodied Chaser *Libellula depressa*, Scarce Chaser *Libellula fulva*, Four-spotted Chaser *Libellula quadrimaculata*, Black-tailed Skimmer *Orthetrum cancellatum*, Common Darter *Sympetrum striolatum*.

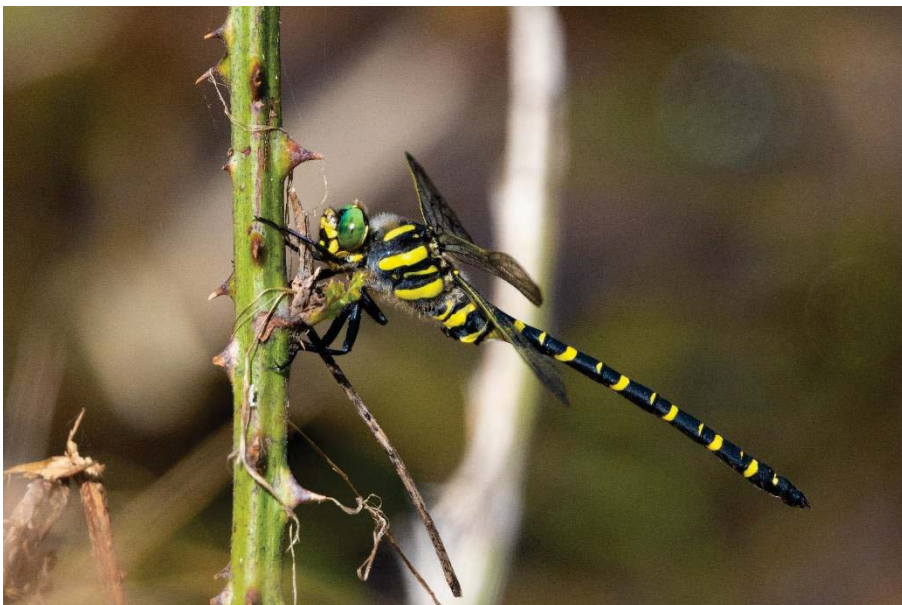


Plate 6: Golden-ringed dragonfly *ordulegaster oltonii* Photograph by Robin Martin.

There were four new species in 2023: Southern Hawker *Aeshna cyanea*, Brown Hawker *Aeshna grandis*, Golden-ringed Dragonfly *Cordulegaster boltonii* and Ruddy Darter *Sympetrum sanguineum*, There was an additional damselfly species seen on the 3 June 2023 that was not included in the counts as later review of some photographs showed that it was probably a Variable Damselfly *Coenagrion pulchellum* and was seen on the Poplar Wood Transect. The formal records have been left unchanged and it is likely it was recorded as a Common Blue Damselfly.

4.3 Discussion

Most species of butterflies were observed on both transects with the comparative numbers corresponding largely to the differences in habitat. For instance, Speckled Wood and Holly Blue were more numerous in the Poplar Wood transect, while Marbled White and Common Blue favoured the herb-rich grasslands of the railway sidings. It is believed that suitable larval foodplants exist on site for all the butterflies recorded so far. Transect recording of adults will continue next year and it is hoped that more time will be spent searching for larvae and so prove breeding on site.

Golden-ringed Dragonfly was an exciting find this year as they are uncommon in North Somerset. Initially one was seen on the western aspect of the Land eo River on the Poplar Wood Transect on 7 July. A second individual was seen in flight on the railway sidings Pond on 16 August. The presence of both Demoiselles, despite what

the books say about needing different substrates underwater, is interesting, as is the record of Brown Hawker, which is more usually associated with acidic rather than calcareous waterbodies. Hopefully, we will be able to confirm a sighting of Variable Damselfly in 2024.

The survey results provide a useful baseline to monitor future change as the rewilding of the site progresses. This will be particularly important for the Poplar Wood transect where the rewetting of the fields west of the Poplar Wood will change the habitat significantly. There are a number of dragonflies, in particular, that favour still water and, preferably, with vegetation. It will be fascinating to see how these populations vary in accordance with changes in the vegetation around the still water ponds in the re-wetted area. The development of butterfly banks, in 2023, that have been seeded to encourage butterflies and other groups of insects might promote colonisation by new species as well as increasing the overall number and diversity of insects.

5 Other Invertebrates

5.1 Methods

Surveying started in May 2022 and was conducted largely by one surveyor. Several visits have been made each month, using a variety of techniques. Methods include sweeping low vegetation with either a lightweight butterfly net, or a more robust net where a lightweight net would likely be damaged; pond-dipping for water beetles and bugs; small pitfall traps to catch ground-dwelling insects; vacuum sampling (a converted garden leaf-blower) to extract insects from tussocky grasses, bases of hedgerows, etc.; flight interception traps installed in trees adjacent to rot holes, or similar, and out of reach of animals; and a beating tray to catch insects dislodged from tree branches by the use of an entomological dislodger' (a walking stick). A start has also been made to record leaf mines and plant galls caused by insects other than moths.

Some insects caught by these various means can be identified in the field and released, but many are too small and need to be potted and taken home for later identification. This usually involves humane killing, allowing individual specimens to be examined under the microscope and recorded. When scarce species are found, advice or confirmation of identifications is sought from experts known to the surveyor. All identifications are formally recorded with details of what, where, when and by whom, together with any other relevant details. All records are submitted to Belmont Estate, BRERC and County Recorders for moths and beetles. At this point it is worth noting that, in strict accordance with the national Code of Conduct (published in 2002), specimens are only taken in very low numbers, well below anything that could jeopardise the local population of any species.

5.2 Results

The total number of species recorded to the end of 2023 is 738. These may be grouped as follows:

Flies	278
Beetles	270
Terrestrial Bugs	84
Water Bugs	13
Frog & Leaf Hoppers	25
Grasshoppers, Crickets, etc.	9
Earwigs	1
Caddisflies	18
Mayflies	2
Ants, Bees, Wasps, Sawflies, etc	20
Stoneflies	1
Lacewings & Allies	7
Pseudoscorpions	2
Millipedes	2
Centipedes	2
Woodlice	3
Mites	1
Total	738

5.3 Discussion

It should be noted that practical considerations (weather, surveyor ability and availability) meant that the objective could only be a determination of absence or presence and not abundance of species. The methods used and locations chosen for each visit were with the intention of recording as many species as possible for the whole site. There are some obvious gaps in the records, notably spiders, snails, etc.; we would be pleased to hear from anyone who could help rectify this.

With so many species recorded, it is tricky to pick out those of particular interest. The following have been selected and those which did not appear in the BRERC database, when accessed in November 2023, have been marked with an asterisk*.

5.3.1 Flies

*Crumomyia pedestris** A bizarre short-winged Lesser Dung Fly.
*Dolichopus virgultorum** Very few records in the South West of England.
Mycomya occultans A fungus gnat which is spreading from its present range in southern England; there are two previous records in BRERC, the last in 2001.

*Allodia lugens**, *Bradysia nitidicollis**, *Diadocidia ferruginosa**, *Mycetophila luctuosa**, *Tarnania fenestralis** These are all fungus gnats which are notoriously difficult to identify. These were kindly identified for us by Peter Chandler (author of the identification guide to this family). They were found in several flight interception traps installed at strategic locations.

Pocota personata This is only the third BRERC record for this large, scarce hoverfly, which was found walking over Ramsons in early May. It breeds in rot holes in trees, especially Beech. Again, it is conjectured that there could be a link with the neighbouring woods at Belmont and Tyntesfield.

5.3.2 Beetles

Agelastica alni is a species of leaf beetle that, until fairly recently, was very localised, but is now rapidly spreading.

*Amalus scortillum** A very small weevil on Knotgrass *Polygonum aviculare*.

Aulonothroscus brevicollis A scarce beetle whose larvae develop under bark in dead branches and in wood mould, probably mainly oak; very thin scatter of records and all in ancient wood pastures. It is conjectured that its occurrence at Watercress Farm could be linked to possible favourable breeding conditions in the neighbouring woods at Belmont and Tyntesfield. One was found in a saproxylic invertebrate survey of Tyntesfield in 2016.

*Brachygluta haematica** A very small psephaline staphylinid found in the leaf litter in Poplar Wood.

*Chaetocnema picipes** A scarce leaf beetle (very similar to the commoner *Chaetocnema concinna*) and usually found on knotgrasses *Polygonum* spp.

*Epuraea melina** A scarce and local species of sap beetle which (like the commoner *Epuraea aestiva*) can be found on Hawthorn blossom in the Spring.

*Esymus pusillus**, *Euorodalus coenosus** Two dung beetles found by sweeping and vacuum sampling the pastures used by the cattle.

*Heteroceris marginatus** Normally found in mud beside streams, etc. This one was attracted to an MV light trap during a moth-trapping session.

*Kissophagus vicinus** A frequent, but local bark beetle, found in dead and dying stems of Ivy *Hedera helix*. This one was found in Poplar Wood.

*Larinus carlinae** A scarce weevil found by sweeping rough pasture which includes its food plant, thistles *Cirsium* spp.

*Sericoderus brevicornis** A tiny beetle that feeds on moulds in leaf litter, etc. An established introduction originally described from Australia and first detected in Britain in 2006. The ones recorded at Watercress were all males; there may have also been females, but they can only be separated from a similar species by dissection.

*Trixagus carinifrons** A throscid beetle similar to the closely-related click-beetles. This one was found in a flight interception trap installed in ivy in Poplar Wood.

5.3.3 Terrestrial Bugs

*Dicyphus tamaninii** Probably the first Somerset record of a mirid bug that was new to Britain, first found in Surrey in 2008.

*Salicarus roseri** Another mirid, not often recorded; normally on willow *Salix* spp. and unaccountably very few records in the South West of England.

5.3.4 Psyllids

*Psylla alni** Significant numbers of this relatively large psyllid bug were on the lower leaves of a large Alder at the beginning of August. It is surprising that this fairly obvious creature has not been recorded locally before and that there are only three records on the National Biodiversity Network Atlas database.

5.3.5 Leafhoppers

Ledra aurita is probably Britain's largest leafhopper and several individuals were attracted to moth traps in mid-August.

*Macrostes horvathi** and *Macrostes ossiannilssoni** two leafhoppers swept from the waterlogged grassland adjacent to the pond on the embankment.

6 Reptiles and Amphibians

6.1 Method

Reptiles were surveyed using standardised placement of 'artificial cover objects' (ACO), under which reptiles (and other creatures) rest. These were both corrugated iron and bitumen mats, and 43 were placed within suitable habitat along a stretch of approximately 500 metres on the sidings. This site was chosen as being the only part of the Farm where the pigs were excluded and would therefore not disturb the mats.

Surveys began in April 2023 and were conducted every fortnight on average until October. Volunteers supported survey work which involved lifting the ACOs and recording what species were underneath. When small mammals were found, these were recorded, in addition to the reptiles and amphibians. The pond on the sidings has been surveyed using a high-powered torch, however the aim is to conduct further surveys in the future and with more advanced techniques where possible.

6.2 Results

Froglife (1999) Reptile Survey Guidance (RSG) provides a table which allows the classification of the relative size of the different species of reptile populations on the basis of survey counts. Species recorded so far are as follows. Juvenile and adult male Grass Snakes *Natrix helvetica* (maximum of three in one survey visit): classified as a low population according to the RSG table. Common Lizard *Zootoca vivipara*, male

& female, maximum of one in one visit, also classified as a low population. Slow-worms *Anguis fragilis*, highest count was seven (a good population). Incidental records of Common Frog *Rana temporaria* and Common Toad *Bufo bufo* were made when recording other species and were usually in single figures. These amphibians are likely under-recorded by this method; an indication that numbers of amphibians on site are stable is the presence of Grass Snake for which amphibians are a major prey item. A single juvenile Palmate Newt *Triturus helveticus*, was found in a pitfall trap for invertebrates near Land Yeo River.

No Great Crested Newts *Triturus cristatus* have been found to date.



Plate 7: Three Grass Snakes *Natrix helvetica* tangled together. Photograph by Jo-Hannah Rees.

6.3 Discussion

Future surveys hopefully will include licensed torch surveys for amphibians and a continuation of surveys for reptiles in areas not covered so far, if methods can be devised to avoid disturbance by livestock.

7 BIRDS

7.1 Methods

Bristol Ornithological Club (BOC) has undertaken regular bird surveys at Watercress Farm since 2020. The first surveys were in the fields around the Poplar Wood (shown on some maps as Watercress Wood), and in March 2022 the surveys were extended to include a transect in the railway sidings and a new transect in the New Arable Fields to the south and east of the farm and sidings. Finally, in August 2023, a fourth transect was started in the fields north of Watercress Farm.

7.2 Results

The total number of species seen in the three years 2020 to 2023 was 86, including seven species seen in 2023 for the first time. These were: Water Rail *Rallus aquaticus*, Snipe *Gallinago gallinago*, Green Sandpiper *Tringa ochropus*, Great White Egret *Ardea alba*, Cetti's Warbler *Cettia cetti*, Tree Pipit *Anthus trivialis* and Common Redstart *Phoenicurus phoenicurus*.

Other notable species seen in previous years include: Lapwing *Vanellus vanellus*, Red Kite *Milvus milvus*, Barn Owl *Tyto alba*, Dartford Warbler *Curruca undata*, Spotted Flycatcher *Muscicapa striata*, and Whinchat *Saxicola rubetra*.

We do not systematically survey for breeding birds, nests or nesting behaviour. However, we can infer breeding by several species from casual observations of behaviour, singing males or fledglings and family groups. These include Skylark *Alauda arvensis* (5-6 singing males) and Meadow Pipit *Anthus ratensis* breeding on the ground in the fields. Other habitats support several probable breeding migrants including Blackcap *Sylvia atricapilla*, Whitethroat *Sylvia communis* and Lesser Whitethroat *Sylvia curruca*. Residents displaying breeding behaviour include yellowhammer *Emberiza citrinella*, Blue Tit *Cyanistes caeruleus*, Great Tit *Parus major*, Dunnock *Prunella modularis*, Robin *Erithacus rubecula*, Greenfinch *Chloris chloris*, Linnet *Linaria cannabina*, Song Thrush *Turdus philomelos*, Mistle Thrush *Viscivorus* and Blackbird *Turdus merula*. A Kingfisher *Alcedo atthis* pair nested in the bank of the Landeo River but the nest has been unsuccessful for the last two years with probable predation in 2023. The only raptor observed to breed on site is Kestrel *Nyctala tinnunculus* but Buzzard *Buteo buteo*, Tawny Owl *Strix aluco* and Barn Owl are thought or known to breed close to the site.

There is ample deadwood and also tree holes in the riverside trees and the Poplar Wood for other hole nesting species such as Great Spotted Woodpecker *Picus endrogon* and Green Woodpeckers *Picus viridis* and Nuthatch *Sitta europaea*. From now on we are intending to make notes about breeding activity during the regular surveys.

The whole site, and in particular, the New Arable Fields, is clearly attractive to overwintering birds and the following have been seen in good numbers (maximum flock numbers): Stock Dove *Columba oenas* (150), Skylark (65), Redwing *Turdus philomelos* (88), Fieldfare *Turdus pilaris* (60), Meadow Pipit (25), Chaffinch *Fringilla coelebs* (400+), Linnet *Linaria cannabina* (105), Goldfinch *Carduelis carduelis* (85), Siskin *Spinus spinus* (75), Yellowhammer (20+) and Reed Bunting *Emberiza schoeniclus* (16)

7.3 Discussion

Watercress Farm continues to show encouraging results in terms of biodiversity and habitat development. The bird survey findings reflect this with an encouraging increase in species seen and the wetland project will enhance this in coming years. Nocturnal thermal imaging is being considered to look for cryptic species such as Woodcock *Scolopax rusticola* and owls.

Currently the mix of habitats at Watercress Farm offers various opportunities for bird species to feed and breed. The New Arable Fields offer an important habitat for wintering passerines and breeding for the farmland birds that have been in serious decline in intensively managed farmland. The good population of Yellowhammer and Skylarks in this area reflects this important habitat restoration.

The railway sidings offer bramble scrub that is a good breeding habitat for Whitethroat and Dunnock. The pasture areas offer hunting opportunity for raptors such as Kestrel and Barn Owl.

The wetland area will give good habitat for a new range of birds as it develops. The river realignment and rewetting works carried out in 2023 will provide an important additional resource for passage migrants and, as the waterside vegetation becomes more established, it should become attractive for passage migrants and, perhaps, breeding birds such as Reed Warbler *Acrocephalus scirpaceus*.

The butterfly banks should become attractive to a wide variety of invertebrates, which will, in turn, attract the insectivores and potentially provide cover for nesting birds.

8 Mammals

8.1 Methods

Bat surveys are currently undertaken on site using two methods. One is an annual walked transect using two surveyors with a bat detector in either July or August. The other is by using a static detector located on the edge of Poplar Wood, facing south. The detector is deployed continuously throughout the year to collect ten nights' worth of data per month from April – October. The data is sent for analysis to assess species presence and activity levels. Surveys have been continuous since they began in 2021.

Otter *Lutra lutra* surveys were conducted by observing field signs - most commonly spraints, footprints and occasional visual sightings. As they spraint habitually at the same sites, a regular route along the Land Yeo has been followed monthly since summer 2021. Sites checked include rocks in, and adjacent to, the river and under and near bridges. Occasional spraint is seen elsewhere when the water levels might be very high. A camera trap was installed in the summers of 2022 and 2023 to identify animals passing through.



Plate 8: Otter signs as observed in the field. Left, otter footprints, photo by Gill Brown. Right, otter spraint containing probable frog bones, photo by Robin Martin.

Dormouse *Muscardinus avellanarius* presence was confirmed after one survey of 20 nest tubes within a hedgerow in October 2022. The site has been registered as a National Dormouse Monitoring Site and 40 nest boxes were installed in 2023 in the Poplar Wood.

Other mammals have been recorded through field sightings.

8.2 Results

14 bat species have been recorded so far, including: *Myotis*, *Pipistrellus* and *Nyctalus* species, Lesser Horseshoe bat *Rhinolophus hipposideros*, Greater Horseshoe bat *Rhinolophus ferrumequinum*, Brown Long-eared bat *Plecotus auratus*, Serotine *Eptesicus serotinus* and Barbastelle *Barbastella barbastellus*. All identifications are preliminary, subject to further analysis.

Otter spraint has been found in most months at regular sprainting sites and there have been sightings on a camera trap of a mother and two cubs in summer 2022; a Mink *Neovison vison* was also identified.

No Dormice or their nests were recorded between April and November 2023 in the wood.

Other mammals include Badger *Meles meles*, Wood Mouse *Apodemus sylvaticus*, Brown Hare *Lepus europaeus*, Roe Deer *Capreolus capreolus*, Grey Squirrel *Sciurus carolinensis*, Common Shrew *Sorex Araneus*, Pygmy Shrew *Sorex minutus*, Harvest Mouse *Micromys minutus*, Fox *Vulpes vulpes*, Mole *Talpa europaea* and vole species.

8.3 Discussion

Since the wetland creation works began in summer 2023, Otter signs have become more sporadic, possibly due to the temporary disturbance resulting from the works. The river was also very high from summer onwards. However, reports of Otter signs downstream have continued, so they are still active in the area, and Otter footprints were seen for the first time in the rewetted field in November 2023. In the longer term it is hoped that the works will be of benefit to Otter populations by virtue of the significant amount of additional habitat created.

The wider habitat is excellent for Otters with extensive cover east of the Farm and in Poplar Wood; water quality is good as shown by Riverfly results (see section 10) but obviously could be affected by upstream use. The lake on neighbouring land must also be a draw for Otters. Further exploration upstream is planned for 2024 when the water levels are lower, as the overgrown vegetation is undisturbed and could hold possible couches (temporary resting places) and holts.

The woodland is not optimal for Dormice, as a field layer is sparse in some areas, although there is Hazel to provide a food resource. It may be that dormice use only the hedgerows to disperse throughout the landscape. Further survey work will continue in 2024 within the woodland and in other areas of the farm concentrating, on hedgerows and the sidings area.

It is intended that monthly bat transects will continue between April and October.

9 Fungi

9.1 Method

Occasional observations began in 2022, but somewhat more regular surveys were not started until May 2023. Since then, an experienced volunteer has made visits, approximately monthly, but governed more by current and recent weather conditions

as these have a significant effect on the emergence of fruiting bodies. Searching tends to be dictated by experience, rather than strict transects.

9.2 Results and Discussion

Of the 40 species identified, not unsurprisingly, most (29) were found in Poplar Wood. Here the most interesting find was Poplar Knight *Tricholoma populinum*, which is seldom recorded. The value of retaining fallen and cut timber to promote natural processes is demonstrated by the records of Scaly Oysterling *Crepidotus calolepis* and Coral Spot *Nectria cinnabarina* on woody debris in the fields and hedgerows. It is conjectured that the paucity of fungi in the fields and grassland is possibly due to the previous agricultural management systems; will the variety of fungi increase in coming years under a less interventionist approach?

10 River Quality

10.1 Method

Riverfly' is a national, citizen-science way of assessing river health. The Environment Agency sets minimum thresholds for sites all over the country. Ongoing sampling takes place by volunteers at each site to count several aquatic invertebrate families using a three minute kick-sweep methodology (<https://www.riverflies.org>).

10.2 Results

Quarterly surveys started in September 2021 at Watercress Farm, which has a reasonably high Riverfly site threshold, reflecting EA expectations of a healthy stream. To date all samples at Watercress Farm have been on, or above, the threshold. Freshwater shrimps *Gammarus pulex* are consistently present at Watercress Farm in fair numbers (reasonably pollution tolerant, common). However, members of the caddis *Trichoptera*, stonefly *Plecoptera* and mayfly families *Ephemeroptera*, including those such as *Baetis* species also occur and are typically much more pollution sensitive, so a good sign. Fish Bullhead *Cottus gobio* also turn up in the net sometimes.

An additional Riverfly site has recently been established on the new river channel dug in the summer downstream of Poplar Wood. The first survey yielded shrimps, mayflies, caddis; the rate of colonisation has been very impressive. Ongoing research by the University of the West of England has recently detected the presence of Eel *Anguilla anguilla* DNA in the river.

So, some positives but the river does have an issue with elevated dissolved nitrates, picked up via volunteer sampling under the RiverBlitz scheme <https://bristolavonriverstrust.org/>. Where this occurs, it is often due to agricultural

inputs further upstream in a catchment (i.e. probably outside the boundary of Belmont Estate). High nitrates can foster excessive algae growth at the expense of aquatic macrophytes such as water crowfoots *Ranunculus* spp. and abundant algae was noted in late 2023. It is possible the wet summer increased surface runoff entering the river, carrying with it nutrients from animal dung/slurry. Reducing nitrates would help the diversity and abundance of aquatic species still further.

11 Acknowledgements

The volunteer team would like to thank the owners and staff of Belmont Estate for permission to carry out the surveying activities and for their enthusiastic support.

12 Authors

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Birds: Alastair Fraser and Robin Martin

Mammals: Sian Parry, Charlie Phillips and Sarah Roberts

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River Quality: Peter Coleman Smith

Vegetation Map: Luke Ramsay

Avon Needs Trees

The Evolution of a Tree Planting Charity

Cathy Bedford

Introduction

Avon Needs Trees (ANT) was founded in 2019 by environmentalist and writer, Nikki Jones, to address the dual nature and climate emergencies in the Bristol-Avon River catchment. Based in Bristol, we achieve our objectives by buying land and creating woodlands that will stand for generations, locking up carbon, boosting local biodiversity and providing natural flood management, as well as publicly accessible green space.



Figure 1: Summer tree maintenance day at Great Avon Wood, Pwllheli

Over time, the River Avon catchment has lost most of its woodlands. Deforestation has progressed in waves, intensifying in the 20th century with extensive use of timber during the First World War and clearance for agriculture and grazing. The woodland that remains is highly fragmented. Small, disconnected pockets lack the variety of tree species, height and age needed for healthy ecosystems to be sustained. Isolated wildlife habitats result in a small genetic pool, lack a healthy range of food sources and are vulnerable to climate change. The result is that species weaken or die out. With de-forestation also comes increased propensity for flooding, and with it degradation of the soil and run off of chemicals from agriculture into the rivers.

Climate change is only amplifying this situation. Until recently, large scale, impactful funding has not been available to address the problem.

Ha eland

ANT was advised by the Environment Agency (EA), that the high river catchment is where tree planting can really make a difference to flooding further downstream. Acting on this advice, ANT's first land purchase was Ha eland - 34 acres of mixed habitat, near Calne in Wiltshire. Ha eland was purchased in August 2020, following intensive fundraising, with the help of the National Lottery Heritage Fund (NLHF), Woodland Trust, local trusts and donations from individuals. It was, and still is, a magical site, including ancient woodland, flooding meadows alongside the River Marden, a partially derelict canal, large pond and low-grade pasture suitable for tree planting. We felt a strong sense of responsibility for this beautiful place and a determination to proceed carefully.

As we have done at every new site since Ha eland, we first commissioned an ecological survey to help us establish a baseline against which future surveys could be compared. The variety of bats present on the site was particularly exciting: Bechstein's *Myotis bechsteinii* Daubenton's *Myotis daubentonii* Barbastelle *Barbastella barbastellus* Lesser and Greater Horseshoes *Rhinolophus hipposideros* and *R. ferrugineus* pipistrelle *Pipistrellus pipistrellus* Noctule *Nyctalus noctule* and Serotine *Eptesicus serotinus*. During this survey to ensure we worked around precious habitats or species-rich areas, we began to plan the new woodland and to develop a management plan for other areas of the site.

Over the next three years, with the help of 345 mostly local volunteers we planted 10,000 native species trees at Ha eland. From the start, we knew we didn't want to plant in regimented lines and that planting in concentric rings, incorporating glades, shrubby edges and rides would best define the loose, natural character of the woodland we wanted to create. We used a choice range of native trees and shrubs, influenced by soil type, aspect and what trees were growing nearby. Plastic tree guards were off limits, as were pesticides and chemical treatments. We were supported in these early decisions by a range of knowledgeable partners, including the EA, the Forestry Commission and the Woodland Trust.

The existing woodland at Ha eland has been managed with a light touch. The main interventions have been to coppice one area to let in light and air, encouraging Bluebell *Hyacinthoides non-scripta*, Primrose *Primula vulgaris* and orchids, including Early purple orchid *Orchis mascula*, to appear and felling some dieback-affected ash trees for safety purposes only. The furthest, most remote part of the site we left to regenerate naturally. Here, Alder *Alnus glutinosa* and willows *Salix* spp. are starting to appear, spreading from hedges that are billowing out into the field.

AVON
NEEDS
TREES

Welcome to
Hazeland

Find out what's hiding here



Peacock butterfly (*Aglais io*)

The Peacock's spectacular pattern of eyespots, which have evolved to startle or confuse predators, make it one of the most easily recognized and best-known species. Undersides of the wings are very dark and look like dead leaves. A fairly large butterfly and a strong flyer.

Conservation Status:

- Butterfly Conservation priority: Low
- European status: Not threatened

Habitat: Common and found in a range of habitats.

Interests: Peacock butterflies are the only members of the *Lycaeidae* subfamily that lay their eggs singly on individual plants.

1

[illegible]

when feeding.



Slow worm (*Anguis fragilis*)
The slow worm is neither a worm nor a snake, but in fact, a legless lizard - its identity is given away by its ability to shed its tail and blink with its eyelids. Much smaller than a snake, it has smooth, golden grey skin. Males are paler in colour and sometimes sport blue spots, while females are larger, with dark sides and a dark stripe down the back. Sunbathers in sunny spots and feeds on a diet of invertebrates.

UK under the Wildlife



Heron (*Ardea cinerea*)

Spot these tall, prehistoric-looking birds standing like a sentry in a field. They are usually seen in pairs, but their most useful trait to watch for is their long, straight necks. When they are really excited, they will raise their long legs, a long, white neck, bright yellow bill and a black eye stripe that continues as long, drooping feathers down the neck. Look out for these incredible footers in flight. Their slow flapping wings and long legs held out behind are hard to miss!

Conservation status: Common. Classified in the UK as Green.

Height: 24cm Wingspan: 1.8m

Average lifespan: 5 years

Habitat: Freshwater, coastal and wetlands.

Time to cost: All year



Otter (*Lutra lutra*) Silver otter

The European otter is a large member of the weasel family. You are more likely to see an otter today in the UK than ever before. Otters have a long history in Britain. In the past, before their elusive nature still makes them a difficult prey item, otters were hunted for their valuable fur. Otters have adapted to life on land and also in the water. They have webbed feet for swimming, dens for hibernation, and they can close their ears and nose underwater.

Conservation status: Protected in the UK under the Wildlife and Countryside Act, 1981.

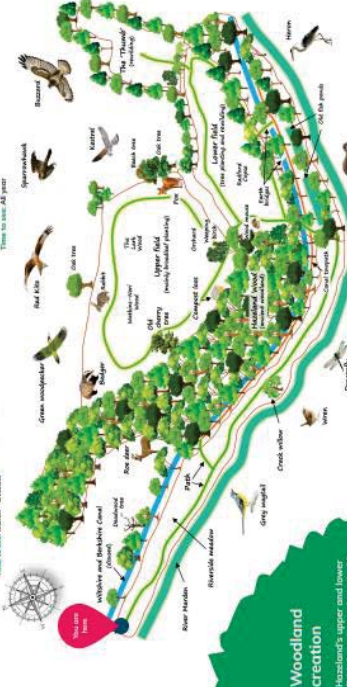
Habitat: Rivers, coastal and wetlands.

of fish bone and scales in the sprint on



Common Pipistrelle (*Pipistrellus pipistrellus*)
The common pipistrelle is our smallest and most common bat. All UK bats are nocturnal – preferring to come out only at night. They feed on insects – and other flying insects that they find in the dark – including moths and other flying insects that they find in the dark by echolocation. They roost in tree hollows, bat boxes and in the roof spaces of houses, often in small colonies. During the summer, females have maternity colonies and have just a single pup each.
Conservation status: Protected in the UK under the Wildlife and Countryside Act 1969.
Wingspan: 20–22cm
Weight: 3.5–4.5g
Life span: 4–5 years

for the last century. Boats are still under threat from building and



Woodland
creation

Hazelwood's upper and lower fields have been planted with 10,000 trees and shrubs of native species such as Pedunculate Oak, Common Alder, Hazel and some rarer threatened species, such as Black Poplar. Both these fields were once woodland in the last century, but were cleared for the Second World War. Explore Hazelwood and discover our other information boards which tell you about the trees of Hazelwood, as well as the history of the canal.

Please share your love of Hazeland
spread the word and get involved.



anNeedsTrees

www.AvonNeedsTrees.org.uk

Welcome to Hazeland,
a 34 acre site of mixed
habitat which is owned
and managed by Avon
Needs Trees to plant
woodland and improve
biodiversity.

Our aim is to buy land in the Bristol-Avon River catchment where we can create new, permanent woodland, capture carbon from the air, enhance biodiversity, provide natural flood management and improve water and air quality. We hope you enjoy your time at Hozland. Please stick to the paths and be aware that in order to protect the wildlife here we are not able to allow dogs (unless assistance / guide dogs) on the site and ask that you leave the site as you find it, taking all your waste away with you.

A HUGE thank you...

We would like to thank the many generous individuals who have made the Hasbrouck project possible and the volunteers who have contributed so much to the site.

We would also like to thank The National Lottery Heritage Fund, the North-Wardians family, Simmonds family, Nutcracker Ltd, RHS Trust, Walsley Council and Calne Town Council for all their invaluable support. The Hasbrouck Copse is named in memory of environmentalist F Redford. The Copse Wood is named in celebration of the lives of Alan & Hazel Whitbread.

Thank you to our founder Niki Jones for all the energy and passion she put into setting up Avon Needs Trees.



Made possible with
Heritage Fund

We planted one area with fruit trees, providing for site users and wildlife, starting a tradition that prevails at all our sites. The riparian meadow along the River Marden remains an unbelievably rich haven for plants and animals including Water Vole *Arvicola am hi ius*, Otter *utra lutra*, Green Woodpecker *Picus viridis*, Slow Worm *Anguis fragilis* plus various birds of prey, bats, dragonflies and damselflies, and butterflies to name but a few.

From the start, it was important for us to involve local people. Ha eland has hosted family days, school visits, Forest Schools, wellbeing days, coppicing days and foraging events. A range of highly knowledgeable amateur experts have led bird events, butterfly counts, amphibian surveys and insect days, which will continue periodically over the coming years, to engage people with the ecology of the site and record how it is changing. A whole area is given over to trialling new approaches with partners, such as different planting mediums and their effect on drought survival with niversity of Bristol. A rudimentary gathering area for groups is marked out in one of the upper fields with some tables to eat lunch at and superbly designed and executed compost loos. An example of a notice board is given above.

Having got Ha eland up and running, we took a moment to think about our progress thus far. This was the start of a strong lessons learnt culture. A key concern was ANT's capacity to expand, with no paid staff in place. Trustees were already actively involved in designing and delivering woodland creation Nikki's work load was extreme and unsustainable. So, the search began for a paid director. In June 2021 Dave Wood (aptly named) was appointed, funded for three years by a generous grant from a local trust, and our paid team began to expand. Dave has been an extraordinary catalyst for ANT's development.

We thought hard about how to move on from one site to another in future. How could we square the need to protect the site, maintain the high standard of tree care we had set ourselves and continue public access, whilst also turning to focus on other sites in different parts of the catchment What has happened at Ha eland is that short term funding has been secured for a local person to take on the management requirements of the site, supported by a cohort of volunteers turned site guardians who live locally and can keep an eye on things. This is a model we hope will prove sustainable in the longer term.

Looking to the future, we also thought hard about a model for progressing site ownership around the catchment. A flagship site surrounded by a circle of smaller satellite sites would allow us to work with the same group of volunteers on multiple sites, circulate the same equipment and keep travel to a minimum. This implied much more control of where land came up for sale than was realistic at the time, but surprisingly this model has stuck to a certain extent, as we have expanded.

uddin Broo ood

As we began hunting for our next site in the spring of 2021, it was clear the price of land had rocketed while we had been immersed in Ha eland. We nevertheless pushed forward with the search and were lucky to find 14-acres of land at Stanley Lane, just a few miles from Ha eland, enabling us to put the practicalities of the satellite model to the test. This was a much more straightforward site than Ha eland. It comprises one large, seasonally wet field, where there was little in terms of existing habitats to work around, allowing us to concentrate primarily on creating new woodland, including wet woodland, and hedges with the help of the Ha eland volunteers and equipment. Again, we worked hard to involve local people in what we were doing, giving them a part in renaming the site Pudding Brook Wood after the small brook that runs through the site, and creating public access and a picnic area off the cycle path that runs along the edge of the site.

We have planted 9,000 trees at Pudding Brook Wood, and natural regeneration areas have been left to allow local trees to create their own woodland over time. Shrubby edges and smaller trees flank the woodland groves with generous open space contributing to a diverse mix of habitats and ecotones. Pudding Brook Wood is now looked after by a group of local site guardians and the new Friends of Pudding Brook, with oversight from ANT.

The Pudding Brook Wood site was the first time we drew significantly on funding from a local community forest. There are 15 community forests across the country, providing advice and funding for woodland creation projects. The Great Western Community Forest (covering the eastern area of the catchment) funded 100 of our planting and infrastructure costs at Pudding Brook Wood, as well as a portion of staff costs. In working closely with a community forest in this way we had taken a step towards a more strategic approach to land purchase.

Ed oods

In spring of 2022 we started site hunting again, hoping that affordable land would present itself in a place convenient to us. This time our thinking revolved around a completely different set of considerations. It was clear that a sea change was underway in terms of funding and woodland creation more widely. New government funding streams, the expansion of community forests, the development of local authority woodland and nature recovery plans, and the approaching roll out of Biodiversity Net Gain (BNG), were all beginning to influence landowner decisions about whether to sell their land or hang on to it. This was an increasingly fast-changing environment and we knew we needed to remain nimble. Sitting passively, waiting for land to fall into our lap was not going to work.

Our land acquisition method for the first two sites had involved online land searches, a long fundraising period before purchase and a patient vendor. The downside of this process is that it can take up to a year. The upside is that it gives space for fundraising, and fundraising has an unparalleled ability to coalesce the community around a common aim, generate publicity, and create a sense of achievement once the target is reached – and this feeds into the ongoing project. It was clear, however, that this method of purchasing land could not, alone, be relied upon to secure our targeted one-two sites per year, in time for tree planting to start every November. New methods of acquiring land were needed to run alongside. We considered long leases plus tree protection orders, conservation covenants, transfer of ownership and other legal mechanisms which would guarantee our long-term legal control of the land, without actually owning it. We hoped the upshot of all of this was that the choice of new sites would be greatly increased, allowing us to be more strategic in how we expanded across the catchment.

Our site hunting was conducted with these models in mind. We had a couple of false starts: one where we were stopped in our tracks by the discovery of a Roman iron works on site, another where the requirements of an Area of Outstanding Natural Beauty made the project unworkable. But there was incredibly little on the market and what there was, was expensive and had to be snapped up quicker than we could manage. Eventually, we identified a land partnership opportunity right at the southern boundary of our catchment, in the hamlet of Bodden, near Shepton Mallet. This was 10 acres, belonging to a family that wanted to plant the site in memory of their father, as part of a wider nature restoration project with neighbours. With the help of volunteers, we re-named the site Ed Woods, and planted 4,000 trees in the first few months of 2023. Under the land partnership agreement, ANT works with the site landowners to create permanent woodland, rather than fundraising to buy the site. The permanence of Ed Woods will be guaranteed by a Conservation Covenant, new environmental legislation passed in September 2022. This agreement is legally binding on the landowner and for subsequent owners of the land, guaranteeing protection of the woodland.

reat Avonood

With one land partnership identified, we also needed a purchase. A call for land was launched across all our communications channels. In April 2022, the monthly Directors report highlighted a profound shortness in supply for land within ANT's catchment area, which seems to be getting worse as time goes on. Meanwhile, in May, Mark Funnell, Director of Campaigns and Communications at the National Trust, was appointed as our new chair of trustees – another landmark appointment. And then in June, a breakthrough. A new piece of land, flagged by a trustee with the words in our dreams! : 119 acres of farmland, separated into 3 blocks but on sale as a whole for £1m, at Publow, 2 miles from the southern edge of Bristol.



Figure 3: Great Avon Wood woodland creation Phase 1

The land sits at the heart of two landscapes that are regionally important for nature's recovery: the Limestone-Link and the southern border of the Dundry Downs. It is also within the West of England Nature Partnership's Nature Recovery Network. It consists of a combination of grassland, hedgerows, deciduous woodland, streams and rush *uncus* spp. beds. This was the site we had been waiting for, one that would really increase our impact and put us into contact with larger, more diverse communities, which were only a bus ride away. We had to push the boat out to secure it. Luckily, the Forest of Avon Trust was interested in progressing it as a partnership project, which made it more doable. Our joint offer on the site was accepted and fundraising commenced.

While the fundraising was slowly progressing, the summer of 2022 was drought-ridden. Reports were coming in from across the country of newly planted trees left to die and we were determined ours would not follow suit. Volunteers and staff dedicated their time to keeping trees across all sites alive, mulching and watering where possible. When we counted our losses the following winter, we found we had a 90 survival rate (as opposed to 0-25 in other areas of the country) which showed our efforts had paid off.

By Autumn 2023, we still had not completed on the Publow site and tree planting season was almost upon us. Being the first applicant to access new funding from Department for the Environment Food and Rural Affairs (DEFRA), there were many unknowns and firsts to contend with. We were also awaiting the outcomes of other funding applications, consulting widely with local communities, and carrying out interviews for new public engagement staff funded by the NLHF.

We finally completed in February 2023, with funding secured from DEFRA, West of England Combined Authority, the Woodland Trust and NLHF. By now we were well into the planting season. Thanks to the extended build up to purchase, and time to publicise the project, we had doubled our volunteer cohort, which now numbered around 1000. We named the Publow site as a whole, Great Avon Wood, a sign of our growing sense of being part of a wider strategy, a wider movement towards woodland creation and nature recovery. We asked local people to help us name the individual blocks of land. By spring 2023 we had planted block 2 of Great Avon Wood – a huge tribute to the heroic work of volunteers and staff. Our plan is to plant a block per year for three years. Local biodiversity and wildlife corridors will be enhanced as the woodland grows and plans include the protection and care of existing, species-rich grassland and areas of natural regeneration.

Public engagement is a very important feature of what we are doing at Great Avon Wood. Volunteering, a free public engagement programme (forest schools, heritage events, nature counts) and a woodland heritage trail (being implemented 2024) are all underway. Public engagement focusses on children and underrepresented communities, breaking down barriers to bring them into contact with wild places.

Funding from the NLHF has provided staffing to drive this public engagement, swelling the ANT team further. An example of an information board is given above.

Lower Chew Forest

At the end of tree planting in Spring 2023, we spent some time processing the developments of the previous year. The charity was growing so fast our internal systems all needed updating or renewing and the need to ensure that ANT was sustainable into the future was now pressing. A working group was established to develop a long-term vision in which ANT had varied, resilient income streams that could entirely cover our organisational costs. The potential for BNG and earned income to play a part in this was clear. It being springtime, we also started looking our next site. Following our satellite model, we wanted land near Great Avon Wood and we wanted to be able to again make use of the DEFRA funding, before this funding stream was closed for good. Again, we found there was very little on the market. We did a co-ordinated search, accompanied by publicity, and could find nothing, except for a few very small-scale land partnership opportunities. Then in June 2023, another in our dreams site came on the market, only this time it was four times the size of Great Avon Wood - Wick Farm, just south of Compton Dando, on the market for £7.5m. The price tag was terrifying. The site comprises 422 acres of arable land and pasture with a few small, disconnected areas of woodland and some good species-rich hedgerows, with three tributaries of the lower Chew River running through it. At the centre of it is a large farmhouse, cottage and agricultural buildings.

The site is full of potential – we would aim to plant 100,000 trees, creating new woodland to join up the existing woodland at the edges of the site, including wood pasture to leave large swathes of land to natural regeneration to create species-rich grassland, wetlands, expand hedges and other habitats in the percentage of land where trees are not appropriate to stop chemical run off into the stream. Given the size of the Wick Farm project, there is also potential for climate resilient crop production and agroforestry for climate resilient grazing and of course, great potential for public engagement and skills development. The site also offers potential for income generation from the buildings and environmental credit income, primarily BNG, which will transform our long-term sustainability and create a land purchase pot for the future. At time of writing (May 2024) we have also taken on leadership of the Lower Chew Landscape Recovery project, spanning 2,500 acres to the south of Bristol, encompassing both Wick Farm and Great Avon Wood. This inspiring project brings landowners together to create woodlands, improve connectivity, enhance habitats, manage existing woodlands for carbon storage, improve the soil's ability to store carbon and hold water, thereby reducing flooding, and improve hydrological function of the River Chew. There is also potential for creation of grassland from poor arable land, and natural flood management interventions, including wetland and leaky dam creation, and more. Climate resilient food production is an important

element of the Landscape Recovery scheme, using land smartly by improving soil health to yield more climate resilient crops and capturing carbon to slow climate change and reduce flooding. We have a huge responsibility, as a group of landowners, to ensure the right intervention in the right place and our wider partnership of existing and new partners will be crucial in the co-design process.



Figure 4: Wick Farm from the air.

The Lower Chew Landscape Recovery project is forging ahead and, after months of hard work and an incredible fund-raising campaign, the purchase of Wick Farm was completed in May 2024 as this was being written. Public support for the project has been heard loud and clear through an immensely successful crowdfunder. In four years ANT has progressed from being a tiny, reactive charity on the edge of viability, to being an established, land-owning charity, with a trading arm, employing 25 people, able, with luck, to continue buying land for trees and nature into the future. How did this happen? A fortuitous combination of funding, extraordinary people and partners, growing environmental public awareness, bravery and a lot of hard work. By 2050, we aim to double woodland cover in the region from 8 to 16, create an additional 6,000 hectares of land managed for nature and wildlife, closing nature recovery network gaps in the process and contribute to the improved ecological status of our river, mitigating flooding in the process. This ambitious target will only be achievable if we can keep up the momentum of our first few years. To do this, we need continuing support – both financial and volunteering. For an update on Lower Chew Forest and our other sites, and information on how to get involved see <https://avonneedstrees.org.uk>.

Bristol and District Invertebrate Report, 2023

R.J. Barnett

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Introduction

Following the very hot weather recorded in the summer and early autumn of 2022, the question was whether this would have an observable impact on our invertebrate populations in 2023. Whether or not this was the cause, the spring of 2023 was one which saw many entomologists alarmed at the very low numbers of species and individual specimens seen and recorded. Fortunately, numbers seemed to recover over the summer months and so may suggest that the impact of the previous summer was very much dependent upon what stage of the lifecycle certain species were at when the high temperatures were experienced (e.g. larvae may have died from lack of suitable food as plants shrivelled in the heat whereas eggs may have been more resilient). Also, the particular stage that certain species overwinter as (e.g. egg, larva, pupa or adult) may have had a significant impact upon survival of individual invertebrates. Insect species which overwinter as larvae can be those most susceptible to changing climate and adverse weather conditions.

Butterfly Conservation's national and annual Big Butterfly Count reported results which suggested butterfly numbers were better over the recording period (14 July – 6 August) than the previous 4 summers but this disguised long-term trends. The latter, analysed for the 13 years of the survey, show significant declines in many butterfly species overall. Despite widespread and local acknowledgement of the biodiversity and climate crises we face, little action to reverse such highly concerning trends seems to be being taken or at least to be having a discernible impact so far.

Maico Weites again kindly arranged and led several BNS Invertebrate Section meetings – field meetings at Troopers Hill (6 May), Walton Common (13 May) and Hutton Hill (8 July). A field meeting, jointly with the British Entomological & Natural History Society (BENHS) at Priddy Mineries (29 July), arranged by Ray Barnett, was also held.

Watercress Farm on the Belmont Estate at Wraxall, was the subject of intensive surveying, including for invertebrates, by a team of volunteers whose results are summarised elsewhere in this volume.

Significant reports are listed below by relevant group of invertebrates. These records are not just from members of the Society but include other sightings I am aware of. My thanks to all those who have submitted records to myself and/or the Bristol Regional Environmental Records Centre (BRERC) especially Maico Weites, Rupert Higgins, Bob Fleetwood, Andy Pym, members of the Bristol Moth Group,

contributors to the Avon Insects *WhatsApp* group and others who have listed their sightings on open fora such as social media platforms.

Dragonflies & Damselflies (Odonata)



Plate 1: Willow emerald damselfly *Chalcolestes viridis*. Photo by Mark Coller.

In 2022 I speculated that the Lesser Emperor *Anax parthenope* might be breeding at Chew Valley Lake, following the sighting by Rupert Higgins that year. In 2023, this species was seen at Catcott Heath (29 June) and also at Westhay Moor (Andrew Kirby) where ovipositing was photographed, so it does seem to be breeding, at least on the Somerset Levels (pers. comm. Fred Giles). Closer to Bristol, examples were seen at Portbury Wharf (10 August, Howard Taffs) and one was present at Stoke Park from 11 to 20 August (Larry Sweetland) with a further sighting at Chew Valley Lake, as in 2022 by Rupert Higgins, in the same month. Breeding at these sites seems increasingly likely.

The Southern Migrant Hawker *Aeshna affinis* is a further species which was previously a migrant but is now a resident species, known to be breeding in in the South East especially around the Thames Estuary. Two examples were seen in our region in 2023, one at Dyrham Park on 1 August and another at Oldbury Power Station on 11 August (the latter seen separately on the same day by Heather England and Ray Barnett).

The spring of 2023 also saw a substantial influx of the Vagrant Emperor *Anax ephippiger* to the South West of England and a hawker seen at Sand Point by Oliver Smart on 9 April was probably of this species. This dragonfly migrates from Africa and the Middle East but so far does not seem to have become established here.

In north Bristol, at Stoke Park, Larry Sweetland confirmed the continued presence of the Scarce Blue-tailed Damselfly *Ischnura pumilio* first seen here in 2021. This remains a very rare species locally, associated with early successional flushes and seepages, but easily overlooked. A Willow Emerald Damselfly *Chalcolestes viridis* was photographed at Kingsgate Park, Yate by Mark Coller (pers. comm. Rich Andrews) on 2 September. This is yet another new colonist to the British Isles where it can be found breeding primarily from the Midlands eastwards, it may become a new resident in our region in the near future.

Grasshoppers and crickets (Orthoptera)

There were no sightings of significance reported in 2023 in our region that I am aware of. This reflects the surprising lack of interest in this order, not just locally but nationally, compared to many other insect groups. However, the relatively recent arrivals Roesel's Bush-cricket *Roeseliana roeselii* (first reported in the region in 2007) and the Long-winged Cone-head *Conocephalus fuscus* (which first made it to the region in the early 1990's) continue to be common and widespread. Any location where grass is not regularly mown may become colonised by these two splendid species.

True bugs (Hemiptera)

The spread of the mirid bug *Globiceps flavomaculatus* reported last year (single examples found in 2020 and 2022) was added to by the discovery of another specimen but this time at Lower Woods, Wetmoor on 29 June 2023 by Ray Barnett. The National Biodiversity Network (NBN) Atlas has fewer than a dozen records, primarily from the South East of England with the odd one in the north and Midlands so these sightings represent a significant extension of its known range.

A further extension of range came with the joint BNS and BENHS meeting at Priddy on the Mendips on 29 July (Ray Barnett) when a specimen of the Vernal Shield Bug *Peribalus strictus* was swept. Usually only known from the coastal counties eastwards from Devon to Kent, there are a few historic records from elsewhere of which one is from Somerset in the early 20th Century. The mirid bug *Polymerus unifasciatus* was also swept from bedstraw *Galium*, and there are no previous Somerset records listed on the NBN site.

The colonisation of our area by the rhopalid bug *Stictopleurus punctatonervosus* continues with one recorded at Cleaves Wood, near Wellow on 2 June (Ray Barnett).

Similarly, a recent colonist is *Nysius huttoni* (a New Zealand native): one was reported in 2021 (Walton St Mary, Bob Fleetwood); a second was recorded from Little Stoke on 10 May 2023 (Rupert Higgins); and a third from Lamplighter's Marsh, Bristol on 3 August 2023 (Ray Barnett).



Plate 2: The striking rhopalid bug *Stictopleurus punctatonervosus* is colonising our area.
Photo by Rupert Higgins.

The mirid *Dicyphus tamaninii* was found at Watercress Farm (Bob Fleetwood and confirmed by Jim Flanagan), a species added to the British list about 15 years ago and thought to have been introduced as a predator of greenhouse crops but has since escaped. This is likely to be the first record for the whole of Somerset.

Alydus calcaratus, the sole British member of its family, was found at Troopers Hill, Bristol on 2 June 2033 (Rupert Higgins) confirming its continued presence on this site after an absence of records for several years.

Butterflies (Lepidoptera)

2023 was notable for the large numbers of Red Admiral *Vanessa atalanta* seen across the region and throughout the year. This species was the commonest recorded on the national Big Butterfly Count (14 July – 6 August), the first time it has been in this position and considered to be probably a result of climate change benefitting this species. By contrast, our once very common Small Tortoiseshell *Aglais urticae* came

in just 8th and Butterfly Conservation data suggested it has declined by almost 30% over the 13 years of the running of this national survey. Many of our other butterflies we regard as common and abundant show similar worrying declines eg Common Blue, Meadow Brown and Ringlet. Locally, BRERC is developing techniques to analyse the data it holds (across many taxa) to see whether such trends are being mirrored in our region. The national results here would suggest much more still needs to be done to prevent many common insects (highlighted by our butterfly species) from continuing to disappear from our gardens and landscapes.

These trends should not be confused with very localised gains or new records, which although welcome should not obscure the overall concern. One such gain was a Small Blue *Cupido minimus* seen at a new site near the Shirehampton Park & Ride in Bristol on 18 May (Steve Judd), an excellent discovery of this elusive species. Also, the Holly Blue *Celastrina argiolus* continues to be a regular in gardens and had a decent year in 2023. A report on social media of a Camberwell Beauty *Nymphalis antiopa* from Stockhill Plantation on the Mendips on 17 April, if correct, raises that perennial question as to whether individuals may be releasing reared stock (as there were no other reports across the country at this time in places where genuine migrants might be expected). This issue was highlighted in 2023 with an unofficial release of examples of the extinct Black-veined White *Aporia crataegi* in south east London. Although well meaning, such releases are usually doomed to fail and may even introduce new problems for native insects (internal parasites, or bacteria or viral disease, or weak genetic stock). They of course, confuse those trying to establish what is happening with natural responses to habitat and climate change and if the species released is non-native, the action is illegal.

Moths (Lepidoptera)

With the large number of species and the now large number of recorders in the country, information on our changing moth populations is one of the best ways of trying to understand what changes are happening to our insect fauna as a whole. 2023 did not disappoint as it continued the trend of new patterns of immigration and colonisation. Harder to spot though, are the declines in abundance of what are still relatively common species.

11 species were added to the moth list for the Bristol region (i.e. the old Avon County area) in 2023. These were the macro moths - the Beautiful Marbled *Eublemma purpurina*, Porter's Rustic *Athetis hospes*, Sombre Brocade *Dryobotodes tenebrosa*, Cloaked Pug *Eupithecia abietaria* and Spiny Hook-tip *Watsonalla uncinula*, plus the micro moths – *Grapholita caecana*, *Yponomeuta irrorella*, *Gelechia senticentella*, *Spoladea recurvalis*, *Triaxomera caprimulgella* and *Caloptilia honoratella*.

The Beautiful Marbled was an individual to light in Bishopston, Bristol (24 August, Jean Oliver). The first British record was in 2001 for this very attractive migrant moth. Porter's Rustic by contrast is rather dull looking but was spotted in Sand Bay, Weston-super-Mare (21 August, Paul Bowyer) and then two in Timsbury, Bath (8 and 10 September, Mike Bailey). The Sombre Brocade, as you might guess from the name, is another of the grey noctuids and like Porter's Rustic, usually resident in the Mediterranean region. Examples were light-trapped in Weston-super-Mare by David Gibbs on 5 and 6 October. The Cloaked Pug (Whitchurch, 19 June, Rich Andrews) is a relatively well-marked member of the notorious group of similar looking pug moths. The larvae feed on Norway and Sitka Spruce *Picea abies* and *P. sitchensis* so it could have been overlooked in the region until now as few moth trappers target coniferous woodland, although it is also known as a migrant, which could be an alternative reason for its appearance.



Plate 3: The Cloaked Pug *Eupithecia abietaria*. One of the more striking of the pugs.
Photo by Rich Andrews.

The Spiny Hook-tip is a very interesting case as it appears superficially to be extremely similar if not identical to the common Oak Hook-tip *Watsonalla binaria*. Discovered new to the British Isles near Stroud in October 2023, subsequent examination of other examples showed it to be present in South Wales and also Weston-super-Mare (David Gibbs), Clevedon (Paul Chapman) and Henbury, Bristol (Peter Mansfield) in October and November. The larvae feed on Holm Oak *Quercus ilex* and the question arises as to whether it may have been here undetected for some time or is yet another very recent new arrival from the continent.



Plate 4: Micro moth *Yponomeuta irrorella*, new to our area in 2022/3. Photo by Rich Andrews.

Of the micro moths, *Y. irrorella* had in fact been seen in 2022 (Keynsham, John Aldridge) but was not recognised as new to the Bristol Region list until 2023 when further examples were found at several sites (eg Whitchurch, Rich Andrews and Keynsham, Alan Bone both on 7 July). In similar vein, Andy Pym reported *G. senticetella* from Filton in 2022 but this was only confirmed for sure with a further sighting on 6 July 2023 at the same locality. The challenge of identifying some species was exemplified by *G. caecana* only identifiable by dissection (Bath, Paul Wilkins, 19 June 2023).

Two examples of the migrant pyralid moth *S. recurvalis*, a species more at home in the tropics, were reported. The first from Clevedon on 9 October (Paul Chapman) and then at Burnett near Bath on 11 October (Philippa Paget and John Aldridge). *T. caprimulgella* was only able to be identified by dissection after it had been attracted to a pheromone trap on the Watercress Farm, Belmont Estate, Wraxhall. The pheromone used is that of the Lunar Hornet Moth *Sesia bembeciformis* (which was not found) but it is speculated that *T. caprimulgella* whose larvae, like those of the Lunar Hornet, utilise dead wood as a food source, find new suitable timber by following the scent trail of the larger moth.

The final new species is of the genus *Caloptilia* which seems to be turning up several new species to the country regularly. Again, dissection is really necessary and this example was checked by Paul Wilkins after being found on Combe Down, Bath (7 October). A micro moth which appeared suddenly in numbers in 2022 was the Beet Moth *Scrobipalpa ocellatella* and I speculated last year on whether it might have

become established in our region. However, there were no sightings of it in 2023, so apparently not.

It seems reasonable to suggest that this increasing number of new migrants and colonists is a result of climate change and specifically warmer, wetter winters. This may also explain a rash of Humming-bird Hawk Moth *Macroglossum stellatarum* sightings in the months of February, March and April 2023 (Longwell Green, Bristol, 12 February, Donna Harvey; Avon Gorge, Dylan Peters, 14 February; St Pauls, Bristol, 20 March, Tiffany Webster; St Andrews, Bristol, 22 March, Roger Edmondson; Bishopston, Bristol, 15 and 29 April, Dylan Peters). Other early records included a Double-striped Pug *Gymnoscelis rufifasciata* in the first week of January (pers. comm. Jean Oliver) and the Lesser Yellow Underwing *Noctua comes* Jean recorded in her Bishopston garden on 30 December 2022 was either a very late one for that year or a very early one for 2023!

The larva of Death's Head Hawk Moth *Acherontia atropos* found looking for a pupation site on 19 July in Portishead (pers. comm. Dorothy Jerreat) was only eclipsed by the discovery of 4 others nearby. Presumably a migrant female had been laying eggs earlier in the season. Not far away as the moth flies, Giles Morris came across a larva of a Humming-bird Hawk Moth on Walton Common on 22 August, this too must have resulted from earlier examples seen on the wing in the spring.

The spring of 2023 was very poor for numbers of the common resident species (in line with observations of other insect groups) but there were some winners it seems. Numbers of the Light Brocade *Lacanobia w-latinum*, Chocolate-tip *Clostera curtula*, Seraphim *Lobophora alterata*, White-point *Mythimna albipuncta* and Large Nutmeg *Apamea anceps* all seemed to be greater than normal (White-point was once just a migrant but now thought to be resident here). Moth numbers seemed to recover over the summer and another species perhaps commoner than usual was the Dark Spectacle *Abrostola triplasia*. Recent colonists Clifden Nonpareil *Catocala fraxini* and Box-tree Moth *Cydalima perspectalis* continued to thrive (356 examples in one night's trapping by Rich Andrews at Whitchurch, for the latter species!). Other migrants also did well including Delicate *Mythimna vitellina*, Convolvulus Hawk *Agrius convolvuli*, Vestal *Rhodometra sacraria*, *Palpita vitrealis*, Scarce Bordered Straw *Helicoverpa armigera* and an added bonus were one or two examples of Clancy's Rustic *Caradrina kadenii*, The Cosmopolitan *Leucania loreyi* and Golden Twin-spot *Chrysodeixis chalcites*.

A species of plume moth of local occurrence was recorded in Bishopston in 2023 by Rupert Higgins, *Merrifeldia baliodactylus* on 28 June, more normally associated with sites like the Avon Gorge. A further surprising moth was an example of the pyralid *Synaphe punctalis* at Rupert Higgins' Bishopston light trap on 7 July. Although the second record for the region after one in Bath in 2005, this is a resident primarily of the East Anglian and Dorset/Hants coast.

Beetles (Coleoptera)

Although less obvious to the casual recorder perhaps, the changes taking place in say our moth fauna are echoed in groups such as the beetles. The Alder Leaf Beetle *Agelastica alni* is one such example. Considered extinct in Britain between 1946 and 2003 it is now very common across our region and often on a variety of trees not just Alder *Alnus glutinosa*.

Larry Sweetland continued his one-man crusade in 2023 to record ladybirds and especially those less well known and smaller examples. He began the year with a Horse-shoe Ladybird *Clitostethus arcuatus* from Snuff Mills, Bristol on 6 March.

The very localised large ground beetle *Carabus monilis* was found by Nicola Cooke and the team at the Wild Place (Bristol Zoo) site on the northern edge of Bristol in early July, whilst surveying the site for its native wildlife. A further example was found on Priddy at the BNS/BENHS meeting on 29 July. Otherwise, this has been a rather quiet year for beetle recording in the region.



Plate 5: Two Jewel Beetles. Left, *Agrilus cyanescens*. Right, *Agrilus laticornis*, exhibiting an unusual behaviour of flicking its elytra, apparently in display. Both photos by Rupert Higgins.

Rupert Higgins has added some important beetle records to our knowledge of the local fauna. *Ischnomera cyanea* Chew Valley Lake 19 May (Rupert Higgins) is a species which seems to be increasing locally with new localities turning up most years. *Donacia clavipes* found at Hoar Gout, Avonmouth 24 May (Rupert Higgins) is a localised reed beetle. *Microplontus campestris* Stoke Bishop 30 May (Rupert Higgins) is only the third ever record in the Bristol region but Oxe-eye Daisy *Leucanthemum vulgare* should be checked for it in spring. Both *Agrilus cyanescens* and *A. laticornis*, two of our species of Jewel Beetle, were recorded at the Memorial Woodlands, Tytherington 13 June (Rupert Higgins). At the same time a tiny weevil located on the site, *Coelidinus rubicundus*, is the first record for the Bristol region. *Amara tibialis* is associated with dry sandy soils and of local distribution, so one at

Lawrence Hill, Bristol on 25 August (Rupert Higgins) extends the known distribution in the region.

Only one previous record of the deadwood beetle *Platypus cylindrus* is known from the region (Leigh Woods 2019 Bob Fleetwood) so a second record Stoke Bishop, Bristol 7 July 2023 (Rupert Higgins) is welcome. *Dacne rufifrons* breeds in bracket fungi and we have just a few scattered records from the region, two at Chew Valley Lake on 24 October (Rupert Higgins).

Bees, wasps, ants etc. (Hymenoptera)

The sawflies are insects which are regularly seen in gardens and elsewhere but there is a gap in the market for a modern reference book to aid identification. Fortunately, one way to circumvent this is by access to national experts on social media who can help identify photographs (when it is possible to do so). There are two species of sawfly whose larvae feed on *Geum* and Dylan Peters recorded one of them, *Claremontia waldheimii*, on 29 April 2023 in Bishopston. There are no other records from the region on the NBN Atlas or the BRERC website. Much remains to be discovered about sawflies locally. The Pine Sawfly *Diprion pini* can be a pest of pine *Pinus* plantations but there are very few local records, larvae were found on the BNS/BENHS visit to Priddy on 29 July.



Plate 6: The sawfly *Claremontia waldheimii*. Sawflies are one of our less well-known insect groups. Photo by Dylan Peters.

You would think that we would have a much better understanding of the species of social wasp in the region but there are still surprises to be had. Gillian Smith sent Maico Weites images of the European Paper Wasp *Polistes dominula* from her Bristol garden in 2023. Regarded as an 'intermittent' British resident by the Bees, Wasps Ants Recording Society (BWARS), there are suggestions it has been in the Bedminster area of Bristol previously and since at least 2020. One to look out for across the city and also in Bath, in particular.

Monosapyga clavicornis is a solitary wasp which breeds in holes in deadwood as a cleptoparasite of certain species of bee (i.e. it steals the food of the other species), one was seen at Patchway, Bristol on 16 May (Rupert Higgins). As with most solitary bees and wasps we have relatively few records from the Bristol region.

True flies (Diptera)

Several of the hoverflies are excellent bumblebee mimics. One of the best was spotted on a leaf at the Watercress Farm, Wraxall on 5 May 2023 by Bob Fleetwood and Ray Barnett, *Pocota personata*. This localised species has only one other recent record for the region and is associated with rot holes in ancient trees such as Beech *Fagus sylvatica*, Sycamore *Acer pseudoplatanus* and Ash *Fraxinus excelsior* which the larvae inhabit.

Other excellent hoverfly records included *Mallota cimbiciformis* Ashton Court 20 August (Rupert Higgins) probably just the second record for the Bristol region. *Anasimyia contracta* found at Hoar Gout, Avonmouth 24 May (Rupert Higgins) is also a very localised hoverfly.

Also with few local records is the tachinid parasitoid fly *Phasia pusilla*: about 10 were seen by Rupert Higgins in Ashton Court on 20 August.

Spiders and Allies (Arachnida)

Harvestmen (Opiliones)

The tiny (just a few millimetres long) orange harvestman *Scotolemen doriae* was found under stones on Brandon Hill, Bristol by Maico Weites on 26 March and again on 1 April. This is another example of a Mediterranean species, presumably accidentally introduced to the UK but now living in a few sites quite happily (also known from Plymouth for example, but probably overlooked).



Plate 7: a tiny harvestman *Scotolemen doriae* from Brandon Hill. Photo by Maico Weites.

Mites and Ticks (Acari)

The closest any of us get to looking at mites is perhaps spotting the occasional red spider mite *Tetranychus urticae* scuttling over a surface, or if pond dipping, watching aquatic mites swimming in our catch. Maico Weites found an example of a bright orange mite under stones in Leigh Woods on 22 April 2023 which proved to be *Calyptostoma velutinus* (identification assisted by Matthew Shepherd of the Acari Recording Scheme). Perhaps understandably, there are just two records of this species on the NBN Atlas (both from South Wales), so if you would like to take up an overlooked and under recorded group of invertebrates, the mites are waiting for you. The Sheep Tick *Ixodes ricinus* has become exceedingly common in recent years locally. However, numbers seemed down in the spring of 2023, perhaps impacted by the hot dry weather in 2022. Unfortunately, they are able to restore those numbers very quickly in favourable conditions which were seen throughout most of 2023.

Woodlice (Crustacea, Oniscidea)

Maico Weites photographed the tiny, soil-dwelling woodlouse Sar's Red-eye *Trichoniscoides sarsi* found under some rocks on the Chocolate Path (alongside the New Cut, River Avon, Bristol) on 21 December 2023.



Plate 8: The tiny, soil-dwelling woodlouse, Sar's Red-eye *Trichoniscoides sarsi* is no more than 4 mm long. From the New Cut, Bristol. Photo by Maico Weites.

As with the mites, such very small creatures inhabiting the soil are often very under-recorded and this is likely to be the case with this species which is regarded as 'Nationally Scarce' but, in reality, may not be so. First recorded locally by Frank Ashwood in Clevedon in 2020, another species worth looking for in gardens. Maico has also reported on how common the Southern Pill Woodlouse *Armadillidium depressum* is in his St George, Bristol, garden, a species with a strong concentration in the south west of England which may be related to the damper climate over this way.

Weather report for 2023

Barry Horton

1 Introduction

No natural system is so simple that it can be explained away easily and climate is certainly complex with many complicated inputs and feedbacks. Nevertheless, the vast majority of scientists are sure that global warming is being driven by human activity. There may be some minor and diminishing uncertainty around by how much our activities are creating the climate issues, but our sheer volume of energy use, agricultural practices and a whole host of human activity, especially in the west, are driving us to an uncertain and potentially very dangerous future. The changes we are witnessing tell us that the climate crisis is already upon us and we must all do what we can. There is still reluctance from those who have the power and are well briefed to take the difficult decisions and to start to put the situation right before it is beyond redemption. The time for prevarication is over. This year the global population has passed 8 billion people, with countless species of flora and fauna. In order to support that growing number we need to take our global and regional climate very seriously.

On the global scale The World Meteorological Office (WMO) reported that The shift from cooling La Niña to warming El Niño by the middle of 2023 [was] clearly reflected in the rise in temperature from last year .

The European Centre for Medium-Range Weather Forecasts (ECMWF) confirmed the same, that the high temperatures from June onwards led to 2023 becoming the warmest year on record by a large margin. The temperature was close to 1.5°C above the pre-industrial level, according to the E 's Copernicus Climate Change Service (C3S) implemented by ECMWF'.

WMO Secretary-General Prof. Celeste Saulo said we are clearly in new territory with regard to our climate, and whilst the introduction of the shift from cooling La Niña to warming El Niño by the middle of 2023 took place, there is little doubt that human activity is contributing to climate change and we have to make drastic reductions in greenhouse gas emissions and accelerate the transition to renewable energy sources as soon as possible.

The Bristol weather station that has been in the area for 30 years now and shows the city's rising temperatures making the point that locally we are not shielded from larger scale and global trends.

There has been an amateur weather station in Totterdown, Bristol since 1993 and it is from here the weather data has been collated and analysed in this article. You can look at the data and follow the weather as it is updated via the internet at <http://www.bristolweather.org>. The weather station is situated in Bristol's urban area

and with that in mind, there are influences placed upon the data that would not be the case in a more rural setting. Since 2005 the weather station data has largely been collected automatically but the author still manually checks the daily rainfall amount collected even though rainfall is also measured automatically. The historical weather data used in this article comes from a variety of locally published historical sources. Some of the data is from as early as 1853 but there are time gaps and site differences which are too numerous to detail here. Broadly speaking the author has collated continuous records of rainfall and temperature for the Bristol area since 1882 and 1891 respectively; periods of 142 and 133 years.

To see further information on the different date periods and the sources used see <http://www.bristolweather.org/Historical.htm>. There are also several other good web sources of weather data in the Bristol region. The 30 year averages used in the text are a standard Meteorological Office device to easily denote the 'longer term' weather 'normal'. This may not be a perfect method but it is well understood and widely used for comparison with the current data. The present 30 year period being used as the countrywide standard is 1991-2020 and is the one referred to unless otherwise stated.

One of the effects of urban sited weather station are the elevated temperatures especially at night and early morning when compared with a rural setting. Even though the site is not ideally situated, and is 'amateur'. It is probably correct to say any long term data set is of value, if from one place, so time series comparisons can take place.

2 Annual data

2023 can be summed up as a warm and wet year.

2.1 Temperature

The annual average temperature for 2023 was 12.6°C. It was the second warmest since continuous records started in 1891 for the Bristol area. 2022, with an annual average temperature of 12.7°C, was the warmest. The 30 year average temperature for the city is 11.6°C. For a recent historical comparison the 30 year average for Bristol between 1961 and 1990 was 10.3°C. The current warming trend is obvious.

Table 1 below lists the 10 warmest years in Bristol. All ten have occurred in the last 35 years and so one has yet more evidence that the climate, not just globally, is warming compared to the recent past. In addition to the continuous data the author has found data from Dr Burder of Hotwells dating from 1853 when he recorded the annual average temperature of 8.2°C. Evidence suggests that the summer of 1853 was particularly cool and Hotwells might be generally cooler than Clifton, however, it does give a good indication of where we are heading, when in 2023 we had an average annual temperature 4.4°C above that figure.

10 Warmest Bristol annual average temperatures 1891-2023		
Year	Temperature °C	Rank (Hottest first)
2022	12.7	1
2023	12.6	2
2014	12.5	3
2020	12.4	4
2011	12.2	5
2018	12.1	6
2017	12.1	6
1997	12.1	6
1990	12.1	6
1899	12.1	6

Table 1: 10 highest annual mean temperatures, Bristol.

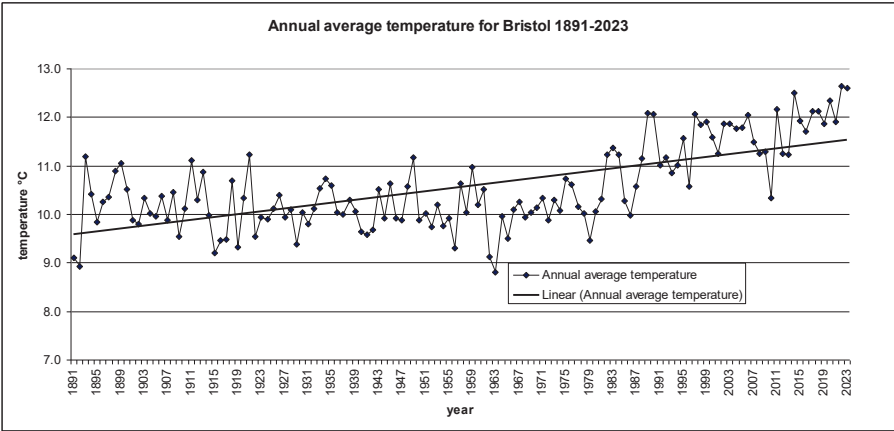


Fig. 1: Bristol Average temperatures 1891-2023

The graph (**Fig. 1**) puts a visual representation on these rising temperatures since 1891. It should be remembered that earlier records for the city are from different parts of the city, with different equipment and different recorders. One should therefore expect some minor differences and inconsistencies but I think the overall picture is clear. There seems to be a fairly consistent variation year on year for the average temperature up until the late 1960's, early 1970's. From then on there appears to be a rising variation. Fig. 1 is overlaid with a linear regression line running through the

whole of the continuous average temperature series. One can see that the calculation starts at around 9.6°C and ends in 2023 at about 11.5°C. Not only is this rise significant in itself it also have implications for agriculture, vegetation, migration and all animals. Ironically it is we humans in wealthy parts of the world, in northern latitudes, that are probably the best placed to feel minimal consequences from the industrialisation and CO2 emissions that are one of the main drivers of these temperature rises.

Month	Average monthly temperature (1991-2020) °C	Average temperature 2023 °C	Difference from average °C
JAN	5.7	6.3	0.6
FEB	6.0	7.4	1.4
MAR	8.0	8.4	0.4
APR	10.6	10.0	-0.6
MAY	13.7	14.9	1.2
JUN	16.6	19.3	2.7
JUL	18.5	17.2	-1.3
AUG	18.1	17.8	-0.3
SEP	15.5	18.4	2.9
OCT	12.0	13.9	1.9
NOV	8.1	9.0	0.9
DEC	6.1	8.6	2.5
Average	11.6	12.6	
accumulated monthly difference °C =			12.3

Table 2: monthly temperature anomalies for 2023 compared with 30 year averages.

It is interesting to take all the anomalies from the monthly average temperatures for 2023 (**Table 2**) and compare them with the recent 30 year average for Bristol. Even with three months showing a lower than average temperature (April, July and August) the positive anomaly still adds up to a total of 12.3 C. June and September’s large positive temperature anomalies both wipe out all the three month’s small negative temperature anomalies.

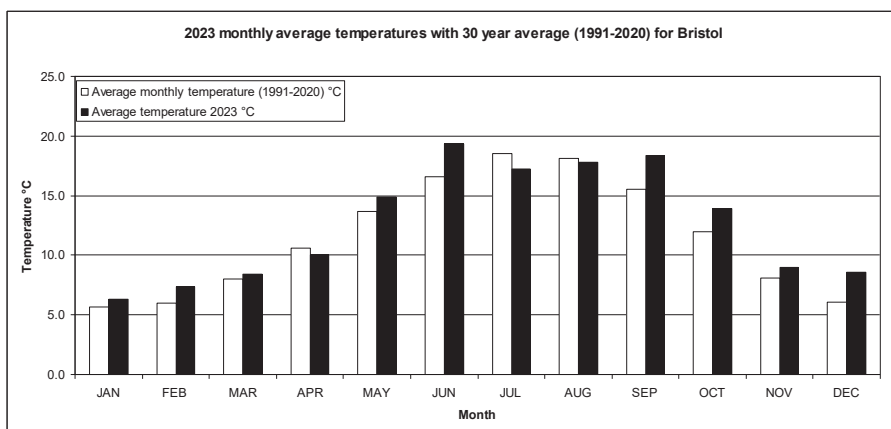


Fig. 2: Bristol 2023 monthly average temperatures compares with 30 year average.

With regards to the average monthly temperature, compared with the 30 year average, one can see from **Fig. 2** (and Table 2) that it tended to be the autumn months that saw the largest positive anomalies. Particularly noteworthy were September (+2.9°C), June (+2.7°C) and December (+2.5°C).

2.2 Annual Rainfall

You may have noticed how wet it was and in fact the annual rainfall for Bristol in 2023 was 1247.6 mm making it the 2nd wettest year since the annual rainfall data started in 1853. The wettest year was 1315.4 mm in 2012. The 30 year average for the city is 913.8 mm so 2023 represents 137% of the average, 400 mm above the average.

The measurable rainfall duration for 2023 was 566 hours or 6.5% of the year. This measurement requires at least 0.2 mm to have been recorded. There were 224 days when the rainfall exceeded 0.2 mm. There were five 24 hour periods (09:00-09:00 GMT) when rainfall was greater than 25 mm. There were 104 days (excluding 'trace' which is less than 0.1 mm) without rainfall in 2023. The longest period without rainfall was for 21 days May 20th to June 9th.

Regarding the annual rainfall the graph below (**Fig. 3**) shows that there is in fact continuous annual data for the city of Bristol goes right back to 1853. Unfortunately some of the early monthly data is missing. 171 years is a good long period with which to be able to look back and analyse trends. It is worth noting that some UK sites go back into the 18th century and the Bristol record is from several different sites around the city so some care should be taken when drawing very specific conclusions about the rainfall and possible trends. From the graph (Fig. 3) below, despite the obvious

inter annual variability of the annual rainfall; there is an almost horizontal dotted linear regression trend line. This demonstrates that overall there is little movement, of either an upward or downward trend, in the total annual rainfall record for Bristol. The ten year solid black line moving average shown on Fig. 3 shows some shorter term rises and falls of rainfall within the dataset. In more recent years, perhaps from the early 1990's, there has been a short term trend of wetter years. Earlier in the 1890's and again in 1960's and 70's there were drier periods. From the graph it is easy to see the wet outliers: 1882 with 1219.9 mm, 1903 with 1200.7 mm, 1924 with 1246.5 mm, 2000 with 1241.9 mm, 2012 with 1315.4 mm and 2023 with 1247.6 mm.

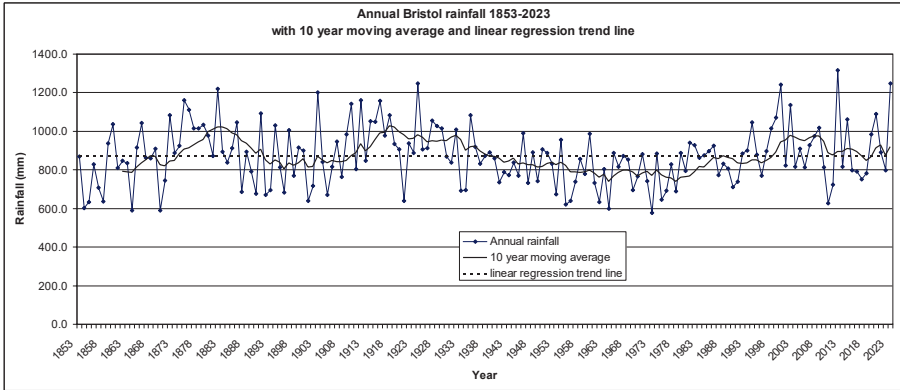


Fig. 3: Bristol annual rainfall 1853-2023 with 10 year moving average and linear regression line.

The graph below (**Fig. 4**), depicting the monthly rainfall for 2023 shows striking anomalies with some very wet months in excess of their 30 year averages. The 30 year average for Bristol broadly shows a wet autumn and winter and a drier spring and summer. April is usually the driest month whilst December is the wettest. Summer rainfall data can be misleading, for example in an essentially dry month, the monthly rainfall can be high if an intense thunderstorm occurs causing a heavy downpour and short term flooding, with several millimetres of rainfall falling in a short period of time. This tended not to happen in 2023, even though July was much wetter than usual there were no days of thunderstorms recorded. March 2023 was the wettest since records began in 1853 with precipitation being 305.9% the 30 year average for the month, though there are 13 early March's with data missing. December 2023 was the wettest month in terms of quantity of rain with 199.7 mm which is 196.2% of its 30 year average.

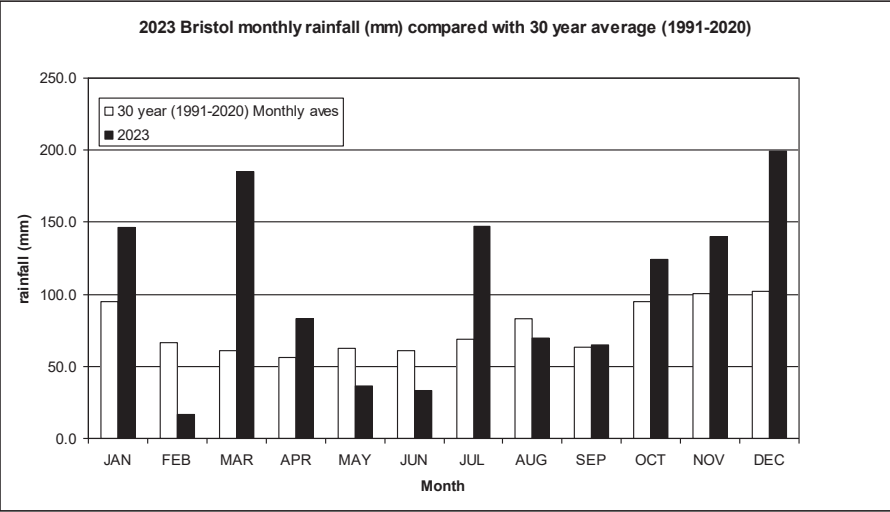


Fig. 4: 2023 Bristol monthly rainfall compared with 30 year average.

Fig. 5 shows, as expected, a rainfall duration with a similar pattern to the rainfall graph (Fig. 4). This shows March, July and December standing out, and to a lesser extent April, which usually has little rain in our area.

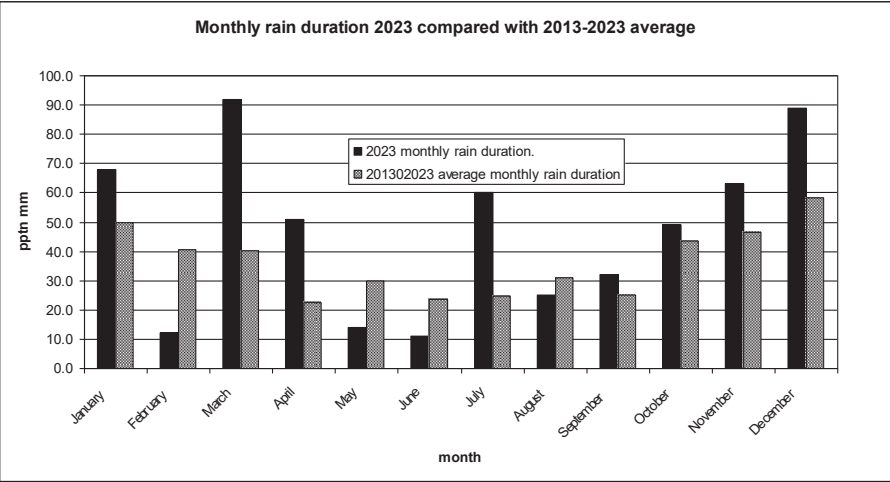


Fig. 5: Monthly rain duration Bristol compared with 2013-2023 average.

2.3 Wind and Pressure

2023 was a windier year than 2022 with an average wind speed of 4.6 mph but it was still below the average of 5.4 mph which is the average from when records began in 2005. There were more ‘calm’ days in 2023 at 4.9% than the average percentage (2005-2022) of 1.4%, but they were less than the 7.1% recorded in 2022. A calm day is when the average daily wind speed is less than 0.5 mph. There was no wind speed gust greater than 50 mph 2023. The highest gust was 44 mph on 10th April.

The daily wind direction in **Table 3** below is broken down into 8 main compass points by month. One fairly consistent weather statistic is the annual wind directions for Bristol. In 2023 this follows the typical pattern of the South Westerlies (SW & WSW) being the dominant wind direction in our region. South Westerlies accounted for 47.9% of the total days with North Easterlies accounting for 17.5% of the total wind directions. This data is calculated automatically by the weather station’s software. The annual average pressure of 1012 mb was the lowest since 2012.

2023	N	NE	E	SE	S	SW	W	NW	Calm	Total
January	3	0	0	0	0	18	4	1	5	31
February	4	4	0	3	0	13	2	0	2	28
March	4	5	0	0	5	14	3	0	0	31
April	4	9	1	1	3	10	2	0	0	30
May	4	17	0	0	0	10	0	0	0	31
June	1	13	0	0	0	14	2	0	0	30
July	1	1	0	1	2	21	5	0	0	31
August	2	1	1	1	2	13	8	1	2	31
September	3	4	1	0	3	9	4	0	6	30
October	3	4	2	0	2	18	2	0	0	31
November	0	6	0	0	1	18	3	0	2	30
December	4	0	2	1	1	17	5	0	1	31
Totals	33	64	7	7	19	175	40	2	18	365
Percentage for year	9.0%	17.5%	1.9%	1.9%	5.2%	47.9%	11.0%	0.5%	4.9%	100.0%

Table 3: Daily and monthly wind direction by month 2022

As noted earlier to some small extent 2023 saw a slight increase in wind speeds but in the graph below, **Fig. 6**, 2023 still lags behind the longer term average with regard to monthly average wind speeds. Only July and December 2023 saw above average monthly wind speeds whilst February, April to June and August to October saw wind speeds below the longer term monthly averages.

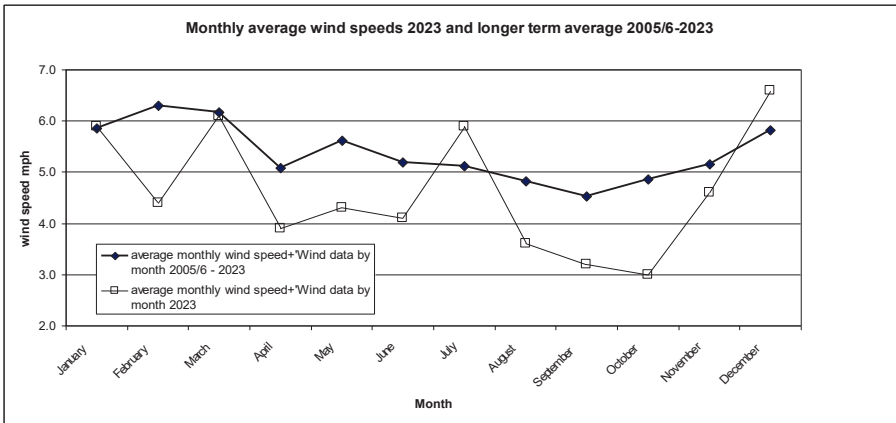


Fig. 6: Monthly average wind speeds with longer term average 2005/2006.

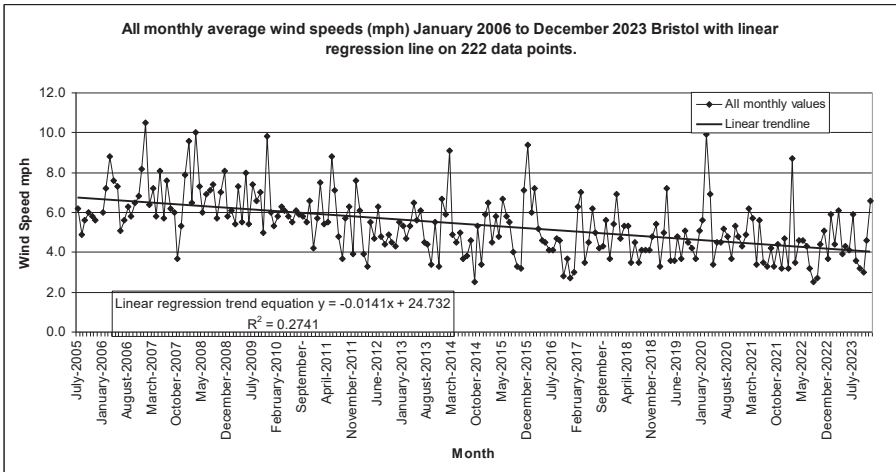


Fig. 7: Average monthly wind speeds mph Bristol 2006-2022

Fig. 7 shows all the average monthly wind speeds starting in May 2005. The added linear regression line on the graph shows a clear lowering of wind speeds as we come into to the current period. In the earlier part of the time series average monthly wind speeds were generally between 6 to 8 mph. Much more common in recent times, 2016 onwards, average monthly wind speeds have been 3 to 5 mph. This also explains the increase in 'calm' days as discussed earlier. The author has no evidence based explanation for this but it is possible that the equipment is under reporting. However this is thought to be unlikely as in early January 2024 a wind speed gust of 51 mph was recorded. This is often the upper limit for wind gusts in this relatively inland

urban setting. Fig. 7 also shows the above average winds speeds well. In 2023 the highest average wind speed was in December with 6.6 mph. More notable in the past was February 2020 with 9.9 mph, and the windiest month in this relatively short time series. With regard to the average wind speed the windiest month was January 2007 with an average wind speed of 10.5 mph.

We can see from **Figures 8a and 8b** that the predominate wind direction for Bristol over 2023, and the 18 year longer term average, were from a South Westerly direction (202° to 247° - SSW-WSW) as seen in Table 3 earlier. There are however some subtle differences between the longer average and last year. There has been an increase in north easterlies, westerlies and 'calm' winds in 2023 and a corresponding decrease in south westerlies, southerlies and northerlies. There is some discussion with what is called 'drift' within the data when the equipment is moved. This last happened in 2010, but the writer thinks that the overall picture and longer term changes are broadly maintained. The increase in calm days has already been noted.

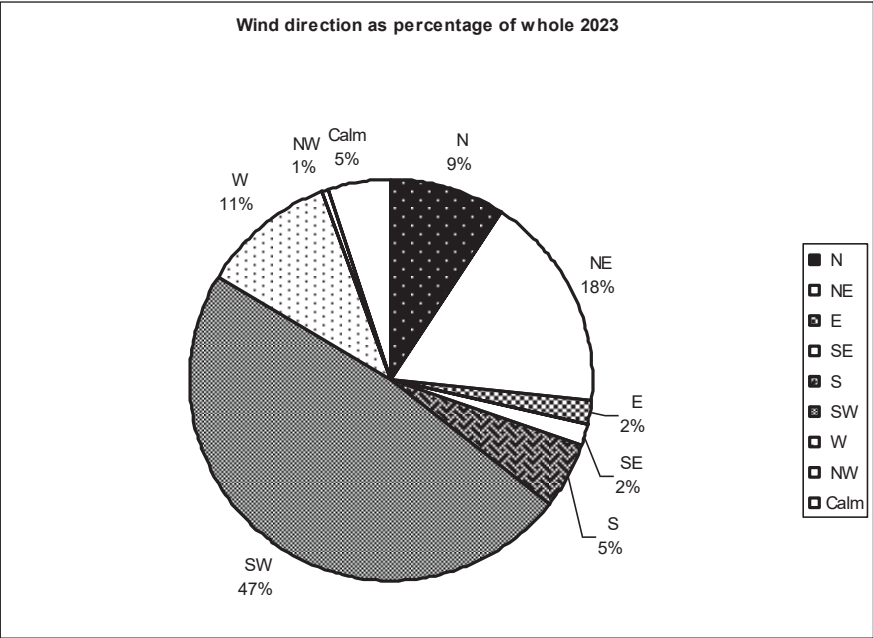


Fig. 8a: 2023 percentages of wind direction

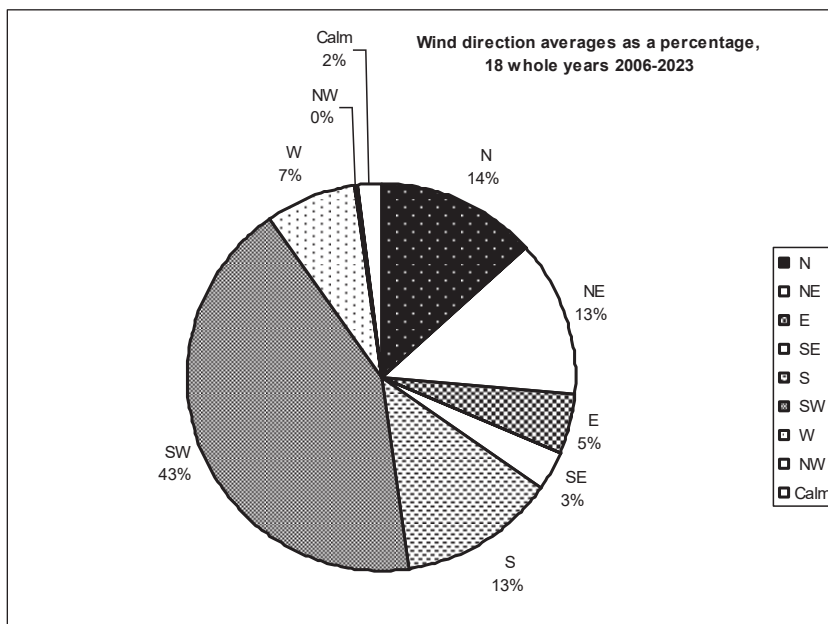


Fig: 8b: 18 whole year (2006-2023) percentages of wind direction.

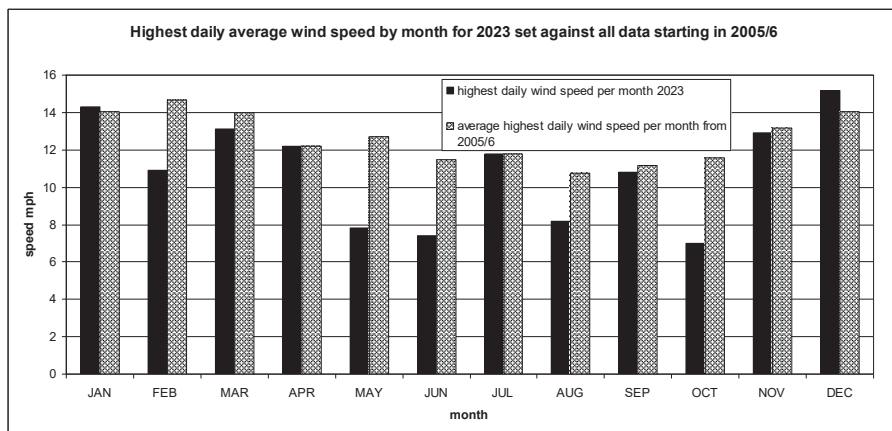


Fig. 9: Highest daily average wind speeds by month compared with the longer term average.

The above graph (**Fig. 9**) shows the highest average daily wind speed during each month and this is set against the longer term average. In 2023 it is seen that the highest daily wind speed occurred in the months of January, March, November and December, with October 2023 being the least windy of the year with regard to the

daily average high wind speeds per month. Compared with the longer term average, from 2005/6, five of the 2023 months were significantly calmer.

There is some evidence that changes to the Jet Stream are weakening the wind speeds regionally. These wind speeds are, in turn, due to the asymmetric differences in the temperature changes between the Arctic and mid latitudes, differences which have been reduced by global warming. The Arctic is warming faster than scientists had predicted. This means the temperature gradient (and therefore pressure gradient) between the north and the mid latitudes are less great and so less windy with more high-pressure (or 'blocking?') patterns over the north eastern Atlantic and Greenland. One must be careful in interpreting local phenomena and correlating it with global influences but it is very marked how average wind speeds have fallen in the last 17 years at the local site. One wonders if this trend will continue.

2.4 Other parameters

There were 19 days of air frost as seen in **Fig. 10** below. The graph has a linear regression line fitted and it can be seen that the number of frosts has been declining. The total time in 2023 that the temperature was below 0.0°C was 144 hours. There were 5 days of thunderstorms (11th January, 12th June, 26th August, 5th September and 2nd October) and 4 days of small hail (14th March, 12th April, 1st November and 30th December). There was only 1 day of snowfall which was lying for 1 day at 09:00 GMT on the 8th March.

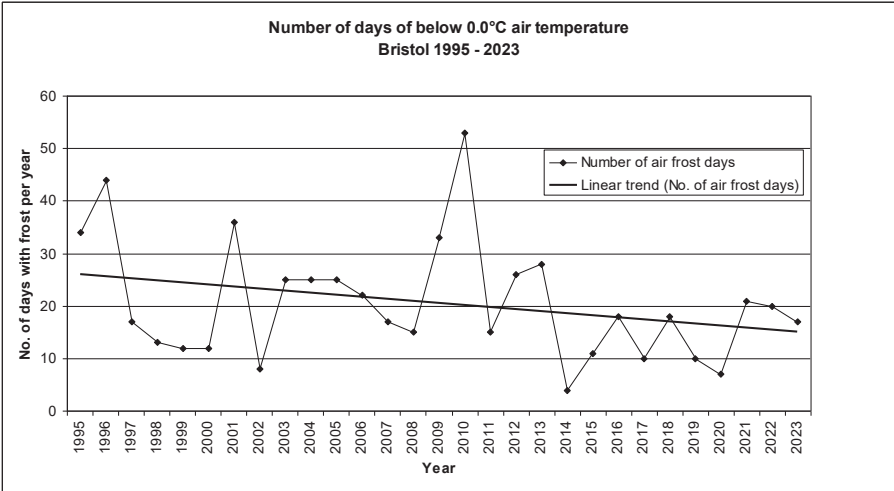


Fig. 10: number of days with temperature less than 0.0°C

With regard to sunshine, measured as solar radiation, in 2023 it was very close to the yearly average for the percentage of maximum sunshine at 39.1%. The average (2006-2023) is 39.9%. The sunniest year in this relatively short time series was 42.5% in 2020. In 2023 the average megajoules per square metre (MJ m^{-2}) was 9.48 MJ m^{-2} . The average 2006-2-23 is 9.39 MJ m^{-2} . From the graph (Fig. 11) below, it can be seen that May and June were the sunniest months whilst March was the standout dulllest month with regard to the average maximum percentage sunshine. April's deficit of sunshine is also seen. Most of the other months are close to their longer term average.

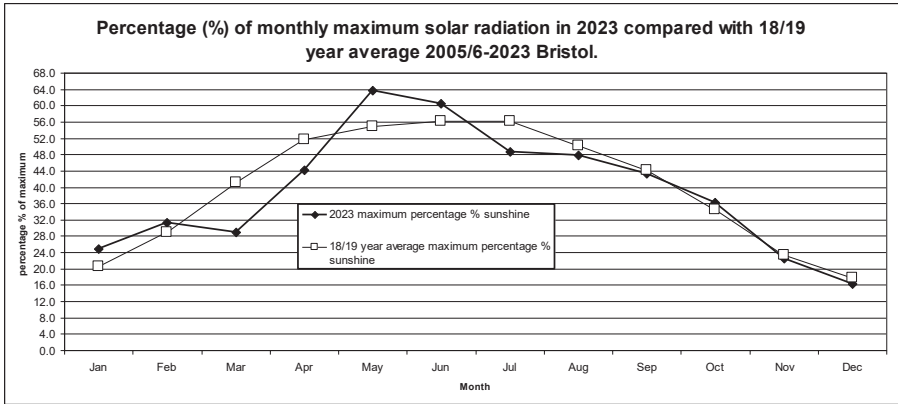


Fig.11: Maximum monthly % of solar radiation for 2023 compared with longer term average.

3 Seasonal data

3.1 Winter 2022/23 (December February)

With an average winter temperature of 6.2°C it was 26th warmest in Bristol in 133 years of data. It was 0.3°C above the 30 year average for the city. The total rainfall for the 3 winter months was 462.4 mm. The 30 year average for the city is 260.7mm, 173% above the average. This total makes 2022/23 the 3rd wettest winter in 142 years in the city after 2013/4 493.4 mm, and 1994/5 463.8 mm. There were 26 days of frosts for a total of 243 hours. This was the equal highest, with 2013/4 with regard to days of frost since the data started 10 years ago. There was only one day of snowfall for the winter of 2022/23. Note the winter seasonal figures span more than one calendar year whereas the annual data does not.

3.2 Spring 2023 (March May)

The spring of 2023 was the 13th warmest with respect to the average temperatures, with a mean temperature of 11.1°C . Continuous data for the city started in 1891. The

spring rainfall of 2023 was the 5th wettest out of 142 years of data with 304.5mm. The 30 year average is 179.5mm so 2023 represents 170% of the average.

3.3 Summer 2023 (June August)

The summer of 2023 was the joint 18th warmest, with 2021, in 133 years. With an average temperature of 18.1°C it was 0.4°C above the 30 year average. The warmest summer was 1995 with an average temperature of 19.4°C. The coolest summer was in 1954 when the average temperature only reached 14.4°C. The summer rainfall total was 250.6 mm which was 118% of the 30 year average of 212.7 mm. It was the 40th wettest summer in 142 years of data for Bristol.

3.4 Autumn 2023 (September November)

It was the warmest autumn on record in 133 years of data for Bristol. The mean temperature was 13.8°C which was +1.8°C above the 30 year average of 12.0°C. It was the 24th wettest autumn on record in 142 years of data. With a total rainfall of 329.8 mm in the autumn it was 127% above the 30 year average of 258.8 mm.

4 Monthly data

January 2023 was very clearly split into two halves. From the 1st to the 15th the weather was very wet and mild. In the second half it was much dryer and colder until the last week when temperatures recovered. The consequence of this was for the monthly average temperature of 6.3°C to come out at a very modest 0.6°C above the average for the month. Rainfall for the month, despite the dry last two weeks, on the other hand was still high at 146.3 mm (154.5% of the 30 year average). It was the wettest January since 2014 and continues a slightly rising January rainfall over the historical period starting in 1853. There was no snowfall but there were 9 consecutive days when frost was recorded. There were 71 hours when the temperature was below 0.0°C in the month and this is the highest in January since this data started in 2016. It was the sunniest January since records began in 2006 with 24.8% of the maximum. The average for January is 20.2%. Nearly 60% of the wind direction was from a south west (SW) or west south westerly (WSW) direction despite the cold snap in the month which mainly saw calm days.

February With high pressure dominant for much of the month, it was dryer and warmer than average although high pressure at this time of year doesn't always mean warm days. It is often down the source of the winds and this can be from a cold continental Europe in the East. Wind speeds were abnormally light for the time of the year. Rainfall was well below average for the month and there were 11 consecutive days without any measurable rainfall. The total rainfall was 16.7 mm, only 25.2% of the 30 year average. It was the driest February since 1993 and followed four months of above average rainfall. The average temperature for the month was 7.4°C which is

1.4°C above the 30 year average. The lowest daily maximum temperature for February of 7.4°C on the 25th was the highest since 8.0°C was recorded in 1960 and is the 2nd highest since this data started in 1960 in Bristol. Pressure was high and the average of 1028 mb for the month was the 2nd highest since records began in 1994. The highest was 1031 mb in 2012 which was the highest for all months at the current site. It was the sunniest February since 2019 with regard to the actual percentage of maximum sunshine, but the 09:00 hours measurement of the overcast nature of the sky was 75% which is a duller than average start to the day. On average the days of February 2023 brightened up as the day progressed.

March The monthly total rainfall of 185.4 mm was the highest recorded in March in Bristol since records began in 1853. The previous record was 165.1 mm in 1869. The rainfall of March 2023 was 306% of the 30 year average for the month of 60.6 mm. It was the 24th wettest of all 1,899 months with data. The record is held by September 1918 which recorded 258.3 mm. The average temperature for the month was close to the 30 year average at 8.4°C. This was 0.4°C above the average but it masks -0.3°C lower than average maximum temperature and 1.1°C higher than average minimum temperatures. The mean maximum temperature in March was only 0.5°C above that of February. It was the duller March on record with only 28.9% of the maximum sunshine when the average is 41%. This data started in 2006. The average wind speed of 6.1 mph for the month made it the windiest month since February 2022 and the average monthly pressure of 1007mb was the lowest for the month since 1001 mb in March 2018.

April 2023 was a cooler than average month, with higher than average rainfall. The average temperature of 10.0°C was -0.6°C below the 30 year average. Maximum temperatures were -1.0°C on average. The minimum average temperature of 6.2°C was -0.3°C below the 30 year average. The rainfall for the month of 82.7 mm was 146.4 %, above the same 30 year average. April 2023 was the wettest since 2012 when 170.0 mm was recorded. The 30 year average for the month is 56.5 mm. The maximum percentage sunshine for April 2023 was below average at 44.1%. The average since the data started in 2006 is 51.6%.

May 2023 was warmer than average. The mean temperature of 14.9°C was 1.2°C degrees above the 30 year average. Rainfall was below average at 58.3% of the same 30 year average. All of the 36.4 mm of rain that did fall in the month was in the first 19 days. From the 20th May there were 12 consecutive days of no rain. Over the same period the predominate daily wind direction was unusually from a North Easterly direction. With 63.8% of the maximum sunshine recorded for May 2023 it was the 2nd sunniest since this data started in 2005. The average of all of May's data starting in 2005 is 55.2%. The highest recorded for the month was in 2020 when 74.2% of the maximum sunshine was reached.

June It was the hottest June on record with regard to the average temperature in Bristol since 1891. With an average of 19.3°C it was 2.7°C above the 30 year average. The previous warmest June was in 2018 when the average was 18.4°C. The average maximum and average minimum temperatures for June were also records. The average maximum temperature at 24.4°C was 3.5°C above the 30 year average, and the average minimum temperature of 14.1°C was 1.7°C above the 30 year average.

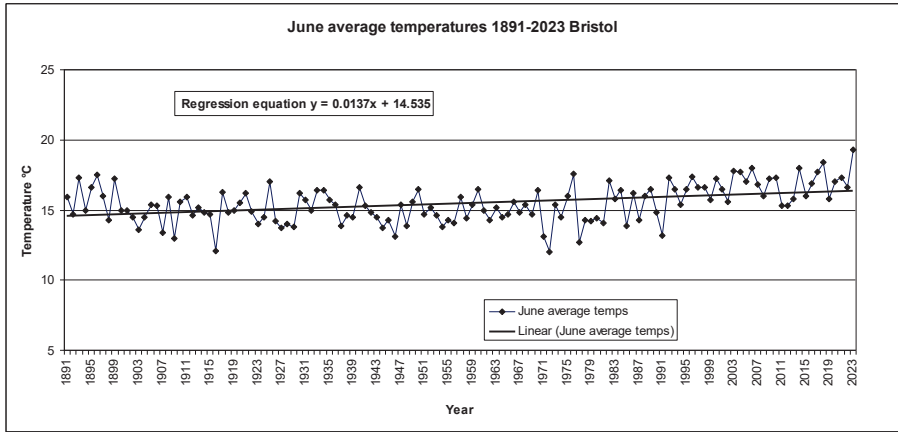


Fig. 12: June average temperatures 1891 – 2023 Bristol

Fig. 12 shows all the continuous records of average June temperatures since 1891. We can see the high temperature of 2023 and with the regression line we can calculate that in 133 year of data for the city the temperature for June has risen approximately 1.8°C. The total rainfall for the month was 33.2mm which is 54.3% of the 30 year average for the month. It was the driest June since 2018 which only had 4.0 mm.

July 2023 was a dull, wet and windy month with rainfall well above average. Temperatures were below average and sunshine levels low for this time of the year. It was also a windier month than average with low air pressure for this time of the year. Rainfall for July 2023 was over double the average for the month at 147.7 mm which is 214.2% of the 30 year average. It was the 6th equal wettest July, with 2009, since records began for Bristol. The wettest was 1888 with 161.8 mm. Measurable rain fell for 60.3 hours which represents 8% of the whole month. The average temperature for the month of 17.2°C was -1.3°C below the 30 year average and was the coolest July since 2012 which had an average temperature of 17.0°C. Notable was the low mean maximum temperature for the month of 20.5°C which was -2.2°C below the average, whilst the mean minimum temperature was only -0.3°C below the average. With an average air pressure of 1004 mb it was the lowest recorded for this site for a July from the data that started in 1995. Wind speeds were higher than the average with the highest daily gust average for the month of 25 mph This was the highest for any month since May 2021 which was also at 25 mph. Two thirds of all

the predominate daily wind directions were from the SW or WSW. It was a dull month with only 48.4% of the maximum monthly sunshine when the average is 55.9%. This was a lower average percentage sunshine than the months April through to August. It was the dulllest complete July month of data since records began in 2005.

August The August average temperature of 17.8°C was 0.3°C below the 30 year average for Bristol. It was a duller than average month with 47.8% of the maximum sunshine. The August rainfall of 70.0 mm was 84.4% of the 30 year average for the month. Notable for the second consecutive month was the low air pressure values. The average pressure in August of 1006 mb was the lowest for the month since this data started in 1995. Likewise the lowest pressure for the month of 979 mb was the lowest for August since this data started. The highest pressure of 1016 mb was the lowest for the month in the same period. The predominate westerly wind direction for August was the first time this has occurred in any month since March 2011.

September It was the warmest September on record since this data started in 1891. With an average temperature of 18.4°C it was +2.9°C above the 30 year average. The previous warmest was 2006 with an average temperature of 17.7°C. September was warmer than both July and August. The average minimum temperature of 14.3°C for the month was the highest since continuous data started in 1894. The average maximum temperature of 22.5°C was the second highest since 1895.

Year	Temperature °C	Rank (Hottest first)
2023	18.4	1
2006	17.7	2
2014	17.5	3
2021	17.5	3
1895	17.1	5
2016	17.1	5
1999	16.9	7
2005	16.8	8
1949	16.6	9
1898	16.5	10

Table 4: Ten warmest Septembers in Bristol since 1891 ranked.

Table 4 shows 2023’s number one position as the warmest September in 133 years of data. Unlike some of the other temperature data there are warm Septembers from earlier years in the time series. Particularly notable in the above table is 1895 which was the joint 5th warmest September in the time series. It must have felt particularly warm that year as the annual average temperature was only 9.9°C as opposed to 12.6°C in 2023. Rainfall was close to the 30 year average at 65.0 mm. The average

pressure of 1012mb was the lowest since 2006 when the average pressure at 09:00 hours was 1011 mb. Wind speeds were very low in the first half of the month but picked up in the second half.

October was another warm month. It was the 6th warmest since continuous records began in 1891. With an average temperature of 13.9°C it was 1.9°C above the 30 year average. The average maximum temperature for October of 17.2°C had a larger anomaly of +2.1°C set against the 30 year average. Rainfall was 131.3% above the 30 year average at 124.5 mm.

November Despite a short cold period at the end of the month the average temperature of 9.0°C was still 0.6°C above the 30 year average. The monthly rainfall of 140.3 mm was 139.6% of the 30 year average. It was as usual a predominately SW/WSW wind direction month, only swinging more northerly in the last few days of the month.

December The average temperature of 8.6°C was 2.5°C above the 30 year average. It was the joint 4th warmest December with 2018. The total rainfall was 199.7 mm. This was the 3rd highest since continuous annual records for Bristol began in 1853. The wettest December was in 1929 with 205.2 mm, followed by 200.0 mm in 1965. Furthermore, it was the 11th wettest of all months in Bristol's known data record. The 30 year average for Bristol's rainfall is 101.8 mm so 2023 was 196.2% of the average. It was a dull month with restricted sunshine only amounting to 16.4%. It was the 3rd dullest month on record which started in 2005. December 2023 was the windiest month since February 2022 and the windiest December since 2015.

5 Some notable events in 2023

5.1 Temperature

The lowest daily maximum temperature of 1.1°C on the 21st January was the lowest for the month since 0.2°C in January 2013. The lowest daily mean temperature of -0.7°C also on the 21st was the lowest for January since 2010.

The highest daily maximum temperature on the 29th April of 19.0°C was the lowest since 18.2°C was recorded in April 2016.

The lowest daily maximum temperature of 16.2°C on the 8th May was the highest recorded for Bristol since this data started in 1960.

The lowest daily maximum mean temperature of 16.4°C on the 4th of July was the lowest for July since 16.1°C in 2015. The highest daily mean of 21.4°C on the 7th was the lowest for July since 20.4°C was recorded in July 2011.

There were some notable daily maximum temperatures in September. From the 4th to the 9th consecutively the maximum daily temperature reached over 30.0°C.

On the 4th and 6th the maximum reached was 30.7°C and these were the highest temperatures of 2023. The maximum minimum temperatures of 20.8°C recorded on the 7th and 10th were the highest for September since the data started in 1960. The daily maximum temperature of 24.5°C on the 8th October was the 3rd highest for the month since continuous data started for Bristol in 1891. The minimum temperature of -1.4°C on the 25th November was the lowest for the month since -3.3°C was recorded in 2016.

5.2 Rain

January 11th 2023 saw a 24 hour rainfall of 43.2mm. This was the second highest for the month. The highest was 52.0mm in January 1926 with data starting in 1893. Between 11th and 13th of January 77.3 mm of rain was recorded.

The wettest 24 hour period in March 2023 was 23.2 mm on the 31st. This was the highest for the month since 27.2 mm in March 2016.

Almost half of May's monthly total rainfall fell in one 24 hour period on the 8th May. Between 10th to the 15th July there was 88 mm of rain recorded. The 30 year average for the whole of July is 68.8 mm so in those 5 days there was 128 of the month's rainfall.

The maximum 24 hour rainfall of 33.9 mm recorded on the 9th of November was the most for the month since 2012 when 39.8 mm was recorded.

The 35.0 mm 24 hour maximum rainfall on the 4th of December was the highest since 37.7 mm was recorded in 2013. In the last 7 days of December at the year end there was 77.3 mm of rain recorded.

5.3 Hail

Small hailstones (less than 5 mm) were recorded on 14th March, 12th April, 1st November and 30th December.

5.4 Wind and pressure

The 09:00 hour's pressure of 1046 mb on 5th of February 2023 was the highest of the month and 2nd highest of all months since 1994. With regard to the average wind speed it was the 2nd least windy February since records started in 2006. The maximum wind speed gust of 33 mph on 17th was the equal 2nd lowest maximum gust for the month since this data started in 2006.

The highest wind gust of the year of 44 mph was recorded on 10th April.

The maximum daily wind speed of 7.8 mph on the 29th May was the least windy day for the month since this data started in 2006. The maximum gust of 28 mph on the 10th was the equal lowest for the month, with 2012, since this data began in 1995.

The maximum daily pressure of 1011 mb recorded on three days in July were the lowest of any month since February 2014. The highest daily maximum pressure of 1013.8 mb recorded on the 17th July was the lowest for any July with data starting in 2005. The lowest daily maximum pressure of 989.4 on the 15th was the lowest for the month. Pressure this low is usually reserved for the late autumn and winter months.

The low pressure of 976mb at 09:00 GMT on October 20th was the lowest for the month since the data started in 1995. It was the 2nd least windy October with an average wind speed of 3.0 mph since data started in 2005. The lowest was 2.8 mph in 2016. The windiest day of October on the 13th of 7.0 mph average wind speed was the lowest for the month since the data began in 2004.

Pressure was generally low for the whole of November but the 957.2mb at 05:00 hours on the 2nd of the was the lowest recorded at this site since this data started in 2005. The 09:00 GMT hour's pressure started in 1994 and the 962.0 mb recorded, also on the 2nd, was the lowest at this site. Pressure is usually measured at 09:00 GMT but the current software additionally allows anytime low and high pressures to be observed.

The maximum daily wind speed on December 24th of 15.2 mph was the highest of the year.

5.5 Solar radiation

The hourly sunshine record for April was broken on the 25th when 910.3 Wm² (Watts per square metre) was recorded for the hour starting at 13:00 GMT.

6 Conclusion

I can do no better than report from the WMO (World Meteorological Office) that 2023 is the warmest year on record, by a huge margin. Six leading international datasets used for monitoring global temperatures show that the annual average global temperature was 1.45 ± 0.12 °C above pre-industrial levels (1850-1900) in 2023. Global temperatures in every month between June and December set new monthly records. July and August were the two hottest months on record.

Much of this, but not all, has been reflected in the local climate of Bristol and its immediate environs. It is getting warmer and recent winters wetter. Locally we are not exempt from the larger scale global trends and patterns.

The WMO go on to say Climate change is the biggest challenge that humanity faces. It is affecting all of us, especially the most vulnerable. We cannot afford to wait any longer. We are already taking action but we have to do more and we have to do it quickly. We have to make drastic reductions in greenhouse gas emissions and accelerate the transition to renewable energy sources. Let's hope we all realise this and take the appropriate action.

BRISTOL NATURALISTS' SOCIETY



SOCIETY ANNUAL REPORT 2023

1 Society Organisation

This year the Bristol Naturalists' Society has been able to run a full programme of activities with both field meetings and lectures well attended by members. The Bristol Create Centre was adopted as our base for indoor meetings, with its well-equipped lecture theatre and ample free parking making it an ideal venue.

The Annual General Meeting took place at the Create Centre on 15th March 2023. The following members were appointed to serve on the BNS Council for the years 2023/2024 and Ray Barnett formally handed over the Presidency to Rupert Higgins.

Officers

President: Rupert Higgins [1st year of 3-year term]
Hon. Secretary: Vacant (Richard Ashley, acting secretary)
Hon. Treasurer: Vacant (Mary-Jane Steer, acting treasurer)
Hon. Membership Sec: Margaret Fay
Hon. Librarian: Jim Webster
Hon Bulletin Editor: David Davies
Hon. Archivist: vacant
Hon. Publicity Sec: Alex Morss
Hon. Proceedings Receiving Editor: Dawn Lawrence

Members:

Ray Barnett
Tim Corner
Steve Nicholls
Rhian Rowson

Section Reps:

Geology: Richard Ashley
Invertebrates: Maico Weites
Ornithology: Giles Morris
Botany: David Hawkins

At the April Council meeting Giles Morris was voted in as Council Chair. Our grateful thanks must go to both Richard Ashley and Mary Jane Steer for agreeing to continue as acting Secretary and Treasurer until new candidates for these vital posts could be found. Ray Barnett has subsequently offered to take on the role of Society Archivist.

The Proceedings of the Society, Nature in Avon, was published and distributed to members. This was the first from the new editor, Dawn Lawrence, and she is to be congratulated on maintaining the high standard set by her predecessor. Dawn Lawrence has also been integral to the setting up of the Society's new Instagram account, with daughter Tilda, which enables members to share images of the natural world in our area. The site now has over 160 regular followers at time of writing (June 2024). Our warmest thanks also to Alex Morss, Roger Steer and David Strawford for their work in promoting the Society online via Facebook and X (formerly Twitter).

Our other annual publication, the Avon Bird Report, is produced by the Avon Ornithology Group and co-sponsored with us by the Bristol Ornithological Club. Harvey Rose and his team deserve our thanks for another impressive edition.

Our excellent monthly newsletter, Bristol Naturalist News, has kept members informed and in touch throughout the year. David Davies continues to do outstanding work under great time pressure each month as its editor, chasing up and editing submissions. The consistent high quality of the Bulletin accurately reflects his industry, tact and professionalism and we should not take it for granted.

2 Society Events

Our programme of Society Winter Lectures mostly took place in the Create Centre this year with only one Zoom lecture in February. By posting recordings of our talks on the website the talks remain accessible even to members who are unable to get to the venue. Our thanks to Peter Holladay for his expertise in setting up this service.

The following Society talks were held during 2023:

- January:** The Bristol Avon Rivers Trust, speaker: Amy Wade; the work of this charity which delivers education, land and river management advice and practical river restoration work throughout the Bristol Avon catchment.
- February:** Wild Fell, Haweswater, speaker: Lee Schofield; a personal account of a decade of work to breathe life back into 3,000 hectares of moorland, mountain, meadow and stream in the Lake District National Park.
- March:** Society AGM & The Continuing Discovery of Our Native Flora, speaker: Fred Rumsey; the Clive Lovatt Memorial Lecture on new additions to our flora.

- October:** The Evolution of Flowers, speaker: Nick Wray; an exploration of the diversity of floral reproduction (this was the postponed 2022 Clive Lovatt Memorial Lecture).
- November:** Pollinator Ecology and Conservation, speaker: Prof Jane Memmott; research on the importance of pollinators in Britain and abroad.
- December:** Saving the Planet through Poetry, speaker: Martin Kiszko; Bristol's own Green Poet gave us a thought-provoking insight into the planet's problems.

3 Grants given in 2023

Bristol Regional Environmental Records Centre – support for reprinting 'The Geological Sites of Bristol'. 1000.

Andrew Cummins – This application is for a project to ring birds and to record their biometrics, age, breeding and moult condition at a nature reserve site near Portbury. The group are British Trust for Ornithology volunteers. The grant is to be used to buy equipment. £398.

Lyndon Roberts – support for the publication of 'A Life with Buzzards' by Robin Prytherch. Robin was a well-known local bird watcher who studied the buzzards for more than 40 years in a 75 square-kilometre area in the Gordano valley, west of his home in Long Ashton. £500.

Dee Holladay

4 Website Report 2023

The website has now been in operation for 18 months. Relations with Pixelfish continue to be good – queries, upgrades and fixes required have been dealt with quickly. We have had well over 100 new members during that time, which is probably double the previous average. Renewals are automatic after a warning email which allows the member to cancel if they wish. The membership secretary has access to the PMPro system.

Grants: We have had 5 applications via the website this year, 3 of which have been accepted for funding (see above).

Editing: Three members can edit and also add Events: Giles Morris, Tim Corner and Dee Holladay. (The system deletes past events, normally within 24 hours.) Any complex edits are done by Pixelfish.

Zoom meetings: If lecturers have provided permission, Zoom meetings are recorded and added to the Members' Area. Some live Indoor Meetings have also been recorded this year and are also available. *It is important that these links are not shared.*

Dee Holladay

5 The Library

Following the Covid lockdown, the library committee took the decision to reopen the BNS library to members on the first Saturday of each month; or by appointment. This appears to have worked well and will continue until there is an increased demand for the service.

While the lending aspect of the library has been subdued, the committee has not been inactive. In addition to its superb lending library collection, it houses a large number of vintage bound journals from many different societies, plus the BNS archives. Also, for over half a century has become the place to store possibly useful equipment, surplus magazines etc. A start has now been made to sort and organise this material stored around the library room and in the overloaded stock room. This is a long-term project, which should result in an attractive library, with all its contents readily located via the computer, in a similar manner to the lending library books.

I would like to personally thank all the Museum and Art Gallery staff for all their friendly and unfailing help over many years.

Jim Webster Hon Librarian

6 Section Reports for 2023

Botany Section

The Botany Section held thirteen field meetings and one indoor meeting in 2023 (one more of each than in 2022). The section committee continued from the previous year, featuring Helena Crouch, David Hawkins (Secretary), Rupert Higgins, Nicky Hodges, Jenny Greenwood and John Thompson. In light of the fact that we failed to convene for a section AGM in 2022, the new committee was sworn in/re-elected at our AGM and Members' Evening in January 2023, which took place at the Alma Church in Clifton.

Again, we participated in the Botanical Society of Britain and Ireland's (BSBI) annual New Year Plant Hunt at the beginning of January. Helena Crouch led a sharp-eyed group around Weston-super-Mare, finding 53 species in flower (in the top ten totals for the country!). The most exciting item of the day was a large plant of Striped Goosefoot *Chenopodium strictum*, spotted by Dawn Lawrence. The aforementioned AGM evening also featured a series of fascinating short talks from members,

covering: adventive aliens in Somerset (Helena Crouch), rhine flora of the Gordano Valley (David Hawkins), fungal finds at St George's Flower Bank – 171 species and counting! (Jean Oliver), and toxic algal blooms (Brian Ottway).

February saw us link up with old friends the Gloucestershire Naturalists' Society for an investigation of winter twigs in Leigh Woods, led by Clare and Mark Kitchen. A flushed woodcock was an unexpected bonus. The March meeting in West Tanpit Wood, Lower Failand, was notable for experiencing the highest attendance of recent years: 35 botanists of all levels were present, which presented a few challenges when trying to make sure everyone saw items of interest. Thankfully, we naturally split into several smaller groups with expertise dispersed among them. With spring now in full flow, Rupert Higgins led an April meeting at Westonbirt Arboretum, where a small patch of Lady's-mantle *Alchemilla filicaulis* subsp. *vestita* was an exciting find for our region.

For the Maying we visited Cleeve Wood (beyond Hanham, not near Cleeve), targeting Bath Asparagus aka Spiked Star-of-Bethlehem *Ornithogalum pyrenaicum*, nationally rare but a local speciality, which we encountered in abundance. In June we held two meetings, both of which saw exceedingly dry conditions and parched vegetation. The first was a weekday evening at Goblin Combe, led by Helena Crouch as a joint meeting with Somerset Rare Plants Group. Despite the drought this was still rewarding, and Limestone Fern *Gymnocarpium robertianum* was located on the north-facing scree. Later in the month, thanks to Jenny Greenwood we were granted special access to a private section of the Mendip ridge at Shiplate Slait. This exceptionally rich limestone grassland held many delights – albeit some of them stunted by the extreme dryness – including Somerset Hair-grass *Koeleria vallesiana*.

Some rain happened at last, enough to get a decent flow into the River Frome – as we saw when visiting the Black Rocks area of Frampton Cotterell in July. Two members of local group Frampton Cotterell Nature kindly showed us around their patch, pointing out many items of interest. In the river, abundant Stream Water-crowfoot *Ranunculus penicillatus* subsp. *pseudofluitans* was flowering. August then found us wandering under the big skies of Nailsea Moor, where the rhynes are rich and curious. There was something for everyone, from Arrowhead *Sagittaria sagittifolia*, to Frogbit *Hydrocharis morsus-ranae*, to the floating liverwort Fringed Heartwort *Ricciocarpos natans*, to Fragile Stonewort *Chara globularis*.

Our customary pilgrimage to the saltmarsh happened in September, with a visit to Severn Beach where Rupert Higgins guided us through a varied flora which included flowering Marsh-mallow *Althaea officinalis*. In October, an urban meeting was held at Hengrove Park. Rupert led again and was able to refind the site's notable species in the form of Narrow-leaved Bird's-foot-trefoil *Lotus tenuis* and Dyer's Greenweed *Genista tinctoria*.

Bryophytes were the focus in November, with a beginner-friendly meeting at Arno's Vale cemetery. As ever, it was good to see some new faces among the familiar fellow-travellers. Finally, we ended the year as we began it: the BSBI's New Year Plant Hunt can happen anytime from 30th December to 2nd January and we chose the first of those dates. Scrutinising the kerbs, verges and rough ground of Portishead mustered an impressive 69 species in flower, in a year of high totals nationwide.

This year attendance maintained the good numbers seen in 2022, and probably witnessed a slight increase again. The exceptional numbers at West Tanpit Wood were not quite repeated, and if they were then in several cases we would have needed to split up into more than one group at the outset of the meeting in question.

In addition to meeting reports, the bulletin also held discussions of notable records and curios. Special mention once again goes to Dylan Peters, who made various interesting discoveries throughout the year and also offered details on the likes of dandelions, comfrees and the unpredictable nature of the seedbank, among other things.

Grateful thanks go to all BNS members who sent in records and queries – whether vascular plants, bryophytes, lichen or fungi – and especially to everyone who contributed material that was reproduced in the bulletin.

I shall end in the same way as last year, by recalling a remark that Clive Lovatt was fond of repeating. The adage belongs to J.W. White, and is found in his seminal *The Bristol Flora* (1912): 'Finality in field botany is fortunately unattainable.' So we keep hunting.

David Hawkins, Hon Secretary

Geology Section

At the Geology Section Annual General Meeting held by Zoom on Monday 20th March 2023 the Annual Report for 2022 was approved. Richard Arthur was re-elected as President of the Section and Mark Howson was elected as Section Secretary. Richard Ashley agreed to help the new Secretary by continuing to represent the Geology Section on the BNS Council.

The following Field Meetings were held during the year:

Sunday 4th June, Portishead Coast, leader Mark Howson

Saturday 24th June, Somerton and Langport Quarries, leaders Simon Carpenter and John Whicher (joint meeting with Dorset Geologists Association Group)

Sunday 16th July, Ogmore by Sea, leaders John Nudds and Cindy Howells (joint meeting with South Wales GA)

Sunday 3rd September, The Lower Cornbrash (Middle Jurassic) near Woolverton, Somerset, leader Simon Carpenter

Saturday 9th September, Cheddar, leader Richard Arthur

Reports of these meetings were printed in *Bristol Naturalist News* and in addition to these reports there were a number of short articles relating to geology written by members of the Section; particularly Richard Arthur.

The 2022 edition of *Nature in Avon* (Proceedings of Bristol Naturalists Society) printed in 2023 included four geology papers for the most part contributed by members of the section. Members of the section have continued to be active in geological investigation and research including the writing of Papers. Members are also involved in the writing of chapters for the new Geologists' Association guide to the Geology of the Bristol Region; that it is hoped will be published in time for the Geologists' Association Conference in Bristol in September 2023.

Mark Howson and Richard Arthur have also been involved through the Avon RIGS Group in advising Bristol City Council on measures that both protect the public and yet still allow the geology to be seen at roadside exposures in Frenchay Park Road and on Suspension Bridge Road.

Mention should also be made of the work of Simon Carpenter in helping curate important geological collections at the Somerset Earth Science Centre

Richard Ashley

Ornithology Section

Committee

Giles Morris: Honorary President:

Mel Parker: Honorary Secretary

Mike Johnson: Committee Member

Alastair Fraser: Committee Member

2023 was a good year for the section. COVID seems a distant memory now, and the number of members attending the field meetings has increased.

The weather for the year has continued unpredictable, with unseasonable extremes of temperature and rainfall. Named storms have lashed the southwest and driven a number of migrating birds well off course.

Indoor Meetings

The monthly indoor meetings have been held regularly, with a mixture of Zoom and in person talks. The Create Centre is a central and well-equipped venue; including hot water urns and crockery (they even do the washing up).

January: 35 Years Birding in Portugal by Frank McClintock – our first international zoom talk from a unique birding centre in the Alentejo.

February: Ham Wall, a Volunteer's Story by Bob Buck – Ham Wall's story told by this BNS member who has worked there from the early days.

March: The Use of Drones in Conservation by Dr Jim Vafidis – an insight into the technology used in conservation.

October: Pool Harbour Osprey Project by Brittany Maxted – how Ospreys have been successfully reintroduced in Dorset.

November: WWT Steart Marshes by Alys Laver – the reserve's site manager discussed how this huge project has developed into a superb nature reserve.

December: The Science and Beauty of Birds by Oliver Smart – a feast of high quality bird images from this accomplished photographer.

Field Meetings

Trips were held in every month of the year except for August, which is typically a quiet month, with breeding largely over and the autumn migration not yet fully underway. We also continued our recent policy of holding two field meetings in each of April, May and June.

January: RSPB Greylake – extensive ice cover restricted the duck numbers, but made other species, such as Water Rail *Rallus aquaticus*, more visible.

February: Chew Valley Lake – notable for good views of the long-stay female Smew *Mergellus albellus*.

March: Keynsham – a birding walk along the River Avon.

April: Blaise Estate – an enjoyable walk, but Blaise on a busy Sunday morning did not provide the best birding experience!

April: Leigh Woods – plenty of spring bird song, but another very busy weekend venue.

May: Portishead – a good mix of spring flowers and bird song.

May: RSPB Ham Wall – a wealth of wildlife with warblers in full song and plenty of dragon and damselflies.

June: Stock Hill – poor weather, but Crossbills *Loxia curvirostra* in the woods and Cuckoo *Cuculus canorus* and Stonechats *Saxicola torquata* in the Mineries.

June: Watercress Farm – Alastair Fraser gave us a guided tour of this regenerative farm project.

July: Forest of Dean – this was a joint trip with BOC; few braved the severe storm, with a mature Oak *Quercus* uprooted in the high winds on Nagshead, but a good variety of birds seen and heard.

September: RSPB Newport Wetlands – poor weather again spoiled the visit to this wetland reserve.

October: Severn Beach - a good turnout for the walk to New Passage, a good variety of waders and wildfowl seen.

November: Blagdon Lake - a good mix of species seen at this well watched venue.

December: Clevedon - Grey Wagtail *Motacilla cinerea*, Goosanders *Mergus merganser*, Stonechats and a Peregrine *Falco peregrinus* brightened up a cold morning.

Thanks to the stalwart committee members who lead the walks, come rain or shine. More Committee members are always welcome.

Surveys

Members continue contribute to various Ornithological surveys:

RSPB

Annual Garden Birdwatch

BTO Surveys:

Breeding Bird Survey

Waterways Breeding Bird Survey

Garden Bird Survey

Local Surveys:

The Avon Winter Birds Survey

Counts at Watercress Farm, Belmont Estate

We are actively encouraging more members to participate in these surveys, as these observations make an invaluable contribution to the monitoring of British bird populations.

Mel Parker, Honorary Secretary

Invertebrate Section

In 2023 the Invertebrate Section organised three field meetings. Despite some rescheduling and cancellations due to the ever-unpredictable weather we welcomed several new people to our field meetings and collected some good records.

Our first field meeting of the year was at Troopers Hill on the 3rd of June. Originally this was planned earlier in the year but the weather made it necessary to reschedule our visit. Perhaps this was for the better as we had lovely weather and besides some of the usual attendees we also were able to welcome new faces. The heather-clad hill is an unusual feature in Bristol which is mostly dominated by base-rich soils. This also showed in the invertebrates we encountered. The groundbug *Kleidocerys ericae*, a heather specialist, was very common on the hill for example and we also encountered numerous Large Shaggy Bees *Panurgus banksianus*. This is mostly a coastal species in the UK and the Troopers Hill population is rather isolated but still going strong. The most surprising find was Dalman's Leatherbug *Spathocera dalmanii*, a first record for the county. The nearest other records are from Dorset and Oxfordshire. This small leatherbug was found by sweeping a patch of Sheep's Sorrel *Rumex acetosella*, its host plant.

Jen Greenwood from the Avon Wildlife Trust invited us to visit a site that had only recently come into the AWT's ownership: Hutton Hill near Weston-super-Mare, on the edge of the Mendips. On the 8th of July six of us met up at our starting point and made our way through the grassland armed with nets and beating trays. We had a good mix of more experienced entomologists and people new to the world of small critters and this made for an educative experience as well as a one with a nice species list. In the grassland we found large numbers of singing Roesel's Bush-crickets *Roeseliana roeselii*, Dark Bush-crickets *Pholidoptera griseoaptera* and Long-winged Coneheads *Conocephalus fuscus*. Though not everyone was able to hear these as their song is very high-pitched! Some other notable mentions in the grassland were the lacebug *Kalama tricornis* and a Brown Chafer *Serica brunnea*. At the usual snail's pace we made our way into the wood and here we found lots of ground beetles such as *Pterostichus madidus* and *Abax parallelepipedus*. David Agassiz found numerous micro-moths, often in the form of larval feeding signs. Notable were the larval workings on the spores on the underside on Hart's-tongue Fern *Asplenium scolopendrium* caused by the caterpillars of *Psychoides filicivora*. We were lucky with the weather as it was raining that day before and after the field meeting but we were spared it on our walk!

Our busiest field trip of the year was our joint meeting with the British Entomological & Natural History Society to Priddy Mineries, organised by Ray Barnett. We met at the car park on Old Bristol Road and slowly made our way to ponds on the south side of the reserve. The combination of calaminarian (rich in heavy metals) grassland, woodland, and more boggy areas made for an interesting walk with interesting species such as the ground beetle *Carabus monilis* and parasitoid flies with poetic names such as Waisted Beegrabber *Physocephala rufipes*, Four-banded Beegrabber *Conops quadrifasciatus*, and Sieve-winged Snailkiller *Coremacera marginata*.

Besides the field meetings I have also received several emails from people for identification requests and about interesting invertebrates they have lurking in their gardens. Please continue doing so as this can lead to bits for the Bulletin to share with a wider audience as well as in helping us understand species distributions and how these are changing.

I would like to thank all those who helped with organising these meetings and those who attended. Hopefully see you again in 2024!

Maico Weites Section President

7 Membership

The updating of our website, enabling new members to join and pay online, continues to bring an increase in numbers over previous years. The system appears to be working smoothly, and a few members who joined prior to the updated website, have elected to renew their subscriptions online.

The total of new registrations for the year to January 2024 inclusive: **66**

Our current membership totals: **434** including:

117 Stripe members (joined online)

80 Second in house

9 Honourable members

14 Students

Over the year there were, sadly, some deaths reported (see below), plus a number of resignations together amounting to a total: **24**

Write-offs for May 2023 totalled: **18**

Our membership currently includes 30 members whose membership extends over **50+** years, and includes a number who have been members for considerably longer.

My thanks are due for the support and help received from Dee Holladay, and Dan Hinton of Pixelfish, regarding any issues connected with Stripe.

The Society received the sad news of the deaths of the following members during the year:

Mr John C Gill	Joined BNS 1996
Mr Robert Muston	" 2000
Dr Paul M Wood	" 1997
Mr Paul Skinner	" 1969
Mr R W Rowe	" 1970
Mrs Alice Maltby	" 2007
Mrs M Stephens	" 2000
Mr Grant Burleigh	" 2006
Mr Ron L Carey	" 1996

Margaret Fay Hon Membership Sec

8 Thanks

As always our sincere thanks go to Bristol City Council's Culture Creative Industries department for the Museum's continued support of our Society Library, located within the Bristol Museum and Art Gallery.

Finally, our thanks go to all those members of The Bristol Naturalists' Society who gave so willingly of their time and energy over the course of the year to support the aims and aspirations of the Society.

Treasurer's Report for 2023

Membership has continued to increase, and the Stripe membership option via the website has proved popular. Members who have paid their subscription via Stripe will be reminded to renew by the system.

The Society made the following grants in during the year, and welcomes applications for 2024:

£1000 towards the reprint of the BRERC publication Geological Sites of the Bristol Region

£398 to Andrew Commins towards the cost of bird ringing equipment

£500 to Bristol Books towards publication of a new book by Lyndon Roberts

We also received a donation of £500 from Joyce Lance.

The COIF fund investments continue to provide a useful additional income, and have also increased in capital value during 2023.

Gift Aid is a useful additional source of income raising £1645 for the Society in 2023. Members who pay income tax are encouraged to sign up to this, at no additional cost to themselves. Please contact the Treasurer for further details.

The Society is in a healthy financial situation and has been able to absorb significant cost increases on room hire, and also continuing expenditure on the website and printing costs. Although the finances are in good shape, costs are rising and membership subscriptions have stayed static for several years now. Council may wish to consider a small increase in membership subscriptions for 2025.

After several years in post I am retiring as Treasurer at this AGM, and hope you will give our new Treasurer, Richard Rivers, as much support as you have given me over the past few years.

Mary Jane Steer

Treasurer

Bristol Naturalists' Society

BRISTOL NATURALISTS' SOCIETY ANNUAL ACCOUNTS

Balance sheet as at 31/12/23

ASSETS	2023	2022	2021
	(year to date)	(year end)	(year end)
	£	£	£
Lloyds Bank	6,446.72	8,763	2,520
Skipton Building Society	20,750.90	20,751	40,632
COIF funds sum invested	80,000.00	80,000	68,000
Creditors	0.00	0	-570
	<u>107,197.62</u>	<u>109,514</u>	<u>110,583</u>
LIABILITIES	None	None	None
NET ASSETS - General fund	<u>107,197.62</u>	<u>109,514</u>	<u>110,583</u>
inc £60,000 Barry Harper Memorial Fund			
RECONCILIATION			
2022 Final Balance	109,513.87	110,583	81,041
2023 Cashflow	-2,316.25	-1,069	29,543
2023 Final Balance	<u>107,197.62</u>	<u>109,514</u>	<u>110,584</u>
MEMBERSHIP SUBSCRIPTIONS			

	2023	2022	2021
Received in previous year	0.00	570	965
Received in current year	9,487.12	8,506	7,503
Pre-payments for following year	0.00	0	-570
Total	<u>9,487.12</u>	<u>9,076</u>	<u>7,898</u>

Continued below.

BRISTOL NATURALISTS' SOCIETY ANNUAL ACCOUNTS

Balance sheet as at 31/12/23

Continued.

Recent Valuation of COIF Funds

	2023	2022	2021
COIF Fixed Interest Sum invested	34,228	34,228	20,000
COIF Fixed Interest Valuation 31/12/2021	32,678	32,678	20,228
COIF Fixed Interest Valuation 30/06/2022	28,980	28,980	
COIF Fixed Interest Valuation 31/12/2022	28,586		
COIF Fixed Interest June 2023	28,837		
COIF Short Duration Bond Dec 2023	30,095		
COIF Fixed Interest unrealised Profit/Loss	-4,133	-5,248	228
COIF Ethical Sum invested	34,359	34,359	20,000
COIF Ethical Valuation 31/12/2021	38,468	38,468	20,359
COIF Ethical Valuation 30/06/2022	34,000	34,000	
COIF Ethical Valuation 31/12/2022	33,689		
COIF Ethical June 2023	34,740		
COIF Ethical Dec 2023	36,998		
COIF Ethical unrealised Profit/Loss	2,639	-359	359
COIF Global Equity Income Fund invested	12,000	12,000	
COIF Global Eq. In. Fund Val. 30/06/2022	11,184	11,184	
COIF Global Eq. In. Fund Val. 31/12/2022	11,426		
COIF Global Eq. June 2023	12,204		
COIF Global Eq. Dec 2023	12,998		
COIF Global Eq. In. Fund unrealised Profit/Lo	998	-816	

ACCOUNTS for the Year to 31/12/2023

(Profit and Loss)

	2023		2022		2021	
	(Full year)		(Full year)		(Full year)	
INCOME						
	£	%	£	%	£	%
Membership Fees	9487.12	68	8,506	54	7,503	20
Advance payments made in previous year	0.00	0	570	4	965	3
Advance payments made for coming year	0.00	0	0	0	-570	-1
Gift Aid	1645.35	12	1,478	9	1,504	4
Donations/Legacies	575.00	4	3,035	19	15,065	39
Trading	256.64	2	85	1	48	0
Interest(Skipton Building Society)	0.00	0	118	1	20	0
Interest(COIF Charity Funds)	2064.87	15	2,038	13	1,490	4
App/Dep COIF Charity Funds	0.00	0	0	0	794	2
Misc. (double payment 2023)	25.00	0	0	0	11,527	30
TOTAL	<u>14053.98</u>	<u>100</u>	<u>15,830</u>	<u>100</u>	<u>38,346</u>	<u>100</u>

EXPENDITURE

Administration

Printing & stationery	24.97	1	0	0	0	0
Post & telephone	121.47	6	132	2	80	20
Council meetings	0.00	0	0	0	144	37
Insurance	157.00	8	96	1	96	25
Capital Items (Conference System)	525.81	26	0	0	0	0
Website	<u>1181.06</u>	<u>59</u>	<u>7,294</u>	97	<u>70</u>	18
TOTAL	<u>2010.31</u>	<u>100</u>	<u>7,522</u>	<u>100</u>	<u>389</u>	<u>100</u>

SURPLUS of Income over Running Costs	12043.67		8,308		37,957	
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Charitable Activities

Meetings (Speakers' Fees & Room hire)	1935.66	13	518	6	355	5
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Continued.	2023		2022		2021	
	£	%	£	%	£	%
Bulletin Production	4479.03	31	3,720	44	3,063	41
Avon Bird Report Printing	2550.61	18	2,025	24	2,019	27
Proceedings (Nature in Avon)	3007.00	21	1,845	22	1,711	23
Printing						
Grants	1898.00	13				
Publicity	0.00	0	0	0	0	0
Library (books & periodicals)	464.62	3	269	3	411	5
Misc (refund duplicate payments)	<u>25.00</u>	0	<u>0</u>	0	<u>0</u>	0
TOTAL	<u>14359.92</u>	<u>100</u>	<u>8,377</u>	<u>100</u>	<u>7,558</u>	<u>100</u>
SURPLUS of Income over Running Costs and Charitable Activities	-2316.25		-69		30,398	

Instructions for authors

The editor welcomes original papers or short notes on the natural history and geology of the greater Bristol region for consideration for publication in *Nature in Avon*.

Text should be submitted by email in Word. Please send all illustrations as separate files (they may also be embedded in the Word file to indicate placing). These files may be sent separately in emails or by Dropbox (or similar application) links.

The Deadline for submission is March 31 and publication is in June. Recent issues, subject to a 2-year moratorium, are available for download on the BNS website at www.bristolnats.org.uk.

Historical issues of *Nature in Avon* and its predecessor *Proceedings of the Bristol Naturalists' Society* can be found on the Biodiversity Heritage Website at www.biodiversitylibrary.org.

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VOLUME 83 (2023)

CONTENTS

	<i>Page</i>
Editorial	1
Correlations within the Clifton Down Limestone	
A. Kirkham	2
Making Geology field work accessible - a case study	Richard Arthur 27
The biostratigraphy and palaeoecology of the Lower Cornbrash	Simon Carpenter and Deborah Hutchinson 41
The Redcliffe Sandstone: Great Outcrops at Stapleton	
Maurice Tucker and Mark Howson	59
Dandelions of the Bristol Region	Dylan Peters 69
Studying obscure fungi on obscure plants - bryophilous fungi in the molecular age	George R. L. Greiff 95
Wildlife Surveying and Recording at Watercress Farm	
Bob Fleetwood <i>et al</i>	105
Avon Needs Trees: The Evolution of a Tree Planting Charity	Cathy Bedford 129
Invertebrate Report 2023	Ray Barnett 139
Weather Report 2023	Barry Horton 152
Society Annual Report 2023	172
Society Accounts 2023	184



Rerum cognoscere causas – Virgil

Cover: Wetland Creation Works at Watercress Farm

Aerial photograph by Sam Ingles and Graham Scott

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