

Occurrence of *Antrobathynella stammeri* (Jakobi, 1954) (Crustacea: Syncarida: Bathynellidae) in the hyporheic zones of two English karst rivers

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Abstract: This paper reports the first records of *Antrobathynella stammeri* in the British Isles since 1985. Numerous individuals were observed in hyporheic water extracted from the River Skirfare (Yorkshire, UK), whilst, in an independent study, a single confirmed specimen was recorded from hyporheic water pumped from the River Lathkill (Derbyshire, UK). The latter observation is the first record of the superorder Syncarida in the Peak District and provides an important geographical link between previously recorded individuals in Scotland and north-west England and records from the south of England. These records suggest that bathynellids may be more abundant in the UK than previously thought, highlighting the need for more effective sampling of subterranean habitats to determine the conservation status of such rarely seen species.

The ecology of subterranean ecosystems has, until recently, received little attention in the UK. The implementation of the Water Framework Directive and the new Groundwater Directive, however, has focussed research efforts in groundwater ecology in the last few years (Robertson *et al.*, 2008). At the same time, the concept of the 'hyporheic zone' (i.e. the saturated sediments below the river bed that exchange

water with the surface channel and, in some cases, the underlying groundwater) has come into wider usage (Boulton *et al.*, 1998), accompanied by an international increase in the sampling of hyporheic fauna (e.g. Hunt and Stanley, 2003; Datry *et al.*, 2007). To date, however, most ecological research considering the hyporheic zone has focussed on the macroinvertebrate community, using sampling techniques that may exclude meiofauna (e.g. Davy-Bowker *et al.*, 2006; exceptions including Stead *et al.*, 2004), the latter being defined as organisms that pass through a 1000µm mesh sieve but are retained by a 63µm sieve (Giere, 1993; Robertson *et al.*, 2000).

Most species of the superorder Syncarida can be considered as meiofauna, being microscopic crustaceans, c. 1mm long, that occur predominantly in the interstitial pore spaces of the hyporheic and phreatic zones of freshwater habitats (Schminke, 1986; Proudlove *et al.*, 2003). In the UK and Ireland, syncarids (exclusively from the family Bathynellidae) have most commonly been reported from the hyporheic zone of sand and gravel-bed rivers (Gledhill and Gledhill, 1984; Gledhill *et al.*, 1993), with additional reports from cave waters (Gledhill and Driver, 1964; Serban and Gledhill, 1965). As in other geographical regions (e.g. Fiers, 2007), bathynellids are considered rare in the British Isles, and it has been almost 25 years since any member of this taxon was recorded here (Gledhill and Gledhill, 1984; Hypogean Crustacea Recording Scheme, 2008). This apparent rarity may, however, be misleading, reflecting instead the difficulty in observing near-microscopic individuals, the species' stygobitic life history (i.e. it is entirely restricted to groundwater habitats (Gledhill *et al.*, 1993; Proudlove *et al.*, 2003; Robertson *et al.*, 2008)), and the rarity with which appropriate sampling is conducted within subsurface environments. Where research has been conducted using appropriate sampling strategies, meiofauna (including microcrustaceans of the orders Cladocera and Copepoda) have on occasion been found to occur in greater abundances than had previously been assumed (e.g. Ward *et al.*, 2000; Wood and Greenwood, 2001).

The current observations are from the River Skirfare in the Yorkshire Dales National Park (North Yorkshire, UK) (54° 08.9' N 2° 07.2' W; SD923725), and the River Lathkill in the Peak District National Park (Derbyshire, UK) (53° 11.2' N 1° 44.4' W; SK190657) (Fig. 2). Both rivers are underlain by carboniferous limestone, which is covered at both study sites by alluvial deposits. The sampling site on the River

Skirfare is located at the tail of a riffle, and mini-piezometers have confirmed that water is strongly upwelling at this site; in contrast, in the River Lathkill, the porous nature of the karstic bedrock and extensive subsurface lead mining drainage levels both contribute to water being lost from the surface channel, and water here is strongly downwelling. At the time of sampling, the surface channel above the River Lathkill sampling point was a shallow (5cm depth), moderately fast-flowing (0.313m s^{-1}) riffle, with similar conditions reported for the River Skirfare. Various water chemistry parameters of the hyporheic water in which the specimens were collected were measured *in situ* using standard instrumentation or subsequently analysed in the laboratory (the inconsistency in the variables measured reflecting that samples were taken by independent research teams) (Table 1).

Table 1: Water chemistry parameters for hyporheic water in which *Antrobathynella stammeri* has been observed

River	Sample depth (cm)	Temp (°C)	pH	Cond ($\mu\text{S cm}^{-1}$)	DO*	NPOC**	NO ₃ ⁻	PO ₄ ³⁻	Cl	SO ₄ ²⁻
Skirfare	50	13.3	7.8	255	5.45	n/a	1.86	<1	10.11	4.74
Lathkill	30	9.5	7.9	612	4.0	0.4985	1.18	0.17	n/a	n/a

*Dissolved oxygen

**Non-purgeable organic carbon

The collection and observation of *Antrobathynella stammeri* (Jakobi, 1954) (Syncarida: Bathynellidae) in both the River Skirfare and the River Lathkill occurred opportunistically, during the course of two independent research projects into hydrologic and geologic controls influencing hyporheic invertebrate assemblages. Similar techniques were employed to sample the hyporheic invertebrate community in the two rivers. In the River Skirfare, a standpipe and Bou Rouch pump (Bou and Rouch, 1967) were used to pump five litres of water from depths of 20cm and 50cm, whilst in the River Lathkill, a bilge pump was used to extract six litres of water from PVC pipes previously inserted into the hyporheic zone to depths of 10, 20 or 30cm. In the River Skirfare, the extracted water was filtered through a 63 μm -mesh sieve, whilst a 125 μm -mesh size was used on the River Lathkill, then the samples preserved. Subsequent processing of the samples then varied, reflecting the greater importance of meiofauna in the River Skirfare research project. In the River Skirfare study, rinsed

and elutriated samples were processed using a Bogorov counter tray at 30x magnification, whilst samples from the River Lathkill were processed without magnification, although this was partly conducted on a black background to facilitate observation of unpigmented meiofauna.

To date, a total of 288 hyporheic samples from five sites along the upper reaches of the River Lathkill have been processed, comprising 96 samples from depths of 10cm, 20cm and 30cm respectively. Of these, only a single specimen observed in a single sample taken from a depth of 30cm on 13th June 2008 has been confirmed as belonging to the Syncarida (a second specimen was too damaged to be positively identified). In contrast, only four samples from the River Skirfare have been processed to date, including a single sample collected on 28th June 2008 from a depth of 50cm in an upwelling riffle tail, in which 18 syncarids were recorded (from a 25% subsample). All specimens were later confirmed as *A. stammeri* on the basis of the setation of the uropodal sympodite (Gledhill *et al.*, 1993). The relatively high abundance of *A. stammeri* recorded in the River Skirfare is not uncommon where appropriate sampling is conducted (e.g. Maitland, 1966; Serban and Gledhill, 1965).

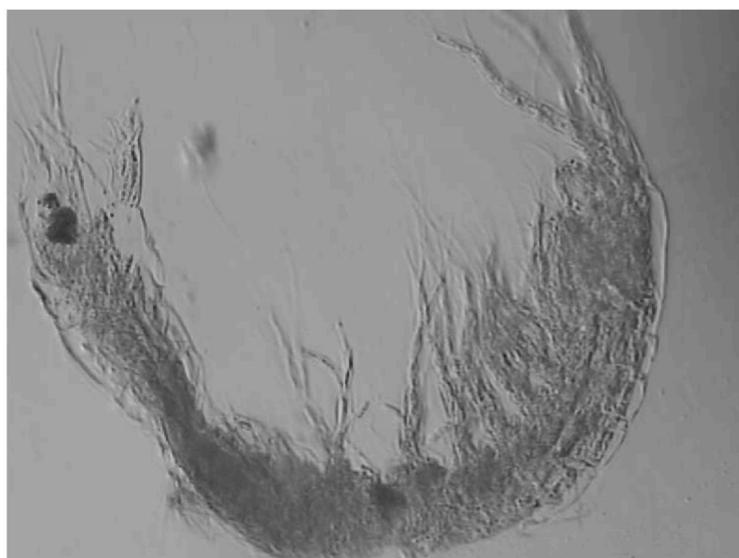


Figure 1: *Antrobathynella stammeri* (Jakobi, 1954) (Syncarida: Bathynellidae) from the River Skirfare (Yorkshire, UK). Length is approximately 1.3mm (Photograph by Mark Dunscombe).

Fiers (2007) notes that bathynellids have previously been found in association with the stygobitic families Parastenocarididae and Chappuisiidae (Copepoda: Harpacticoida). In the River Lathkill, however, *A. stammeri* occurred alongside *Polycelis felina* (Turbellaria: Planariidae) and unidentified species of Ostracoda, Chironomidae and Oligochaeta, all of which are common inhabitants of both benthic and hyporheic sediments. Other microcrustaceans that have been recorded during the River Lathkill investigation include members of the Cladocera and the copepod orders Cyclopoida and Harpacticoida, however these specimens have not been identified to species level to date. Similarly, in the River Skirfare, *A. stammeri* was found in association with a combination of ubiquitous taxa (Oligochaeta, Acari, Chironomidae) and microcrustaceans (again, the copepod orders Cyclopoida and Harpacticoida). In contrast to the River Lathkill assemblage, however, *A. stammeri* was by far the most numerous taxon in this River Skirfare sample.

The taxonomy of the Bathynellidae in the British Isles is currently unclear. Specimens have previously been identified as one of two species: *A. stammeri*, and *Bathynella natans* Vejdovsky, 1882, although various synonyms of the latter have also been used (Proudlove *et al.*, 2003). The identification of specimens as *B. natans* has, however, been called into question, and it is now thought probable that all bathynellids recorded in the British Isles are *A. stammeri* (Gledhill *et al.*, 1993; Proudlove *et al.*, 2003). Records of bathynellids confirmed as *A. stammeri* are concentrated in the north-west of England, particularly in Cumbria (Gledhill *et al.*, 1993) and additionally in Yorkshire (Gledhill and Driver, 1964; Serban and Gledhill, 1965) and in County Kerry in south-west Ireland (Gledhill and Gledhill, 1984) (Fig. 2). In contrast, specimens originally recorded as *B. natans* are, apart from records from Stirlingshire (Maitland, 1962; 1966) restricted to the south of England, including the counties of Wiltshire (Lowndes, 1932), Berkshire (Efford, 1959), Oxfordshire and Devon (Spooner, 1961) (Fig. 2). However, Gledhill and Proudlove (see Proudlove *et al.*, 2003 p. 88) re-examined specimens under the names *B. chappuisi* and *B. natans* held at the Natural History Museum, London. The specimens from Wiltshire (BMNH 1931 12 29:1-3) collected in 1927 (Lowndes, 1932) and from Stirlingshire (Maitland 1962; 1966) were, based on the setation of the uropodal sympodite, identified as *A. stammeri*, thus strengthening the proposal that only this species occurs in Britain and Ireland (the specimens collected by Efford (1959) and Spooner (1961) appear to be

lost). Nevertheless, it is emphasised that, in most cases, identification of British and Irish bathynellids has been based on one character, i.e. the setation of the uropodal sympodite. Thus, with many bathynellid taxa in two families (Bathynellidae and Parabathynellidae) and numerous genera recorded from continental Europe (Schminke, 1986), it is not unreasonable to surmise that more species are present in the British Isles. As Serban (1973) wrote following his elevation of the subgenus *Antrobathynella* to genus rank, ‘....., il est nécessaire d’étudier de nouveau le pénis de type *stammeri* (Serban, 1966), ainsi que les populations de l’espèce *stammeri* trouvées en Allemagne, en Italie, en Angleterre, en Tchécoslovaquie et en Roumanie; à notre avis, ces population n’appartiennent pas à une seule espèce.’ (‘it is necessary to re-examine the *stammeri*-type penis (Serban, 1966), as well as populations of the species found in Germany, Italy, England, Czechoslovakia, and Romania; in our opinion, these populations do not belong to a single species’).

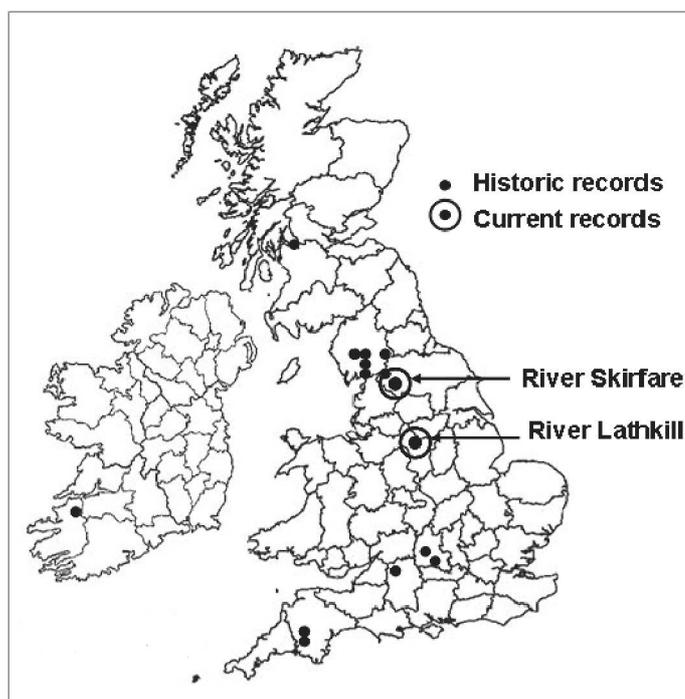


Figure 2: Locations of U.K. records of species of Syncarida, including the current records of *Antrobathynella stammeri* from the River Skirfare and River Lathkill (historic records provided by the Biological Records Centre and used with permission).

Whilst sampling of subterranean habitats, in particular the shallow hyporheic zone, has increased considerably in recent years, the use of sampling strategies that

facilitate the collection and observation of stygobitic meiofauna is still rare (e.g. Hahn, 2006). However, the recognition that such habitats may harbour diverse invertebrate assemblages (Sket, 1999; Boulton *et al.*, 2008) capable of providing ecosystem goods and services (Tomlinson *et al.*, 2007), as well as the recent introduction of EU legislation requiring the protection of groundwater-dominated ecosystems, has highlighted the need for further research. Concurrently, calls for the incorporation of biological sampling protocols into routine surveys of groundwater quality have become more frequent (e.g. Malard *et al.*, 2007; Tomlinson *et al.*, 2007). Such research and monitoring are needed to determine the conservation status of meiofauna species such as *A. stammeri*. Whilst the observations reported here indicate that this species may be more abundant than previously thought, it may be that measures are required to protect this and other rarely observed stygobitic taxa, such as has recently been afforded to the well shrimp *Niphargus glenniei* (Amphipoda: Niphargidae) through its addition to the UK Biodiversity Action Plan priority species list (Knight, 2008). In addition, further research is required into the taxonomy of UK bathynellids to confirm the number and identity of British species, particularly considering the conservation implications of the conclusions reached.

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