Bennelongia Environmental Consultants

Medcalf Project: Assessment of Subterranean Fauna Values

Prepared for:

Audalia Resources Limited

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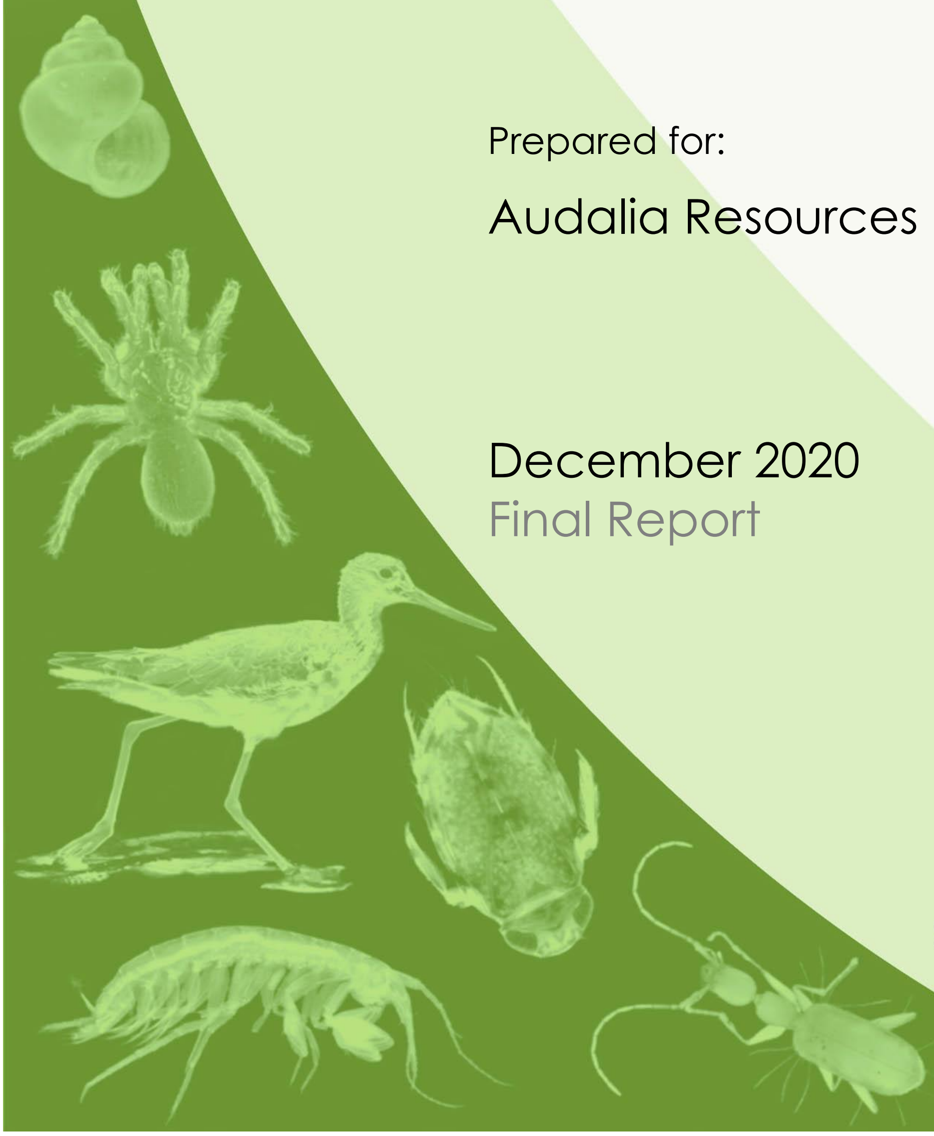
Final Report



Short-Range Endemics I Subterranean Fauna

Waterbirds I Wetlands

Medcalf Project: Assessment of Subterranean Fauna Values

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EXECUTIVE SUMMARY

Audalia Resources Limited proposes to develop the Medcalf Project ('the Project') in the Goldfields-Esperance region of Western Australia. This report presents the results of a desktop review of habitat information and relevant biological records, as well as results of two rounds of a field survey to appraise the values of subterranean fauna (stygofauna and troglofauna) in the Project and surrounds.

The Project lies in the Archaean-aged Lake Johnston greenstone belt in the Yilgarn Craton. The belt contains komatiite lava flows, subvolcanic intrusions, mafic volcanic rocks, felsic volcanic rocks, banded iron formation (BIF) and sedimentary rocks. Regolith and weathered bedrock in the Project area extend to depths of 60–80 m. Neither fresh rock nor the water table were encountered during exploration drilling in the proposed mine pits (hole depths of up to 90m). The targeted mineral deposits are deeply weathered. The mapped geological units within each of the mine pits continue outside the pits, indicating the potential for habitat connectivity. Diamond core photographs and associated lithological logs demonstrate cavity development in mineralised zones at depths up to about 40m within the proposed mine pits. Cavities several centimetres across comprise up to 10% (but usually less) of some mineralised lithologies as a result of clay removal.

The regional hydrogeology is characterised by low relief and palaeodrainage draining to the northeast with aquifers in fresh and fractured rock, as well as tertiary palaeochannel sands and surficial deposits of laterite, alluvium and calcrete. In the Project area, groundwater levels are closer to surface in areas of lower relief (proposed mine pits are in more elevated areas), particularly towards the Lefroy palaeovalley that encroaches into the Project area to the east and northeast. Available geological mapping does not identify any substantial calcrete bodies in the vicinity of the Project. Groundwater exploration drilling reported predominantly hypersaline groundwater.

A desktop search within a radius of 100 km from the approximate Project centroid did not reveal records of stygofauna species. The closest records of stygofauna are more than 130 km southwest of the Project. At least five species of troglofauna have been recorded within the search area at Mt Henry, approximately 90 km east-north-east of the Project, including two pseudoscorpions, one silverfish, one isopod and one symphylan. The primary habitat of these species appears to be mineralised BIF. It is unlikely that these species have large ranges and they are hence considered unlikely to occur at the Project, although these records demonstrate that troglofaunal communities can occur in mineralised rock in the Yilgarn. No listed subterranean communities or species occur in the vicinity of the Project.

A two round field survey of subterranean fauna was undertaken by Bennelongia. Sampling for troglofauna via scraping and trapping was conducted at 78 uncased exploration drill holes located in, around and up to 1.8 km from the proposed mine pit footprints, while nine bores in the potential water supply borefield to the northeast, east and southeast of the mine area were sampled for stygofauna via net hauling. In the first round, due to travel restrictions resulting from bushfires and other scheduling issues, troglofauna traps remained in the ground for approximately six months, as opposed to the usual two months.

Except for seven nematode worms, no stygofauna were collected at the Project. Groundwater chemistry measured at the top of the watertable, including where the water table was very shallow, aligned with measurements from groundwater exploration drilling and provided further support for a low level of prospectivity. The results of the stygofauna survey indicate an extremely depauperate stygofauna community in the study area. The Project is therefore considered highly unlikely to threaten stygofauna species.

In contrast to expectations of a depauperate troglofauna community based on desktop information, sampling for troglofauna yielded a total of 110 specimens belonging to 20 species of confirmed and potential troglofauna. This included one spider (Araneae), one pseudoscorpion (Pseudoscorpiones), three species of centipede (Chilopoda), two species of millipede (Diplopoda), three species of symphylan/'pseudocentipede' (Symphyla), two species of pauropod (Pauropoda), three species of beetle (Coleoptera), one species of planthopper (Hemiptera: Cixiidae) and four species of isopod (Isopoda). Based on morphological characters, most species of troglofauna collected at the Project are troglobitic and represent new species that have not been recorded outside the area sampled yet.

The main factor that could potentially threaten species of troglofauna at the Project is the excavation of the four proposed mine pits. In total, nine species of troglofauna were collected both within and outside the proposed mine pits, while five species were recorded only in reference bores. The other six species have currently been collected only from holes within the extent of the proposed mine pits. The low capture rates (presumably as a result of low population densities), combined with moderate to small sampling extent, mean it is likely that some if not all the species have undetected occurrence outside the proposed mine pits.

The collection of species in both impact and reference holes show that species that are currently known only from the proposed mine pits can also potentially have ranges extending outside pit footprints, since mapped geologies indicate continuity of suitable habitat outside the pits. It is therefore unlikely that any of the troglofauna species recorded have distributions entirely confined to the proposed mine pits, which are very small in relation to the typical ranges of troglofaunal species.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

1. INTRODUCTION

Audalia Resources Limited (Audalia) proposes to develop the Medcalf Project ('the Project'), south of Lake Johnston and approximately 100 km southwest of Norseman, in the Goldfields-Esperance region of Western Australia (Figure 1). This report presents the results of a desktop review of habitat information and relevant biological records, as well as the results of a two round field survey to appraise the values of subterranean fauna (stygofauna and troglofauna) in the Project and surrounds.

1.1. Project Description

The Project comprises three tenements that are together referred to as the 'Project area': Mining Lease M 63/656 and Exploration Licenses E 63/1133 and E 63/1134 (Figure 1). There are also two applications in progress, Exploration Licence E 63/1855 and Miscellaneous Licence L 63/65. Mining will target mineralised deposits of vanadium and titanium.

The Project is planned to consist of two development envelopes, representing the mine area and transport and borefield infrastructure area. Proposed developments in the mine development envelope include four open cut mine pits, an ore beneficiation plant, a tailings storage facility (TSF), a waste rock landform and support infrastructure, including accommodation, laydown area, workshops and administration offices (Figure 1).

The transport/borefield development envelope is proposed to include a private haul road of approximately 74 km in length running from site to the Coolgardie-Esperance Highway, associated borrow and gravel pits, a groundwater borefield to supply mine and transport infrastructure, an ore transfer hub near the Coolgardie-Esperance Highway and support infrastructure.

1.2. Aims

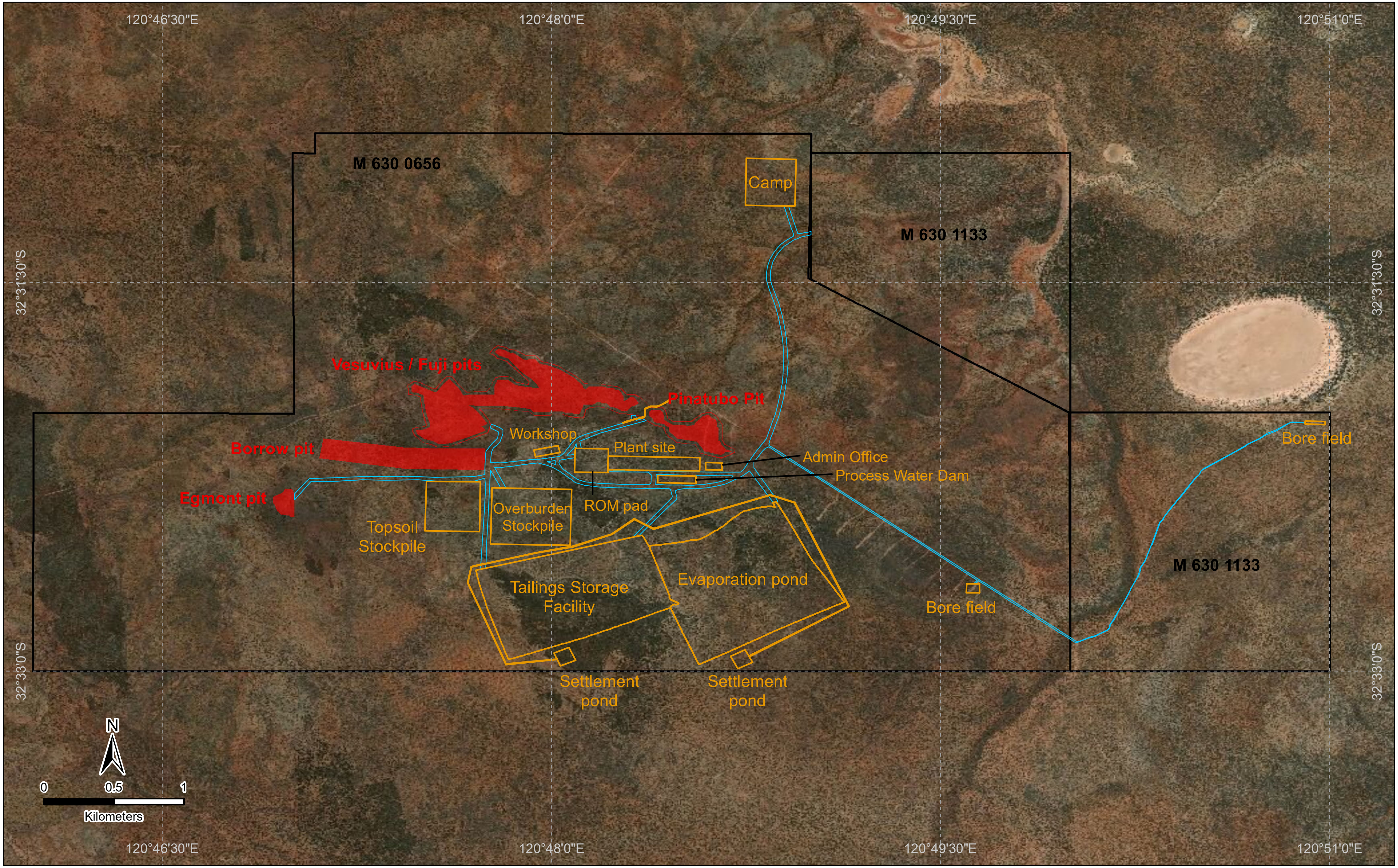
The specific aims of this assessment are to:

1. Review available geological and hydrogeological information to assess the prospectivity of habitats in the vicinity of the Project for subterranean fauna.
2. Compile and evaluate records of subterranean fauna within the vicinity of the Project (including listed species and ecological communities), assess ranges of recorded species and incorporate these results into the appraisal of prospectivity.
3. Present and discuss the results of field surveys of stygofauna and troglofauna at the Project, including the ranges of species recorded
4. Outline potential impacts to subterranean fauna from proposed developments.

2. SUBTERRANEAN FAUNA FRAMEWORK

The term subterranean fauna includes aquatic stygofauna and air-breathing troglofauna. Both groups typically have reduced or absent eyes and are poorly pigmented due to lack of light. Other morphological and physiological adaptations, such as vermiform bodies, elongate sensory structures, loss of wings, increased lifespan, a shift towards K-selection breeding strategy and decreased metabolism reflect the habitats occupied by subterranean species (Gibert and Deharveng 2002). Ignoring the fauna of caves, except for a few species of fish and reptiles, all subterranean fauna species in Western Australia are invertebrates.

Many subterranean fauna species are obligate inhabitants of subterranean habitats (stygobites and troglobites), but some have a life-stage in surface and soil habitats (stygophiles and troglophiles). Stygophiles and troglophiles usually have larger distributions than obligate subterranean species, as a result of greater dispersal opportunities. Stygoxenes and trogloxenes are species that use subterranean habitats opportunistically. Although inconspicuous, subterranean fauna contribute markedly to the overall biodiversity of arid parts of Australia.



Bennelongia Environmental Consultants

GCS_GDA_1994
Author: B. Buzatto
Date: 03-09-2020

Legend

- Pit footprints 3.09.20
- Minesite layout 3.09.20
- Minesite roads 3.09.20
- Tenements

Figure 1. Location and proposed layout of the Medcalf Project

The Yilgarn, Pilbara and neighbouring regions of Western Australia are recognised as hotspots of subterranean faunal biodiversity, with an estimated 4,000 or more subterranean species likely to occur (Guzik *et al.* 2010), the majority of which remain undescribed. A high proportion of subterranean species are likely to satisfy Harvey's (2002) criteria for short-range endemism (SRE), namely a total range of less than 10,000 km^2, occurrence in discontinuous or fragmented habitats, slow growth and low fecundity.

Given that species with small ranges are more vulnerable to extinction following habitat degradation than wider ranging species (Ponder and Colgan 2002), it follows that subterranean species are highly susceptible to anthropogenic threats such as groundwater abstraction or excavation. In Western Australia the Environmental Protection Authority (EPA) requires consideration of subterranean fauna as part of environmental impact assessments (EPA 2016a, c).

3. HABITAT

Troglofauna occupy subterranean spaces, such as alluvial interstices, vugs and fissures, while stygofauna inhabit water held by such structures. Additionally, stygofauna sometimes occur in the alluvium of hyporheic zones – the confluence of groundwater and surface-water habitats – as well as in groundwater-fed springs. Geology and hydrogeology are significant drivers of the distributions of subterranean species and communities (Eberhard *et al.* 2005; Hose *et al.* 2015).

Highly transmissive geologies tend to support richer and more abundant assemblages of subterranean fauna. For example, clastic alluvial media may host rich assemblages in the interstitial spaces between constituent sand and gravel. Coarse sediments usually host the richest assemblages while silty or clay-rich substrates are generally not considered prospective (Korbel and Hose 2015). Physical and chemical weathering of consolidated media can also provide inhabitable spaces such as underground vugs and caves. In arid and semi-arid regions, fluctuating groundwater levels and subsequent deposition of carbonate-rich material in palaeochannels has led to the formation of calcrete aquifers that offer habitat similar to karst. Many subterranean species are confined to single, isolated geological structures or aquifers (e.g. Eberhard *et al.* 2016; Harvey and Leng 2008).

3.1. Local Habitat

Several information sources provide a basis for characterising potential habitats and appraising the prospectivity of the Project area and immediate surrounds for subterranean fauna:

- Groundwater report based on exploration drilling (GRM 2019)
- Geological mapping, including the Lake Johnston 1:250,000 map sheet (Gower and Bunting 1971) and composite regolith mapping (Marnham and Morris 2003)
- Description of local geology (memorandum to Audalia from B. Butler, January 2019)
- Palaeovalley mapping (Bell *et al.* 2012)
- Diamond drill core photographs and associated lithology logs in proposed mine pits
- Hydrogeological desktop report for the Project area and surrounds (GRM 2015)

The geology of the Project area and surrounds is shown in Figure 2. The Department of Water and Environmental Regulation's (DWER) Water Information Reporting (WIR) database does not list any water bores in the vicinity, although regional information compiled by GRM (2015) provides some indication of expected conditions.

3.2. Geology

The following descriptions of Project geology were provided in an unpublished memorandum to Audalia by B. Butler (January 2019). The Project lies in the Archaean-aged Lake Johnston greenstone belt in the Yilgarn Craton. The belt extends approximately 110 Km trending north-northwest and contains komatiite lava flows, subvolcanic intrusions, mafic volcanic rocks, felsic volcanic rocks, banded iron formation (BIF) and sedimentary rocks.

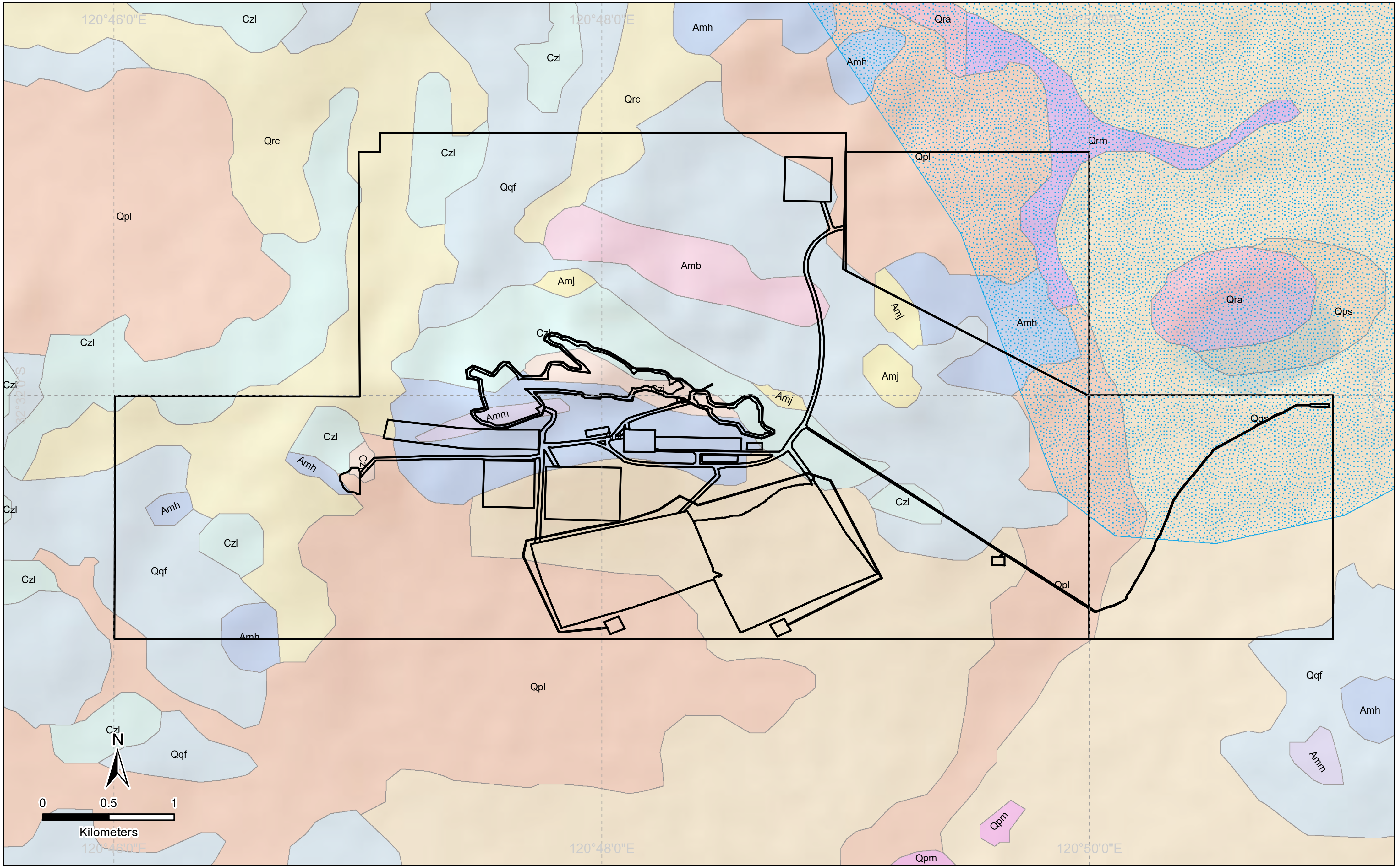


Figure 2. Geology of the Project and surrounds

Geological codes are provided by the layer source: Geological Survey of Western Australia (1976) 1:250 000 geological map - Lake Johnston (SI51-01)

Target mineral deposits are hosted by the Medcalf layered sill, which is a flat-lying igneous body that has intruded parallel to the enclosing basalts. The sill consists of upper gabbroic, middle pyroxenite and lower amphibolite zones. The bedrock geology is widely masked by lateritic duricrust, deep oxidation and transported material including lacustrine, alluvial and colluvial deposits (GRM 2015). The regolith and weathered bedrock extend to depths of approximately 60–80 m and fresh rock was not encountered during exploration drilling (hole depths of up to 90 m). Four mine pits containing vanadium and titanium mineralisation have been identified in the Project area – Vesuvius, Fuji, Egmont and Pinatubo. Vanadium and titanium have been concentrated in a pyroxenite unit, which has been subsequently enriched through weathering and regolith-formation. The deposits are deeply weathered, with over 60 m of saprolite showing vertical zonation of weathering minerals. The lateritic weathering profile has four zones (from shallowest to deepest): lateritic residuum, mottled zone, saprolite and saprock. The mapped geological units within each of the mine pits continue outside the pits, indicating the potential for habitat connectivity (Figure 2).

Diamond core photographs and associated lithological logs demonstrate cavity development in mineralised zones at depths up to about 40 m within the proposed mine pits. Cavities several centimetres across comprise up to 10% (but usually less) of some mineralised lithologies as a result of clay removal. An example of examined drill cores, including cavity development, is presented in Plate 1 and the site from which this core was drilled is depicted in Figure 3 and Figure 4.

Plate 1. Examples of diamond cores reviewed to identify the presence of potential subterranean fauna habitat.
Hole MDD015: A) 0–7.4 m; B) 7.4–13.4 m; C) 13.4–20.1 m; and D) 20.1–26.7 m. Cavity development is most apparent in image B.

Available geological mapping does not identify any substantial calcrete bodies in the vicinity of the Project, although moderately large areas identified as Qpl ('alluvium and colluvium – clay, loam and silt, calcareous in part; quartz, ironstone gravel, weathered rock float, gilgai') occur within and near the Project area and may contain some calcrete, particularly in the palaeochannel (Figure 2).

3.3. Hydrogeology

The regional hydrogeology is characterised by low relief and a palaeovalley draining to the north-east, underlain by Archaean sequences. Aquifers typically occur in: (1) regional catchment-controlled fresh and fractured rock, which are most common in mafic, ultramafic and granitic rocks; (2) tertiary palaeochannel sands, which typically provide the largest source of regional groundwater; and (3) surficial deposits of laterite, alluvium and calcrete (GRM 2015). On a regional scale, groundwater salinity is variable, but typically freshest (e.g. 1,000–5,000 mg/L TDS) at the edges of catchment divides and in shallow alluvial and calcrete aquifers. Deeper aquifers in palaeochannel sands and fractured rock are typically saline to hypersaline.

Exploration drill holes within proposed mine pits to depths of 90 m did not intersect the water table, although groundwater levels are probably closer to surface away from the proposed pits in areas of lower relief, particularly towards the Lefroy palaeovalley that encroaches into the Project area to the east and north-east (Figure 2).

Based on recent groundwater exploration drilling, aquifers in the vicinity of the Project occur in palaeochannel sands and deeper fractured rock. Water quality appears to be saline to hypersaline in both aquifer types. Palaeochannel aquifers appear to be acidic (pH values as low as 3.7), while those in fractured rock are circumneutral (GRM 2019).

Water quality measurements collected during water bore drilling (GRM 2019) were provided to Bennelongia for seven bores in and around the borefield to the east of proposed mine pits. The data show circumneutral pH for the most part, with the exception of bore MWH003, which had lower pH of 3.7 in shallow sands and 3.8 in deeper weathered rock.

Electrical conductance of bore water indicated the water was saline to hypersaline, ranging from 54,000 µS cm^{-1} in the Driller's Bore, to 170,000 µS cm^{-1} in MWH009 (Table 1). While stygofauna have been recorded in very saline aquifers (e.g. Schulz *et al.* 2013), the assemblages in such habitats typically comprise very few species, if any at all.

Table 1. Water bore information provided by GRM.

Bore ID	SWL (m bgl)	Slotted Interval (m bgl)	Aquifer type	pH	EC (µS cm^{-1})
MWH001	17.43	6-66	Fractured bedrock	7.2	140000
MWH003	6.48	18-27	Sand	3.7	100000
		33-39	Weathered breccia	3.8	110000
MWH009	9.45	6-66	Fractured bedrock	7	170000
MWH012	23.48	18-54	Fractured bedrock	7.6	89000
MWH013	TBC	18-54	Fractured bedrock	7.9	55000
MWH014	TBC	18-54	Fractured bedrock	7.6	56000
Driller's bore	24	Unknown		7.7	54000

4. BIOLOGICAL RECORDS

To further inform an appraisal of the prospectivity of the Project area, records of both stygofauna and troglofauna were compiled from Western Australian Museum (WAM) and Bennelongia databases, within a search area with a radius of 100 km from the approximate Project centroid (-32.54°, 120.80°). Resultant species data were investigated spatially and cross-referenced with other records, including those outside the search area, to determine the distribution of each species relative to the Project. Higher-order identifications were not regarded as distinct species unless they belonged to taxa that had otherwise not been recorded.

4.1. Stygofauna

The desktop search did not identify any records of stygofauna species within the search area. Outside the search area, the closest records of stygofauna are over 130 km southwest of the Project, where between eight and 10 species have been collected, including a nematode, an oligochaete, a syncarid and four species of copepod (Bennelongia, unpublished data). While these records are of limited direct relevance to the Project, they nevertheless demonstrate the potential for stygofauna species to occur in the understudied landscapes of southern Western Australia, including aquifers in fractured rock.

4.2. Troglofauna

At least five species of troglofauna have been recorded within the search area (Table 2). These species were recorded by Bennelongia in 2012 at Mt Henry, approximately 90 km east-north-east of the Project and include two pseudoscorpions, one silverfish, one isopod and one symphylan (Bennelongia 2013). The primary habitat from which these species were collected appears to be mineralised BIF.

It is unlikely that these species have large ranges and therefore they probably do not occur at the Project. However, the records from Mt Henry, while indicative of only a moderately rich assemblage, show that mineralised deposits in the southern Yilgarn are prospective for troglofauna, particularly where adequate underground spaces have developed.

Table 2. Troglofauna species recorded in the search area.

Higher Classification	Lowest Identification	Locality	Total no. of holes
Arachnida			
Pseudoscorpiones			
Chthoniidae	*Austrochthonius* sp.		1
	Tyrannochthonius sp. B25		1
Insecta			
Zygentoma			
Nicoletiidae	*Trinemura* sp. B23	Mt Henry	2
Malacostraca			
Isopoda			
Armadillidae	Armadillidae sp. B08		1
Symphyla			
Cephalostigmata			
Scutigerellidae	*Scutigerella* sp. B05		1

4.3. Listed Species and Communities

An ecological community comprising a naturally occurring biological assemblage in a particular habitat type may be listed by the Minister for the Environment as a Threatened Ecological Community (TEC) if it presumed to be totally destroyed, critically endangered, endangered or vulnerable. A community that is threatened but does not meet these criteria, is rare but not threatened, is near threatened, has recently been removed from the TEC list, or is conservation-dependent, may be listed by the Department of Biodiversity, Conservation and Attractions (DBCA) as a Priority Ecological Community (PEC). Many calcrete aquifers in the Yilgarn, Pilbara and neighbouring regions of northwestern Australia are listed as either TECs or PECs on the basis that they harbour significant stygal communities. A smaller number of communities are listed on the basis of troglofauna. No listed subterranean communities occur in the vicinity of the Project, nor are there records of listed subterranean species.

5. DESKTOP CONCLUSIONS

The complete lack of stygofauna records inside the search area is likely to be, at least in part, an artefact of the very low historic sampling effort targeting stygofauna in the region. By the same token, in the context of habitat availability, as interpreted from geological and hydrogeological information, it is considered that a rich stygal assemblage is unlikely to occur within the Project area. Prospectivity for stygofauna in the proposed pits and other Project areas with relatively high elevation is limited by the great depths to water, as suggested by exploration drilling (up to 90 m), which did not intersect groundwater. While the analogy between the southern Yilgarn and Pilbara is not certain, Halse *et al.* (2014) reported low yields of stygofauna in the Pilbara where depth to water was greater than about 30 m (although animals were present in lower numbers at greater depths).

Although not intersected by exploration drilling, the geology underlying the weathered material is likely to comprise fresh and fractured rock. While stygal communities have been documented in surficial, non-calcrete aquifers and fractured rock aquifers elsewhere in the Yilgarn, they tend to be depauperate (e.g. Bennelongia 2009b, 2011). The richest stygal assemblages in the Yilgarn are in calcretes and, based on available habitat information, few calcrete aquifers appear to be present in the Project area and where they are present, such as in the vicinity of MWH001, groundwater is highly saline and therefore not considered very prospective. The most prospective areas for stygofauna in the vicinity of the Project are surficial aquifers within and immediately adjacent to the Lefroy palaeochannel to the east and north-east, especially if fresh or only moderately-saline.

The primary potential habitat for troglofauna in the Project area comprises mineralised zones with well-developed cavities, such as those evident in some drill cores (Plate 1). When compared to geologies containing rich troglobitic communities elsewhere in the Yilgarn (e.g. Bennelongia 2016a) and in the Pilbara (Bennelongia 2016b), the abundance and size of subterranean spaces in the geologies of the Project area appear to be limited. Prior to sampling, it was expected that the abundance and species diversity of any troglobitic community present would reflect this limitation.

6. FIELD SURVEY

To check whether conclusions of the desktop review were correct, a two-season field survey of subterranean fauna was undertaken by Bennelongia. The first round was conducted between October 2019 and April 2020, whereas the second round was conducted between May and August 2020. Both troglofauna and stygofauna were targeting during both rounds of survey.

Sampling for troglofauna via scraping and trapping was conducted at a total of 78 uncased exploration drill holes located in, around and up to 1.7 km away from proposed mine pit footprints (Figure 3). The distribution of troglofauna samples relative to mine pit footprints is summarised in Table 3. Any records of troglofauna recorded outside of these locations is as a result of by-catch from stygofauna sampling.

Nine bores in the potential water supply borefield to the northeast, east and southeast of the mine area were sampled for stygofauna via net hauling (Figure 3). Details of the holes and bores sampled are provided in Table 4. All stygofauna samples were outside the mine area. Any stygofauna specimens recorded outside of these locations are a result of by-catch from troglofauna sampling. Sampling was conducted by Anton Mittra, Mike Scanlon and Jim Cocking. Specimens were identified by Jane McRae.

Table 3. Summary of the distribution of troglofauna samples relative to mine pit footprints.

	Scrape		Trap (double)	
Sampling round	**Impact**	**Reference**	**Impact**	**Reference**
First round (Oct 2019 – April 2020)	19	8	18	8
Second round (May – August 2020)	13	38	13	38
Total	**32**	**46**	**31**	**46**

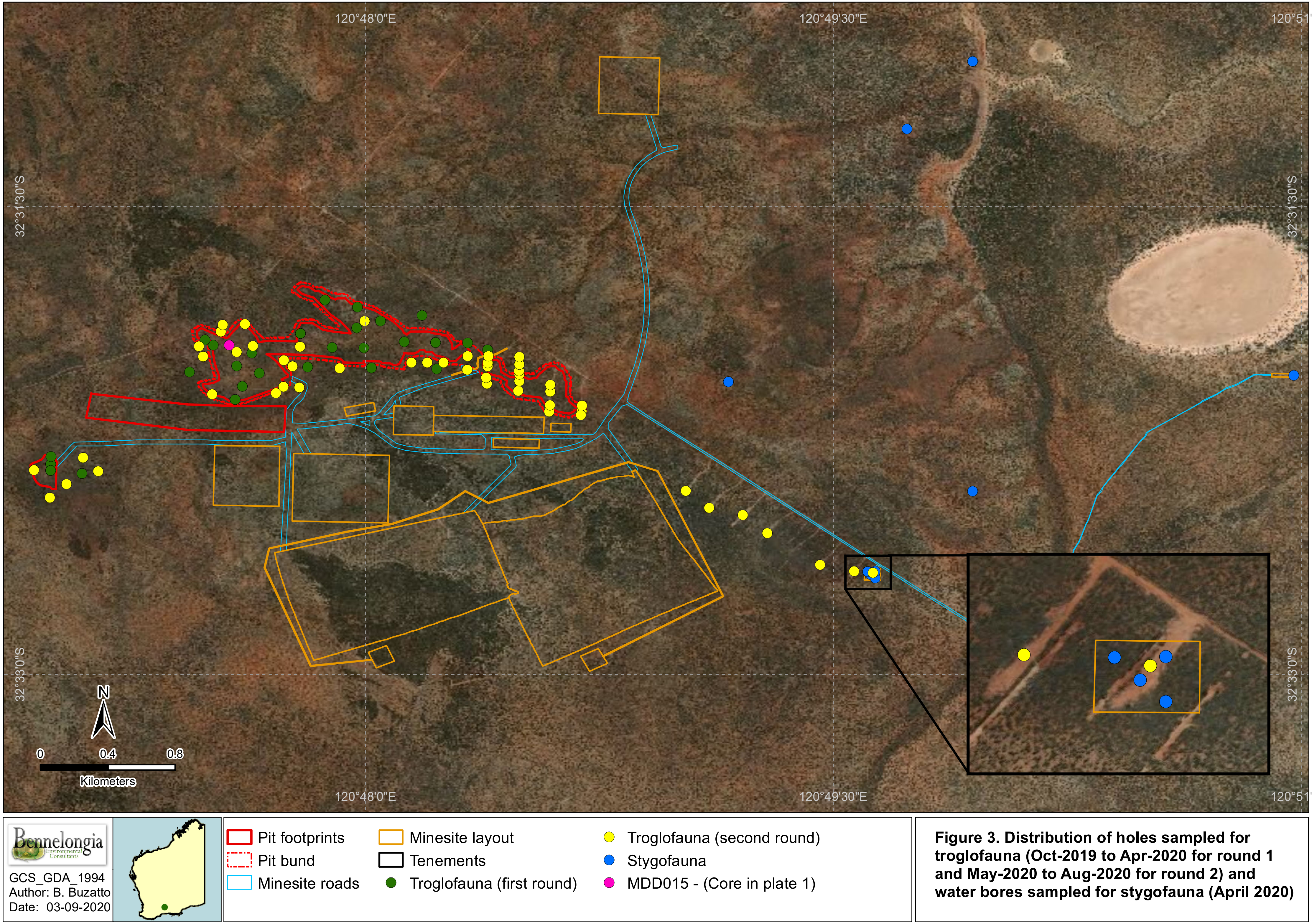


Figure 3. Distribution of holes sampled for troglofauna (Oct-2019 to Apr-2020 for round 1 and May-2020 to Aug-2020 for round 2) and water bores sampled for stygofauna (April 2020)

6.1. Methods - stygofauna

Stygofauna were sampled at each bore using weighted plankton nets. Six hauls were taken at each site, three using a 50 µm mesh net and three with a 150 µm mesh net. The net was lowered to the bottom of the hole, jerked up and down to agitate the benthos (increasing the likelihood of collecting benthic species) and then retrieved slowly through the water column. Substrate in the terminal vial of the net was collected after each haul, preserved in ethanol and kept on ice in the field prior to refrigeration at the conclusion of work. Nets were washed thoroughly between holes to minimise contamination between sites.

In the laboratory, samples were elutriated and sieved into size fractions using 250 µm, 90 µm and 53 µm screens. Samples were sorted under a dissecting microscope and stygofauna specimens identified to the lowest level possible using available keys and species descriptions.

Basic *In situ* water quality parameters – temperature, electrical conductance (EC) and pH – were measured for each bore with a TPS WP-81 field meter, using water collected from the top of the watertable with a bailer. Standing water level was measured using a Heron water level meter.

6.2. Methods – troglofauna

Each hole was sampled via scraping and trapping. Scrapes were collected immediately prior to setting traps using a troglofauna net (150 µm mesh) that was lowered to the bottom of the hole (or to the watertable) and scraped back to the surface, along the walls of the hole. Each scrape comprised at least four sequences of lowering and retrieving the net to give adequate coverage of the inner walls of the hole. Scrapes were preserved in ethanol and kept on ice in the field prior to refrigeration at the conclusion of work.

Traps consisted of cylindrical PVC traps with numerous apertures, which were baited with moist leaf litter and lowered on nylon cord to depths considered to give the best sampling coverage along the length of the hole. The leaf litter bait had been collected from either the Yilgarn or Pilbara, wetted, allowed to decompose over weeks or months and sterilised via microwaving. Holes were capped at the surface while traps were set to minimise the collection of surface invertebrates. Due to travel restrictions resulting from bushfires and other scheduling issues, troglofauna traps in the first round remained in the ground for approximately six months. In the second round, traps were in place for the usual two months. After the trapping period, traps were carefully pulled out of each hole and the contents placed in zip lock bags, allowing enough oxygen for transit back to the laboratory. Scrape and trap samples within the same site were treated as sub-samples of a single sample for reporting purposes.

In the laboratory, the preserved contents of scrapes were screened into size fractions (250 µm and 90 µm) and sorted under a dissecting microscope Troglofauna were extracted from the leaf litter in traps using Tullgren funnels under incandescent lamps: light and heat from the lamps drives troglofauna (and other invertebrates) out of the litter towards the base of the funnel and into a collection vial containing 100% ethanol. The contents of each collection vial were sorted under a dissecting microscope. Litter from each funnel was also examined under a microscope for any remaining animals.

Specimens were examined for troglomorphic characteristics and, if troglofauna, identified to species or morphospecies level using existing taxonomic frameworks. Where a specimen could not be placed in a described species, it was assigned a morphospecies code (unless juvenile).

6.3. Stygofauna Results

The only stygofauna recorded at the Project were nematodes (Nematoda sp.), collected from one bore (one individual in MRC088) in the first round and three bores (six individuals from bores MRC065, MRC078 and MRC119) in the second round, both within and outside the pit footprints of the project

(Table 4). However, none of the bores targeted for stygofauna sampling yielded any stygofauna, and all of these nematodes were collected as by-catch in troglofauna samples. These animals belong to a group for which taxonomic and ecological knowledge is extremely limited in a subterranean context, and they are not considered in impact assessments in Western Australia.

In conclusion, the results of the stygofauna survey indicate an extremely depauperate stygofauna community in the study area. With the exception of MWH009 (1,970 µS cm^{-1}), all of the bores sampled had hypersaline groundwater at the top of the watertable, which is consistent with a depauperate community.

Table 4. Species of stygofauna collected as by-catch at the Project.

Higher Classification	Lowest Identification	Collection Location			
		MRC065	MRC078	MRC088	MRC119
Nematoda	Nematoda spp.	1	3	1	2

6.4. Troglofauna Results

In contrast to expectations of a depauperate community based on desktop information, sampling for troglofauna yielded a total of 110 specimens belonging to 20 species of confirmed and potential troglofauna. This included one spider (Araneae), one pseudoscorpion (Pseudoscorpiones), three species of centipede (Chilopoda), two species of millipede (Diplopoda), three species of symphylan/'pseudocentipede' (Symphyla), two species of pauropod (Pauropoda), three species of beetle (Coleoptera), one species of planthopper (Hemiptera: Cixiidae) and four species of isopod (Isopoda) (Table 5). Photographs of a selection of these species are shown in Plate 2 and 3 and the collection locations of all species are shown in Figure 4. The symphylan ?*Symphylella* sp. BSYM099, both pauropods (Pauropodidae sp. BPU094 and Pauropodidae sp. BPU095), and the pseudoscorpion *Tyrannochthonius* sp. BPS289 were collected in scrape samples only. The beetle *Gracilanillus* sp. BCO193, the isopod *Pseudodiploexochus* sp. BIS396 and the symphylan *Hanseniella* sp. BSYM098 were collected from both scrape and trap samples, whereas the remaining 13 troglofauna species were collected in traps.

Based on morphological characters, most species of troglofauna collected at the Project are troglobitic (obligate subterranean). This is further supported by collection depths (based on trap depth) of between 10 and 60 m below the surface. Except for the spider *Oreo* sp. and the pincushion millipede *Lophoturus madecassus*, which represent species that are widespread in Western Australia, all other species are new and have not been recorded outside the area sampled yet.

6.4.1. Limitations

The trapping period of approximately six months in the first round is likely to have increased trapping success compared to the usual period of 6–8 weeks specified by sampling guidelines (EPA 2016b). However, the relatively small spatial extent of sampling (Figure 3) means that collection records potentially provide a poor guide to the ranges of species. Moreover, in the first round of sampling there was an uneven distribution of holes between impact and reference locations (Table 3), leading to bias towards collecting troglofauna in the impact areas. The second round of sampling balanced the ratio of impact and reference sampling, although with traps that were not in the ground as long.

6.4.2. Species accounts

Details of collected troglofauna that could have limited distributions are outlined below.

***Oreo* sp. (spider from the family Gallieniellidae)**

These minute spiders are rarely collected and poorly studied, especially in Western Australia, from where only two species have been described to date (*O. bushbay* and *O. capensis*; Platnick 2002). Based on size and general morphology, it is possible that the female collected represents a new species of this genus, but confirming this would require the dissection of a miniscule epygine (only 0.2 mm wide), which would be a challenge to experts on the group. Unfortunately, molecular work here would not help, as there are no reference sequences of this genus available for comparison. However, identification below the genus level here is not essential for two main reasons. Firstly, spiders of the genus *Oreo* are usually very widespread, with linear ranges of more than 700 km for *O. bushbay* and *O. capensis* and more than 1,000 km for *O. renmark* and *O. muncoonie*. The species *O. kidman* is only known from the type locality, but that probably reflects poor sampling of this taxon in the Northern Territory. Secondly, species of *Oreo* are usually collected on the surface, from pitfall traps or leaf litter. To our knowledge, this is only the second time that a species from the family Gallieniellidae has been collected from a subterranean habitat, but its coloration, presence of eyes and the fact that the majority of records of the group are on the surface, indicate that this species is probably a trogloxene and not a true representative of troglofauna in the area.

The pseudoscorpion *Tyrannochthonius* sp. BPS289

There are currently 22 described species of *Tyrannochthnonius* in Australia, and most of them are only known from one or few locations (ALA 2020), although a few are much more widespread (for example, *T. aridus* in the Pilbara). *Tyrannochthonius* sp. BPS289 was collected from a scrape of a single reference hole PTC024, close to the west end of the Pinatubo pit (Figure 4). The closest record of a species from this genus is *T.* sp. B25 (Table 2), which Bennelongia collected in 2012 from a 13m deep scrape of a hole in Mount Henry, approximately 94 km ENE of the project area. However, that specimen was a juvenile and cannot be morphologically compared to the female collected in the current survey. Therefore, it is possible that *T.* sp. BPS289 is a new species only known from the study area. Genetic data is needed to confirm this through comparisons with the sequences of other WA species of *Tyrannochthonius* studied by Harrison et al. (2014). Even if *T.* sp. BPS289 is a new species, the fact that the specimen was collected from a reference hole suggests this species would not be impacted by the proposed development.

Centipedes of the genus *Cryptops*

The taxonomy framework of the centipede genus *Cryptops* is not well developed, and the species ranges are very poorly understood. Three species of *Cryptops* were collected in the survey: *C.* sp. BSCOL062, *C.* sp. BSCOL063 and *C.* sp. BSCOL068. The latter two species are morphologically similar to the described species *Cryptops spinipes*, however this species is currently considered a complex of cryptically different lineages. *Cryptops* sp. BSCOL062 (Plate 3) is known only from a single hole (MDD006) within the proposed footprint of Vesuvius pit (Figure 4), where it was collected in a 49m deep trap. *Cryptops* sp. BSCOL063 is known from impact bore MDD009, from a trap at a depth of 21 m and from two reference bores: MRC023, from a 18m deep trap and MRC006, from a 60m deep trap. These holes are approximately 1 km apart (Figure 4). *Cryptops* sp. BSCOL068 is a bit more widespread (confirmed minimum range of 3.13 km), having been collected from two reference holes (KJC032, from a 25m deep trap and PTC001, from a 6m deep trap) and one impact hole (MRC045, from a 30m deep trap).

Millipede Siphonotidae sp. BDI066

In the first round of this survey (Bennelongia 2020), two juveniles of the millipede "Siphonotidae `BDI066`" (Plate 2) were collected from two holes: MDD009, within the proposed footprint of Vesuvius pit, from a trap at a depth of 21m; and MRC133, approximately 80m to the east of Vesuvius, from a trap at a depth of 15m. After the second round of the survey, five more individuals of this species were collected in a deep trap (60m) from hole MRC006, approximately 145m west of the Vesuvius pit. This time adults were collected, and based on morphological characteristics, the identification was changed to Siphonophoridae. Individuals were then sent to Paul Marek (Virginia Tech University), who after closer inspection concluded that the original identification was accurate, reverting the species back to Siphonotidae `BDI066` (Plate 3). This is the first record of a troglobiotic siphonotid, and the first record of a blind Polyzoniidan. The number of body segments in this species is more than double the maximum known for the order, which is another reason why the specimens originally keyed to Siphonophorida. Siphonotidae sp. BDI066 is therefore certainly an undescribed species, probably representing a new genus of Western Australian siphonotids. The species was collected from three different holes, approximately 450m apart (Figure 4), and two of these bores are reference holes, up to 150 m to the west of the Vesuvius pit.

Table 5. Species of troglofauna collected at the Project.

Numbers are number of specimens. Impact holes are those inside proposed mine pit footprints. Animals only found within impact areas are highlighted in light red, whereas animals that could not be identified to species level are in light grey.

Higher Classification	Lowest Identification	Impact												Reference												Confirmed minimum linear range
		MDD003	MDD006	MDD007	MDD009	MRC041	MRC045	MRC078	MRC101	MRC112	PTC015	PTC027	PTC028	KJC014	KJC026	KJC032	MRC004	MRC006	MRC023	MRC115	MRC123	MRC126	MRC133	PTC001	PTC024	
Arachnida																										
Araneae																										
Gallieniellidae	*Oreo* sp.															1										Singleton, but probably not true troglofauna
Pseudoscorpiones																										
Chthoniidae	*Tyrannochthonius* sp. BPS289																								1	-
Chilopoda																										
Scolopendrida																										
Cryptopidae	*Cryptops* sp. BSCOL062		1																							**Singleton within impact footprint**
	Cryptops sp. BSCOL063 (*spinipes* sl.)				1													1	1							0.98 km
	Cryptops sp. BSCOL068 (*spinipes* gp)						1									1								1		3.13 km
	Cryptops sp.																	1								Probably juvenile of *C.* sp. BSCOL062
Diplopoda																										
Polyxenida																										
Lophoproctidae	*Lophoturus madecassus*														1											Widespread in WA
Polyzoniida																										
Siphonotidae	Siphonotidae sp. BDI066				1													5					1			0.45 km
Symphyla																										
Cephalostigmata																										
Scutigerellidae	*Hanseniella* sp. BSYM096																		1							-
	Hanseniella sp. BSYM098						2															1				0.20 km

	?Symphylella sp. BSYM099							1																		**Singleton within impact footprint**
Pauropoda																										
Tetramerocerata																										
Pauropodidae	Pauropodidae `BPU094`											1														**Singleton within impact footprint**
	Pauropodidae `BPU095`										1															**Singleton within impact footprint**
Insecta																										
Coleoptera																										
Carabidae	*Gracilanillus* sp. BCO193	2																			3					0.94 km
Staphylinidae	Pselaphinae sp. BCO205			4	12	2											1									0.41 km
Family unknown	Coleoptera sp. BCO206									2																**Singleton within impact footprint**
Hemiptera																										
Cixiidae	Cixiidae sp.													1												Singleton
Malacostraca																										
Isopoda																										
Armadillidae	*Pseudodiploexochus* sp. BIS396			4	1	1										30										3.19 km
Philosciidae	Philosciidae sp. BIS371				1	2																				**0.09 km, only within impact footprint**
	Philosciidae sp. BIS372								1											1						1.75 km
Platyarthridae	*Paraplatyarthrus* sp. BIS373		8										3			5								1		3.12 km

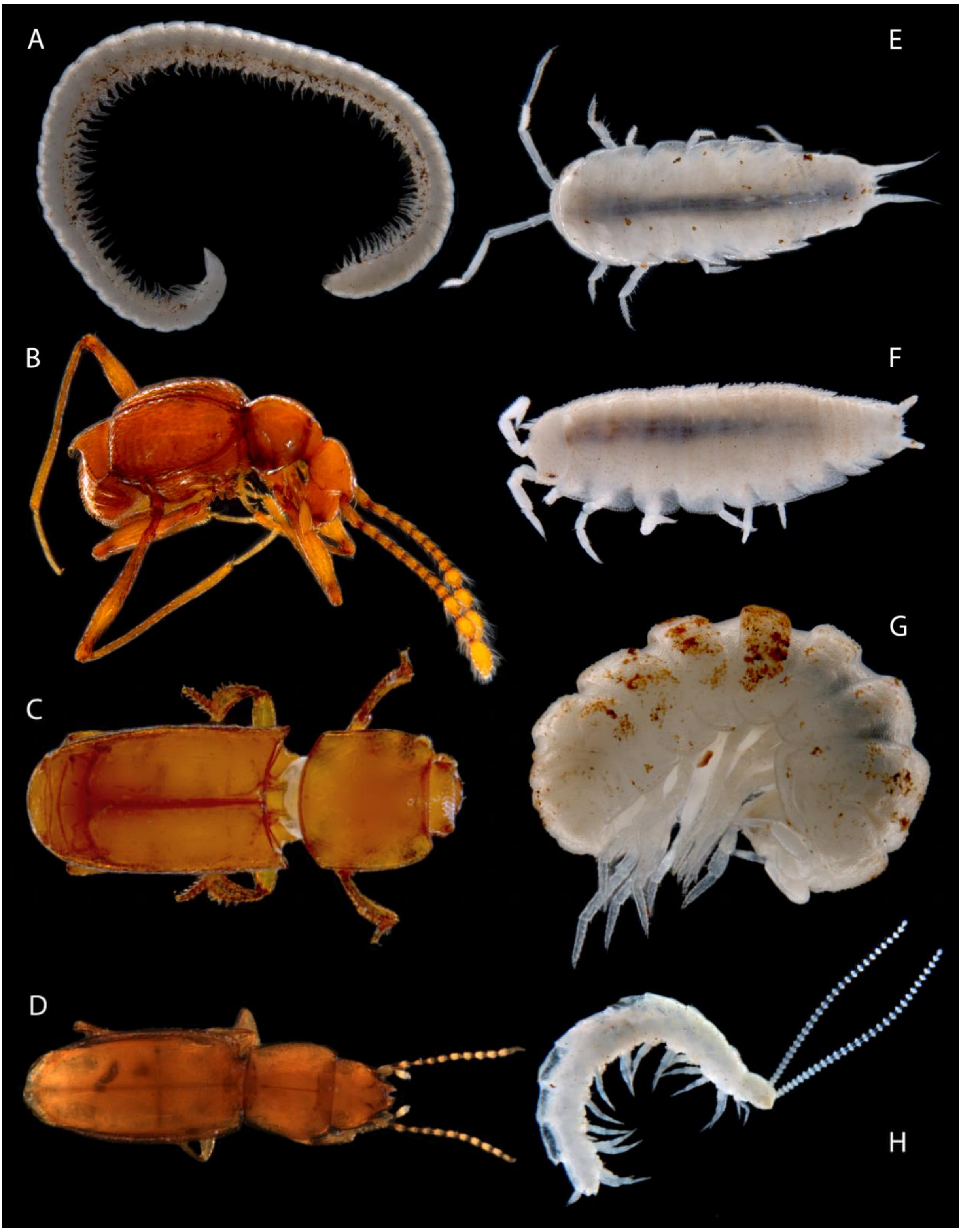


Plate 2. A selection of troglofauna specimens collected at the Medcalf Project in round 1.
A) Juvenile of Siphonotidae sp. BDI066; B) Pselaphinae sp. BCO205; C) Coleoptera sp. BCO206; D) *Gracilanillus* sp. BCO193; E) Philosciidae sp. BIS371; F) *Paraplatyarthrus* sp. BIS373; G) *Pseudodiploexochus* sp. BIS396; H) *Hanseniella* sp. BSYM096.

Symphylans
Symphylans are a group of small myriapods related to centipedes and millipedes and are commonly recorded in surveys of troglofauna communities. The taxonomic framework for troglofaunal symphylans is underdeveloped and the ranges of species, though likely to be small, are poorly understood.

Hanseniella sp. BSYM096 and *Hanseniella* sp. BSYM098
H. sp. BSYM096 was recorded from a single reference hole (MRC023) in a trap at a depth of 10 m, whereas *H.* sp. BSYM098 was collected in a reference (MRC126, from a 20m deep trap) and an impact hole (MRC045, from a scrape), approximately 190 m apart.

?Symphylella sp. BSYM099
A juvenile of what is probably a new species of the genus *Symphylella* (Plate 3) was collected as a singleton from an impact hole (MRC078; Table 5) within the projected footprint of the Fuji pit. Since this individual was collected from a scrape, it is not possible to determine a precise collection depth, but the hole from which it was collected is only 14m deep. The closest location to the project area where any species of *Symphylella* has been collected previously is Lake Deborah, 246 km NNW of the project area, so it is unlikely that *?Symphylella* sp. BSYM099 belongs to any of the previously collected species.

Pauropods: Pauropodidae sp. BPU094 and Pauropodidae sp. BPU095
Pauropods are also a group of small myriapods, less commonly recorded in troglofauna surveys than symphylans, but they are diverse. In Australia alone, 51 new species were described by Scheller (2013), but the vast majority of those are epigean species from the Dwellingup area. The closest location to Medcalf where pauropods have been previously collected is Lake Deborah, 246 km to the NNW of the project area, so it is very unlikely that the project species have been collected previously. The two specimens found in the project area (Plate 3) represent new species collected as singletons in scrapes of impact bores (Pauropodidae sp. BPU094 from PTC027 and Pauropodidae sp. BPU095 from PTC028) within the proposed footprint of the Pinatubo pit (Figure 4). It is not possible to determine a precise collection depth for the new species, but the maximum depths of the holes where they were collected are 22m for P. sp. BPU094 and 16m for P. sp. BPU095.

Subterranean beetles
Gracilanillus sp. BCO193
Troglobitic species of the genus *Gracilanillus*, from the extremely diverse beetle family Carabidae, have been recorded from the Pilbara and Goldfields regions. Six species collected in the Pilbara have been described (Baehr and Main 2016) and there is some framework for separating new species based on morphology. The described species are each known from few locations (often single holes). In the first sampling round, two specimens of the new species *Gracilanillus* sp. BCO193 were collected in a scrape sample within the proposed Vesuvius pit footprint in hole MDD003. In the second round, three more specimens were collected, this time from a trap set at the depth of 15m in the reference hole MRC123 (Figure 4), expanding the confirmed minimum linear range of this species to 940 m.

Pselaphinae sp.BCO205
Troglobitic species of the beetle family Staphylinidae (rove beetles) are not often collected, but prior to the current survey, Bennelongia had records of seven species from the Yilgarn, including from Mt Cauden (Rockwater 2010), Koolyanobbing (Bennelongia 2009a, 2014), Helena Aurora Ranges (Bennelongia 2016a), Jackson (Bennelongia 2008a, b) and Mt Gibson (Bennelongia 2016c). The sub-family Pselaphinae appears to contain many troglobitic species, but there is virtually no framework for their identification. Pselaphinae sp. BCO205 is a new species and after both sampling rounds is now known from four holes: impact sites MDD009 (in a trap at a depth of 21m), MRC041 (in a trap at a depth of 15m), and MDD007 (in traps at depths of 20m and 40m), all in the proposed Vesuvius mine pit footprint; as well as reference site MRC004 (in a trap at a depth of 20m), approximately 70m to the south of the proposed Fuji mine pit footprint. The confirmed minimum linear range of this species is currently just over 410 m.

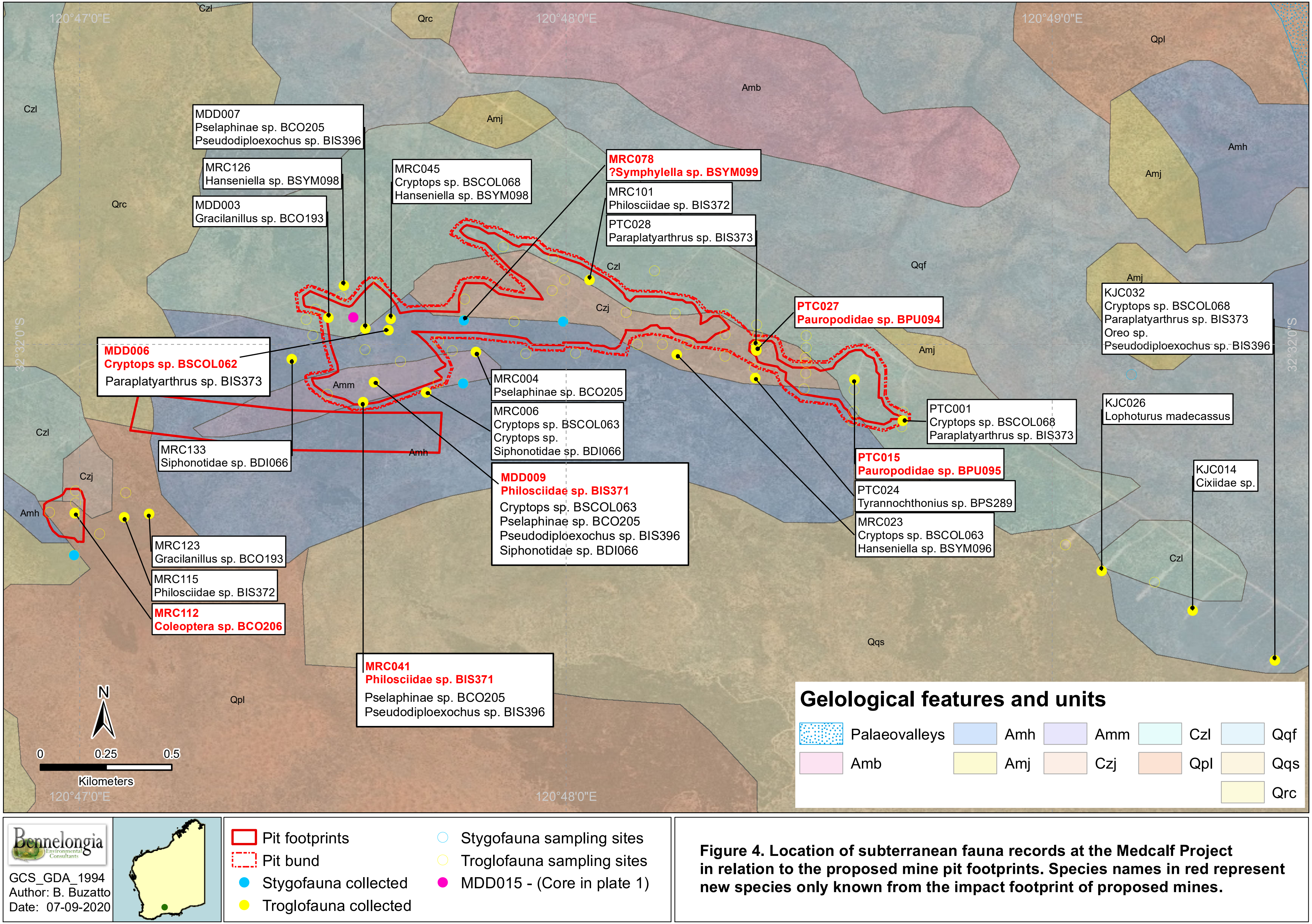


Figure 4. Location of subterranean fauna records at the Medcalf Project in relation to the proposed mine pit footprints. Species names in red represent new species only known from the impact footprint of proposed mines.

Coleoptera sp. BCO206

The identification of the beetle Coleoptera sp. BCO206 could not be taken beyond the level of order, as it is a new species, and its family placement is unclear. It was collected from a single hole, MRC112, in a trap at a depth of 41m within the proposed mine pit footprint of Egmont. Due to collection from just one site, the potential range of Coleoptera sp. BCO206 cannot be determined.

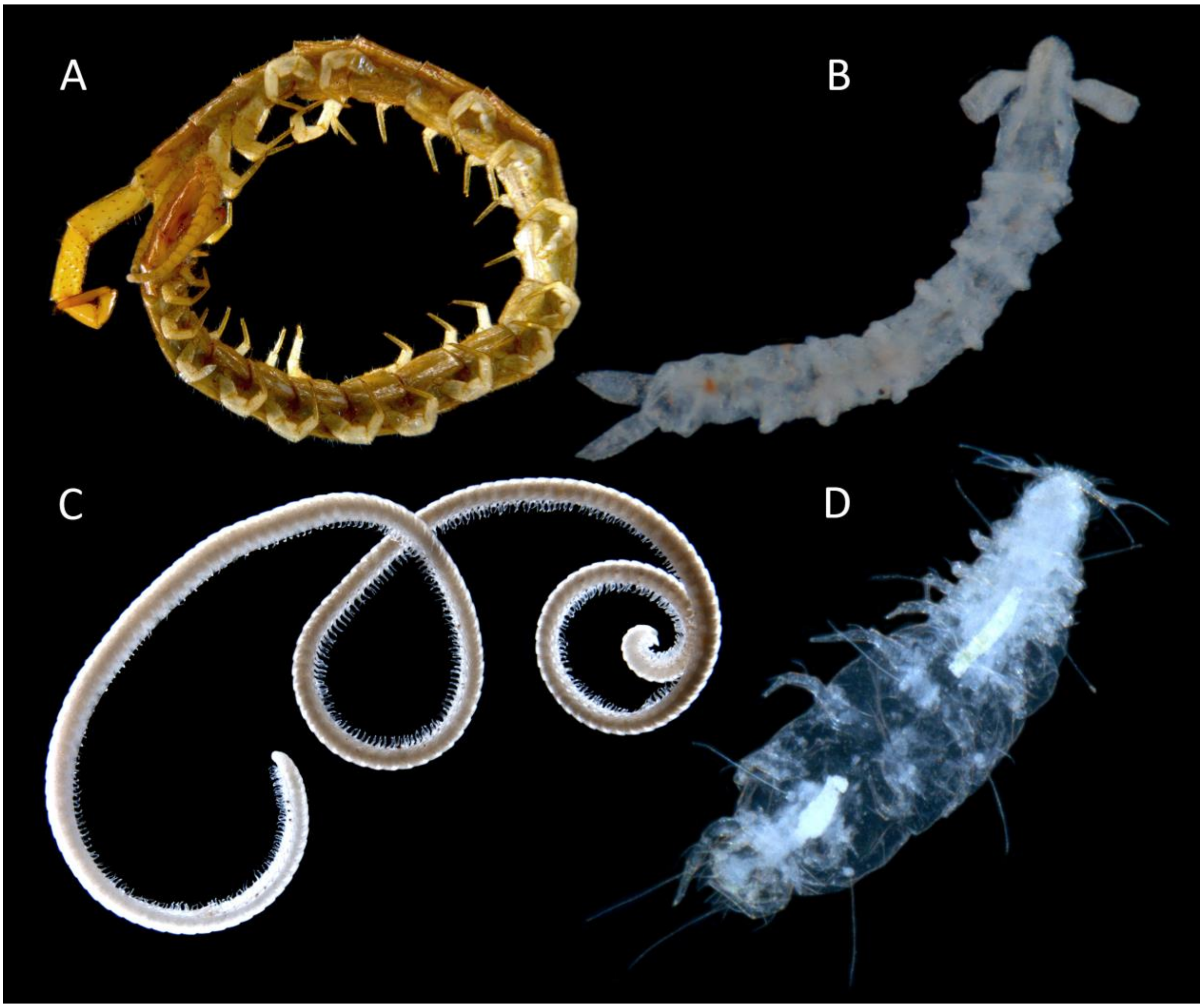


Plate 3. Additional troglofauna specimens collected at the Medcalf Project.

A) *Cryptops* sp. BSCOL062; B) A juvenile of the symphylan ?*Symphylella* sp. BSYM099; C) An adult of Siphonotidae sp. BDI066; D) Pauropodidae sp. BPU095.

Isopod species

Isopods (slaters) are typical constituents of most troglofauna communities in Western Australia and are often very diverse at the species level. At the Project, four species from three families were recorded (Table 5).

Pseudodiploexochus sp. BIS396

In the first round of sampling, a new species was collected and called Armadillidae gen. indet. 'BIS370'. This species was initially found in two holes, MDD009 (in a trap at a depth of 21 m) and MRC041 (in a trap at a depth of 15 m), separated by approximately 84 m in the southern portion of the proposed Vesuvius mine pit footprint (Figure 4). In the second round of the survey, the species was collected in two new locations, the impact hole MDD007 (two individuals from a 20m deep trap and another two from a 40m deep trap) and the reference hole KJC032 (one individual from a scrape and 29 individuals from a 20m deep trap). This expands the species confirmed minimum range to 3.19 km. With the higher availability of individuals collected in the second round of the survey, it was possible to assign this species to the genus *Pseudodiploexochus,* and consultation with an expert on the family indicated that this is a new species, for which the name *Pseudodiploexochus* sp. BIS396 is used here.

Philosciidae sp. BIS371 and Philosciidae sp. BIS372
Two species of the family Philosciidae were recorded. Philosciidae sp. BIS371 was only collected from impact holes MDD009 (in a trap at a depth of 21 m) and MRC041 (in a trap at a depth of 15 m), separated by approximately 84 m in the southern portion of the proposed Vesuvius mine pit footprint (Figure 4). Meanwhile, Philosciidae sp. BIS372 was collected from hole MRC101 (in a trap at a depth of 25 m) in the proposed Fuji mine pit footprint, as well as from the reference hole MRC115 (in a trap at a depth of 10 m), east of the proposed Egmont mine pit footprint (Figure 4). Whereas the minimum confirmed range of Philosciidae sp. BIS371 is only around 90 m (all within an impact area), Philosciidae sp. BIS172 has a larger known linear range of approximately 1.75 km.

Paraplatyarthrus sp. BIS373
This species belongs to a genus of isopods that is well known from Yilgarn calcretes (Javidkar *et al.* 2017). In the first round, eight individuals of this species were collected in a trap at a depth of 15 m in a single hole (MDD006) within the proposed Vesuvius mine footprint (Figure 4). In the second round, this species was collected in three new sites: the impact hole PTC028 (three individuals from an 8m deep trap) and the reference holes KJC032 (five individuals from a 25m deep trap) and PTC001 (one individual from a 6m deep trap).

7. POTENTIAL IMPACTS

The main threat to the conservation of troglofauna at the Project is the excavation of the four proposed mine pits (Figure 1). Excavations would directly remove habitat within the volume of the mine pits and, by definition, any species whose range was entirely within the mine pit would face extinction. The principal threat to stygofauna species, if any are present, would be habitat removal via groundwater drawdown as a result of mine dewatering. However, no dewatering is proposed for the pits of the Medcalf Project, meaning that habitat removal is not a concern for stygofauna in this project.

7.1.1. Stygofauna

Based on both desktop review and field survey results, the stygofauna community in and around the Project is very depauperate (or possibly absent), with only a single species recorded whose status as stygofauna cannot be confirmed. Since there will be no groundwater drawdown associated with mine dewatering at the project, it is considered that the Project is highly unlikely to threaten stygofauna species.

7.1.2. Troglofauna

The proposed mine pits are relatively small, ranging from less than 2 ha at Egmont to 31.5 at Fuji and 5.9 ha at Pinatubo, with a total area of excavation of approximately 39.3 ha. Proposed pit depths will be no more than 50 m, but under a precautionary approach troglofauna habitat is assumed to not extend beneath the pits.

Six of the 20 species of troglofauna recorded at the Project are known only from holes that are within the boundaries of the proposed mine pit footprints (Table 5; Figure 4). There are currently limited collection data with which to confirm the actual distribution of each species, partly due to low capture rates (presumably resulting from low population densities) and the moderate extent of sampling coverage. However, within the survey dataset, the known ranges of some species provide some support for other species also having more extensive ranges than can currently be demonstrated. For example, the isopod Philosciidae sp. BIS371 is only known from holes MDD009 and MRC041, over a linear range of around 80 m within the proposed footprint of Vesuvius pit. However, all four other species collected from MDD009 (*Cryptops* sp. BSCOL063, Siphonotidae sp. BDI066, Pselaphinae sp. BCO205 and *Pseudodiploexochus* sp. BIS396) were also collected from holes outside pit footprints and have linear ranges of up to 3.19 km (Table 5; Figure 4). This points to the likelihood of Philosciidae sp. BIS371 having a more extensive distribution that can be currently confirmed, including outside proposed mine pits. The caveat to using this kind of surrogate information (using the range of one species as evidence of the range of another) is that the life history (and therefore capacity to disperse) of each species is not known.

The reported ranges of troglofauna species in the Pilbara are generally much larger than the total area of the proposed Project pits (Halse and Pearson 2014) and it would be expected that ranges as small as the proposed pits would only occur in association with pronounced geological or topographic features. As shown in Figure 2, the continuity of the geological units in each of the proposed mine pits with surrounding undisturbed areas provides support for the notional continuity of key troglofauna habitats. While ranges may be inferred from the extent of suitable habitat, determining ranges of troglofauna with confidence is difficult. While the collection of many species from only single bores (e.g. Baehr and Main 2016), despite extensive sampling, may be due to sampling artefacts, it cannot be ruled out that very small ranges are more common than recognised.

Overall, based on the small proposed extent of mine pits and information gained from the field survey, it is considered unlikely that any of the troglofauna species recorded will have distributions entirely confined to mine pits, although direct support for this conclusion is limited.

8. CONCLUSIONS

Based on the combined results of the desktop review and field survey, it is considered very unlikely that more than a depauperate stygofauna community occurs in the vicinity of the proposed mine pits. Habitat here is primarily limited by great depths to water. The most prospective habitats for stygofauna in the vicinity of the Project are surficial aquifers in palaeochannel deposits to the east and northeast of the mine area in and adjacent to the Lefroy palaeochannel. However, sampling at nine bores in these areas did not yield any stygofauna. Seven specimens of nematodes, which were actually collected as by-catch in troglofauna samples associated with the mine development area were collected as a part of the subterranean fauna survey. The status of nematodes as stygofauna cannot be confirmed and they are usually not considered in environmental impact assessments. Sampling also confirmed that aquifers are generally hypersaline, which is a physiological constraint on the occurrence of stygofauna. It is considered that the Project is highly unlikely to threaten stygofauna species.

Based on the desktop review, it was expected that any troglofauna community in the Project area would be depauperate. Unexpectedly, a field survey of 78 holes in and around the proposed mine pits via scraping and trapping recorded 110 specimens from 20 new species of troglofauna including a spider, a pseudoscorpion, centipedes, millipedes, a symphylan, pauropods, beetles, a planthopper and isopods. Most species were collected by trapping at least once (as well as scraping, further supporting that they represent true troglofauna), with the exception of the symphylan ?*Symphylella* sp. BSYM099, both species of pauropod and the pseudoscorpion.

In total, out of the twenty species, nine species of troglofauna were collected both within and outside the proposed mine pits, while five other species were recorded only in reference bores. The other six species have currently been collected only from holes within the extent of the proposed mine pits. The low capture rates, combined with moderate sampling extent, mean that the undetected occurrence of some species outside the proposed mine pits is likely. The occurrence of the majority of pit-collected species in both impact and reference holes suggests it is likely that the other species collected in the proposed mine pits have more extensive distributions. Mapped geologies also provide support for the notion that species are likely to have wider ranges. It is therefore considered unlikely that any of the troglofauna species recorded will have distributions entirely confined to the small proposed mine pits, although direct support for this conclusion is limited.

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Appendix 1. Details of holes and bores sampled for subterranean fauna at the Project.

Stygofauna

Bore	Latitude	Longitude	Sample date	Depth to groundwater (m)	End of hole (m)	Temperature (°C)	Electrical conductance (μS cm^{-1})	pH
Drillers Bore	-32.5446869	120.8270449	8/04/2020	24.18	42	19.1	62200	6.72
MWH001	-32.5402222	120.8324444	8/04/2020	7.32	62	22	144000	3.53
MWH003	-32.5340278	120.8496111	8/04/2020	7.25	39	21.1	110000	3.19
MWH008	-32.51725	120.8324444	8/04/2020	5	27	22	151000	3.53
MWH009	-32.5208611	120.8289444	8/04/2020	9.38	66	20	1970	6.57
MWH011	-32.5343611	120.8193889	8/04/2020	45.6	66	21.9	85600	6.75
MWH012	-32.5448611	120.82725	8/04/2020	23.61	71	19.6	97000	6.83
MWH013	-32.544505	120.826836	8/04/2020	25.23	54	20	59000	6.9
MWH014	-32.5445	120.82725	8/04/2020	24.11	54	21	62000	7.04

Troglofauna

Bore	Latitude	Longitude	Sample date (scrape and trap set)	Date (trap retrieved)	Depth to groundwater (m)	End of hole (m)	Trap depth shallow (m)	Trap depth deep (m)
KJC002	-32.54457282	120.827126	43977	44047		22	10	20
KJC014	-32.542455	120.8214809	43977	44047		25	12	24
KJC017	-32.54148542	120.8201735	43977	44047		21	10	20
KJC025	-32.54019706	120.8171278	43977	44047		17	7	14
KJC026	-32.54109326	120.8183624	43977	44047		15	7	14
KJC032	-32.54415425	120.824304	43977	44047		27	12	25
MDD003	-32.53240742	120.7918569	43753	43929	51	51.2	15	40
MDD006	-32.53283471	120.7939137	43753	43929		50	15	49
MDD007	-32.5327797	120.7931202	43979	44047		50	20	40
MDD008	-32.53351471	120.7931063	43753	43929		45	20	44
MDD009	-32.53461655	120.7934195	43753	43929		22	10	21
MDD011	-32.53390646	120.79432	43753	43929		34	15	33
MDD018	-32.53876928	120.7831772	43754	43929	18	19	10	15
MRC001	-32.5322672	120.803749	43753	43929		53	20	40
MRC002	-32.53222713	120.8020656	43753	43753		64	Traps lost – hole collapse	
MRC003	-32.53363374	120.7986245	43978	44047		76	20	50
MRC004	-32.53358708	120.7969153	43753	43929		60	20	50
MRC005	-32.53354429	120.7960929	43978	44047		58	20	40
MRC006	-32.53497166	120.7952064	43978	44047		81	30	60
MRC014	-32.5312814	120.7935614	43979	44047		21	10	20
MRC017	-32.53503827	120.7918087	43979	44047		36	15	30
MRC022	-32.53362041	120.8003223	43753	43929		44	15	40
MRC023	-32.53368288	120.8038	43753	43929		19	10	18
MRC025	-32.53228681	120.8054654	43753	43929		18	10	17
MRC026	-32.53372597	120.8054462	43978	44047		15	7	14
MRC031	-32.53168266	120.7922741	43979	44047		25	15	24
MRC041	-32.53530505	120.7930378	43753	43929		35	15	34
MRC045	-32.53244327	120.7939907	43979	44047		34	15	30

MRC057	-32.53463621	120.7956191	43978	44047		15	7	14
MRC065	-32.53466015	120.7964702	43978	44047		9	5	8
MRC068	-32.53321157	120.7956327	43978	44047		11	5	10
MRC078	-32.53249633	120.7965018	43978	44047		14	7	13
MRC079	-32.53177666	120.7965191	43753	43929		24	12	23
MRC081	-32.5325377	120.7982196	43753	43929		35	15	30
MRC084	-32.53111386	120.7999528	43978	44047		27	12	24
MRC088	-32.53254153	120.7999041	43753	43929		34	10	30
MRC096	-32.53333099	120.8024537	43978	44047		18	9	17
MRC097	-32.53332785	120.8033054	43978	44047		11	5	10
MRC098	-32.53333408	120.8041782	43978	44047		14	7	13
MRC101	-32.53112017	120.8008107	43753	43929		31	10	25
MRC111	-32.53835398	120.7831883	43754	43929		16	8	15
MRC112	-32.53911476	120.7831624	43754	43929		42	18	41
MRC115	-32.53925739	120.7848501	43754	43929		21	10	20
MRC116	-32.53982505	120.7840154	43979	43979		15	7	14
MRC119	-32.54054883	120.7831246	43979	44047		15	7	14
MRC121	-32.53909116	120.7822874	43979	44047		12	6	11
MRC122	-32.5384158	120.7849017	43979	44047		15	7	14
MRC123	-32.53914237	120.7857036	43979	44047		16	8	15
MRC126	-32.53131475	120.7923789	43979	44047		66	20	50
MRC128	-32.53212099	120.7914131	43753	43929		64	15	40
MRC129	-32.53247357	120.7910943	43979	44047		56	20	50
MRC131	-32.53301854	120.7913152	43979	44047		45	20	40
MRC133	-32.53383907	120.7906012	43753	43929		31	15	30
MRC134	-32.53080765	120.8030259	43753	43929		29	15	28
MRC138	-32.52998235	120.7978415	43753	43929		18	10	17
MRC141	-32.5303701	120.7995639	43753	43929		38	15	35
MRC142	-32.53147196	120.7995255	43753	43929		26	12	24
PTC001	-32.53594258	120.8115457	43978	44047		12	6	11
PTC002	-32.53564528	120.8115636	43978	44047		14	7	13
PTC003	-32.53614935	120.8115088	43978	44047		21	10	20
PTC005	-32.54448303	120.8261061	43977	44047		21	10	20
PTC007	-32.53596664	120.8098205	43978	44047		20	10	19
PTC009	-32.53561563	120.8098609	43978	44047		17	10	16
PTC013	-32.53488546	120.8098786	43978	44047		22	10	21
PTC015	-32.5345339	120.8098872	43978	44047		16	8	15
PTC016	-32.53485541	120.8081547	43978	44047		23	11	22
PTC018	-32.53431548	120.8082211	43978	44047		36	16	34
PTC020	-32.5339549	120.8082298	43978	44047		21	10	20
PTC021	-32.53378307	120.8082021	43978	44047		21	10	20
PTC022	-32.53344089	120.8082317	43978	44047		20	10	19
PTC023	-32.53303506	120.8082309	43978	44047		23	11	22
PTC024	-32.53447452	120.8064819	43978	44047		21	10	20
PTC025	-32.53414043	120.8064581	43978	44047		20	10	19

PTC027	-32.53353739	120.806526	43978	44047		22	10	20
PTC028	-32.53336593	120.8065195	43978	44047		16	8	15
PTC030	-32.53298789	120.8065607	43978	44047		13	7	12
PTC031	-32.53265991	120.8065337	43753	43929		28	10	25
PTC032	-32.53299561	120.8054533	43978	44047		33	15	30