The Western Australian Biodiversity Science Institute

RESEARCH UPDATE 2021

SUBTERRANEAN FAUNA RESEARCH PROGRAM

Closing the knowledge gaps

A SHARED VISION

Dramatically improve assessments of the impacts of resource developments and threat mitigation strategies on subterranean fauna by transforming our knowledge of patterns and processes in subterranean ecosystems.

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The University of Western Australia

WAM Western Australian Museum

Government of Western Australia Department of Biodiversity, Conservation and Attractions

Government of Western Australia Department of Primary Industries and Regional Development

Government of Western Australia Department of Jobs, Tourism, Science and Innovation

Government of Western Australia Department of Mines, Industry Regulation and Safety

Government of Western Australia Department of Water and Environmental Regulation

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Closing the knowledge gaps

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The Western Australian Biodiversity Science Institute

This document provides an update on the progress of the research program for stakeholders who participated in consultation workshops, and others with an interest in subterranean fauna who want to become involved.

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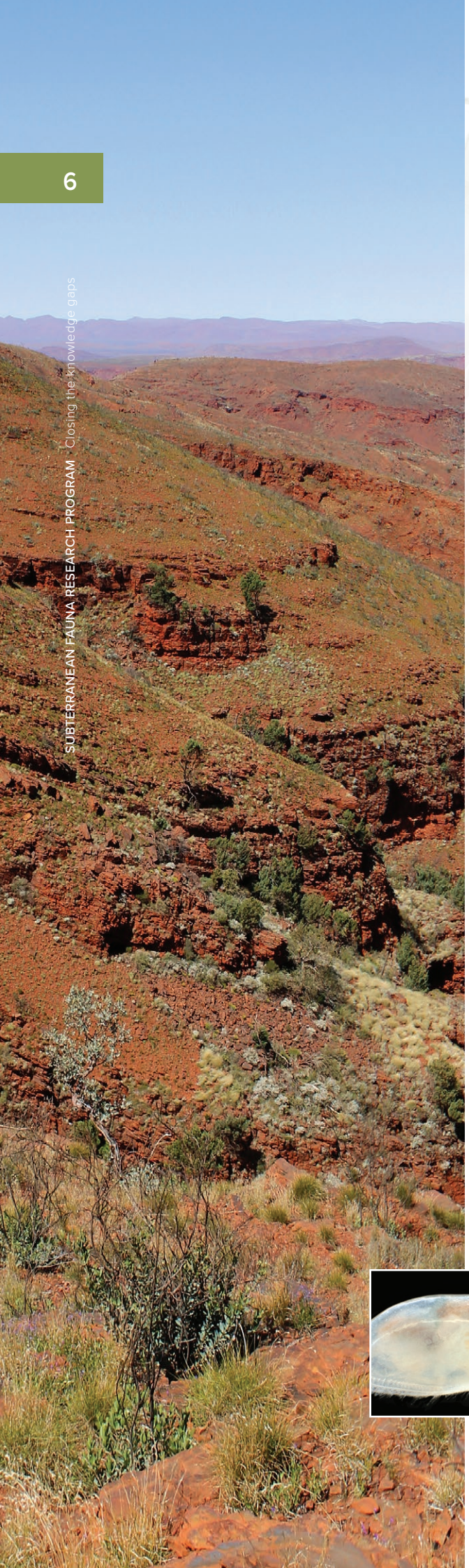
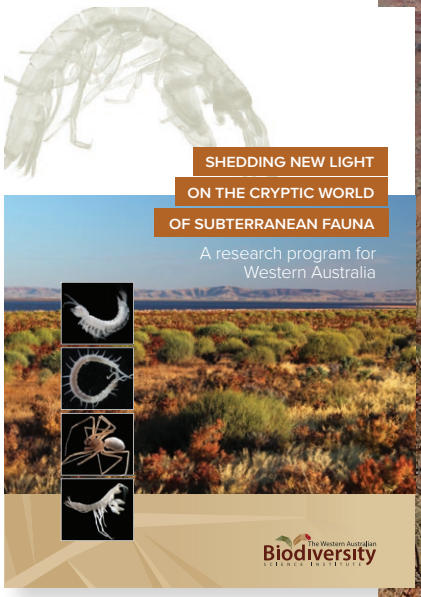


Background

Subterranean environments contain a diverse and unique obligate fauna; both, aquatic living in the groundwater and terrestrial living in voids above the water table. In the arid region of the western part of the Australian continent, a particularly rich subterranean fauna coincides with a concentration of natural resource extraction operations. Since the inclusion of subterranean fauna in assessments of environmental impact in the mid-1990s, taxonomic research in Australia on this mainly invertebrate group has grown exponentially. However, remaining knowledge gaps continue to frustrate both environmental regulators and development proponents due to high uncertainty in the decision-making process. In early 2017, The Western Australian Biodiversity Science Institute (WABSI) was tasked with leading the development of a research program to improve on the current state of knowledge of subterranean fauna.

WABSI ran a series of workshops which brought together a broad range of stakeholders from the scientific and resources sector, policy makers, potential funders, and environmental consultants to identify knowledge gaps. There was a clear consensus on five broad focus areas to be progressed: (1) more accurate, efficient and consistent species identification processes to increase taxonomic certainty; (2) improved survey and sampling protocols to optimise effectiveness and efficiency; (3) improved understanding of habitat requirements to better define species distributions; (4) improved understanding of resilience to disturbance to inform mitigation strategies; and (5) data discoverability and accessibility to provide spatial and temporal context.



A Subterranean Fauna Research Program Plan was completed in June 2018 (available on the WABSI website) which included a review of the status of knowledge within each focus area above, research initiatives to close the knowledge gaps, and an analysis of the benefits that the research program would provide. This plan provides a guiding framework to direct resources to research activities that specifically address end-user needs. A scientific publication describing the transdisciplinary approach to the development of the research program was also published in the international journal *Science of the Total Environment*.

A steering committee representing the interests of all stakeholders including end users, researchers and policy makers was established in June 2018 to guide the implementation of the research program. A strategic approach to implementation has focused initially on identifying 'quick-win' short-term projects with the aim to leverage from the success of these to commence addressing the more complex, long-term and resource demanding issues. Below is a summary of the progress to date against each of the focus areas, with descriptions of the projects already underway or soon to commence.

BENEFITS OF THE RESEARCH PROGRAM

INDUSTRY

- Reduced delays in a development proposal decision
- Lower survey and monitoring costs through increased efficiency
- Better defined boundaries for development exclusion zones
- Stronger social licence to operate

REGULATORS

- Increased confidence in predictions for decision making
- Increased community trust in the environmental impact assessment process
- Improved knowledge to inform policy and guidelines
- Increased efficiency in the environmental impact assessment process

CONSERVATION AGENCIES

- Greater knowledge for conservation planning
- Improved understanding of conservation status of species and communities
- Information to support cost-effective recovery planning for threatened species and communities
- Knowledge to support effective mitigation and rehabilitation strategies
- Promotion of healthy groundwater dependent ecosystems

BROADER BENEFITS

- Better environmental outcomes
- Improved understanding of ecosystem services such as maintenance of groundwater quality and bioprospecting opportunities
- Finding solutions that enable mining to proceed while conserving subterranean fauna, thereby facilitating job creation and increased State revenues
- Creating certainty for the wider community by determining where mining may occur and areas where subterranean fauna needs to be conserved
- Protection of intrinsic biodiversity values
- Enhancing a reputation for world-class expertise in subterranean fauna

The primary economic value of the research program will come from:

REDUCED TIME FOR A DEVELOPMENT PROPOSAL DECISION

As an example, avoiding a six-month delay for one large project every two years would mean earlier cash flow for the proponent.

The value of this is annualised at **~$18–24 million**

REDUCED COSTS ASSOCIATED WITH SURVEYING AND MONITORING

~$648,000 per year

TIGHTENED BOUNDARIES FOR DEVELOPMENT EXCLUSION ZONES

Potential annualised saving of **~$22 million per year**, assuming reduction in excluded ore in one major project in the next 20 years.

Closing the knowledge gaps

Research focus

OUTCOME	OBJECTIVE
Efficiency and accuracy of species identification is significantly increased	Develop a standardised best practice approach for recognising species boundaries based on defendable criteria

PROJECT: INFORMING CONSERVATION WITH A COMPLETE TAXONOMY OF PILBARA SUBTERRANEAN INVERTEBRATES

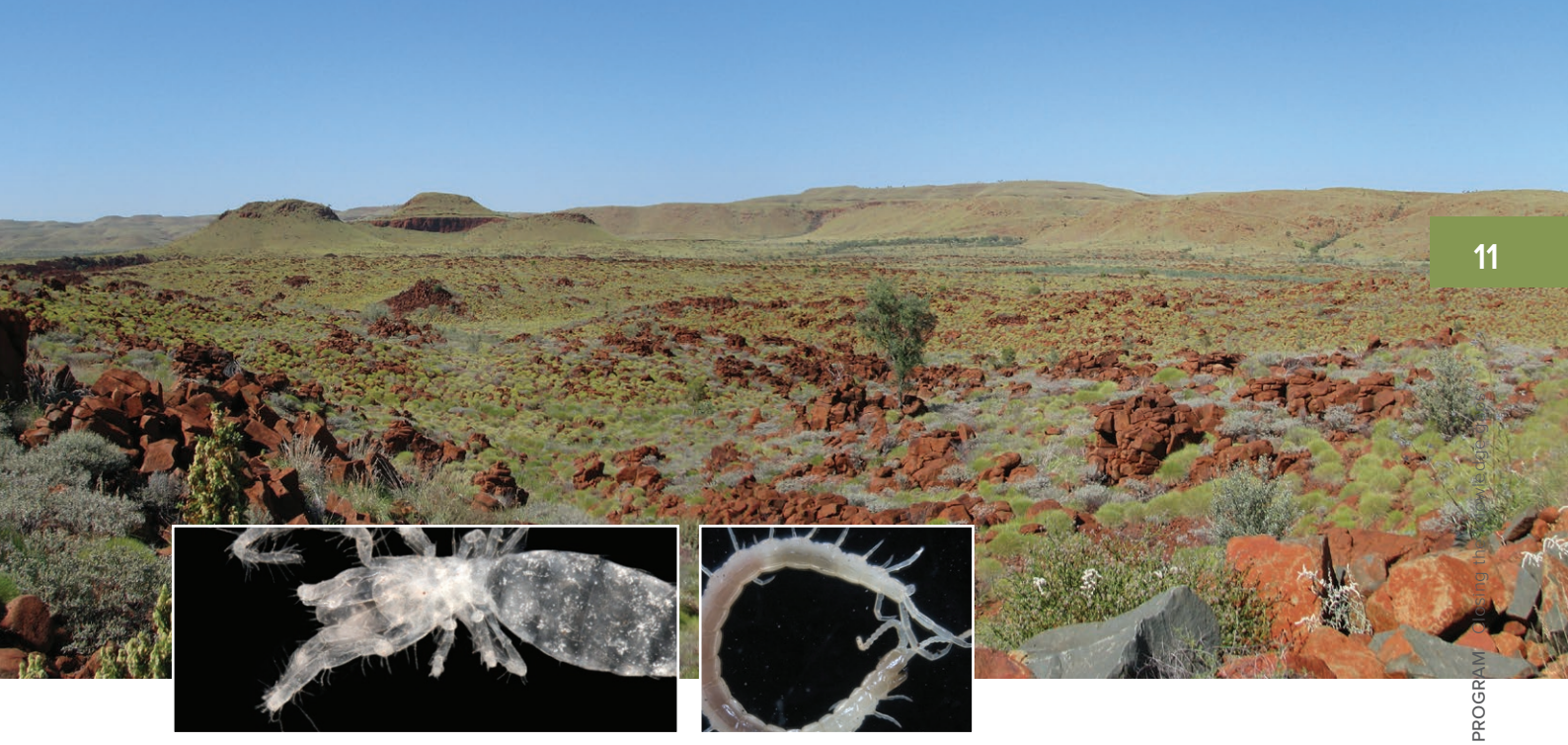
At present, only 13% of the estimated 2,100 subterranean invertebrate species of the Pilbara and adjacent regions have been formally described. This project will generate significant new morphological, molecular, and distributional data, and develop a formal taxonomy, using a rapid integrative approach, to describe all new species for high-priority target groups in the Pilbara.

The species of these target groups will be made readily identifiable through easily accessible interactive morphological keys utilising high-quality imaging technology, supported by DNA sequence criteria. This ambitious project will be completed in stages, targeting successive taxonomic groups as funds become available, and has commenced with troglobitic pseudoscorpions.

STAGE 1 – Taxonomic revision of subterranean pseudoscorpions of the Pilbara

Many pseudoscorpion species in the Pilbara have small distributions, and each are usually confined to an individual mesa or karst formations. This project aims to develop a robust species-level taxonomic framework of all pseudoscorpions that occur in subterranean environments in the Pilbara bioregion, to facilitate an accurate assessment of the identity and distribution of each species.

The major outputs from this project will include a revised taxonomy of subterranean pseudoscorpion species, whereby each species will be provided with a unique Western Australian (WA) Museum species code, supported by digital images and illustrations of relevant taxonomic characters, a list of collection localities and a distribution map. Full completion of this project will require several years of funding, but this first round will enable the comprehensive characterisation of a minimum of 25 species. The outputs will be delivered via the WA Museum's Species' pages, and the species code system will then be available to consultants and industry partners to standardise identifications and cease the proliferation of inconsistently applied codes.



A Postdoctoral Research Fellow was appointed at the University of Western Australia in May 2019 (though based at the WA Museum), undertaking the work in a part-time capacity.

FUNDED BY:

- BHP, Rio Tinto, WABSI

KEY PROGRESS:

- A review of the genus Ideoblothrus has been completed with the recognition of 19 species, including 17 new species. All are short-range endemics and all are restricted to individual landforms.

STAGE 2 – Taxonomy of subterranean amphipods of the Pilbara

The second project focuses on Pilbara subterranean amphipods. At present, the major crustacean groups — amphipods, isopods and bathynellaceans — are among the poorest known at all taxonomic levels. As a first stage to documenting the subterranean crustaceans of the Pilbara, this project aims to locate and assess the quality of all available material in collections of amphipods, isopods and bathynellaceans, and focus taxonomic research on specific amphipod groups.

The project is designed to run for three years but as three discrete one-year sub-projects subject to the availability of funds. The major outputs from this project will include a revised taxonomy of subterranean amphipod species from the Pilbara, whereby each species will be formally described morphologically, supported by sequence data (where possible), digital images and illustrations of relevant diagnostic characters, a list of collection localities and a distribution map.

FUNDED BY:

- Rio Tinto and BHP
- Financial input from other sources is also being sought with the intention of funding another postdoctoral position to be based at the WA Museum (Stage 3). An application for an ABRS grant was also submitted in November 2020.

KEY PROGRESS:

- A Postdoctoral Research Fellow was appointed at the University of Adelaide in November 2020.

Research focus

OUTCOME	OBJECTIVE
Efficiency of survey and monitoring programs are optimised	Refine survey and sampling protocols to ensure contemporary approaches are efficient, repeatable, and effective

PROJECT: SUBTERRANEAN FAUNA SURVEY REVIEW — OPTIMISING SPECIES DETECTION

Adequate survey is integral to understanding both the species present within a given area and to determine their distribution. Assessments of subterranean fauna distributions often rely on sampling bore holes created for minerals exploration or water supply, which may or may not intersect suitable habitat. The restricted access and a generally low capture rate of individuals means that survey strategies are relatively inefficient, with many species only detected in a single bore. Some level of repeated sampling is required to adequately detect a significant proportion of the species occurring at a site, though there are uncertainties regarding the actual level of survey effort required.

As a first step to establishing an optimal and consistent sampling strategy for both stygofauna and troglofauna, a project to review historical data to better understand sampling efficiency using current approaches was proposed, as well as to highlight areas of improvement. This included an assessment of both sampling methodology and effort. The subterranean fauna surveys undertaken for environmental impact assessment (EIA) provide an important source of information for this review.

The Harry Butler Institute at Murdoch University was awarded a contract to undertake the project in March 2019. A working group, with representatives from all funding partners, oversees the progress of the project.

FUNDED BY:

- BHP, Cameco, Department of Water and Environmental Regulation (DWER), Fortescue Metals Group, Rio Tinto and WABSI

KEY PROGRESS:

- Identification and aggregation of data, first from funding partners, then others who volunteered their data. This will help deliver a database at the completion of the project.
- Draft report completed, describing outcomes of the data analysis to compare detection rate based on the sampling strategy used (techniques and effort). The final report is expected to be released over the coming months.

PROJECT: TRANSFORMING THE ASSESSMENT AND MONITORING OF SUBTERRANEAN FAUNAL COMMUNITIES USING ENVIRONMENTAL DNA

The approach of detecting the presence of DNA in the environment (eDNA), such as in soil and water, that has been shed from an organism, has been shown to be effective in both marine and aquatic environments. Without the need to capture the organisms, this approach may be a means of improving the accuracy and efficiency of subterranean fauna survey and monitoring. Recent advances in next generation sequencing metabarcoding mean that only trace amounts of DNA are required, thereby facilitating the detection of rare taxa. Preliminary results from a recently completed proof-of-concept indicated that the eDNA approach is a viable option for holistic surveys of subterranean fauna.

In 2018, an unsuccessful Australian Research Council (ARC) Linkage proposal (led by the University of Adelaide and Curtin University) focusing on applying a combination of eDNA sampling and metabarcoding techniques to detect subterranean fauna resulted in a diversion of funds towards a smaller 12-month 'bridging' project was undertaken by the University of Adelaide under a research agreement. The intention then was to resubmit a revised ARC Linkage proposal and the bridging project would commence two core activities as necessary precursors.

FUNDED BY:

- BHP, Rio Tinto, WABSI

PROJECT COMPLETED. KEY OUTPUTS:

- Progression of a Barcode Reference Library (BRL) for a case study site at Bungaroo Creek in the Pilbara (draft paper under review). The Bungaroo Creek dataset will be used as a basis for a Pilbara-wide BRL in the future. A reference collection of “DNA barcodes” is required to provide accurate taxonomic verification of data generated from eDNA sampling.
- A research paper that describes existing species-specific PCR assay data for the Pilbara blind cave eel detected at Bungaroo Creek. It demonstrates that subterranean fauna can be detected from eDNA in groundwater using PCR based assays.
- The revised ARC Linkage submission was announced as successful in December 2019; led by University of Adelaide and Curtin University with partners from the South Australian Museum, WA Museum, Department of Biodiversity, Conservation and Attractions (DBCA), BHP, Rio Tinto, Chevron, DWER and WABSI.

WHAT’S NEXT?

The overall goal of this project is to significantly improve environmental impact assessments (EIAs) and environmental monitoring for subterranean ecosystems by developing a rigorous, credible, and practicable eDNA assessment framework.

Research focus

OUTCOME	OBJECTIVE
Data associated with subterranean fauna is discoverable and accessible	Consolidate existing subterranean fauna records and associated habitat attributes in a publicly accessible information system

PROJECT: SUBTERRANEAN FAUNA SURVEY REVIEW

Considerable subterranean fauna survey information is collected through EIAs. In 2017, the Western Australian Government launched the Index of Biodiversity Surveys for Assessments (IBSA), the Department of Water and Environmental Regulation's online portal to access information about land-based surveys in Western Australia. Everyone who conducts land-based biodiversity surveys to support assessment and compliance is now required to submit the survey report, associated metadata and spatially referenced raw data from the survey via the IBSA portal. This is a positive first step; however there remains a considerable volume of historical information that has not been captured via this process. An initiative to capture, consolidate and make this data publicly accessible has clear benefits.

KEY PROGRESS:

- The *survey review project* has captured a significant amount of survey data from multiple mining companies; this will be provided as a key deliverable.
- The Subterranean Fauna Research Program Steering Committee is investigating ways to make the information publicly accessible.
- The monitoring review project will capture valuable information which will add to the data available in this database.

FOCUS AREA	HABITAT CHARACTERISATION	UNDERSTANDING DISTRIBUTION	BETTER DECISIONS

Research focus

OUTCOME	OBJECTIVE
Our understanding and ability to map the distribution of suitable habitat for subterranean fauna is significantly advanced	Develop a standardised approach for subterranean fauna assessment based on fine-resolution dynamic three-dimensional habitat characterisation

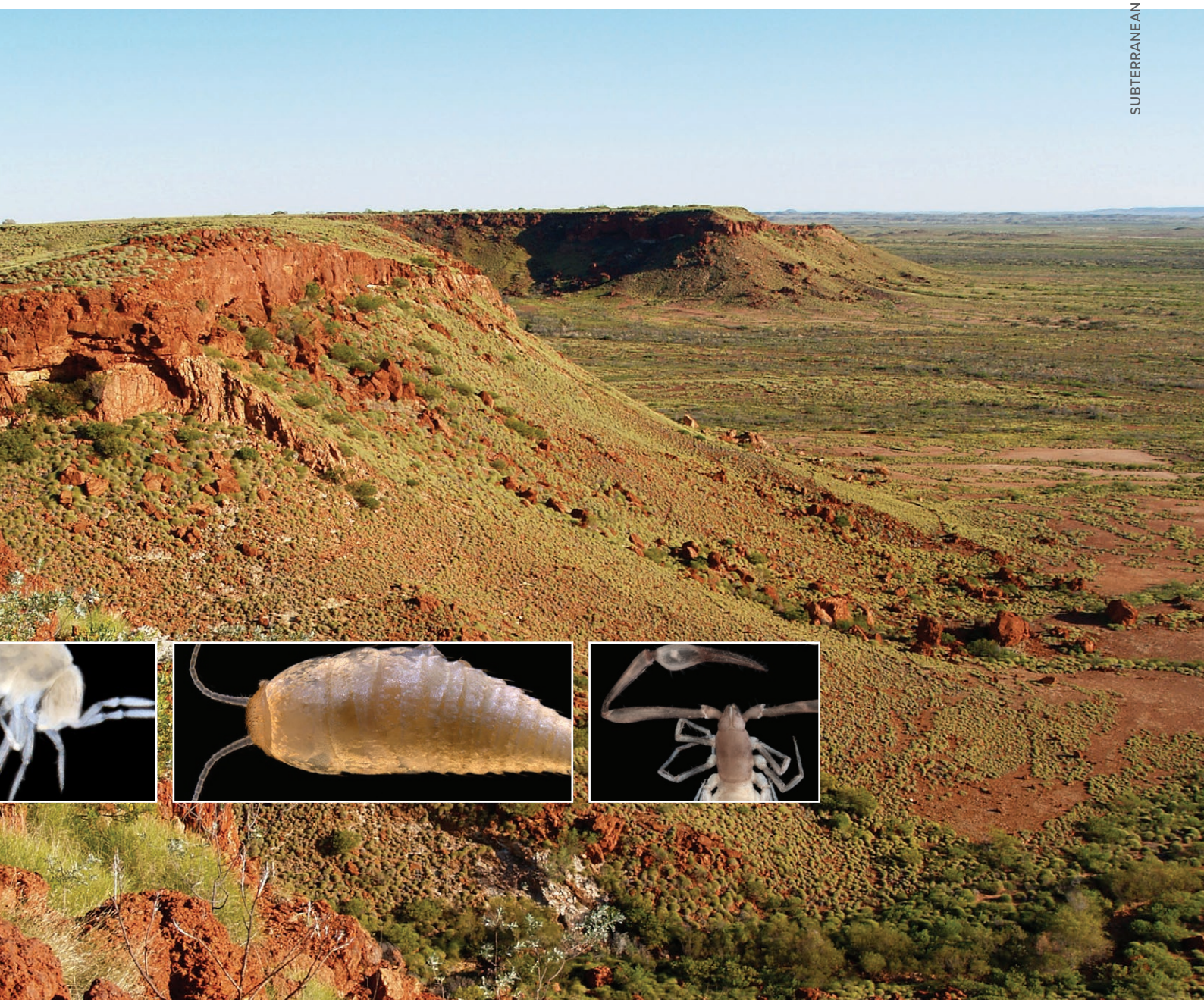
PROJECT: THREE-DIMENSIONAL MODELLING AND SIMULATION OF SUBTERRANEAN FAUNA HABITATS

While it is important to understand what subterranean fauna occur within the footprint of a proposed development, it is equally important to know whether species that may be lost could occur elsewhere. Where a reasonable amount of sampling is unlikely to reveal the range of species, understanding the conditions various species require, including geological and hydrological, can assist in determining likely habitat connectivity and inform predictions about where else those species may occur. The Environmental Protection Authority (EPA) encourages the use of information regarding habitat connectivity to infer the likely presence of a species beyond the area surveyed which means it is important to better understand the habitat preferences of subterranean fauna and improve our capacity to map three-dimensional habitat suitability at fine resolution across the scale of a development and surrounding region.

In August 2019 an Australian Research Council Industrial Transformation Training Centre (ARC ITTC) proposal titled *Data Analytics for Resources and Environments* (DARE) led by Sydney University in partnership with the University of Western Australia and the University of New South Wales was announced.

KEY PROGRESS:

- As one of the industry partners, WABSI is facilitating a PhD project that will investigate 3D modelling and simulation of subterranean fauna habitats using techniques derived from geosciences and Bayesian statistics.
- Based at UWA, a PhD student will undertake a project that will comprise two main components. While the details of the project are still under refinement, the first component aims to build on the *survey review project* above to develop optimal sampling strategies using Bayesian statistics. The second component will construct a 3D model of subsurface habitat by integrating geophysical and geological information from data commonly collected for mineral exploration. The final component will draw from the first two to predict the extent of potential impact of mining activities on subterranean fauna.



Research focus

OUTCOME	OBJECTIVE
Our understanding of the impacts of change in habitat conditions on subterranean fauna is significantly advanced	Determine the response, resilience to and persistence after change in habitat conditions

PROJECT: CAPTURE OF MONITORING DATA TO INFORM RESILIENCE TO CHANGE

The collation of monitoring data associated with development approvals can improve our understanding of the resilience of subterranean fauna to disturbance, particularly in relation to mining. The potential impacts of mining developments on some key habitat features that affect subterranean fauna can be identified such as habitat removal, drawdown of groundwater, inundation, and changes to hydrology/hydrogeology, water quality and nutrient inputs. However, determining the likely significance of these changes on the persistence of subterranean fauna after the impact remains a major challenge when undertaking environmental impact assessments.

Where the EPA concludes there are significant residual impacts to subterranean fauna, conditions are likely to be imposed to reduce or mitigate these impacts. These may include requirements to undertake ongoing monitoring. The resulting monitoring data, collected once the mine has commenced, is a potential source of information that may help to address specific questions regarding the response of subterranean fauna to changes as a result of mining.

This is a 12-month project, commencing in 2021, that was developed concurrently with the *survey review project* above, to review existing monitoring data to examine questions regarding potential impacts of mining activities on subterranean fauna.

FUNDED BY:

- BHP, Cameco, DWER, Fortescue Metals Group, Rio Tinto and WABSI

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- Claire Stevenson (Project Working Group)
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- Department of Biodiversity, Conservation and Attractions

How you can engage with this research program

Seeking industry partners

Invest in leading research that will deliver real world outcomes, increase knowledge and help lift certainty to enable more informed management decisions.

Seeking collaboration on student projects

We invite academic institutions to engage with us on student projects, particularly in relation to resilience to disturbance.

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