# A Survey of the Aquatic Invertebrates of Some Organic Mound Springs in the Shire of Three Springs, Western Australia

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## Introduction

This report presents the results of a survey of aquatic invertebrates from organic mound springs in the Shire of Three Springs, Western Australia. These springs occur in the headwaters of the Arrowsmith River, on the western slopes of the Dandaragan Plateau on alluvial, colluvial and diluvial quarternery deposits of sand, silt and clay (Mory 1994). The survey was commissioned by the Western Australian Threatened Species and Communities Unit (WATSCU) as part of an assessment of a proposal to list the mound spring invertebrates as a Threatened Ecological Community. This work is funded by the Wetland Conservation Project. The aim of this project was to survey the aquatic invertebrate fauna of these springs and to assess to what extent they represent an assemblage not found in other habitats. The only previous studies of aquatic invertebrates of similar springs in south-western Australia are Jasinska and Knott (1994) and Jasinska (1998) who surveyed springs in the Muchea and eastern Gnangara Groundwater Mound regions of the Swan Coastal Plain. A more general review of mound spring habitats is provided by Knott and Jasinska (1997).

## Methods

Five mound springs were sampled on the 14-15$^{th}$ March 2001. All samples were preserved in alcohol, except for a plankton sample collected from the dam on Tumulus Spring 6 (sample TST06a) which was preserved in a formalin based fixative. Unless otherwise stated, invertebrates were collected by scooping interstitial water from shallow holes (10-30 cm deep) dug in waterlogged earth and filtering this through a mesh net of 50 µm pore size.

**Tumulus Spring 1 (TST01).** Composite sample from 2 holes (AMG 350000E 6725434N and 349988E 6725469N) dug in peaty soil under grass and from an area of inundated sedges (AMG 350004 6725469N). Mound with lots of inundated sedges , along track, with TST05 nearby.

**Tumulus Spring 3 (TST03).** Composite sample from several sites on the mound, including interstitial water from an area of waterlogged leaf litter in a hollow (AMG 350206 6725321), an area of flooded Baumea sedges (AMG 350313 6725277) and interstitial water from peaty soil around a small clump of reeds. AP notes: large mound, no track.

**Tumulus Spring 5 (TST05).** AMG 349816 6725390. A single sample of interstitial water from a hole dug in waterlogged peaty soil. This site was otherwise fairly dry near the surface. Small mound near TST01.

**Tumulus Spring 6.** This spring has been largely converted to a farm dam. The dam (site **TST06a** AMG 351506 6724168) was sampled using a 50 µm mesh net to sample the plankton and a 250 µm mesh net to sample the benthos. A separate sample (**TST06b**) consisted of interstitial water from a small hole about 10 m from the dam.

**Tumulus Spring 20 (TST20).** Composite sample from a small (<1m$^2$) shallow (~ 2 cm deep) surface pool and additional water obtained by digging into the sediment at the same spot (AMG 348822 6725166). Also known as TSTA, visible from main road.

**Water chemistry**

Conductivity, salinity (calculated automatically from conductivity) and pH were measured in the field using a WTW Multiline P4 meter at one sampling point per mound spring. Water samples were collected from the same point for analysis of ionic composition, hardness, alkalinity, nutrient concentration, colour, turbidity and concentration of total dissolved solids (TDS) in the laboratory by the Chemistry Centre (WA). Water samples were taken from the inundated sedges at TST01, waterlogged leaf litter at TST03, the dam and the dug hole at TST06 (sites a, b respectively), the excavated hole at TST05 and the surface pool at TST20. In Table 1, alkalinity and hardness are expressed as the equivalent concentration of $CaCO_3$. Total dissolved solids was measured as per APHA (19th ed.) method 2540C.

### Curation

Most specimens are currently held in the laboratory of Dr. Stuart Halse at the Department of Conservation and Land Management's Wildlife Research Centre, Woodvale. The bathynellids have been retained by Dr. Peter Serov (NSW Dept. Land and Water Resources, Armidale).

## Results and Discussion

### Water chemistry

All sites had circum-neutral pH (6.27 - 7.19) and were fresh (salinity 0.3 -0.6 g/L). Total dissolved solids exceeded salinity values based on field measured conductivity for all samples, perhaps at least partly due to high concentrations of dissolved organic compounds in the waterlogged organic soil and/or variable ionic composition. Turbidity was high where water was taken from excavated holes (TST03, TST05 and TST06b) and low where surface water was sampled. All sites except TST05 had high silica concentrations, compared to most freshwater sites sampled during the Salinity Action Plan (SAP) survey of wheatbelt wetlands. Iron concentrations were an order of magnitude higher at sites TS1, TS3 and TST05 than at the remaining sites. The order of cation dominance was always $Na^+ > Mg^{2+} > Ca^{2+} > K^+$. The contribution of calcium (1.27 – 3.2 %) was low compared to fresh surface waters of the wheatbelt region (median 5.03 %) sampled during the SAP survey. In fresh surface waters of the wheatbelt SAP sites magnesium tended to contribute 2 - 5 times more than calcium to cation composition (interquartile range 1.64 to 4.8), whereas for most of the tumulus springs magnesium contributed 8 – 13 times more than calcium. The order of anion dominance was either $Cl^- > SO_4^{2-} > HCO_3^-$ or $Cl^- > HCO_3^- > SO_4^{2-}$. The former was more common, with the contribution of sulphate particularly high (27 %) at TST03. Nutrient concentrations were low at all sites. Total phosphorus and nitrogen are not shown for 3 sites where the sample was collected from interstitial water. This is because the samples were analysed without prior filtration giving erroneous results.

The water chemistry of the Three Springs mound springs differed substantially from that of the mound springs in the Muchea region studied by Jasinska (1998). The Muchea sites were more acidic (pH 3.2 – 4.5), more coloured (470 – 1300 TCU) and were fresher (electrical conductivity 16 – 92.3 μS/cm) than the Three Springs sites. Ionic composition also differed. At the Muchea sites, calcium, magnesium and sulphate contributed more to total ionic concentration than any of the Three Springs sites.

### Invertebrates

At least 88 species of aquatic invertebrate were collected. Some taxa have only been partially identified because only immature stages were found (particularly some water mites) or because of a lack of keys or expertise or a need for taxonomic research. About a third of the species (Table 2) were present only at the dam (TST006a). These species are widespread in the south-west, with the exception of the mosquito *Culex* (*Neoculex*) sp. 1. This species is not included in the main regional identification guide (Liehne, 1991) and was collected from only two freshwater swamps in the southern wheatbelt during the SAP survey. At least 59 species were collected from natural mound spring habitats (Table 3) and only 6 of these also occurred in the dam. Few taxa were collected at more than 1 or 2 springs. However, this may reflect the fact that there was limited habitat available for sampling at some springs because of the stage in the hydrological cycle at which they were visited and the generally drier nature of some springs. This no doubt contributed to the lower species richness at sites TST05 and TST20 than at TST01 and TST03. Most of the species in Table 3 are common in the wheatbelt and broader south-west and only those that are less common or widespread or are poorly known are discussed below.

*Groundwater taxa*. The bathynellids (Syncarida) and ostracods seem to be the only groundwater invertebrates collected. Most of these occurred only at TST01 and TST03, but, since these were the wettest springs, they were more thoroughly sampled than other sites. The bathynellid from TST01 was in poor condition and could not be identified but those from TST03 are an undescribed species of *Bathynella*. There are no bathynellids described from Western Australia at present, although the family is likely to be diverse in the south-west and individual species may have restricted distributions (Peter Serov, Dept. Land and Water Conservation, New South Wales, pers. comm.). Brenton Knott (University of Western Australia) and Edyta Jasinska (now of the University of Alberta) have also collected bathynellids from seepage areas of the eastern Gnangara Mound and from caves in the south-west, but these are yet to be identified (Brenton Knott pers. comm.). Bathynellids have also been collected from groundwater bores in south-western Australia (Peter Serov, pers. comm.). Jasinska (1998) did not collect bathynellids at the Muchea tumulus springs. The ostracods from the mound spring sites belong to families (Candonidae and Darwinulidae) that are common and widespread in Australian groundwater, but taxonomic knowledge of these is insufficient to allow species determination. The identity of the Darwinulidae sp. 715 from TST03 is uncertain, except that it is not a *Darwinula*. A forthcoming publication on the Australasian representatives of this family may allow identification to genus but the single specimen was in poor condition.

*Surface water taxa*. The copepod Harpacticoida sp. 2 was only collected from three wetlands in the wetter parts of the south-west during the SAP survey: Darkin Swamp in the Darling Range, Noobijup Swamp in the Lake Muir region and Lake Pleasant View near the town of Manypeaks. This species is probably widespread in the more coastal areas of the south-west in suitable habitats. Another harpacticoid copepod, Canthocamptidae sp. 6, was otherwise collected only from a granite rock pool just east of the northern wheatbelt during the SAP survey. Halacarid mites are largely marine and freshwater species tend to inhabit subterranean and hyporheic habitats. Unfortunately, the only specimen collected in this survey was immature. The chironomid Pentaneurini sp. F (Tanypodinae), which was collected from three of the springs, may be an undescribed species or simply the unassociated larvae of a species described from the adult. In either case it was not collected during the SAP wheatbelt survey and is not a species included in the key to Australian chironomid larvae by Cranston (2000). The orthoclad chironomid "genus woodminer" has not been previously been recorded from the wheatbelt region but is common in the wetter regions of the south-west (e.g. Lake Muir region, Darling Scarp streams and south coast lakes, D. Edward, The University of Western Australia, pers. comm). The two mosquito species belonging to the genus *Culiseta* were not recorded during the SAP survey and do not resemble the only *Culiseta* species (*Culiseta atra* Lee 1944) described from WA or any of the south-eastern Australian species in Russell (1993). *Culiseta atra* is restricted to the higher rainfall south-west south of Toodyay (Liehne, 1991) and prefers freshwater habitats with abundant leaf litter. Russell (1993) notes that some *Culiseta* species habitually breed in subterranean habitats such as land crayfish burrows and most others prefer small shaded pools, often at the bases of trees or logs. Thus, some of the mound spring habitats appear suitable for species of this genus. The oligochaete *Pristina* sp. 1 is similar to *Pristina rosea* (Piguet, 1906) of Europe but may be an undescribed species and appears to be conspecific with specimens from the Yanchep caves, Jimperding Brook in the Darling Range and a stream near Walpole. It was not collected during the SAP wheatbelt survey. Larvae of the dragonfly *Archaeosynthemis occidentalis* were found at only one site (Yerina Spring, north of Hutt Lagoon) during the SAP wheatbelt survey and has otherwise only been collected from streams or boggy habitats of the Darling Range and coastal south-west south of Perth (K. Sutcliffe, Murdoch University pers. comm.). Jasinska (1998) tentatively identified dragonflies from the Muchea springs as *Archaeosynthemis* ?*leachii*, based on the fact that their morphology appeared intermediate between *A. occidentalis* and *A. spinifer*. These specimens should now be re-examined because a recent publication (Theischinger, 2001) provides the first description of the larvae of *A. leachii*.

On the whole, this complex of springs supports a diverse suite of aquatic invertebrates, including some surface water species which appear to be uncommon or absent in other types of aquatic habitats of the wheatbelt and not particularly common even in the wider south-west. In the lower rainfall regions of the south-west such species may be largely restricted to habitats such as springs and seepages. With current taxonomic knowledge and a paucity of comparable surveys it is impossible to assess the distribution and conservation status of the groundwater elements of the fauna of these springs. However, the bathynellids and ostracods most likely occur in the regional groundwater aquifer associated with these springs and appear near the surface only in seepage/spring areas.

There are several invertebrate groups (*Polypedilum*, *Archaeosynthemis*, *Paracyclops*, harpacticoid copepods, *Candona* and *Aeolosoma*) with tentatively or partially identified species in both our study and Jasinska (1998). Unfortunately, we were unable to locate the specimens from Jasinska (1998) so comparison of these taxa between the two studies was not possible. Some specimens from the Muchea springs were made available by Dr Brenton Knott but these were collected 12 months before those collected for the study of Jasinska (1998). This collection included *Paracyclops* nr. *timmsi* and what we are calling harpacticoid sp. 2 (both species listed in Table 3). These may be equivalent to one of the *Paracyclops* and the harpacticoid copepods listed in Jasinska (1998). Comparison of the species lists is further hindered by the fact that some taxa (rotifers, nematodes, oribatid mites and ceratopogonid midges) have not been identified to an equivalent taxonomic level in the two studies. There were few other taxa in common between the two studies, particularly if those collected only at the dam in the present study are excluded. Those that were collected from springs in both studies are widespread species such as the oligochaete *Pristina longiseta* and the chironomid *Paramerina levidensis*. Jasinska (1998) recorded flatworms (Platyhelminthes), water fleas (Cladocera) and several other mite, worm and beetle species that we did not. By contrast, we collected Trombidioidea and Mesostigmata mites, bathynellids, tubificid oligochaetes, several ostracods and widespread crustaceans and insects not found by Jasinska (1998). All of the mites and tubificid oligochaetes recorded in this study were juvenile so could not be identified.

## Conclusions

This complex of springs provides habitat for a diverse array of aquatic invertebrates. While most of these species are common and widely distributed, there is a small subset of species (those discussed above) that appear to be rare or absent in other types of aquatic habitat in the wheatbelt and a few may even be uncommon in the broader south-west. Although it is unlikely that any element of this subset is restricted to these particular springs, taken together they form an assemblage that may not occur in other aquatic habitats. These springs may represent a northern outlier for the distribution of several species otherwise known only from the higher rainfall south-west. These conclusions refer to the surface water species only at this stage as very little is known of the biogeography of groundwater invertebrates in the south-west.

There are two qualifications to the above assessment. Firstly, some of the species discussed above may be equivalent to species collected in the Muchea mound springs surveyed by Jasinska (1998). This requires investigation through examination of Jasinska's material and further collecting (e.g. for the halacarid mite and ?*Candopsis* ostracod). Secondly, the numerous studies of aquatic invertebrate assemblages in the south-west have involved different levels of taxonomic resolution for some groups and have used different codes for invertebrates that cannot be identified as described species. This limits the confidence with which one can discuss habitat preferences, distributions and conservation status of some aquatic invertebrates.

The mound springs were sampled while at the driest stage of their hydrological cycle for this study. This meant that some springs (particularly TST05 and TST20) were each sampled from only one small hole dug in waterlogged soil. It was obvious that inundated or at least waterlogged habitat would be more prevalent during periods of greater groundwater discharge at these sites. It is recommended that these and additional springs in this system are re-sampled in late winter/early spring, with the aims of:

1. Producing a more complete list of invertebrates utilising these spring habitats over the year.
2. Collecting additional specimens of some taxa which could not be identified from the limited or immature material collected in this survey (such as the water mites, tubificid worms, ?*Candopsis* and Darwinulidae sp. 715).
3. Assessing whether those invertebrates of particular interest (as discussed above) occur across a greater proportion of these springs than is apparent to date.

## Acknowledgements

Jane McRae identified the copepods, Stuart Halse the ostracods and Peter Serov (NSW Department of Land and Water Conservation) the bathynellids. Karen Sutcliffe (Murdoch University) provided maps of the distribution of *Archaeosynthemis* spp. Sue Harrington (Health Department) provided information on *Culiseta* mosquitoes. Sheila Hamilton-Brown and Allan Tinker (Western Flora Caravan

Park) assisted with the field work and identified the organic mound springs. Brenton Knott made specimens from the Muchea mound springs available.

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**Table 1. Water chemistry at the five tumulus springs**

| | TS1 | TS3 | TS5 | TS6a | TS6b | TSA |
|---|---|---|---|---|---|---|
| pH | 6.72 | 6.27 | 6.62 | 7.01 | 6.34 | 7.19 |
| conductivity (μS/cm) | 1687 | 1430 | 1216 | 1273 | 3040 | 808 |
| salinity (g/L) | 0.6 | 0.5 | 0.3 | 0.4 | 1.3 | 0.1 |
| turbidity (NTU) | 30 | 700 | 800 | 2.8 | 600 | 4.5 |
| colour (TCU) | 46 | 8 | 66 | 30 | 260 | 150 |
| total Dissolved Solids (g/L) | 0.88 | 0.88 | 0.76 | 0.79 | 1.6 | 0.47 |
| alkalinity (mg/L) | 30 | 1 | 15 | 30 | 35 | 38 |
| hardness (mg/L) | 140 | 110 | 100 | 110 | 240 | 61 |
| Iron (mg/L) | 20 | 12 | 35 | 0.68 | 1.1 | 0.09 |
| silica (mg/L) | 45 | 162 | 21 | 36 | 86 | 35 |
| sodium (% meq) | 79.04 | 76.24 | 76.02 | 79.85 | 79.41 | 80.57 |
| calcium (% meq) | 1.92 | 1.83 | 3.20 | 1.27 | 1.49 | 2.64 |
| magnesium (% meq) | 15.84 | 18.11 | 15.80 | 16.70 | 16.61 | 13.06 |
| potassium (% meq) | 3.12 | 3.76 | 4.92 | 2.16 | 2.49 | 3.72 |
| manganese (% meq) | 0.07 | 0.07 | 0.06 | 0.03 | 0.00 | 0.00 |
| total cations (meq/L) | 15.57 | 10.90 | 10.93 | 11.82 | 26.73 | 7.56 |
| | 8.240480962 | 9.888577154 | 4.944289 | 13.18477 | 11.12465 | 4.944289 |
| chloride (% meq) | 92.42 | 72.69 | 86.30 | 88.65 | 92.68 | 77.36 |
| bicarbonate (% meq) | 4.23 | 0.13 | 2.58 | 5.15 | 2.73 | 10.34 |
| carbonate (% meq) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| sulphate (% meq) | 3.34 | 27.17 | 11.11 | 6.19 | 4.59 | 12.28 |
| nitrate (%meq) | 0.01 | <0.01 | 0.01 | <0.01 | <0.01 | 0.01 |
| total anions (meq/L) | 14.34 | 12.41 | 11.44 | 11.77 | 25.86 | 7.29 |
| soluble reactive phosphorus (μg/L) | 10 | 10 | 10 | 10 | 10 | 10 |
| total persulphate phosphorus (μg/L) | 10 | - | - | 10 | - | 10 |
| ammonia nitrogen (μg/L) | 70 | 250 | 230 | 10 | 140 | 50 |
| nitrate/nitrite (μg/L) | 40 | 10 | 40 | 10 | 20 | 30 |
| total persulphate nitrogen (μg/L) | 510 | - | - | 210 | - | 920 |

**Table 2. Aquatic invertebrates that occurred only in the dam on site TST006.**

| Taxon | |
|---|---|
| Rotifers | *Lecane* sp. |
| Mites | *Hydrachna* sp. (nymph) |
| Cyclopoid copepods | *Australocyclops australis* (Sars) |
| Seed shrimps | *Limnocythere* ?*dorsosicula* |
| Amphipods | *Austrochiltonia subtenuis* Hurley |
| Freshwater crayfish (yabbie) | *Cherax destructor* Clark |
| Beetles | *Hyphydrus elegans* (Montrouzier) |
| | *Sternopriscus multimaculatus* (Clark) |
| | *Necterosoma penicillatus* (Clark) |
| | *Paracymus pygmaeus* Macleay |
| Mosquito larvae | *Anopheles annulipes* Walker |
| | *Culex (Neoculex) latus* Dobrotworsky |
| | *Culex (Neoculex)* sp. 1 (*) |
| Non-biting midge larvae | *Procladius paludicola* Skuse |
| | *Alotanypus dalyupensis* Freeman |
| | *Corynoneura* sp. |
| | *Tanytarsus fuscithorax* Skuse |
| | *Kiefferulus martini* Freeman |
| | *Polypedilum watsoni* Freeman |
| | *Cladopelma curtivalva* (Kieffer) |
| Bugs | *Microvelia peramoena* Hale |
| | *Agraptocorixa parvipunctata* (Hale) |
| | *Micronecta robusta* Hale |
| | *Micronecta gracilis* Hale |
| | *Anisops thienemanni* Lundblad |
| | *Anisops hackeri* Brooks |
| Damselfly nymphs | Coenagrionidae |
| Dragonfly nymphs | *Aeshna brevistyla* (Rambur) |
| | *Orthetrum caledonicum* (Brauer) |
| Caddisfly larvae | *Triplectides australicus* Banks |

(*) number code used in the CALM voucher collection

**Table 3. Aquatic invertebrates occurring in natural mound spring habitats, with records of these from the dam on site TST006**

| | | Natural mound spring habitats | | | | | | Artificial dam |
|---|---|---|---|---|---|---|---|---|
| **Taxon (*)** | | **TST001** | **TST003** | **TST005** | **TST006b** | **TST020** | **Total** | **TST006a** |
| Rotifers | Bdelloida | | | | 1 | | 1 | 1 |
| Nematodes | Nematoda | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| Aphanoneurans | *Aeolosoma* sp. | | | | | 1 | 1 | |
| Aquatic earthworms | Tubificidae (immature) | | 1 | 1 | | | 2 | 1 |
| | *Pristina longiseta* Ehrenberg | | 1 | 1 | | | 2 | |
| | *Pristina* sp. 1 (nr rosea?) | | 1 | | | | 1 | |
| | Enchytraeidae sp. | | | | | 1 | 1 | |
| Mites | Hydracarina sp. (nymph) | 1 | 1 | | | | 2 | |
| | Halacaridae | 1 | | | | | 1 | |
| | Oribatida | 1 | 1 | 1 | 1 | 1 | 5 | |
| | Mesostigmata | | 1 | | | | 1 | |
| | Trombidioidea | 1 | 1 | | | | 2 | |
| Syncarids | Bathynellidae | 1 | | | | | 1 | |
| | *Bathynella* sp. (sp. 1 of P. Serov) | | 1 | | | | 1 | |
| Cyclopoid copepods | *Mixocyclops* sp. 1 | 1 | | | | | 1 | |
| | *Paracyclops* nr *timmsi* (Kiefer) | 1 | 1 | 1 | | | 3 | |
| | *Paracyclops chiltoni* (Thomson) | | 1 | | 1 | | 2 | |
| | *Mesocyclops brooksi* (Pesce *et al*) | | 1 | 1 | 1 | | 3 | 1 |
| | *Metacyclops arnaudi* (sensu Sars) | | | | 1 | | 1 | |
| Harpacticoid copepods | Canthocamptidae sp. 6 | | | 1 | | | 1 | |
| | Canthocamptidae sp. | 1 | | | | | 1 | |
| | Harpacticoida sp. 2 | 1 | 1 | | | | 2 | |
| Seed shrimps | Darwinulidae sp. 715 | | 1 | | | | 1 | |
| | *Darwinula* sp. | 1 | 1 | | | 1 | 3 | |
| | *Candona* sp. | 1 | 1 | | | | 2 | |
| | *Candonopsis* sp. | 1 | | | | | 1 | |
| | ?*Candopsis* sp. (juvenile) | 1 | | | | | 1 | |
| Beetles | *Liodessus inornatus* (Sharp) | 1 | 1 | | 1 | | 3 | |
| | *Platynectes decempuntatus var. polygrammus* Regimbart | | 1 | | | | 1 | |
| | Staphylinidae | 1 | 1 | | | | 2 | |
| | Scirtidae sp. (larvae) | 1 | 1 | | | | 2 | |
| | Limnichidae | | 1 | | | | 1 | |
| Crane fly larvae | Tipulidae group C | 1 | 1 | | | | 2 | |
| Mosquito larvae | *Aedes* sp. | | 1 | | | | 1 | |
| | *Culiseta* sp. 1 | 1 | | | | | 1 | |
| | *Culiseta* sp. 2 | 1 | | | | | 1 | |
| Biting midge larvae | unidentified Ceratopogonidae | | 1 | | | | 1 | |
| | *Bezzia* sp. (not 1 or 2) | | 1 | | | | 1 | |
| | *Bezzia* sp. 2 | 1 | | 1 | | | 2 | |
| | *Bezzia* sp. 1 | | | | | 1 | 1 | |
| | Culicoides sp. | 1 | | 1 | | | 2 | |
| | Monohelea sp. | | | 1 | | | 1 | |
| | Forcypomyia sp. | | | 1 | | 1 | 2 | |
| | Dasyheleinae | | | 1 | | 1 | 2 | |
| Non-biting midge larvae | *Paramerina levidensis* (Skuse) | 1 | 1 | 1 | | | 3 | 1 |
| | Pentaneurini sp. F | 1 | 1 | 1 | | | 3 | |
| | Orthocladiinae "genus woodminer" | | | | | 1 | 1 | |
| | *Paralimnophyes pullulus* (Skuse) | | 1 | | | | 1 | |
| | Orthocladiinae | | | | 1 | | 1 | |
| | *Tanytarsus* nr *bispinosus* Freeman | 1 | 1 | 1 | | | 3 | |
| | *Chironomus* aff. *alternans* Walker | | 1 | | | | 1 | |
| | *Polypedilum* nr. *convexum* Johannsen | 1 | 1 | | | | 2 | |
| | *Harrisius* sp. A | 1 | | | | | 1 | |
| Other fly larvae | Dolichopodidae sp. A | | | 1 | | | 1 | |
| | Muscidae | | 1 | | | | 1 | |
| | Diptera | | 1 | | | | 1 | |
| | Scatopsidae | | 1 | | | | 1 | |
| | Ephydridae | 1 | | | | | 1 | |
| Mayfly nymphs | Baetidae (probably *Cloeon*) | | | | 1 | | 1 | 1 |
| Dragonfly nymphs | *Archaeosynthemis occidentalis* (Tillyard) | 1 | | 1 | | | 2 | |
| Caddisfly larvae | Leptoceridae | 1 | 1 | | | | 2 | |
| | *Setodes* sp. | | | 1 | | | 1 | |
| | **Species richness** | **30** | **35** | **18** | **9** | **9** | | **6** |

(*) number and letter codes are those used in the CALM voucher collection