Aims and scope of project

The primary aim was to undertake an active survey to identify sites within Gloucestershire that could be described as the Habitats Directive Annex 1 habitat ‘H7220 Petrifying springs with tufa formation (Cratoneurion)’ with the details being added to an inventory of all known H7220 habitats in England to support the GIS inventories for Biodiversity Action Plan (BAP) Priority Habitats (www.natureonthemap.org.uk).

Definition of petrifying springs with tufa formation

The habitat ‘H7220 Petrifying springs with tufa formation (Cratoneurion)’ is defined in the Interpretation Manual of European Union Habitats (European Commission, 2013[1]) as;

- Hard water springs with active formation of tufa. These formations are found in such diverse environments as forests or open countryside. They are generally small (point or linear formations) and dominated by bryophytes (Cratoneurion commutati).
- Confirms that this vegetation type corresponds (in the UK) to the UK National Vegetation Classification (NVC) types ‘M37 Cratoneuron commutatum-Festuca rubra spring community’ and ‘M38 Cratoneuron commutatum-Carex nigra spring community’ as described by Rodwell (1998)[2].
- Lists the following plant species: Arabis soyeri, Pinguicula vulgaris, Saxifraga aizoides; Cochlearia pyrenaica (in sites with heavy metals); Carex appropinquata, Epilobium davuricum, Juncus triglumis (in the Boreal region). Mosses: Catoscopium nigritum, Palustriella commutata, Palustriella falcata, Cratoneuron filicinum, Eucladium verticillatum, Hymenostylium recurvirostrum and Hamatocaulis vernicosus, Philonotis calcarea, Scorpidiurn revolvens, S. cossonii, Palustriella decipiens, Bryum pseudotriquetum (in the Boreal region).
- For the purposes of this report, the habitat ‘H7220 Petrifying springs with tufa formation (Cratoneurion)’ is defined as spring vegetation dominated by either/or both of the pleurocarpous mosses Palustriella commutata, Palustriella falcata (formerly treated as the single species Cratoneuron commutatum). Both these mosses are often, but not exclusively associated with tufa. For more details on the definition and interpretation of H7220 Petrifying springs with tufa formation (Cratoneurion)’ in the UK, refer to Graham and Farr (2014)[3].

Tufa formation

Tufa formation occurs after dissolution by water of rocks rich in calcium carbonate (Banks & Jones, 2012). Once the groundwater emerges at the surface, via a spring or seepage or as river base flow, interactions with the atmosphere cause the loss or evasion of CO₂ and the resultant precipitation of calcium carbonate, as tufa:
Ca\(^{2+}\) + 2 HCO\(_3^-\) ↔ CaCO\(_3\) + CO\(_2\) + H\(_2\)O

The principal sources of calcium carbonate for the sites within this study are the calcareous bedrock aquifers of the Jurassic Oolites, Carboniferous Limestone, Devonian sandstones and Lower Lias mudstones. Tufa can precipitate with varying success rates over a variety of substrates. Tufa can precipitate both on dead (leaves, twigs and logs) and living organic material (bryophytes, liverworts, tree roots etc.) and inorganic material such as stones. Figure 1-1 provides an illustration of rapid tufa formation on Beech leaves at Cranham Wood.

Figure 1-1  Rapid tufa deposition on Beech leaves at Cranham Wood.

Tufa classification

Tufa can occur in two broad geochemical categories. The first is associated with thermal waters (thermogene) and the second associated with meteoric waters (meteogene). Meteogene tufas are the most widely distributed (Pentecost and Viles, 1994[4]) and cover all the examples within this report. Tufa fabric can be visible with the naked eye (mesofabric) or in more detail under the microscope (microfabric). There are many factors that influence tufa fabrics including; temperature, flow rate, CO\(_2\) evasion rate, supersaturation with respect to calcite, ion transport mechanisms, plant growth and animal burrows (Pentecost, 2005[5]). Fabrics have also been the basis of several classification schemes which emphasize the influence of plants (Pentecost and Viles, 1994[4]) on the formation of a variety of tufa fabrics. Bryophytes and algae can influence tufa fabrics through the trapping and binding of calcite (Pentecost, 1993). Tufa morphologies, unlike most erosional or destructive land surface processes are frequently constructive in nature (Pentecost, 2005[5]) and their morphologies are defined in ‘British travertines: a review’ (Pentecost, 1993), summarised in Table 1 and Figure 1-2.

Table 1  Classification of tufa deposits described in this report, after Pedley (1990) and Pentecost & Viles (1994)[4].

<table>
<thead>
<tr>
<th>Classification</th>
<th>Setting</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits on gentle slopes (c. &lt;10°)</td>
<td>Marsh</td>
<td>Paludal</td>
<td>Surface coatings of tufa on vegetation, marshy locations or alluvial valley bottoms (e.g. Cranham Wood, Alder Carr, Midger Wood).</td>
</tr>
<tr>
<td></td>
<td>Lake</td>
<td>Laucustrine crusts</td>
<td>e.g. Malham Tarn (no lacustrine sites identified in this study).</td>
</tr>
<tr>
<td></td>
<td>Cliffs</td>
<td>Cascades (cliffs)</td>
<td>Very slow seepage of calcareous water on cliff faces (e.g. Aust and Sedbury Cliff).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cascades (river)</td>
<td>On waterfalls and steep ground (e.g. Strawberry Bank Cascade, Bathurst Estate, Alder Carr, Cranham Wood).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barrages</td>
<td>Spanning streams or rivers and forming back fill barrages, ponds and pools (including: Slade Brook, Dowdeswell, Strawberry Bank, Kingscote &amp; Horsley Wood, Woodchester Park and Workmans Wood).</td>
</tr>
</tbody>
</table>
Recent european work on H7220

Recent research into the H7220 habitat includes; Heery, 2007[6] & Heery et al, 2014 (Ireland)[7]; Farr, Graham and Stratford, 2014 (Wales, UK)[8]; Graham & Farr, 2014 (Wales)[3]; Lyons, 2015 (Ireland)[9]; Lyons and Kelly, 2016 (monitoring guidelines in Ireland)[10]; Couvreur et al., 2016 (Belgium)[11]; Royal Hoskoning DHV, 2016[12] (nitrate and phosphate threshold values). There is an active EU LIFE project called ‘Springday; Conservation and restoration of petrifying spring habitats (H7220) in Estonia’, due for completion in May 2018 (NAT/EE/000860 www.loodushoid.ee/SPRINGDAY_348.htm).

Invertebrates associated with calcareous springs and seepages

The present survey included only a botanical and hydrogeological assessment of sites. However, the broad habitats present (calcareous springheads and associated seepages, streams in both open habitat and woodland) are very important for invertebrates and therefore warrant the brief assessment below based on a literature review.

Woodland seepages are probably the most widespread, and yet little known seepage habitat in Britain for invertebrates (Boyce, 2012[13]). The woodland seepages included in this survey have great variation in form including: open seepages dominated by tall stands of Pendulous Sedge Carex pendula with other wetland species such as Hemp-agrimony Eupatorium cannabinum, Water Mint Mentha aquatica and Greater Horse-tail Equisetum telmateia; open rocky spring heads (often with tufa); open ‘mossy’ cascades (dominated by bryophytes such as Palustriella commutata, Pellia endiviifolia, Conocephalum conicum) with tufa dams and shallow pools; seepages with significant fallen deadwood and exposed tree roots (often with tufa); heavily shaded seepages with bare mud, detritus and little or no vegetation.

Woodland seepages that are heavily shaded and have a poorly developed ground flora (with much
open mud and detritus) are frequently considered, with perhaps the exception of some shade tolerant fern and bryophyte species, to be of low conservation value. However, Boyce (2012) draws particular attention to the perils of relying too heavily on botanical criteria in assessing invertebrate communities of seepages. Two groups, in particular (crane flies and soldier flies) are associated with such shaded and open habitats and include many species of conservation concern. Boyce (2012) lists invertebrates of conservation concern for woodland seepages of which 62% are crane flies (Tipulidae and Ptychopteridae). Crane flies generally have soft-bodied larvae that thrive in cool, saturated, shaded conditions. Although they occur in seepages with a wide range of chemistry, some rare species (such as Gonomyia abbreviata, Gonomyia bifida, Molophilus corniger, Orimarga virgo, Paradelphomyia ecacarata, Ptychoptera longicauda and Ptychoptera scutellaris) are clearly associated with calcareous seepages (Boyce, 2012). In addition, Godfrey (2012; 2014) surveyed calcareous seepages in Somerset and recorded the UK BAP species Lipsothrix nervosa, Red Data Book species Ellipteroides alboscutellata (a species requiring constant flushing of base-rich waters with most records coming from tufa-rich seepages in woodland) and the Red Data Book species Gonomyia abbreviata (restricted to small shaded streams in woods on calcareous soils).

Soldier flies (Stratiomyidae) also mostly occur in open habitats with many species of conservation concern occurring within seepages with Oxymera analis and Oxymera leonina appearing to be restricted to calcareous seepages in woodland and at woodland edges (Boyce 2012).

Neutral to calcareous seepages are associated with several molluscs of conservation concern. Four rare species (Acicula fusca, Leiostyla anglica, Spermodea lamellate, Phenacolimax major) are closely associated with seepages dominated by Opposite-leaved Golden-saxifrage Chrysosplenium oppositifolium (found amongst Chrysosplenium plants and in saturated leaf litter) while three rare species (Catinella arenaria, Vertigo genesii, Vertigo geyeri) are associated with more strongly calcareous seepages (Boyce 2012). The rare Gloucestershire snails Ena montana, Phenacolimax major, Acicula fusca and Macrogastra rophii are noted as being associated with wet bryophyte-rich flushes within Cotswold Commons and Beechwoods Site of Special Scientific Interest (SSSI).

A number of rare water beetles are also associated with calcareous springs including Hydroporus ferrugineus, Hydroporus longulus, Hydroporus marginatus, Agabus biguttatusis (Boyce 2012). Hydroporus ferrugineus is semi-subterranean occurring in springs, groundwater-fed trickles, H. longicornis is known from woodland flushes and Agabus biguttatusis occurs under stones or amongst gravel in springs (Hammond, 2017). In addition, the rare riffle beetle Riolus subviolaceus occurs on the underside of tufa-encrusted stones (Hammond, 2017) and is recorded from calcareous woodland springs in Somerset (Godfrey, 2014).

The shallow calcareous and rocky water courses that frequently occur close to springs over limestone continue to be an important habitat for the survival of relict populations of the native White-clawed Crayfish Austropotamobius pallipes.

**Site selection**

Sites were selected by Iain Diack (Natural England), Chris Uttly (Stroud Council) and Richard Spyvee (Gloucestershire Wildlife Trust) from both a selection of designated and non-designated sites. Figure 1-3 shows the location and geological setting for each site.
Figure 1-3 Location of tufa forming sites described in this report (Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL and British Geological Survey Data 1:50 000).

References


Category:
- OR/17/020 Survey, characterisation and condition assessment of Palustriella dominated springs ‘H7220 Petrifying springs with tufa formation (Cratoneurion)’ in Gloucestershire, England

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