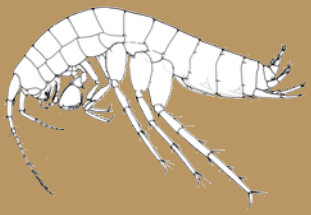
Freshwater Biological Association

Cave Life in Britain



By Lee Knight

CAVE LIFE IN BRITAIN

INTRODUCTION

British caves harbour a wealth of enigmatic life adapted to the rigours of existence without sunlight. The purpose of this booklet is both to inform cavers and others interested in the underground environment, of the species that live below ground and to ask cavers for assistance in recording and investigating subterranean biology.

There is current research into the distribution of the stygobitic crustacean fauna (cave shrimps etc.) of the British Isles. A recording scheme for the group compiles and sends records to the Biological Records Centre. Contact details for the scheme are given opposite. By sending your sightings or records to the recording scheme coordinator you will be contributing to the understanding of the biology and distribution of cave life.

The booklet contains a simple key to the different groups of cave animals, details of their distribution and discusses cave ecology in more detail. Further copies of this booklet are available from Lee Knight (see page opposite for contact details) and a PDF version can be downloaded from the Freshwater Biological Association's Recorders & Schemes website at www.fba.org.uk/recorders.

This leaflet has been produced by the Freshwater Biological Association (FBA) as part of the Recorders and Schemes Project, funded by the Esmée Fairbairn Foundation.
For information about the FBA visit www.fba.org.uk

Esmée Fairbairn FOUNDATION

Freshwater Biological Association

Front cover images: *Niphargus glenniei* (FBA), Pridhamsleigh Cavern, Devon (William Kromhout)
Back cover image: *Crangoynx subterraneus* (re-drawn from Shellenberg, A. (1942), p.83)

RECORDING AND RESEARCH CONTACTS

Recorder / Coordinator for hypogean Crustacea recording scheme: Lee Knight, No1 The Linhay, North Kenwood Farm, Oxton, Nr. Kenton, Devon, EX6 8EX. tel: 01626 891431, mob: 07909 915316, email: lee.knight@talk21.com

Lee Knight is an active caver and as there are very few people involved in the scheme, any records from cavers would be gladly appreciated and would help the scheme to cover a wide geographical area, as well as greatly expanding the current database of records.

Below is an sample record highlighting the information that should ideally be submitted.

Name: Lee Knight	**Date:** 17-10-2007	**Location:** Swildon's Hole	**Grid ref:** ST53125131 (preferably 8-figure)
Species name: *Niphargus fontanus*			
Notes: - Number of specimens observed - 2 - Habitat (pool, stream etc.) - Gour Pool - Location within system - Barnes Loop			

The simple identification key overleaf will help in the identification of different organisms and is accompanied by notes listing the animals most likely to be encountered in the main caving areas. If cavers are unsure of the identity of specimens they can be sent to the address above (preferably in plastic tubes) for identification. The specimens should be preserved in some form of alcohol such as ethanol, methylated spirits or even vodka. It is be preferable to email photographs of live animals. Care should be taken to collect only one specimen. Avoid collection altogether if only one is present.

BCRA Biological Recorder: Graham Proudlove, Department of Zoology, The Manchester Museum, Manchester, M13 9PL. tel: 01706 839752 (home), 0161 200 3111 (work), email: cave-biology@bcra.org.uk

Graham Proudlove from the British Caving Research Association (BCRA) is currently running a project determining gene flow between surface and underground populations of two species, the millipede *Nanogona polydesmoides* (formerly *Polymicrodon polydesmoides*) and the woodlouse *Androniscus dentiger*. *Nanogona* is a fawn to brown-coloured millipede up to 2cm long, common in the threshold zone of caves. *A. dentiger* is a small pink-coloured woodlouse, possibly the most common species recorded underground. It is common in the threshold but is sometimes found further into the dark zone of caves. Graham is interested in collecting specimens for DNA analysis from as many different caves as possible. Interested volunteers should contact Graham (see above) for further information on the project and for advice and equipment if required.

SIMPLE KEY TO CAVE LIFE IN BRITAIN

For species level identification see Gledhill, T, Sutcliffe, D. W. & Williams, W. D. 1993 "British freshwater Crustacea Malacostraca: a key with ecological notes." Freshwater Biological Association Scientific Publication 52

1. Is your specimen shrimp-like?

- If not go to 2

To separate the shrimp-like animals firstly look to see if eyes are present.

If eyes are present it will be in the genus *Gammarus* (fig. 1*a*); if no eyes are present it will either be *Crangoynx subterraneus* (fig. 1*b*) or in the genus *Niphargus* (fig. 1*c*).

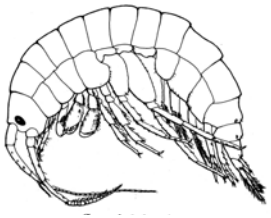


Fig. 1*a Gammarus* (from 'British freshwater Crustacea Malacostraca: a key with ecological notes,' Gledhill *et al*., 1993)

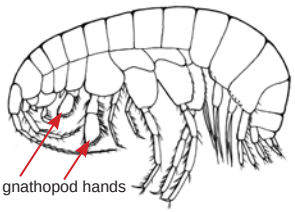


Fig. 1*b Crangoynx subterraneus* (re-drawn from Shellenberg, A. 1942, p.83)

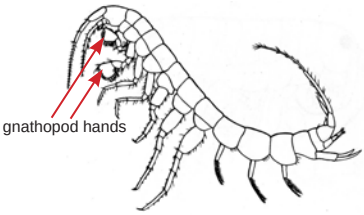


Fig. 1*c Niphargus aquilex* (from 'British freshwater Crustacea Malacostraca: a key with ecological notes,' Gledhill *et al*., 1993)

Separating *Niphargus* from *Crangoynx subterraneus* is more difficult and requires you to look at the gnathopod hands (you probably need a microscope).

Gnathopod hands longer than broad (figs. 1*b*, and 2*a*, *b*) *Crangonyx subterraneus*

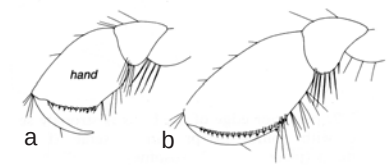


Fig. 2*a* & *b Crangonyx subterraneus*: *a*, male gnathopod 1; *b* male gnathopod 2. (from Gledhill *et al*., 1993)

Gnathopod hands about as broad as long (figs. 1*c*, and 2*c*, *d*) *Niphargus*

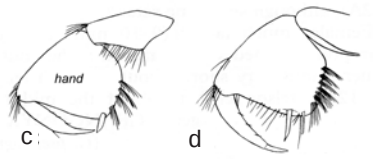


Fig. 2*c* & *d Niphargus aquilex*: *c*, gnathopod 1; *d* gnathopod 2. (from Gledhill *et al*., 1993)

2. If your sample is not shrimp-like it will either look like (fig. 3*a*) a pale, elongate, eyeless woodlouse (*Proasellus cavaticus*) or (fig. 3*b*) a small (about 1mm) eyeless, more or less colourless animal (*Bathynella*).

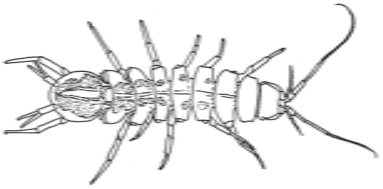


Fig. 3*a Proasellus cavaticus* (from Henry, J. P. & Magniez, G. 1972 Sous Plancher, N.S. 10, 45-49)

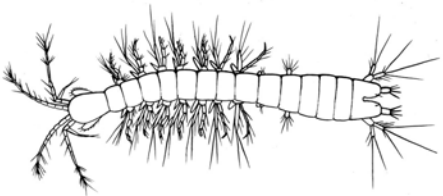


Fig. 3*b Bathynella / Antrobathynella* (from 'British freshwater Crustacea Malacostraca: a key with ecological notes,' Gledhill *et al*., 1993)

NOTES ON DISTRIBUTION

AREA	NOTES ON ORGANISMS
Peak District, Yorkshire Dales, Northern England, Scotland and mines in North Wales	*Niphargus* species are not likely to be encountered in these systems *Gammarus pulex* - If the specimen is largish (~1cm) and shrimp-like with eyes present (these might be white like the rest of the animal). Animal is most likely to be white underground but some specimens, especially in cave streams near the entrance, might have a yellow / orange colouration
South Wales	*Niphargus fontanus* - Shrimp-like white animal without eyes *Proasellus cavaticus* - Aquatic woodlouse-like animal, white, eyes absent *Gammarus pulex* might be present in some caves (see notes above) and can co-exist with both *Niphargus fontanus* and *Proasellus* (e.g. Elm Hole)
Mendips and Forest of Dean	*Niphargus fontanus*, *Proasellus cavaticus* and *Gammarus pulex;* can co-exist together (e.g. Barnes Loop in Swildon's Hole)
Devon	*Niphargus glenniei* - Small (3mm), white, shrimp-like animal, without eyes *Niphargus aquilex* - Larger (8mm), white, shrimp-like animal without eyes, elongate thin body shape Both these species can co-exist together (e.g. Rift Cave, Pridhamsleigh Cave)

Pools with a substratum of fine silt, usually near to some sort of ground-water flow (e.g. below active flowstone) are the main habitats for the species listed above, although they can also be found amongst stones in cave streamways and in resurgence pools, especially after heavy rain. If possible, cavers should try and avoid stepping in such pools. Have a look; you never know what might be beneath your feet!!

NOTES ON CAVE ECOLOGY (BIOSPELEOLOGY)

The subterranean environment varies from large cave systems to mines and the tiniest water-filled gaps in rock strata, gravels and chalk aquifers. Life below ground is harsh. The lack of sunlight and hence primary production means that (with a few notable exceptions) the food chain is totally reliant on a supply of material from the surface. Consequently food tends to be in limited supply and competition is often fierce.

The inhabitants of the subterranean world can be split into three broad categories: trogloxenes, troglophiles and troglobites. The terms stygoxenes, stygophiles and stygobites are used when referring to aquatic subterranean habitats.

TROGLOXENES

Trogloxenes are animals that visit caves but do not complete their life cycle there. Trogloxene species include "habitual trogloxenes" and "accidental trogloxenes". The former category includes bat species that use caves as winter roosts and certain moth, fly and caddisfly species that visit caves either to hibernate over winter, or for part of their life cycle. Herald moth (*Scoliopteryx libatrix*) and tissue moth (*Triphosa dubitata*) adults enter caves in winter in order to undergo a period of diapause (suspended development). This is believed to be necessary for the successful production of viable eggs the following year. Adults of the caddisfly *Stenophylax permistus* enter caves in the summer to undergo a similar period of diapause.

Accidental trogloxenes are animals carried into caves by gravity or flowing water. They include the aquatic larvae of insects (many of which are terrestrial as adults) that are washed underground where streams sink below the surface. Underground, these larvae might survive for a little while if sufficient food continues to be washed into the cave, but when they metamorphose into adults they die. Some fish species are also included in this category and a few cave systems in South Wales are noted for their populations of white trout. These are brown trout (*Salmo trutta*) that have been washed into the caves in times of flood and have been able to survive on a supply of food (most notably the insect larvae mentioned above) carried in by the stream.

TROGLOPHILES

Troglophiles are animals that live in a cave habitat and often complete their life cycle there, although they are not limited to this habitat and are found elsewhere above and below ground. Examples include the cave spider *Meta menardi*, found in the threshold zone, the small pink woodlouse *Androniscus dentiger* and several species of snail, including *Discus rotundatus* (usually limited to the threshold zone) and *Oxychilus cellarius*.

Other troglophiles include the fungus gnat *Speleolepta leptogaster* (a possible troglobite in Britain) , the symphylid *Symphylella isabellae*, several species of beetles, flatworms, mites and millipedes, a host of different species of springtails (e.g. *Folsomia* and *Onychiurus* species) and several species of water fleas (Copepoda) and seed shrimps (Ostracoda).

Perhaps the most widespread stygophiles are freshwater shrimps of the genus *Gammarus*. These shrimps are common in a variety of aquatic habitats on the surface and is also frequently recorded in caves, especially after heavy rainfall. Some *Gammarus* species found in cave streams and higher pools, filled and emptied by flood waters, are part of a transitory population that have been washed underground and spend some time in the system before being washed out of a resurgence (e.g. Elm Hole in the Clydach Gorge where they are found with *Niphargus fontanus* and *Proasellus cavaticus*). The most interesting specimens are those that are found in pools above flood level that are fed by percolation water (e.g. Barnes Loop in Swildon's Hole, where *G. pulex* is often found with *Proasellus*). These appear to be stable stygophilic populations of the species that have existed in isolation from epigean (surface) populations for some time. Stygophilic *G. pulex* lose the orange colour of surface specimens, appearing white, with white eye facets. Some eyeless *G. pulex* have been collected from Lathkill Head Cave and it is possible that some populations of *G. pulex* are in the process of evolving into a new hypogean (subterranean) species, an intriguing question that requires further research.

Gammarus pulex (photo courtesy of Phil Chapman)

As discussed below, it is generally accepted that the stygobitic crustacean fauna of Britain is impoverished and most species are limited in distribution due to the last (Devensian) glaciation, which covered most of Ireland, all of Wales and Scotland and northern England. Perhaps for this reason, none of the larger stygobitic Crustacea has been recorded from the caves of northern England (e.g. the Peak District and Yorkshire Dales) and Scotland and in these systems *Gammarus pulex* is the only shrimp to be found underground, often in large numbers (e.g. Gaping Gill, Peak / Speedwell systems).

TROGLOBITES

Troglobite species are only found underground. These are the most interesting group of the subterranean fauna. They frequently show adaptations for living below the surface, such as the total lack of eyes, lack of skin pigmentation and often over-developed antennae and legs.

The troglobites include the spider *Porrhoma rosenhauri* (found in two South Wales caves, and several caves in Ireland and on mainland Europe) and some species of springtail (e.g. *Oligaphorura schoetti*, *Deuteraphorura inermis* and the rare *Disparrhopalites patrizii*, discovered in 1970 at the Rock House caves in Devon).

By far the most important and widespread group of troglobites are the stygobitic Crustacea (the group including shrimps, lobsters and crabs etc.). The stygobitic species found in Britain and Ireland are listed overleaf.

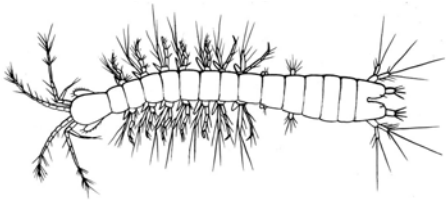
GROUP	SPECIES
COPEPODA	*Acanthocyclops sensitivus*
BATHYNELLIDAE	*Antrobathynella stammeri* / *Bathynella natans*
ASELLIDAE	*Proasellus cavaticus* (formerly *Asellus cavaticus*)
CRANGONYCTIDAE	*Crangonyx subterraneus*
NIPHARGIDAE	*Niphargus aquilex* *Niphargus fontanus* *Niphargus glenniei* *Niphargus kochianus kochianus* *Niphargus kochianus irlandicus* *Niphargus wexfordensis*

Habitats from which stygobitic Crustacea have been recorded include wells; the interstitial water in the gravels of rivers and streams; springs; pools and streams in caves and mines; and underground aquifers, especially in chalk. It is believed that the true habitat of these species is the small channels of deep phreatic (below water table) water in underground rock strata and aquifers. Their presence in caves and mines is usually the result of the organisms being washed out of the fissures in the rock by heavy rain. It is assumed that if conditions are suitable in the cave habitat then a stable population may form on flowstones and in gour pools etc. If the food supply is insufficient or other local conditions are poor then the animals will often crawl back into the interstitial habitat.

Because of the elusive nature of these organisms and the difficulties associated with studying them in their natural habitats, relatively little is known about their biology, life cycles and distribution. This is highlighted by the fact that *Niphargus wexfordensis* was described as recently as 1994. Current research in Britain is focusing on their distribution and DNA.

The copepod *Acanthocyclops sensitivus* is a tiny water flea (copepod) known from a well at Ringwood, Hampshire. It is thought to be the only true sygobitic copepod in Britain.

Antrobathynella stammeri and *Bathynella natans* are tiny animals approximately 1mm long and 0.1mm in diameter. They have long, thin bodies highly developed for living in the tiny water-filled fissures in subterranean rocks and amongst flooded gravels. Much confusion has arisen between identification of the two species in the past. Some specimens previously recorded as *Bathynella natans* have since been shown to have been incorrectly identified and it is possible that *Antrobathynella stammeri* is the only Bathynellid species present in Britain and Ireland. Few records exist for the species, probably a reflection of its small size and the lack of studies of the habitat. It has a wide but disjunct distribution in the British Isles, including Scotland and Ireland. It is mostly recorded from riverine gravels, although it has also been collected from White Scar Cave and Great Douk Cave in Yorkshire. Its distribution includes previously glaciated areas and it is likely to have survived beneath the ice in sub-glacial refugia.

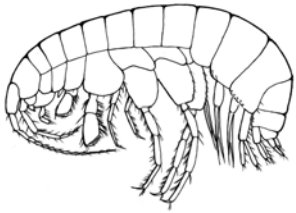


Bathynella / *Antrobathynella* (drawing from 'British freshwater Crustacea Malacostraca: a key with ecological notes, Gledhill *et al*. 1993)

Proasellus cavaticus is a freshwater hoglouse (similar to a woodlouse) widely recorded from caves in South Wales and the Mendips, as well as various interstitial groundwater sites in southern England. There appear to be two distinct size morphs: an 8mm form found in caves in South Wales and the phreatic passages of Cheddar River Cave and Wookey Hole, and a 4mm form found in the vadose zone (above water table) of Mendip caves. It has been suggested that these might be two distinct groups. Genetic studies are being undertaken to investigate this hypothesis.

Proasellus cavaticus
(Photo courtesy of Chris Proctor)

Crangonyx subterraneus and the *Niphargus* species are collectively known as the "well shrimps", since many of the earliest records came from wells. Most of the *Niphargus* species are concentrated in central England, South Wales, the south east and south west. This is thought to follow the limits of the last glaciation, with South Wales having been re-colonised relatively recently (see Proudlove *et al.*, 2003 for further discussion on this theory).



Crangoynx subterraneus (re-drawn from Shellenberg, A. 1942, p.83)

Crangonyx subterraneus is similar in appearance to *Niphargus* and the two genera cannot be easily separated without a hand lens or microscope. It is known from only a few sites in Wales, the Mendips and southern England. These records are mostly from wells and interstitial gravels but also include records from two caves, Gough's Cave and Ogof Pant Canol. Recent records suggest that the species is probably more widespread and common than currently known thought.

Niphargus fontanus is known from groundwater sites across southern England and Wales, including wells and interstitial gravels. It is absent from the far southwest (Devon and Cornwall) but is common in caves in the Mendips and South Wales. It is the cave shrimp most likely to be seen by cavers in these regions.

Niphargus fontanus (photo courtesy of Phil Chapman)

Niphargus aquilex is the most common British niphargid, being recorded from many locations south west of a line drawn from the east coast of Kent to the Wirral Peninsula. There are some records from North Lincolnshire, Anglesey and County Durham, north of the Devensian glacial limit. *N. aquilex* is more common in groundwater (e.g. wells, springs, chalk aquifers) than in caves and has the most superficial habitat of the genus, frequently being found in streams and rivers (especially the headwaters of winterbournes), although probably washed out from shallow riverine gravels. It has a long thin shape, ideal for its interstitial habitat. There are some records from caves in South Wales but (with the possible exception of Paviland Cave) these are thought to be mis-identifications or typographical errors. It is common in Holwell Cave, in the

Quantock Hills of Somerset and frequently occurs in the caves of Devon, often co-existing with *Niphargus glenniei*. Since *Niphargus fontanus* is absent from the far south west it might be that the absence of competition with this more robust species might enable *N. aquilex* to live in the caves of this area. *N. glenniei* is a smaller species and is unlikely to pose a threat to the larger *N. aquilex.*

Niphargus aquilex (photo courtesy of Chris Proctor)

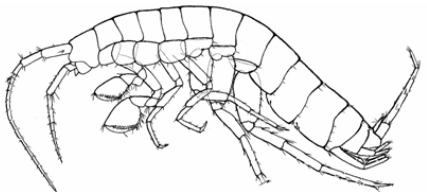
N. glenniei is an endemic British species, first discovered in 1948 in Pridhamsleigh Cave. Until 2000, its known distribution was thought to be Devon, where it has been recorded widely in caves in Devonian limestone, flooded river gravels, a well, two springs and several mines around the edge of Dartmoor. In 2000 it was recorded in West Cornwall and has since been found in several wells as far east as Falmouth. The species is probably far more widespread than is currently known. *N. glenniei* is much smaller than other British niphargids, with an average length of 3mm. Other species tend to be 4 to 15mm in length, with most specimens averaging 8mm. Other morphological differences (primarily differences in hairs on the mandibular palps (mouthparts)) meant that *N. glenniei* was formerly placed in the genus *Niphargellus*.

Niphargus glenniei (Photo courtesy of Chris Proctor)

Niphargus kochianus kochianus has been recorded from several localities in southern England. It is absent from Devon and Cornwall and the far south east. It has mostly been recorded from interstitial ground-water, wells and springs, although records also exist for Holwell Cave (Quantocks), St. Cuthbert's Swallet (Mendips) and Pen Park Hole (Bristol). It appears to be predominately a species of deep phreatic (below water table) water and with the exception of the lake in Pen Park Hole has not been recorded recently from the other two caves.

Niphargus kochianus irlandicus has been recorded from numerous localities across central Ireland, extending into County Kerry in the south west and as far north as County Galway. This means that it is likely to have survived below ground during recent glaciation. It has been recorded from wells, riverine gravels and several caves, especially in County Clare. The sub-species is endemic to Ireland and although morphologically similar to *Niphargus kochianus kochianus*, recent DNA research is suggesting that it might indeed be a separate species. *Niphargus wexfordensis* is the only other *Niphargus* found in Ireland.

Niphargus wexfordensis was discovered in 1980 and is still only known from a single well in Kerloge, County Wexford, southern Ireland. Morphologically it has some similarities with *Niphargus glenniei*, primarily small size and fewer hairs on the mandibular palps.



Niphargus wexfordensis (Drawing from 'A new subterranean amphipod (Crustacea: Gammaridea: Niphargidae) from southern Ireland Schellenberg,' Karaman *et al*., 1994)

FURTHER READING AND GLOSSARY

CHAPMAN, P.R.J. 1993 ‘Caves & cave life.’ New Naturalist series, Harper Collins.

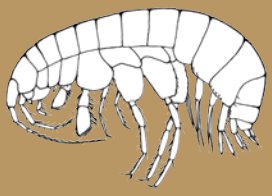
GLEDHILL, T. SUTCLIFFE, D.W. & WILLIAMS, W.D. 1993 ‘British freshwater Crustacea Malacostraca: a key with ecological notes.’ FBA Scientific Publication No. 52.

KARAMAN, G.S., GLEDHILL, T. & HOLMES, M.C. 1994 ‘A new subterranean amphipod (Crustacea: Gammaridea: Niphargidae) from southern Ireland, with comments on its taxonomic position and the validity of the genus *Niphargellus* Schellenberg.’ Zoological Journal of the Linnean Society, 112, p309 - 320.

PROUDLOVE, G.S. *et al*. 2003 ‘A review of the status and distribution of the subterranean aquatic Crustacaea of Britain and Ireland’ Cave and Karst Science, 30, No. 2, p53 - 74.

Relevant chapters on cave biology in the regional ‘Limestone & Caves’ series of books.

GLOSSARY	
Aquifer	Underground layer of water-bearing permeable rock, sand or gravel
Biospeleology	The study of cave biology (cave ecology)
Ecological niche	A combination of the place where an organism lives and the function it performs in the community
Epigean	Above the surface of the earth
Flowstone	Sheetlike deposits of calcite formed where water flows down the walls or along the floors of a cave
Gour pool	Pools formed behind accumulated calcite dams in areas of slow flowing water
Hypogean	Below the surface of the earth (synonym for subterranean)
Interstitial	Tiny spaces in between particles of (usually unconsolidated) sediments such as sand and fine gravels or in porous rocks
Larvae	Juvenile animal (that undergoes complete metamorphosis)
Metamorphosis	Change of body form during development from juvenile to adult
Phreatic zone	Zone below the static water table where spaces between solids are permanently saturated with water
Resurgence	Point at which underground water flows to the surface
Stygobites	Animals that are only found in underground aquatic habitats (also see troglobites)
Stygophiles	Animals that live in aquatic underground habitats and often complete their life cycle there, but are not limited to this habitat, and are found elsewhere above and below ground (also see troglophiles)
Stygoxenes	Animals that live for part of their life cycle in aquatic underground habitats, but do not complete it there (can be habitual or accidental)(also see trogloxene)
Threshold zone	Zone in cave entrance into which daylight still penetrates. Eventually gives way to the dark zone further into the cave
Troglobites	Animals that are only found underground (also see stygobionts)
Troglophiles	Animals that live in a cave habitat and often complete their life cycle there, but are not limited to this habitat, and are found elsewhere above and below ground (also see stygophiles)
Trogloxenes	Animals that visit caves but do not complete their life cycle there (also see stygoxenes)
Vadose zone	Zone above the phreatic zone where spaces between solids are not completly filled with water
Winterbourne	Stream or river on chalk geology that is dry through summer months (mostly found in southern England)



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