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Monitoring Invertebrate features on SSSIs: assessing and reviewing the status of the troglobitic spider *Porrhomma rosenhaueri* in Ogof y Ci and Lesser Garth Cave, South Wales in 2017

Julian Carter, Amgueddfa Cymru – National Museum Wales

NRW Evidence Report No. 246



The cave spider *Porrhomma rosenhaueri* in Ogof y Ci

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Contents

1. Crynodeb Gweithredol	1
2. Executive Summary	2
3. Introduction.....	3
4. Methods.....	3
5. Results	4
5.1. Ogof y Ci.....	4
5.1.1. Survey of Ogof y Ci.....	6
5.1.2. Results of Ogof y Ci survey.....	7
5.1.3. Discussion of Ogof y Ci.....	10
5.2. Lesser Garth Cave.....	11
5.2.1. Survey of Lesser Garth Cave.....	11
5.2.2. Results of Lesser Garth Cave survey.....	12
5.2.3. Discussion of Lesser Garth Cave.....	15
6. Conclusions	16
7. Acknowledgements.....	17
8. References	16
9. Appendix 1: Invertebrates recorded in Lesser garth Cave and Ogof y Ci, Nant Glais Caves in 2017 made during the 2017 survey.....	17
10. Appendix 2: Data Archive Appendix.....	20

List of Figures & Tables

Figure 1. Nant Glais Caves SSSI showing the positions of the entrances to Ogof y Ci.....	4
Figure 2. Survey of Ogof y Ci	5
Figure 3. Shaded passages show the areas surveyed for <i>P. rosenhaueri</i> during the 2017 survey.....	7
Figure 4. The distribution of <i>Porrhomma</i> spp found during the 2017 survey	8
Figure 5. Locations of other notable fauna located during the 2017 survey	8
Figure 6. Suggested location of key survey zones for the long-term monitoring of the <i>P. rosenhaueri</i> population within the Ogof y Ci cave system.....	11
Figure 7. Distribution of adult and subadult <i>Porrhomma rosenhaueri</i> and webs found on the 20/10/2017 visit.....	13
Table 1: Summary of counts of <i>Porrhomma rosenhaueri</i> from the recorded visits to Lesser Garth Cave.....	12
Table 2: Summary of the Conservation Objectives for <i>P. rosenhaueri</i> at Lesser Garth Cave as established by Carter (2010).....	16
Table 3: Amended Conservation Objectives for <i>P. rosenhaueri</i> in Lesser Garth Cave following observations made during the 2017 survey.....	16

List of Images

Image 1: Nick Sharp surveying for <i>P. rosenhaueri</i> in Ogof y Ci.....	6
Image 2: Potential egg sacs in candidate <i>P. rosenhaueri</i> sheet webs in Ogof y Ci.....	9
Image 3: The harvestman <i>Sabacon viscayanum ramblaianum</i> – an increasingly common site in South Wales caves.....	9
Image 4: Richard Gallon & Mike Howe surveying for <i>P. rosenhaueri</i> in Lesser Garth Cave...	12
Images 5 & 6: <i>P. rosenhaueri</i> on web in Lesser Garth Cave.....	14

1. Crynodeb Gweithredol

Mae'r corryn *Porrhomma rosenhaueri* (L. Koch), sy'n byw mewn ogofâu, yn unigryw ymhlith ffawna Prydain gan yr ystyrir mai dyma'r unig rywogaeth o gorryn paleotroglobitig yn y wlad ac, er ei bod yn sicr nad oes digon o waith cofnodi wedi cael ei wneud ar ffawna ogofâu Prydain, mae digon o waith wedi cael ei wneud i awgrymu bod *Porrhomma rosenhaueri* wir yn brin (Fowles, 1994).

Dosbarthiad cyfyng iawn sydd i'r corryn hwn, y mae ei bresenoldeb yn hysbys mewn dim ond dau safle yn ne Cymru, sef Ogof y Ci ger Merthyr Tudful ac Ogof Fach y Garth ger Caerdydd (Harvey *et al.*, 2017; Jefferson, 1989). Cafodd poblogaeth Ogof y Ci ei darganfod am y tro cyntaf yn 1971 (Jefferson, 1989), ond, ers y cyfnod hwn, ni chynhaliwyd unrhyw waith arolygu ar y corryn ac nid oedd statws y corryn yn yr ogof yn hysbys. Cafodd poblogaeth Ogof Fach y Garth ei darganfod yn 1979 yn ystod ymchwiliad o'r ogof ar gyfer yr isopod sy'n byw mewn ogofâu *Proasellus cavaticus* (Chapman, 1980). Ers hynny, cynhaliwyd arolygon yn yr ogof ar gyfer y corryn ar nifer o achlysuron – yn 1997 i ddechrau, fel rhan o asesiad effaith amgylcheddol (Carter a Mann, 1997), ac yn fwy diweddar yn 2009, er mwyn sefydlu protocol Monitro Safonau Cyffredin ar gyfer monitro'r boblogaeth o gorynod yn yr ogof yn yr hir dymor (Carter, 2010).

Sefydlwyd yr arolwg cyffredol hwn gyda dau brif nod:

- Er mwyn asesu p'un a oedd *Porrhomma rosenhaueri* yn dal yn bodoli yn system Ogof y Ci ac, os oedd, er mwyn ystyried hyfywedd sefydlu protocol Monitro Safonau Cyffredin i fonitro'r boblogaeth yn yr ogof;
- Er mwyn ailymweld â'r protocol Monitro Safonau Cyffredin a sefydlwyd ar gyfer Ogof Fach y Garth er mwyn casglu gwybodaeth bellach ar gyflwr poblogaeth *Porrhomma rosenhaueri* a chyflwr ecolegol yr ogof.

Prif amcan y gwaith arolygu oedd cynnal arolwg yn Ogof y Ci, yn ogystal â safleoedd hygyrch eraill yn SoDdGA Ogofâu Nant Glais. Cynhaliwyd dau ymweliad safle yn ystod Medi a Hydref 2017 er mwyn asesu bio-ogofeg SoDdGA Ogofâu Nant Glais ac i gynnal arolwg o Ogof y Ci ar gyfer *Porrhomma rosenhaueri*. Gwelwyd bod y corryn yn dal yn bodoli yn Ogof y Ci - y cofnod cyntaf ers 1971 - gyda chyfanswm o saith corryn byw wedi'u canfod yn ystod arolwg o'r safle. Roedd hyn yn rhoi digon o wybodaeth i awgrymu bod angen protocol monitro ar gyfer y dyfodol yn yr ogof.

Ailadroddwyd y protocol Monitro Safonau Cyffredin ar gyfer Ogof Fach y Garth ym mis Hydref 2017. Cafwyd canlyniadau tebyg i waith arolygu 2009 o ran y nifer o gorynod a welwyd (17 oedolyn a hyd at 47 gwe) a'u dosbarthiad yn yr ogof, sy'n awgrymu bod poblogaeth sefydlog yno.

Ar y cyfan, mae'r gwaith arolygu hwn yn dangos bod *Porrhomma rosenhaueri* yn dal yn bodoli yn y ddau leoliad hysbys, a bod y ddwy ogof hyn yn cynnal cynefinoedd ogof pwysig i infertebratau ym Mhrydain.

2. Executive Summary

The cave-dwelling spider *Porrhomma rosenhaueri* (L. Koch) is unique to the British fauna as it is considered to be the only species of paleotroglobitic spider present, and whilst the cavernicolous fauna of the UK has undoubtedly been under-recorded, sufficient work has occurred to suggest that *Porrhomma rosenhaueri* is genuinely rare (Fowles, 1994).

The spider has a very limited distribution in the UK and is only known from two sites in South Wales, Ogof y Ci near Merthyr Tydfil and Lesser Garth Cave near Cardiff (Harvey *et al.*, 2017; Jefferson 1989). The Ogof y Ci population was first discovered in 1971 (Jefferson, 1989) but since this period no recorded survey work on the spider has taken place and the status of the spider within the cave was unknown. The Lesser Garth Cave population was discovered in 1979 during an investigation of the cave for the cave dwelling isopod *Proasellus cavaticus* (Chapman, 1980). The cave has since been surveyed for the spider on a number of occasions, initially in 1997 as part of an environmental impact assessment (Carter & Mann, 1997), and more recently in 2009 in order to establish a Common Standards Monitoring (CSM) protocol for the longer-term monitoring of the spider population in the cave (Carter, 2010).

This current survey was established with two key aims:

- To assess whether *Porrhomma rosenhaueri* was still present in the Ogof y Ci cave system and if so, to consider the viability of establishing a CSM protocol for monitoring the population within the cave;
- Revisit the CSM established for the Lesser Garth Cave to collate further data on the condition of both the *Porrhomma rosenhaueri* population and the ecological condition of the cave.

The survey of Ogof y Ci, along with other accessible sites within the Nant Glais Caves SSSI, was the primary objective of the survey work. Two site visits were carried out in September and October 2017 to assess biospeleology of the Nant Glais SSSI and to survey Ogof y Ci for *Porrhomma rosenhaueri*. The spider was found to be still present within the Ogof y Ci cave complex, the first record since 1971, with a total of seven live spiders found during the site survey providing sufficient information to suggest a future monitoring protocol for the cave.

The repeat of the CSM protocol for the Lesser Garth Cave occurred during October 2017 and gave comparable numbers of spiders (15 adults & subadults, and up to 47 webs) and their distribution within the cave to the 2009 survey work suggesting a stable population within the cave.

Overall, this survey work demonstrates that *Porrhomma rosenhaueri* is still present at both of its known locations, and that both cave sites support important cave invertebrate habitats within the UK.

3. Introduction

The cave dwelling spider *Porrhomma rosenhaueri* (L. Koch, 1872) is unique to the British fauna as it is considered to be the only species of paleotroglobitic spider present, and whilst the cavernicolous fauna of the UK has undoubtedly been under-recorded, sufficient work has occurred to suggest that *P. rosenhaueri* is genuinely rare (Fowles, 1994).

The spider has a very limited distribution in the UK and is only known from two sites in South Wales, Ogof y Ci near Merthyr Tydfil and Lesser Garth Cave near Cardiff (Harvey *et al.*, 2017; Jefferson, 1989). The Ogof y Ci population was first discovered in 1971 (Jefferson, 1989), but since this period no recorded survey work on the spider has taken place and the status of the spider within the cave was unknown. The Lesser Garth Cave population was discovered in 1979 during an investigation of the cave for the cave-dwelling isopod *Proasellus cavaticus* (Chapman, 1980). The cave has since been surveyed for the spider on a number of occasions, initially in 1997 as part of an environmental impact assessment (Carter & Mann, 1997), and more recently in 2009 in order to establish a Common Standards Monitoring (CSM) protocol for the longer-term monitoring of the spider population in the cave (Carter, 2010; Carter *et al.*, 2010).

Little is known of the biology of *P. rosenhaueri*, with limited detailed survey work with which to base conservation decisions. Consequently, there is little or no information on the lifecycle of the species, and previous attempts to classify the conservation status of the spider have listed it as RBD2: Vulnerable in Bratton (1991), Endangered (EN) using IUCN classifications in a review by Dawson *et al.* (2008), and most recently as Near Threatened/Nationally Rare by Harvey *et al.* (2017). A number of the spiders in this genus can be found living within cracks in the soil surface or even found within mines, cellars and caves e.g. *Porrhomma egria* which also exhibits reduced eyes. Typically, several of the species in the group produce single egg sacs which are attached to the rock, and which are then guarded by the female (Harvey *et al.*, 2002). Mating has not been observed in the species, but males must have to wander in search of females, and lone males of *P. rosenhaueri* have been observed wandering over the cave floor or calcited walls.

As the populations of *P. rosenhaueri* are regarded as SSSI Qualifying features at both Nant Glais Caves SSSI (Ogof y Ci) and Garth Wood SSSI (Lesser Garth Cave), these surveys have been commissioned to provide some further baseline data on the status and ecology of *P. rosenhaueri*.

4. Methods

Ogof y Ci was visited twice in September 2017 by the author and Nick Sharp (NRW), with both surveyors visiting Lesser Garth Cave in October 2017 when they were joined by Mike Howe (NRW) and Richard Gallon (British Arachnological Society). The number of adults/subadults and webs were recorded as well as other invertebrate species encountered, and notes on cave condition were made.

5. Results

5.1. Ogof y Ci

Ogof y Ci is located at OS NGR SO040106 and is part of a small group of caves located within the flanks of the Nant y Glais Valley, just west of Vaynor village near Merthyr Tydfil. The Nant y Glais tributary crosses into the Carboniferous limestone along the line of a major NNW – SSE fault. Subsidiary faults have given rise to numerous fractures parallel to the river, and it is within these fractured limestone that the caves are developed (Ford, 1989).

The cave lies within the Nant Glais Caves SSSI (Figure 1) and runs closely parallel to the gorge beneath its west bank. Access to the cave can be made via one of three entrances. The lower entrance is a tight, wet resurgence with a dry entrance a short way above it, while the third and largest entrance is located further upstream in the gorge below an access stile behind the newer barn at Llwyn Cil Sanws Farm. This is the easiest entrance and intersects the middle of the cave.

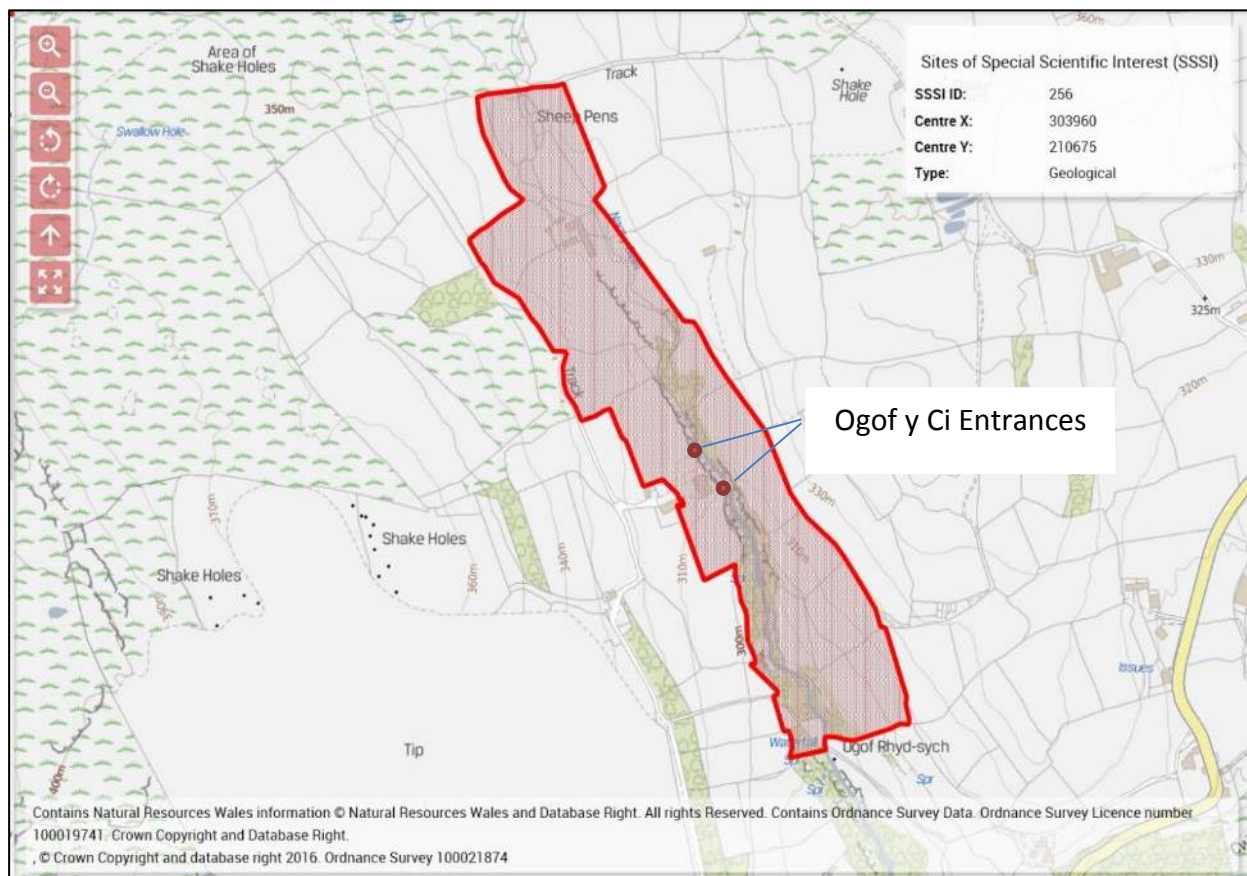


Figure 1: Nant Glais Caves SSSI showing the positions of the entrances to Ogof y Ci. <http://lle.gov.wales/map#b=europa&l=713;&m=-3.3948,51.78591,15>

The cave itself is around 1000m long and is mostly a single active stream passage of varying height with a number of intersecting tight tubes developed on cross-joints (see Figure 2). Generally, the cave is characterized by a triangular cross section with a stream flowing over a boulder-covered floor (Image 1). Around half way into the cave, the first main chamber is found at a cross roads. From this first chamber leads some large walking passage to reach a complex area of oxbows and side passages which

converge on the second chamber with a fine calcite cascade in one corner. From here, the passage splits into two closely-parallel, joint-controlled passages which are generally small in nature. Further information and images can be found at <http://www.ogof.org.uk/ogof-y-ci.html>. The cave should be accessed via Llwyn Cil Sanws Farm where permission to visit the cave should be sought.

Porrhomma rosenhaueri was first discovered in the Ogof y Ci system in 1971 when specimens were collected by R.W. Smith. Whilst the species was considered to be quite numerous in the cave (Jefferson, 1989), no further recorded survey work has occurred since this initial discovery. Thus, a key part of this survey was to establish whether the spider was still present in the cave and if so, to develop a potential Common Standards Monitoring protocol to aid future monitoring of the cave and its biological features.

Note: When surveying it is possible to confuse *P. rosenhaueri* with other species of *Porrhomma*. Both *P. egeria* and *P. convexum* can occur in caves. Both of these species are darker in colouration and larger than *P. rosenhaueri*, although *P. egeria* can exhibit paler colouration and reduced eyes. This survey work is assuming that small, very pale spiders found in the cave are *P. rosenhaueri*, with the selective removal of voucher specimens collected into 80% ethanol used to confirm field identification. For the identification of *Porrhomma* species see Roberts (1997) and British Arachnological Society (BAS 2018). It is potentially more difficult to assume any webs found belong to *P. rosenhaueri*. Thus an assumption has been made that a fine web found in suitable habitat belongs to *P. rosenhaueri*. Finding a live spider on a web will give the field worker a feel for the look of the spider and the structure of its web complex (cover image and Images 5 & 6).

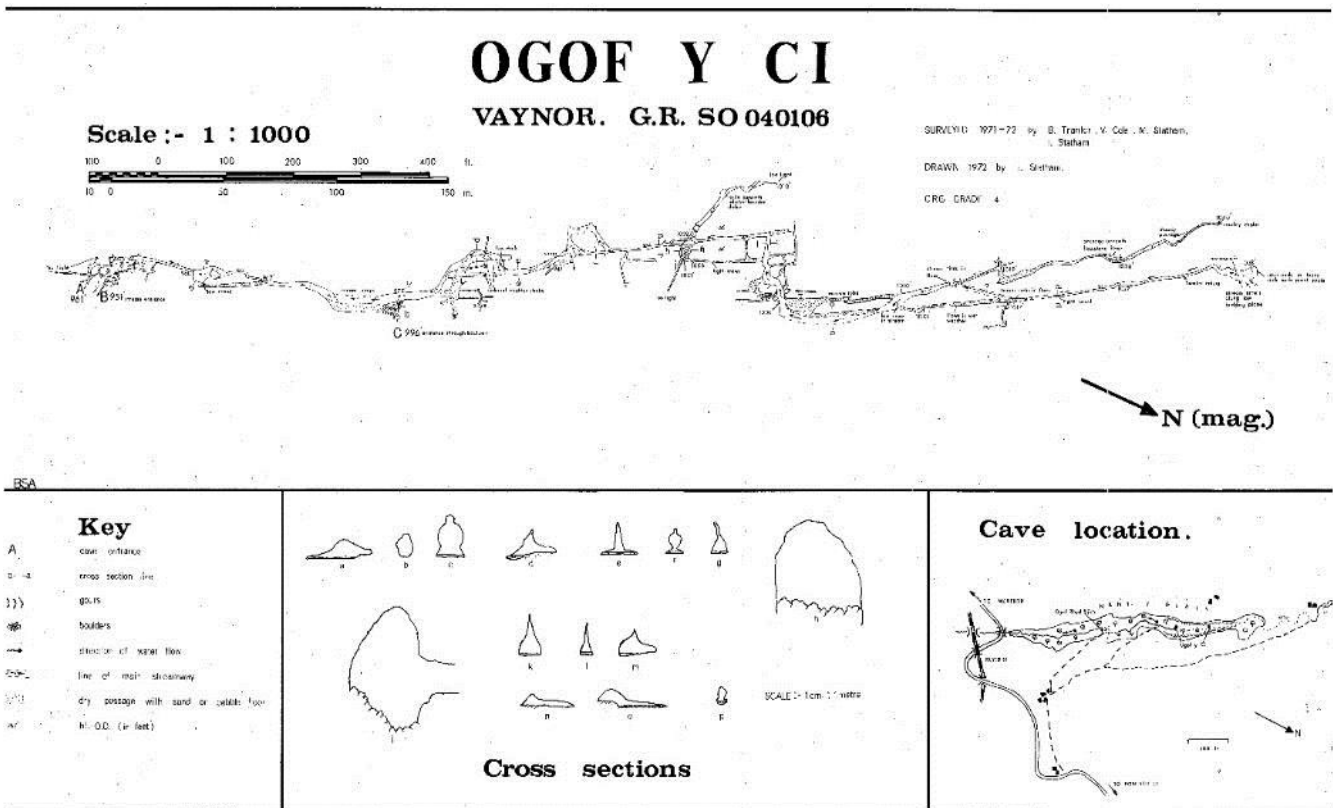


Figure 2: Survey of Ogof y Ci. Used with permission of M. Statham.

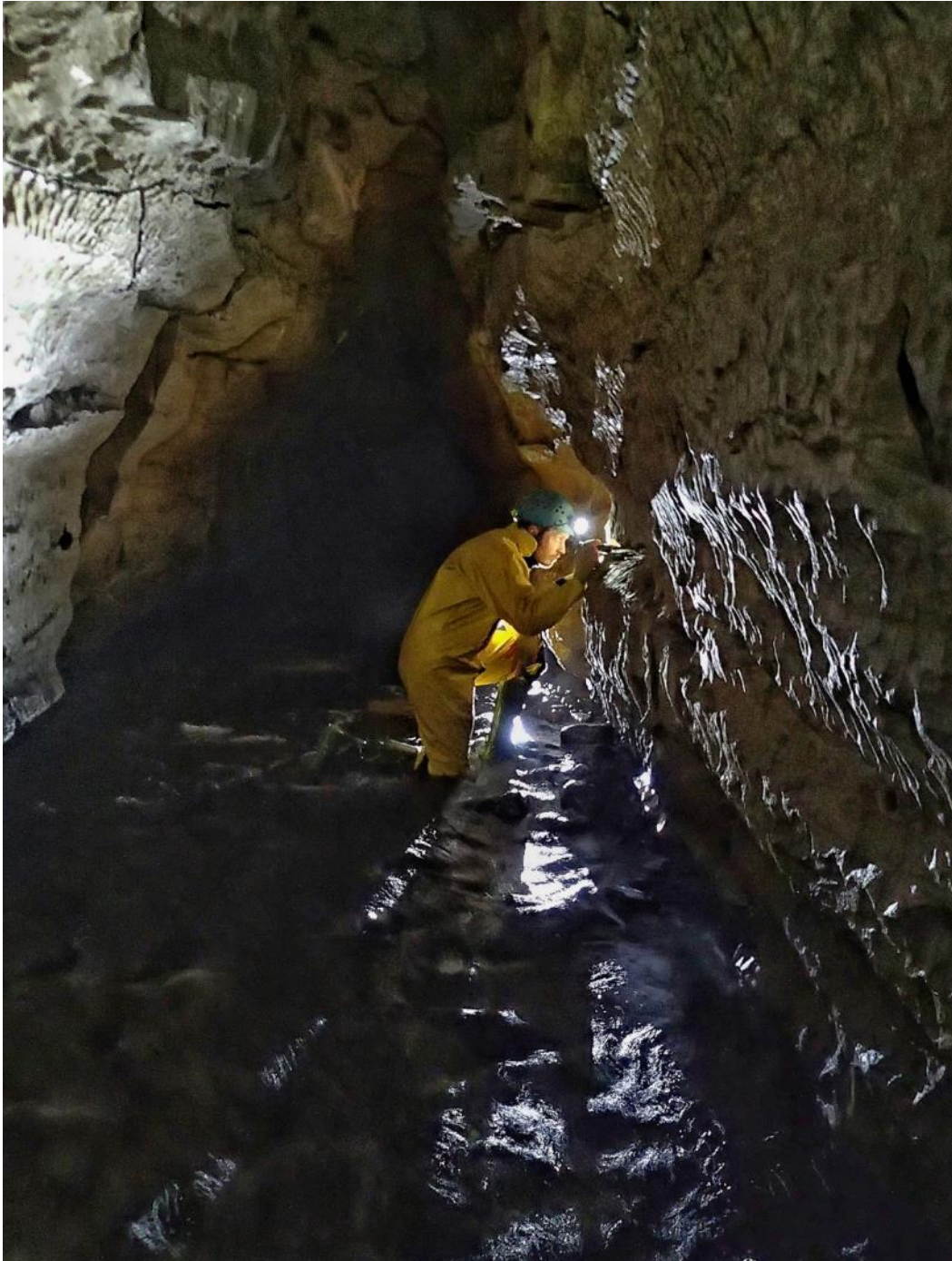


Image 1: Nick Sharp (NRW) surveying for *P. rosenhaueri* in Ogof y Ci. This image is taken just upstream of the upper entrance to the cave in one of the larger sections of cave passage showing the triangular vadose shape typical of the development of the cave.

5.1.1. Survey of Ogof y Ci

Whilst Ogof y Ci is a relatively easy cave to access and explore, the presence of an active streamway and the small nature of many of the passages make surveying the cave for *Porrhomma rosenhaueri* more challenging. Whilst the cave does not normally dangerously flood, higher water levels do make accessing and working in the cave more awkward, and appropriate equipment and clothing needs to be used.

Two visits were made to the cave on 13th September and 13th October 2017 by the report author and the NRW Conservation Officer Nick Sharp. These were to assess the accessibility of the main cave passages for setting up a repeatable survey protocol, and to survey the cave for the presence of *Porrhomma rosenhaueri* and other cave-related invertebrates, following the methods used in Carter (2010). During the survey, a careful search was carried out along the accessible areas of the cave passage, both at floor level and as high on the walls as could be safely assessed. As the spiders are only around 2mm long and very pale-coloured, they are difficult to spot. The trick is to have a hand-held light in addition to the head torch, and to use a raking light to pick up the very fine webs of the spider in suitable fissures, limestone pockets and gaps in rocks. Once a web is spotted then the angled light can be used to look for the presence of a spider on the web. Both spiders and the presence of webs in good condition were recorded on the survey notes. A note was also made of any other species found in the cave as an additional indicator of the condition of the overall environment in the cave.

These visits established a viable section of the caves for the survey, starting at the second main chamber, and then proceeding downstream, focusing search effort where the cave passage was more easily accessible, and avoiding any prolonged immersion in the streamway water. The search ended where the downstream section of cave changed from walking cave to a flatout crawl in water (see Figure 3). A number of voucher specimens were taken to confirm identifications of the spiders found.

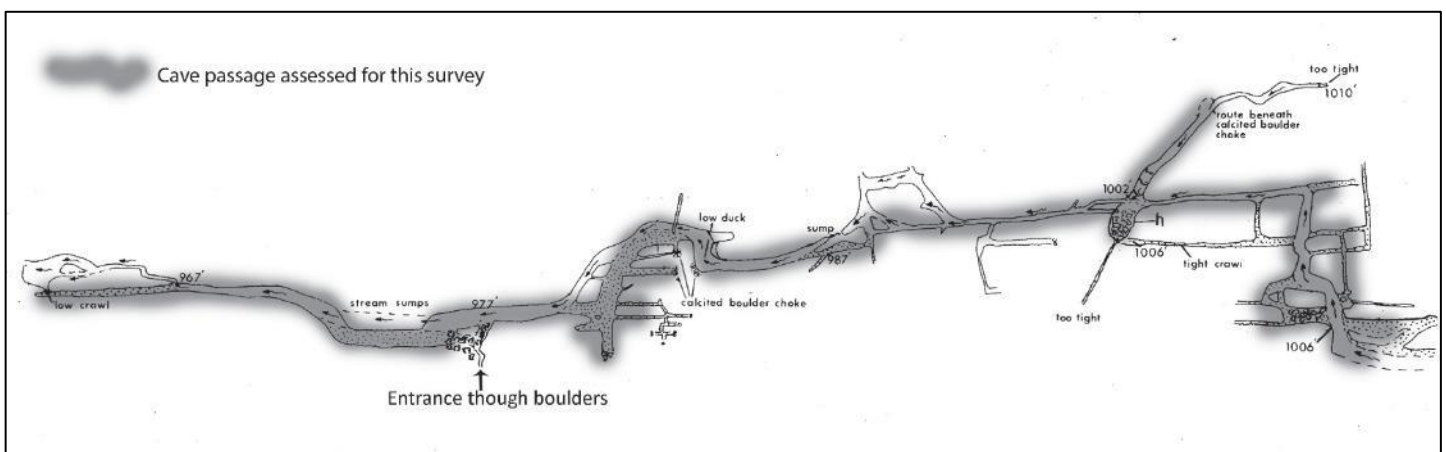


Figure 3: Shaded passages show the areas surveyed for *P. rosenhaueri* during the 2017 survey.

5.1.2. Results of Ogof y Ci survey

Two species of *Porrhomma* were located during the survey – 7 individuals of *P. rosenhaueri* and 3 of *P. convexum*. Interestingly, *P. rosenhaueri* was always found in association with a sheet web, whilst *P. convexum* were all located along shallow limestone cracks outside any obvious web structure. Figure 4 shows the distribution of the live spiders and other sheet webs located during the survey. Two key areas were noted for the presence of *P. rosenhaueri*. The first was around the second chamber area of the cave where a mud and bouldered floored section of the cave above the level of the streamway produced a good number of both spiders and webs. Many of these were in the gaps between boulders and the floor itself. The second area was in the section of larger passage in the downstream direction from the upper entrance. Of note was also the presence of ‘web balls’ in a number of webs not observed in the

previous Lesser Garth Cave surveys – potential eggsacs of *P. rosenhaueri*? (Image 2).

Other notable fauna found during the survey included;

- The presence of the opilionid *Sabacon viscayanum ramblaianum* (Image 3). This was first recorded in the UK on the Gower in the 1980s (Abbott, 1981) and has been spreading across Wales steadily since, with a number of records from cave sites including Lesser Garth Cave.
- The Nesticidae spider *Nesticus cellulanus*. The spider creates a small tangle-web in permanently dark, damp habitats which includes mines, caves, cellars, culverts, sewers, hollow trees, amongst boulders and in thick marshland vegetation. Evidence of this spider was found in several locations through the cave, and included a single male voucher specimen.
- The Niphargidae amphipod, *Niphargus sp* (presumed to be *N. fontanus*) from a small inlet stream and pool in the region of the first main chamber.
- The Trichoniscidae isopod *Androniscus dentiger* downstream of the right upper entrance.
- The upper entrance threshold area had a range of fauna including the Tetragnathidae spiders *Metellina merianae* and *Meta menardi*.

Figure 5 shows the location of some of this fauna.

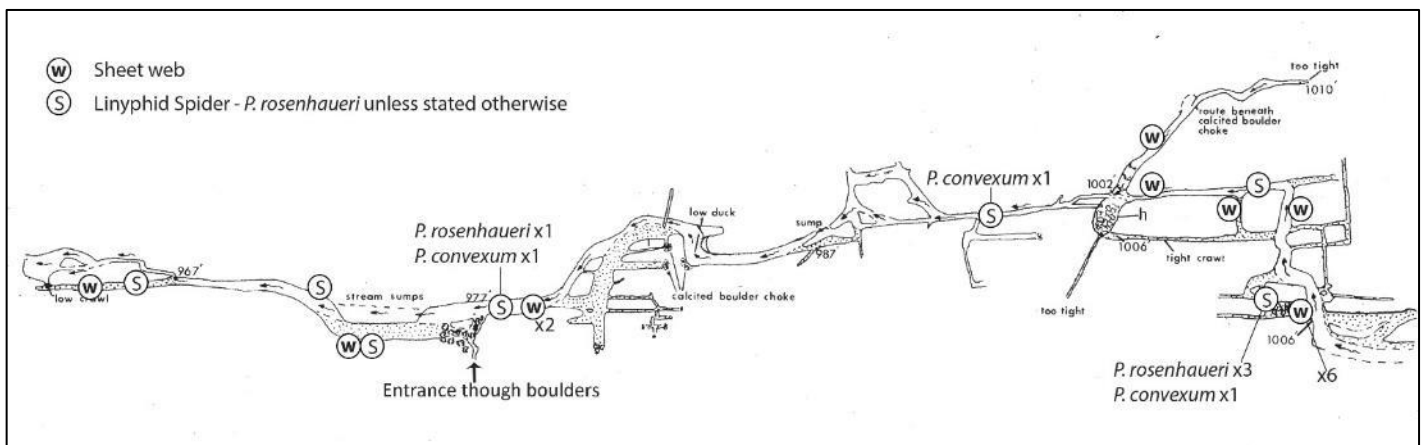


Figure 4: The distribution of the *Porrhomma* spp found during the 2017 survey.

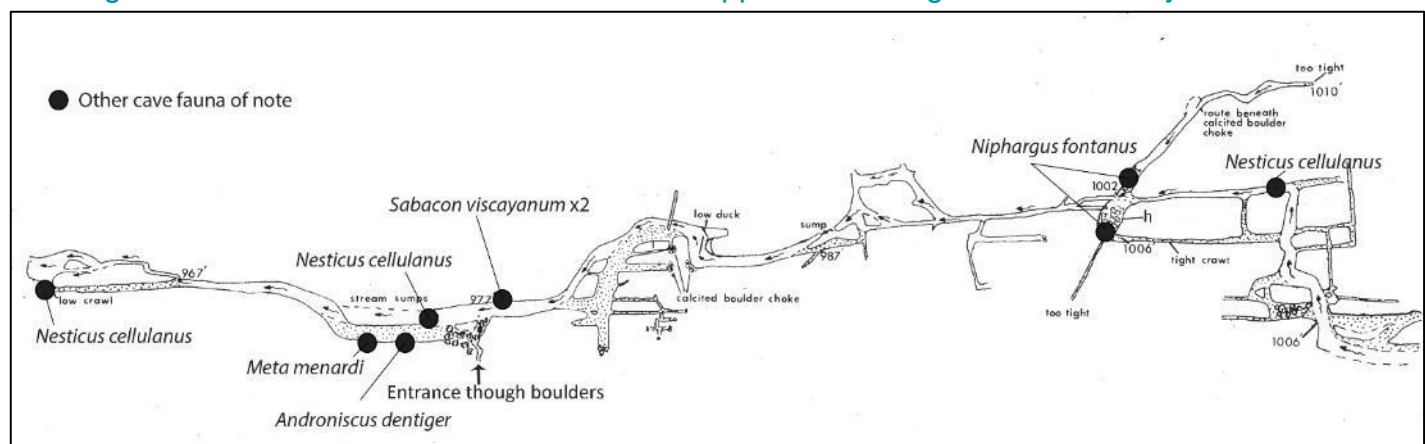


Figure 5: Locations of other notable fauna located during the 2017 survey.



Image 2: In a number of the candidate sheets webs for *P. rosenhaueri* located in Ogof y Ci were found these web balls – potential egg sacs?



Image 3: The enigmatic harvestman *Sabacon viscayanum ramblaianum* is becoming an increasingly common sight in South Wales caves.

5.1.3. Discussion of Ogof y Ci

The findings of this survey show that *P. rosenhaueri* still occurs in the Ogof y Ci cave complex, and the numbers found suggest a good population is present. Additional faunal observations also suggest an important and diverse underground ecology is present, reinforcing its status as a designated SSSI.

Part of establishing a CSM process is to try and define whether the habitat is in favourable condition, but with no detailed surveys of the cave it is difficult to draw conclusions as to status of the *P. rosenhaueri* population and its associated habitat. The cave is open to regular human disturbance from recreational cavers and outdoor pursuit groups, although many of these operate following a code of minimal impact caving (BCA, 2018). The cave is also located close to the Vaynor quarry complex. Although currently not being used, at the time of writing this quarry was in the process of applying for planning permissions to reopen. Despite these potential disturbances, this survey has revealed evidence to support the presence of a significant population of *P. rosenhaueri*, along with a rich cave biodiversity for a British cave system.

Therefore, important habitat attributes within the cave environment that can be recorded are the overall biology of the site, focusing on the absence or presence of some key species, and the overall condition of the cave with reference to pollution and litter debris.

On the findings of this survey, it is suggested that for future monitoring a designated CSM protocol could be set up utilizing a number of important habitat attributes that are accessible and can be recorded;

- Monitoring of the *P. rosenhaueri* population within two key zones of the cave which have shown a strong presence of the spider and are accessible to surveyors. These are shown in Figure 6 and are basically the walking-sized section of cave from the area around the upper entrance to the section where the stream disappears into flat-out crawling passage, and the 'second' chamber area.
- Assess the overall condition of the cave by recording the presence of any other key cave invertebrates encountered that are relatively easily identified in the cave, along with noting the overall condition of the cave with reference to pollution of the streamway and other litter/debris.

Once long-term monitoring has started, the parameters used to decide whether the spider population and the habitat is in favourable condition can begin to be refined. At this stage, it is felt that not enough monitoring data is available and that potential thresholds can only be set following further monitoring work. A suggested protocol at this stage would be;

1. Carry out the survey at a set time of year, such as during September. Additional surveys are of course desirable if resources are available.
2. It is important that field workers are familiar with both the cave environment and how to find the spiders prior to beginning the survey transect. Thus, it is recommended that the survey begins at the transect point at the rear of the cave as the surveyors will then be familiar with the terrain they are to cover, and that time is spent becoming familiar with how to spot the spiders and their webs before starting the actual transect.

3. The survey is carried out in pairs slowly moving through the cave between the two set transect points. Only areas of the cave and floor that are safely accessible are searched.
4. All live spiders are recorded. If a web is found without an obvious spider and considered to be in good condition, i.e. is not fragmented and full of debris, this is also recorded. A starting target threshold could be the presence of 3 live spiders within each of the survey zones, but refined as further data is acquired.
5. During the visit, record the presence of the more obvious cave-associated fauna such as the cave spider *Meta menardi* amongst the entrance fauna; the spider *Nesticus cellulanus* throughout the cave; the continued monitoring of the harvestman *Sabacon viscayanum ramblaianum* which appears to be spreading into cave systems; the presence of the cave amphipod *Niphargus* sp.; and any other key species encountered.
6. Record the general condition of the cave along with evidence of any damaging disturbance within the cave such as vandalism, litter and other forms of pollution. Photography can be useful for this.

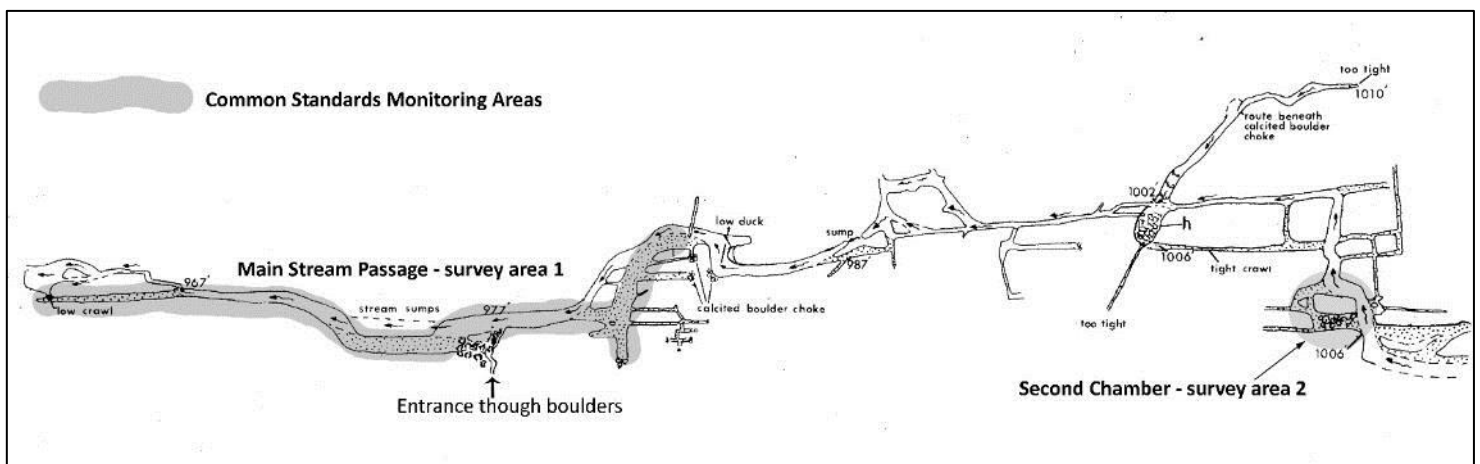


Figure 6: Suggested location of key survey zones for the long-term monitoring of the *P. rosenhaueri* population within the Ogof y Ci cave system.

5.2. Lesser Garth Cave

This visit was to repeat the Common Standards Monitoring protocol established in the previous survey work reported in Carter (2010). The cave system is on land owned by Cemex UK Materials Ltd who own and operate the quarry next to the cave, and from whom permission to visit the cave was obtained prior to the visit. The cave is within the Garth Wood SSSI and the spider itself is a notified feature of the designated site. Access to the cave involves a short but very steep walk up a slope which can be very slippery and thus requires care. The cave itself, although not complex, still requires the use of the correct caving equipment and has hazards such as an 8m pitch and a number of short climbs to negotiate. Further information on the cave can be found in Davis (1983) and at <http://www.ogof.org.uk/lesser-garth-cave.html> (accessed 16/01/2018).

5.2.1. Survey of Lesser Garth Cave

The survey methodology followed Carter (2010), repeating the survey transect set up in the previous survey work. The site visit was made on the 20/10/2017 with Nick Sharp

(NRW), Mike Howe (NRW) and Richard Gallon (British Arachnological Society & Cofnod - North Wales Environmental Information Service) working with the author.

5.2.2. Results of Lesser Garth Cave survey

This survey occurred in a different month to the previous two CSM -orientated surveys. In total, 15 live spiders (e.g. see Images 5 & 6) and 47 potential webs were recorded. Table 1 compares the data from this survey with that of previous known work. A single voucher specimen was removed to confirm identification. Figure 6 shows the distribution of the spiders and webs which overall is similar to the results obtained on 16/09/2009 (Carter, 2010).

The overall habitat of the cave appeared to be good. The cave had the expected entrance fauna of the large cave spider *Meta menardi* along with other associated spiders such as *Metellina merianae*. Deeper within the cave could be found the stygobitic isopod *Proasellus cavaticus* within the two permanent pools in the cave. Also notable was the presence of the opilionid *Sabacon viscayanum ramblaianum* along the transect line (also marked on Figure 6). Throughout the cave, bat droppings showed the site was being actively used, presumably by the Lesser Horsehoe Bat *Rhinolophus hipposideros* with one recorded near the cave entrance.

Survey	Live spiders	Webs
Chapman, July 1980 (initial discovery)	4	-
Carter & Mann, June 1997	6	-
16/09/2009	17	25
04/12/2009	6	28
20/10/2017	15	47

Table 1: Summary of counts of *Porrhomma rosenhaueri* from the recorded visits to Lesser Garth Cave.



Image 4: Richard Gallon (BAS, Cofnod) and Mike Howe (NRW) surveying for *P. rosenhaueri* in Lesser Garth Cave.

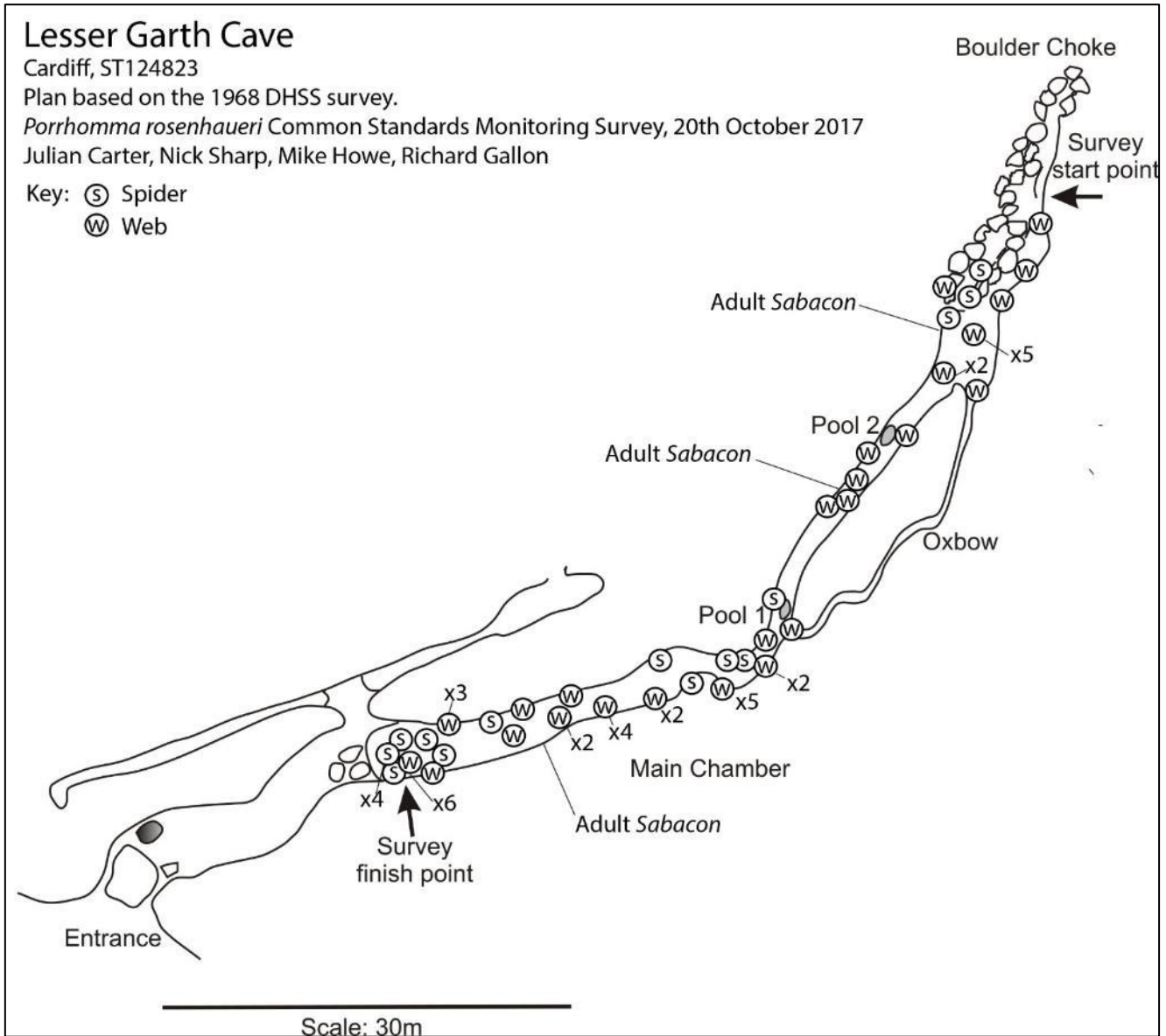


Figure 7: Distribution of adult and subadult *Porrhomma rosenhaueri* and webs found on the 20/10/2017 visit.



Image 5: *P. rosenhaueri* on web in Lesser Garth Cave, located amongst large boulders near the base of the main pitch. This area had a very high density of the spiders. Image © Richard Gallon (BAS & Cofnod).



Image 6: *P. rosenhaueri* on web in Lesser Garth Cave close to area of terminal boulder choke.

5.2.3. Discussion of Lesser Garth Cave

This was the first survey to repeat the CSM established in Carter (2010), with results suggesting that the *P. rosenhaueri* population continues to remain in a similar condition to the surveys in 2009. This is an encouraging result given the continued disturbance of the cave from casual visitors, recreational cavers and the ongoing quarry works next to the cave.

The establishment of a CSM process is to try and define whether the habitat is in favourable condition. This remains challenging with a species such as *P. rosenhaueri* since little is still known about the species and its associated habitat. The previous survey work did establish some draft measurable objectives (see Table 2), and the results of this work fall within these remits. However, this previous work did divide the cave into a series transect sections, and part of the measurable conditions was the presence of the spiders in each section. It is now clearer from the survey work carried out so far within both Ogof y Ci and Lesser Garth Cave that *P. rosenhaueri* prefers drier conditions and can be found at variety of levels in the cave provided suitable recesses for the sheet web are available. As suitable conditions for the spider are not homogenous throughout the survey transect, it is recommended that this stipulation within the favourable condition be dropped and amended as shown in Table 3.

The presence of other cave fauna in Lesser Garth Cave would suggest a favourable habitat is still present, although there is still evidence of damaging disturbance, particularly around the entrance chamber, with minor vandalism and litter. Controlled access to the cave would mediate these issues, but then management of access to the site would present logistical and resource issues. Past evidence shows that when gated the entrance gate is repeatedly vandalised and probably a better way would be through increasing awareness of the cave's importance e.g. through the use of an interpretation notice at the entrance, web-based information sources, or development of a local trail that highlights the importance of the SSSI as a whole. Such actions would require suitable funding and close cooperation with the landowners, management authorities and local community but could be of benefit to all involved.

Conservation Objective (for when the feature is in favourable condition)	To maintain the spider <i>Porrhomma rosenhaueri</i> in Lesser Garth Cave SSSI in favourable condition where
Lower limit	Six spiders and fifteen fresh unoccupied webs recorded in total along the transects, with at least one spider in each of the three transect sections Or: Twenty spiders recorded along the whole transect, with at least two spiders in each transect section
Definition of fresh unoccupied webs	Spider webs that are intact and are not full of debris

Table 2: Summary of the Conservation Objectives for *P. rosenhaueri* in Lesser Garth Cave as established by Carter (2010).

Conservation Objective (for when the feature is in favourable condition)	To maintain the spider <i>Porrhomma rosenhaueri</i> in Lesser Garth Cave SSSI in favourable condition where
Lower limit	Six spiders and fifteen fresh unoccupied webs recorded in total along the transects with at least one spider in each of the three transect sections Or: Twenty spiders recorded along the whole transect with at least two spiders in each transect section
Definition of fresh unoccupied webs	Spider webs that are intact and are not full of debris

Table 3: Amended Conservation Objectives for *P. rosenhaueri* in Lesser Garth Cave following observations made during the 2017 survey.

6. Conclusions

The two surveys reported here have found live adults and subadults of *Porrhomma rosenhaueri*, along with evidence of the spiders throughout much of the sections of the caves surveyed. In addition, the associated cave fauna suggests both caves remain important biospeleological sites within the UK.

This work has added to our knowledge of *P. rosenhaueri* in several ways;

- It is clearer that the spider prefers a drier habitat and is not found in areas of the cave where the surfaces are persistently wet.
- The Ogof y Ci population is still present, having previously only been recorded here in 1971 when it was found for the first time in the UK.
- The Lesser Garth Cave population appears to be in at least an equivalent or stable condition to the previous CSM survey work in 2009.
- The spider can occur at all levels of the cave passage, from ceiling to floor, provided that suitable niches are available for the sheet webs.

- Possible egg sacs were located on webs in Ogof y Ci? (Image 2).

In addition, it is interesting to note the increasing presence of the opilionid *Sabacon viscayanum ramblaianum* in Welsh cave systems. There is some debate as to whether this species is native or an introduction but records do suggest this species is spreading steadily across the region.

The question of why *P. rosenhaueri* is still only known from Lesser Garth Cave and Ogof y Ci within the UK remains unanswered. The two caves are essentially quite different to each other, with Lesser Garth Cave being devoid of any active streamway, whilst Ogof y Ci is an active stream cave though not prone to extreme flooding events. One characteristic the two caves do share is that they are both close to the surface. Such cave systems have low over-burden and are thus more directly linked to the surface ecology and nutrient flows through the soil and fractured rock zones than deeper, more isolated cave passages. The presumed main prey for *P. rosenhaueri* are Collembola (springtails) which have been observed on the walls and pools of the cave systems, and which are common inhabitants within the sub-surface ecology. As a result, it would seem likely that *P. rosenhaueri*, whilst showing adaptation to the cave environment, is still reliant on a more regular food supply than very specialist cave adapted animals such as cave-adapted crustaceans like *Niphargus fontanus* which are known to be highly tolerant to starvation. Many of the species in the *Porrhomma* genus also have a tendency towards subterranean habitats, and it is possible that *P. rosenhaueri* may also be an inhabitant of the fractured rock zone, now classified as the Superficial Underground Compartment (SUC) (Culver & Pipan, 2008), occurring in the cave environment where conditions are suitable. This may explain the seasonal change in adult/subadult numbers if the spider is not exhibiting the prolonged life style expected with many other cave-adapted animals. It also demonstrates that the quality of the surface habitat can potentially have a considerable effect on *P. rosenhaueri*.

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9. Appendix 1: Invertebrates recorded in Lesser Garth Cave and Ogof y Ci, Nant Glais Caves in 2017.

Species	Order	Abundance	Site	GR	Date	Recorder
<i>Meta menardi</i>	Araneae	40 ad	Lesser Garth Cave	ST124823	20.10.2017	Julian Carter; Richard Gallon; Mike Howe; Nick Sharp
<i>Metellina merianae</i>	Araneae		Lesser Garth Cave	ST124823	20.10.2017	Julian Carter; Richard Gallon; Mike Howe; Nick Sharp
<i>Nesticus cellulanus</i>	Araneae	1 female	Lesser Garth Cave	ST12538211	20.10.2017	Richard Gallon
<i>Porrhomma rosenhaueri</i>	Araneae	15 ad & subad	Lesser Garth Cave	ST124823	20.10.2017	Julian Carter; Richard Gallon; Mike Howe; Nick Sharp
<i>Choleva agilis</i>	Coleoptera	2 ad	Lesser Garth Cave	ST124823	20.10.2017	Mike Howe
<i>Propolydesmus testaceus</i>	Diplopoda	2 ad	Lesser Garth Cave	ST124823	20.10.2017	Richard Gallon; Mike Howe. Determiner - Paul Lee
<i>Proasellus cavaticus</i>	Isopoda	10 ad	Lesser Garth Cave	ST124823	20.10.2017	Julian Carter; Richard Gallon; Mike Howe; Nick Sharp
<i>Scoliopteryx libatrix</i>	Lepidoptera	10 ad	Lesser Garth Cave	ST124823	20.10.2017	Mike Howe; Nick Sharp
<i>Triphosa dubitata</i>	Lepidoptera	2 ad	Lesser Garth Cave	ST124823	20.10.2017	Mike Howe; Nick Sharp
<i>Sabacon viscayanum</i>	Opiliones	10 ad	Lesser Garth Cave	ST124823	20.10.2017	Julian Carter; Richard Gallon; Mike Howe; Nick Sharp
<i>Niphargus fontanus</i>	Amphipoda	2 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Meta menardi</i>	Araneae	2 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Metellina merianae</i>	Araneae	2 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Nesticus cellulanus</i>	Araneae	3 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Porrhomma convexum</i>	Araneae	3 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Porrhomma rosenhaueri</i>	Araneae	7 ad & subad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Androniscus dentiger</i>	Isopoda	1 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp
<i>Sabacon viscayanum</i>	Opiliones	2 ad	Nant Glais, Ogof y Ci	SO040106	13.09.2017	Julian Carter, Nick Sharp

10. Appendix 2: Data Archive Appendix

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Species records, which are held on the NRW Recorder 6 database.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <http://libcat.naturalresources.wales> or <http://catllyfr.cyfoethnaturiol.cymru> by searching 'Dataset Titles'. The metadata is held as record no 121120.



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