

Yilgarn Iron Ore Project: Troglafauna Surveys

Final Report

Prepared for Polaris Metal Pty Ltd
by Bennelongia Pty Ltd

August 2011
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Yilgarn Iron Ore Project: Troglafauna Surveys

Bennelongia Pty Ltd
5 Bishop Street
Jolimont WA 6913
www.bennelongia.com.au
ACN 124 110 167

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Cover photo: Filosciidae sp. B9

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Client – Polaris Metal Pty Ltd

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EXECUTIVE SUMMARY

Polaris Metals Pty Ltd (Polaris) currently operates an iron ore mine within its Yilgarn Iron Ore Project (YIOP) known as the Carina Iron Ore Mine. The mine is located approximately 100 km north of Southern Cross and approximately 20 km to the south of the Mount Manning Nature Reserve in the Yilgarn region of Western Australia. The Carina Iron Ore Mine was approved under Ministerial Statement 852 on 28 January 2011, which required Polaris to carry out baseline surveys for troglofauna in accordance with Condition 8. This condition requires Polaris to undertake a baseline troglofauna survey within 15 kilometres of the Project Boundary within 30 months of ground disturbing activities the proponent shall prepare and submit a technical report based on the results of the survey.

The YIOP encompasses approximately 1,000 km² of mining tenements in the Helena and Aurora Range, the Hunt Range (including Mount Dimer and the Yendilberin Hills), and the Mount Jackson Range. The YIOP troglofauna survey comprises sampling at iron ore deposits known as; Carina (Carina Iron Ore Mine), Carina North, Carina Extended, Chamaeleon, Capella, Vela and Hadar. Carina, Carina North, Carina Extended, Chamaeleon, Capella and Hadar are in the Hunt Range. Vela is in the Helena and Aurora Range. Sites of the YIOP leases, along Mount Finnerty Range were also sampled to provide additional information on the regional troglofauna.

This baseline study combines all of the troglofauna survey data of the YIOP. It includes data collected during the Carina Iron Ore Mine EIA and the 2010 survey data collected in accordance to Condition 8 of Ministerial Statement 852. The report seeks to provide a greater understanding of the population and distribution characteristics of the troglofauna communities in the vicinity of the Carina Iron Ore Mine.

The 2010 survey data supported the findings the Carina EIA; further documenting an unremarkable troglofauna community of low abundance by regional standards. The troglofauna community consisted of about 15 species belonging to eight Orders/Classes. The majority of species in the troglofauna community of the YIOP occurred in very low abundance, with less than 5 specimens recorded. Isopods and diplurans dominated the community, each providing 27% of the species. The structure of the YIOP troglofauna community was similar to that of the nearby Mount Jackson and Koolyanobbing Ranges at the Order/Class level; with the notable exception that arachnid Orders were absent from the YIOP community.

The troglofauna species recorded during the YIOP troglofauna surveys appear to have ranges that are mostly restricted on a sub-regional scale, i.e. to the Hunt Range. Two lines of evidence support previous conclusions that troglofauna species are not restricted within the Hunt Range: 1) specimens of the same troglofauna species occur in multiple deposits within the Hunt Range; and 2) troglofauna occur in both mineralized and non-mineralized lithologies within the Hunt Range. It is unlikely, based on both the evidence of field sampling and the geological information about habitat structure, that troglofauna species are restricted the iron ore mineralization that is the focus of mining in the Hunt Range

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1. INTRODUCTION

Polaris Metals Pty Ltd (Polaris) currently operates an iron ore mine within its Yilgarn Iron Ore Project (YIOP) known as the Carina Iron Ore Mine. The mine is located approximately 100 km north of Southern Cross and approximately 20 km to the south of the Mount Manning Nature Reserve in the Yilgarn region of Western Australia (Figure 1.1).

The Carina Iron Ore Mine was approved under Ministerial Statement 852 on 28 January 2011, which required Polaris to carry out baseline surveys for troglofauna in accordance with Condition 8:

8 Troglofauna

8-1 The proponent shall undertake a baseline troglofauna survey within 15 kilometres of the Project Boundary (as shown in Figure 2 and delineated by MGA co-ordinates listed in Schedule 2) in similar geological formations to validate predictions of habitat connectivity and improve knowledge of troglofauna populations in the region to inform future management of mining and associated operations.

8-2 The baseline troglofauna survey shall be undertaken in accordance with the draft Environmental Protection Authority Guidance Statement 54a Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australian (August 2007) or its revisions and to the satisfaction of the CEO.

8-3 Within 30 months of ground disturbing activities the proponent shall prepare and submit a technical report based on the results of the survey required by condition 8-1 to the requirements of the CEO on advice of the DEC.

8-4 The proponent shall make the report required by condition 8-3 publicly available in a manner approved by the CEO.

The YIOP encompasses approximately 1,000 km² of mining tenements in the Helena and Aurora Range, the Hunt Range/Mount Dimer/Yendilberin Hills (hereafter referred to as the Hunt Range), and the Mount Jackson Range (Figure 1.1). The YIOP troglofauna survey comprises sampling at iron ore deposits known as Carina, Carina North, Carina Extended, Chamaeleon, Capella and Hadar (in the Hunt Range) and Vela (in the Helena and Aurora Range) (Figure 1.1). Sites of the YIOP leases, along Mount Finnerty Range were also sampled to provide additional information on the regional troglofauna (Figure 1.1, and see Section 4).

This baseline report combines all of the troglofauna survey data of the YIOP. It includes data collected during the Environmental Impact Assessment (EIA) for Carina Iron Ore Mine (Bennelongia 2009a); and data from the 2010 Survey, which was designed to satisfy Condition 8 of Ministerial Statement 852 (see Section 4.1.1). Additional information from previous troglofauna surveys at Mount Jackson Range (Bennelongia 2008a) was incorporated in an assessment of species ranges.

The specific aims of this baseline report were:

1. To improve knowledge of troglofauna populations in the region; and
2. To validate predictions of habitat connectivity by examining the distributions of troglofauna species in the region.

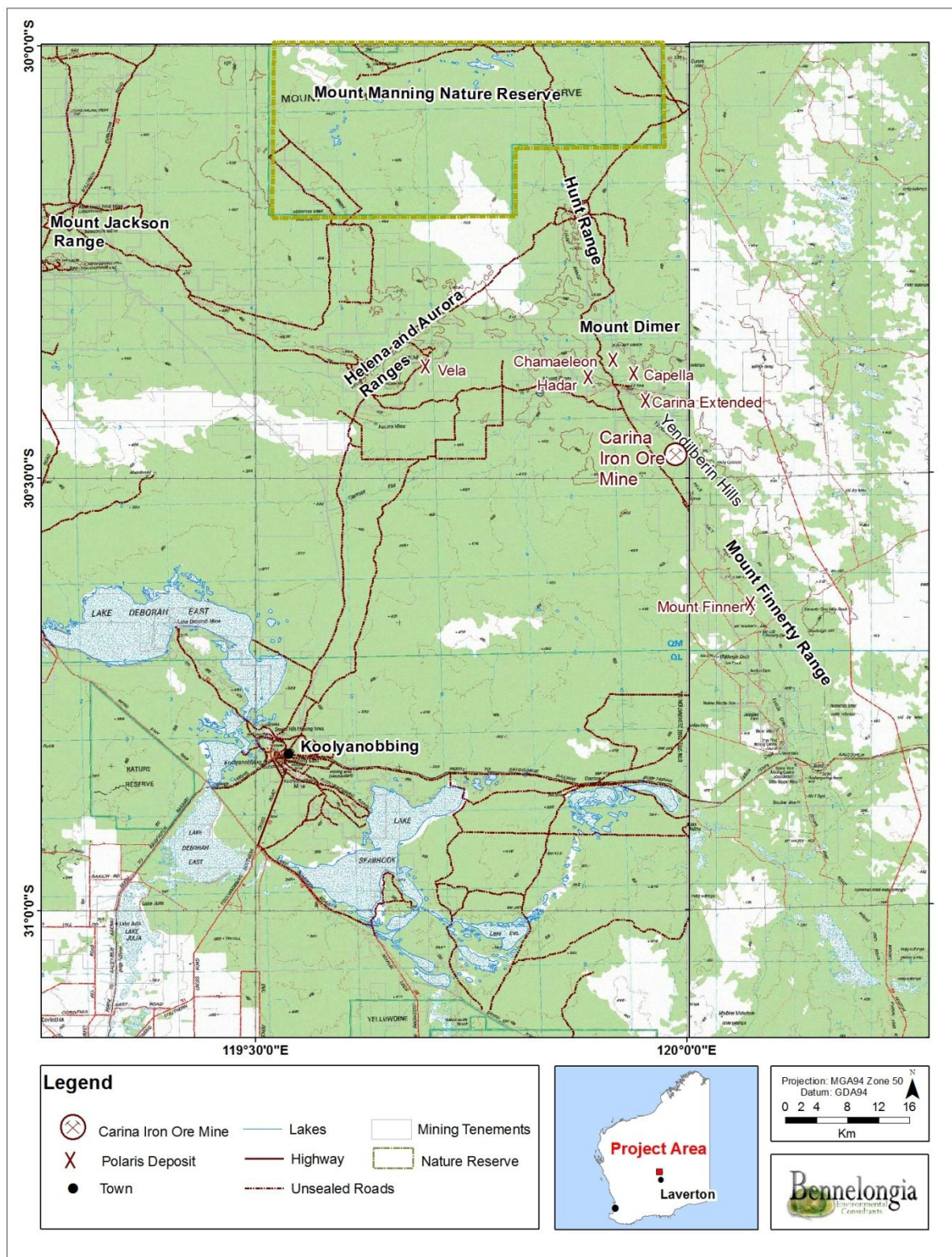


Figure 1.1. Locations of the Yilgarn Iron Ore Project and associated deposits and mine.

2. EXISTING INFORMATION ON TROGLOFAUNA

Troglotauna spend all, or most, of their lifecycle underground and are typically highly adapted to a subterranean lifecycle. Commonly these adaptations include pallid colouration, reduction or loss of eyes, elongate body, long slender appendages and well developed sensory setae. Troglotauna have significant scientific value and a high proportion of subterranean species are short-range endemics (SREs), defined by Harvey (2002) as species with ranges of <10,000 km². The very limited ranges of SRE species means they are particularly vulnerable to extinction as a result of anthropogenic activities and, therefore, they are a focus for conservation (see Fontaine *et al.* 2007).

Troglotauna studies have historically focussed on caves; however, surveys during the past five years have shown that troglotauna are widespread in Western Australia in non-cavernous landforms, where they are represented by numerous invertebrate groups including pseudoscorpions, schizomids, paligrads, spiders, harvestmen, isopods, millipedes, centipedes, pauropods, symphylans, diplurans, silverfish, cockroaches, bugs, beetles and fungus gnats. Troglotauna are ubiquitous in WA and have been recorded from the Pilbara (Biota 2006; Bennelongia 2009b), Kimberley (Harvey 2001), Cape Range (Harvey *et al.* 1993), Barrow Island (Biota 2005a), Yilgarn (Bennelongia 2009a) and South-West (Biota 2005b).

Most troglotauna surveys for environmental assessment have been undertaken in areas of pisolite or BIF. The micro-habitats that troglotauna occupy within these lithologies are still being defined but it is inferred that they utilise the fissures and voids associated with weathering, enrichment and faulting. Information about the occurrence of troglotauna outside mineralized habitats is limited because mine development has been the primary reason for most of the surveys. However, it has been demonstrated that troglotauna occur in calcrete and alluvium in the Pilbara (Edward and Harvey 2008; Rio Tinto 2008), Yilgarn (Barranco and Harvey 2008; Platnick 2008; Bennelongia 2009a) and elsewhere (Biota 2005a,b).

The occurrence of troglotauna is dependent on geological features. Troglotauna habitat is usually considered to extend from the lower layers of loose soil and sand (usually 3-4 m below the ground surface) to the interface with the groundwater (see Juberthie *et al.* 1981). The pattern of occurrence of subterranean spaces, including fissures and voids, largely determine the density and distribution of troglotauna. Vertical connectivity with the surface is important for supplying nutrients to maintain populations of different species (plant roots are an important surface connection), while lateral connectivity of voids is crucial to underground dispersal. Geological features such as major faults and dykes may block continuity of habitat and act as barriers to dispersal, leading to troglotauna species having highly restricted ranges.

Modest troglotauna communities have been collected above the watertable in calcretes of the Yilgarn, with the groups collected including paligrads (Barranco and Harvey 2008), pseudoscorpions (Edward and Harvey 2008), spiders (Platnick 2008) and isopods (S. Taiti in litt.). Troglotaunal pseudoscorpions and, probably, isopods have been collected from Yilgarn BIF (Biota 2007). More recent studies in BIF at Koolyanobbing Range, Mount Jackson Range and the Hunt Range have documented either depauperate or modest troglotaunal communities, depending on site, that include species of isopod, millipede, centipede, spider, silverfish, beetle, symphylan, cockroach, pauropod, bristletail and bug (Bennelongia 2008a,b, 2009c).

3. HABITAT CHARACTERISATION

3.1. Regional Geology

The YIOP is located in the south-eastern part of the Marda-Diemals greenstone belt, within the Archaean Yilgarn Block. A craton-scale sinistral fault zone, the Mount Dimer Shear Zone, separates the Marda-Diemals greenstone belt from the Hunt Range greenstone belt to the north (Prodemas 2007).

Chen *et al.* (2003) subdivided the Marda-Diemals belt into two greenstone successions. The lower 3000 My greenstone succession is characterised by mafic volcanics and Banded Iron Formation (BIF). A sequence of basalt and ultramafic rocks is overlain by the relatively thick BIF/chert unit, which is overlain by mafic volcanics. This lower greenstone succession is unconformably overlain by a 2730 My upper greenstone succession consisting of felsic to intermediate volcanic rocks and clastic sedimentary rocks.

Iron deposits in the region are of the BIF-hosted Archaean Algoma type, in contrast to the Proterozoic Lake Superior type that characterizes the Western Australian Pilbara deposits. All economic ore bodies have been enriched in some way by structural, hydrothermal, supergene or surface weathering processes. The host rocks of the seven deposits in the YIOP planning area are tectonically thickened and supergene enriched BIFs of the lower greenstone succession. The host rocks are carbonate and sulphide-rich, suggesting that hydrothermal alteration has also played a role in concentrating the iron (Chen and Wyche 2001).

3.2. Troglifauna Habitat at the YIOP

3.2.1. Subterranean Spaces and the Occurrence of Troglifauna

Mineralized strata, such as Banded Iron Formation (BIF) and the ore yielding haematite/goethite that occurs within the YIOP, are well known as prospective troglifauna habitat (Biota 2006; Bennelongia 2008a,b 2009b,c). These geologies support troglifauna because the weathering process (which leads to mineral enrichment) creates small voids that allow water to infiltrate the rock and leads to further weathering. The BIF is regionally extensive and can be traced along strike-ridges that are many tens of kilometres in length (Chen and Wyche 2001). These BIFs are typically bound by massive mafic volcanic rock (Chen and Wyche 2001).

Significant vugginess, fractures and subterranean spaces would normally be expected only in weathered BIF in the southern Yilgarn, where host rocks are predominantly basalt or ultramafic. However, the extensive fracturing that has occurred along the Mount Dimer Shear Zone (Figure 3.1) has created fissures and voids in the ultramafic schist surrounding BIF and chert. Much of the mafic schist in the shear zone is laminar and weathering has enlarged the fissures and voids within it.

In line with the occurrence of spaces within ultramafic schist, the troglifauna survey for the Carina Iron Ore Mine EIA showed that troglifauna occur in both the mineralized and non-mineralized (mafic schist) strata within the YIOP (Bennelongia 2009a). Thus, given the continuous mosaic of mineralised BIF bounded by areas of mafic schist, subterranean fauna habitat is expected to be more or less continuous between Carina Iron Ore Mine and the deposits to the north (Carina Extended, Carina North, Chamaeleon, Capella and Hadar) in the Hunt Range. This is illustrated in Figure 3.1, although the extent of the matrix of schist and other volcanic is much more extensive than shown.

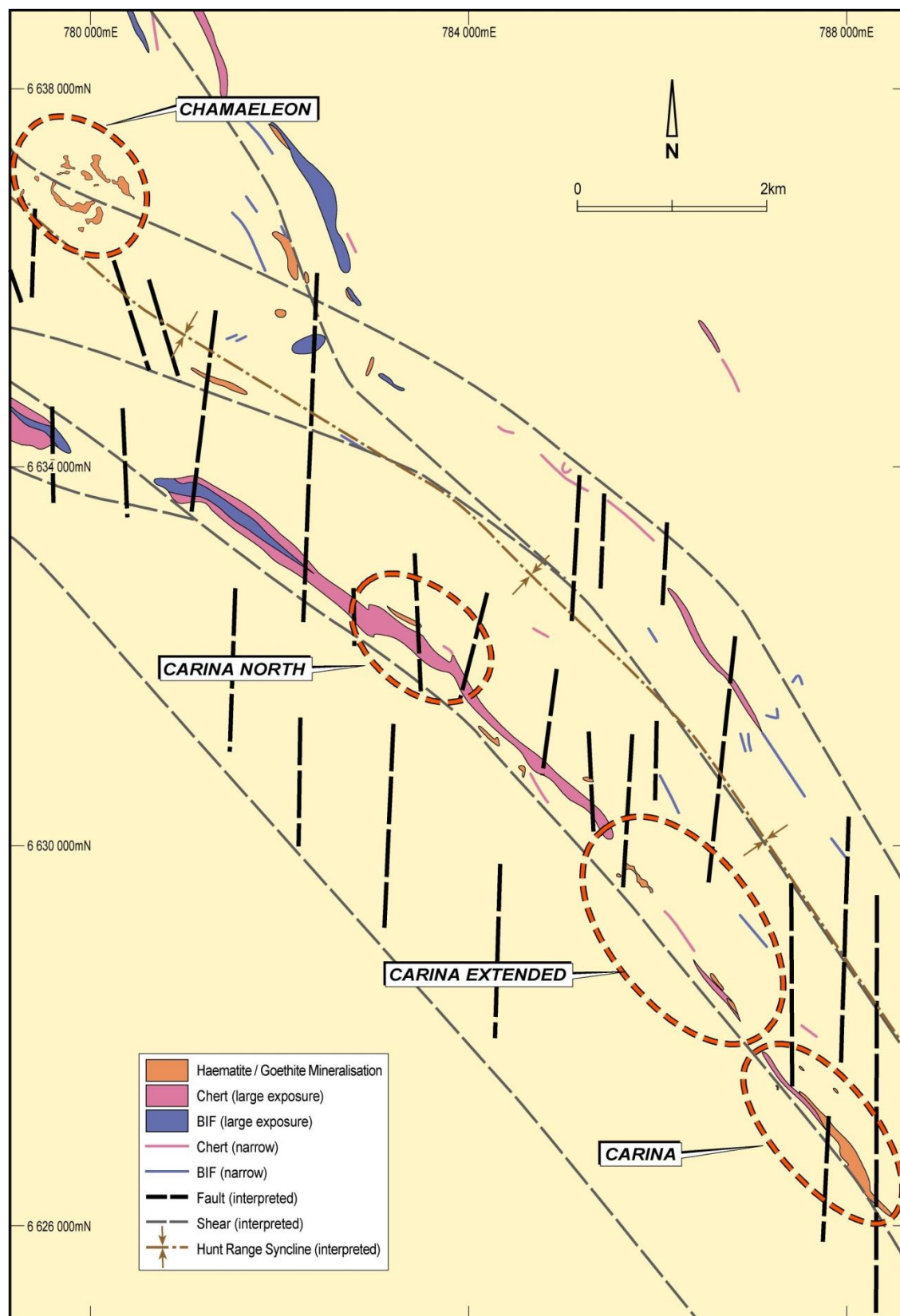


Figure 3.1. Mount Dimmer Shear Zone in relation to the Carina and Chamaeleon deposits (Carina Iron Ore Mine is labelled Carina).

4. METHODS

4.1. Survey Rationale

To provide a better understanding of the troglifauna communities in the vicinity of the Carina Iron Ore Mine, this baseline report combines all of the troglifauna survey data of the YIOP. It includes data collected during the Carina Iron Ore Mine EIA (Bennelongia 2009a); and the 2010 survey data collected in accordance to Condition 8 of Ministerial Statement 852 (see Section 4.1.1).

All troglifauna survey was conducted in accordance with the principles laid out in EPA Guidance Statements Nos 54 and 54a (EPA 2003, 2007).

4.2. Sampling Effort and Timing

The sample effort in accordance with Condition 8 of Ministerial Statement 852 totals 116 samples collected within 15 km of the Carina Iron Ore Mine, with 18 samples from Capella, 66 samples from Carina Extended, 14 samples from Carina North and 18 samples from Hadar (Table 4.1, Figure 4.1). This survey was conducted from 3 August to 21 December 2010.

Table 4.1. Numbers of troglifauna samples collected from the YIOP survey area.

Sampling conducted in 2010 was in accordance to Condition 8 of Ministerial Statement 852 (with 15 km of the Carina Iron Ore Mine). Pre-2010 survey includes sampling of the Carina Iron Ore Mine EIA (Bennelongia 2009a).

Deposits	2010 survey				Pre-2010 survey			
	Scrape	Single Trap	Double Trap	Samples	Scrape	Single Trap	Double Trap	Samples
Capella	18	12	6	18				
Carina					72	55	17	72
Carina Extended	65	46	20	66				
Carina North	14	9	5	14				
Chaemeleon					87	40	12	87
Hadar	16	13	5	18				
Mount Finnerty					17	21		21
Vela					11	5		16
Total Samples				116				196

Calculation of total sampling effort is based on all sampling (i.e. scrape alone or a scrape with trap/s) during a visit to a site being considered as one sample. S Trap = single trap, D Trap = double trap.

Sampling from the Carina Iron Ore Mine, EIA (Bennelongia 2009a) totalled 196 samples; with 72 samples collected from Carina, 87 samples from Chaemeleon, 21 samples from Mount Finnerty and 16 samples from Vela (Table 4.1, Figure 4.1). This survey occurred between 19 August 2008 and 10 September 2009 (Bennelongia 2009a).

4.2.1. Other Sampling

Records of troglifauna collected as by-catch during the stygofauna sampling program for the Carina Iron Ore Mine EIA (Bennelongia 2009a) are also included in survey results. These records provided additional information on species distribution and conservation significance.

4.2.2. Sampling Methods

In nearly all cases, each troglifauna sample was collected using two separate techniques that provided separate subsamples. The two techniques were trapping and scraping.

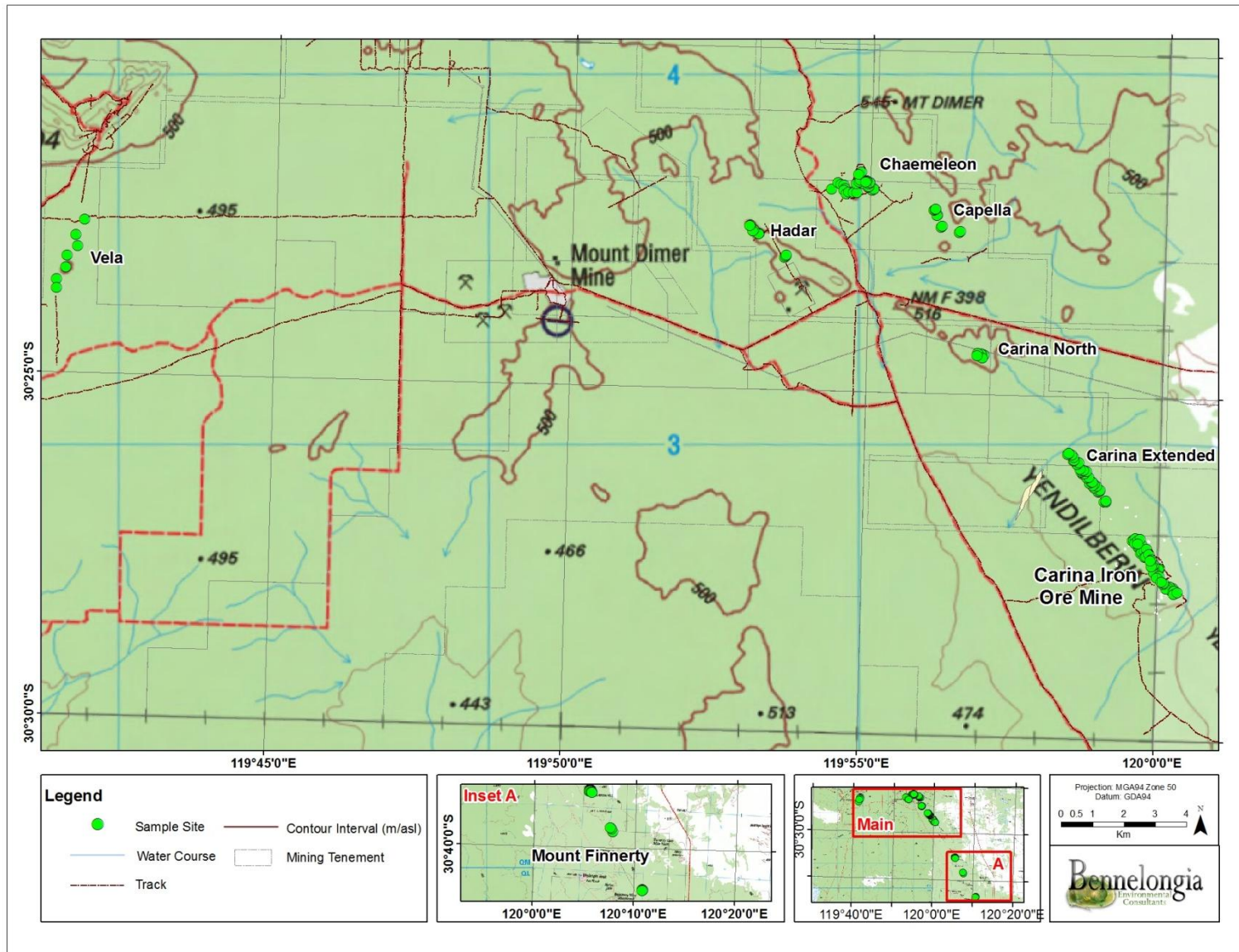


Figure 4.1. Drill holes sampled during the YIOP troglafauna surveys.

1. *Trapping.* Custom made cylindrical PVC traps (270 x 70 mm, entrance holes side and top) were used for trapping. Traps were baited with moist leaf litter (sterilised by microwaving) and lowered on nylon cord to within a few metres of the watertable or end of the drill hole. In every fourth hole, a second trap was set mid-way down the bore. Holes were sealed while traps were set to minimise the ingress of surface invertebrates. Traps were retrieved seven or eight weeks later and their contents (bait and captured fauna) were emptied into a zip-lock bag and road freighted to the laboratory in Perth.
2. *Scraping.* Prior to setting traps, drill holes were scraped. This was done by lowering a troglifauna net (weighted net, 150 µm mesh with variable aperture according to hole diameter) to the bottom of the drill hole, or to the watertable, and scraping back to the surface along the walls of the hole.

Each scrape comprised four drop and retrieve sequences with the aim of scraping any troglifauna on the walls into the net. After each scrape, the contents of the net were transferred to a 125 ml vial and preserved in 100% ethanol.

4.2.3. Sample Sorting and Species Identification

Troglifauna caught in traps were extracted from the leaf litter using Berlese funnels under halogen lamps. Light drives troglifauna and soil invertebrates out of the litter into the base of the funnel containing 100% ethanol (EPA 2007). After about 72 hours, the ethanol and its contents were removed and sorted under a dissecting microscope. Litter from each funnel was also examined under a microscope for any remaining live or dead animals.

Preserved scrapes were elutriated to separate animals from heavier sediment and sieved into size fractions (250, 90 and 53 µm) to remove debris and improve searching efficiency. Samples were then sorted under a dissecting microscope.

All fauna picked from samples were examined for troglomorphic characteristics (lack of eyes and pigmentation, well developed sensory organs, elongate appendages, vermiform body shape). Surface and soil-dwelling species were identified only to Order level. Troglifauna were identified to species or morphospecies level, unless damaged, juvenile or the wrong sex for identification (EPA 2007).

Identifications were made under dissecting and/or compound microscope, with specimens being dissected as necessary. Unpublished and informal taxonomic keys were used to assist identification of taxa for which no published keys exist.

Representative animals will be lodged with the WA Museum after the assessment process has been completed.

4.3. Occurrence of Troglifauna and Geology

Using the lithology from drill logs, the occurrence of troglifauna was categorised according to the geology in which each species was collected using the categories *mineralized* or *non-mineralized*. A species was categorised as known from mineralized habitat if either BIF or haematite/goethite was present in the drill log above the water table. Conversely, a species was categorised as known from non-mineralized habitat if there was no BIF or haematite/goethite present in the drill log above the water table.

4.4. Personnel

4.4.1. 2010 Survey

Fieldwork was undertaken by Dean Main, Mike Scanlon and Jim Cocking. Sample sorting was done by Jane McRae, Dean Main, Mike Scanlon, Jim Cocking, Heather McLetchie, Grant Pearson and Yoav Bar-Ness. Identifications were made by Jane McRae and Dean Main.

4.4.2. Carina Iron Ore Mine EIA

Fieldwork was undertaken by Jim Cocking, Grant Pearson, Peter Cocking and Crispin Rumens-Thornber of Bennelongia; Paul Rokich of Polaris; and Nick Eveleigh of Rockwater Pty Ltd. Sample sorting was done by Jane McRae, Mike Scanlon, Jim Cocking, Heather McLetchie, Andrew Trotter and Dean Main. Identifications were made by Jane McRae.

5. RESULTS

5.1. Occurrence and Abundance

A total of 37 troglofaunal specimens were collected during YIOP troglofauna surveys (Table 5.1). The troglofauna community comprised about 15 species belonging to eight Orders/Classes. Two of the troglofauna species were collected during stygofauna sampling at Carina during August 2008. Isopoda (four species) and Diplura (three or four species) were the most diverse invertebrate groups (Table 5.1, Figure 5.1). Myriapoda (centipedes, millipedes, pseudo-centipedes and pauropods) were represented by four Orders, each with one species. There were two Orders of insect: Hemiptera with one species and Coleoptera with two species (Table 5.1).

The majority of species in the troglofauna community of the YIOP occurred in very low abundance, with less than 5 specimens recorded. The only exceptions were the isopods Philosciidae sp. B9 and Trichorhinae sp. B1 (Table 5.1). Isopods and diplurans dominated the community, each providing 27% of the species.

The 2010 survey collected six species, of which only two species had been previously recorded, Trichorhinae sp. B1 was found during the Carina Iron Ore Mine EIA (Bennelongia 2009a) and Chilenophilidae sp. B1 was found at Mount Jackson Range (see Bennelongia 2008a) (Table 5.1).

The ten singleton records (assuming Japygidae sp. represents a different species) equate to a rate of 3.2 singletons per 100 samples from all sampling in the YIOP troglofauna surveys. This is similar to the results of the troglofauna surveys at Koolyanobbing Range (5.96, Bennelongia 2008a) and Mount Jackson Range (5.04, Bennelongia 2008b).

All deposits surveyed yielded troglofauna, except Vela in the Helena and Aurora Range and Hadar in the Hunt Range (see Section 4.2).

5.2. Troglofauna Distribution

Ten of the 15 species collected were singletons and singleton records provide no information about the extent of a species' range (Appendix 2). Furthermore, Philosciidae sp. B9 is also only known from one drill hole, where ten specimens were collected (Appendix 2). The four species that were represented by specimens collected from more than one bore (Philosciidae sp. B8, Trichorhinae sp. B1, Chilenophilidae sp. B1 and Campodeidae sp. B2) were found to be relatively widespread, with linear

Table 5.1. Troglafauna collected during the YIOP troglafauna surveys.

Higher Groups	Species	Carina	Carina Extension	Carina North	Capella	Chaemeleon	Mount Finnerty	Survey	Known Linear Range (km)	Comments
Isopoda										
	Philosciidae sp. B8	3				1		Carina EIA	12.5	
	Philosciidae sp. B9					10		Carina EIA	-	
	Trichorhinae sp. B1	1	1	4		2		Carina EIA, 2010 Survey	13.7	
	<i>Troglarmadillo</i> sp. B10					1		Carina EIA	-	
Geophilomorpha										
	Chilenophilidae sp. B1		1		2			2010 Survey, Bennelongia 2008a	34.5	Also known from the Mount Jackson Range
Scolopendromorpha										
	<i>Cryptops</i> sp. B18		1					2010 Survey	-	
Pauropodina										
	Pauropodina sp. B18		1					2010 Survey	-	
Symphyla										
	Symphyla Gen. 1 sp. B1	1*						Carina EIA	-	
Diplura										
	Campodeidae sp. B2	1				1		Carina EIA	13	
	Japygidae sp.						1	Carina EIA	-	
	Japygidae sp. B12					1		Carina EIA	-	
	Parajapygidae sp. B6	1						Carina EIA	-	
Hemiptera										
	Meenoplidae sp.		1					2010 Survey	-	Immature specimen, very likely to be the same species that occurs at Koolyanobbing and Windarling (Bennelongia 2008b, 2010)
Coleoptera										
	Carabidae sp. B4		1					2010 Survey	-	
	Curculionidae Gen. 2 sp. B6	1*						Carina EIA	-	

*Collected during stygofauna sampling.

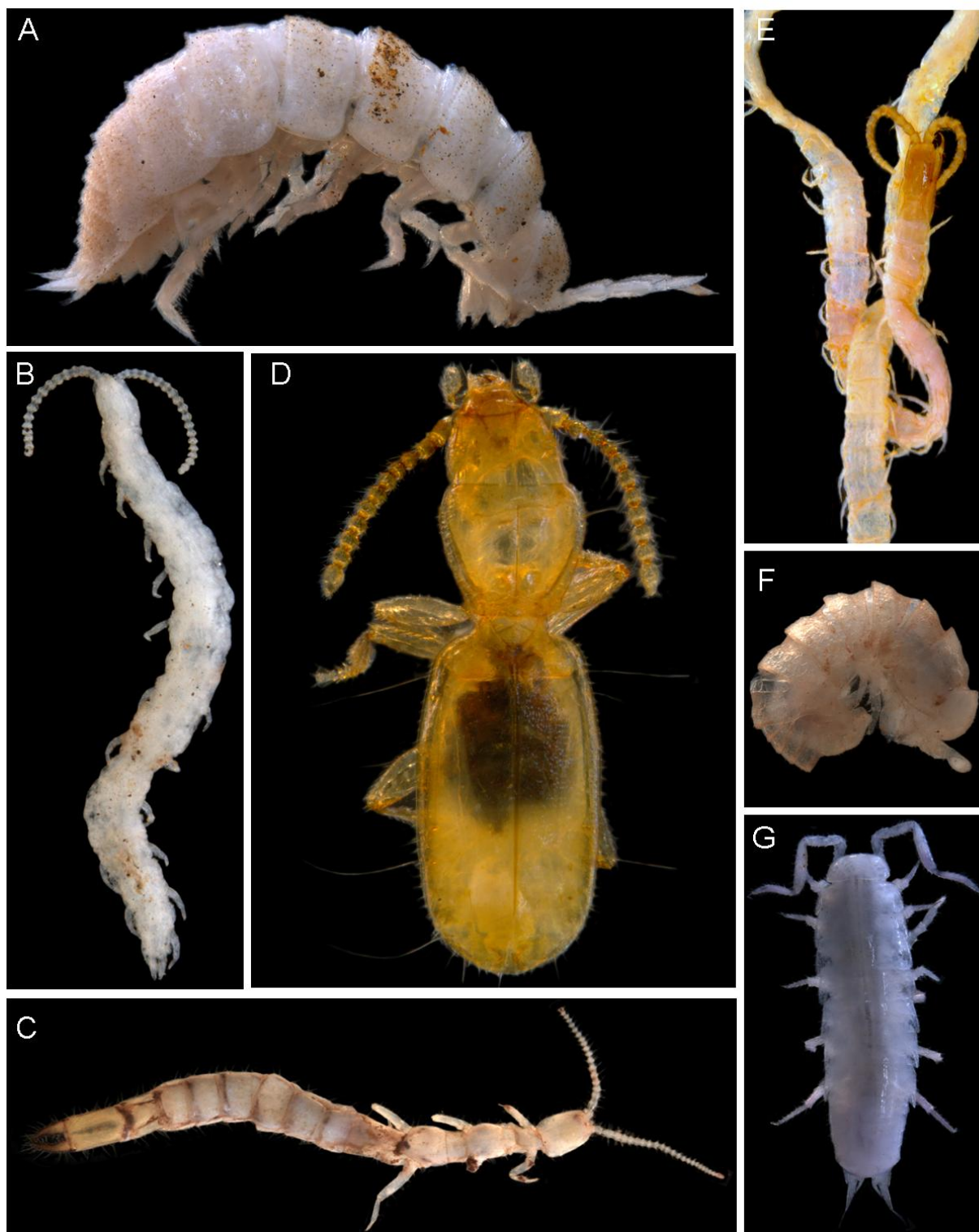


Figure 5.1. Troglafauna photographs. (A) Trichorhinae sp. B1, Isopoda; (B) Symphyla Gen. 1 sp. B1, Symphyla; (C) Japygidae sp. B12, Diplura; (D) Carabidae sp. B4, Coleoptera; (E) Chilenophilidae sp. B1, Chilopoda; (F) *Troglarmadillo* sp. B10, Isopoda; (G) Philosciidae sp. B9, Isopoda.

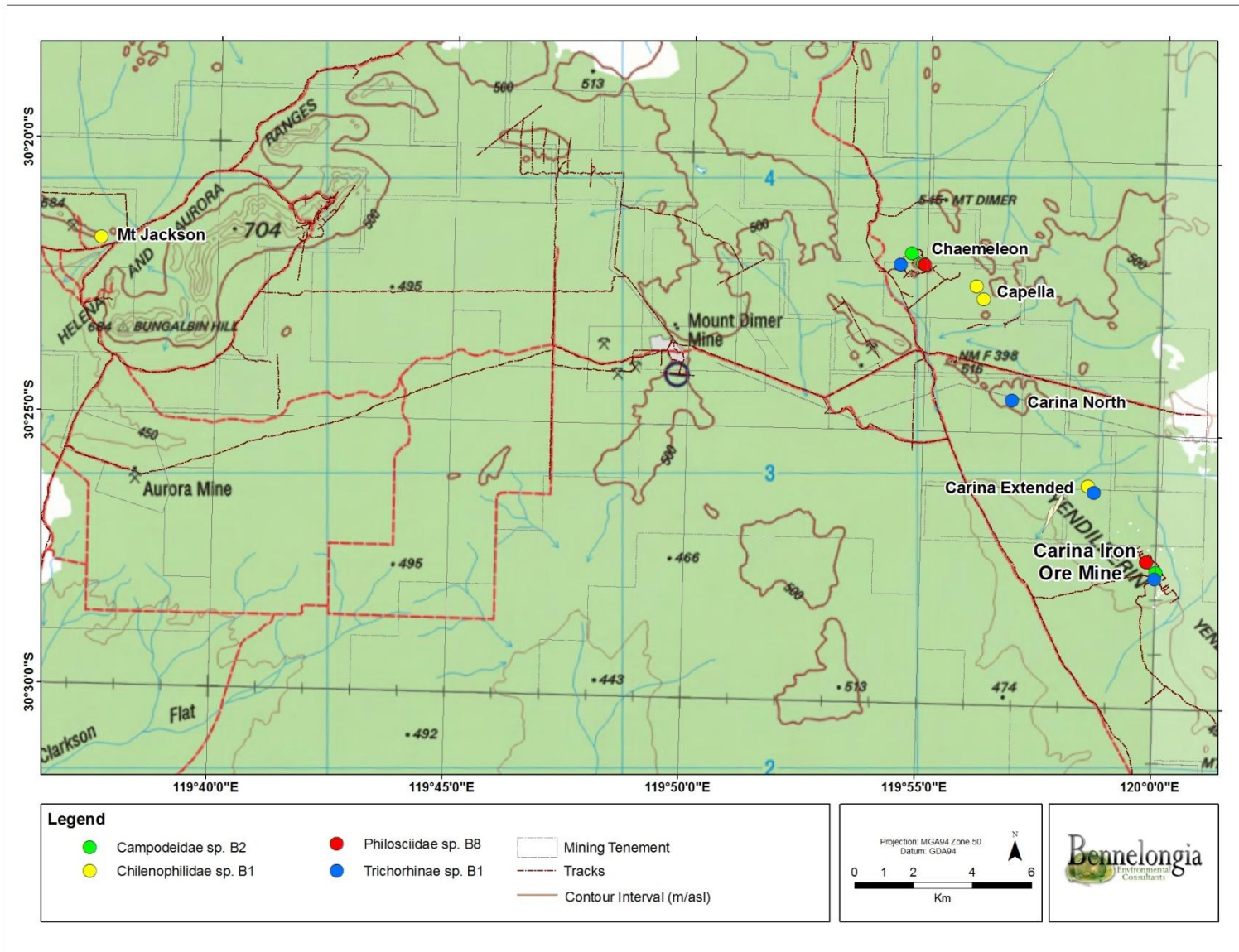


Figure 5.2. Troglafauna species collected at multiple sites during the YIOP troglafauna surveys.

ranges of between 12.5 and 34.5 km (Table 5.1, Figure 5.2). All four species were found at multiple iron ore deposits of the YIOP and *Chilenophilidae* sp. B1 has previously been recorded at Mount Jackson Range (Table 5.1).

5.3. Troglafauna and Geology

Half of the troglafauna species (seven of the 14 species with geological data available) recorded during the YIOP troglafauna surveys have been collected from holes located entirely in non-mineralized strata (Table 5.2). Five of these species have not been recorded from mineralized bores (*Cryptops* sp. B18, *Symphyla* Gen. 1 sp. B1, *Parajapygidae* sp. B6, *Carabidae* sp. B4 and *Curculionidae* Gen. 2 sp. B6), while *Philosciidae* sp. B8 and *Chilenophilidae* sp. B1 are known from both mineralized and non-mineralized hole. The non-mineralized holes predominantly passed through basalt, chert and ultramafic rock.

Table 5.2. Occurrence of troglafauna species in relation to geology.

A species was categorised as known from mineralized habitat, if there was BIF or haematite/goethite present in the drill log above the water table. Conversely, a species was categorised as known from non-mineralized habitat, if there was no BIF or haematite/goethite present in the drill log above the water table.

Species	Mineralized	Non-mineralized
<i>Philosciidae</i> sp. B8	Yes	Yes
<i>Philosciidae</i> sp. B9	Yes	No
<i>Trichorhinae</i> sp. B1	Yes	No
<i>Troglarmadillo</i> sp. B10	Yes	No
<i>Chilenophilidae</i> sp. B1	Yes	Yes
<i>Cryptops</i> sp. B18	No	Yes
<i>Pauropodina</i> sp. B18	Yes	No
<i>Symphyla</i> Gen. 1 sp. B1	No	Yes
<i>Campodeidae</i> sp. B2	Yes	No
<i>Japygidae</i> sp.	No data available for Mount Finnerty	
<i>Japygidae</i> sp. B12	Yes	No
<i>Parajapygidae</i> sp. B6	No	Yes
<i>Meenoplidae</i> sp.	Yes	No
<i>Carabidae</i> sp. B4	No	Yes
<i>Curculionidae</i> Gen. 2 sp. B6	No	Yes

6. DISCUSSION

The 2010 survey provided similar results to those of the Carina EIA (Bennelongia 2009a) and further documented that the YIOP supports an unremarkable troglafauna community of low abundance. The structure of the YIOP community is similar to that of the nearby Mount Jackson and Koolyanobbing Ranges at the Order/Class level; with the notable exception that arachnid Orders are absent from the YIOP community (see Table 5.1). Pseudoscorpions have been recorded from the Koolyanobbing Range and spiders have been recorded from the Koolyanobbing Range and Mount Jackson Range (Bennelongia 2008a,b, unpublished data).

Similar numbers of species have been recorded at the three ranges sampled in the Koolyanobbing area, with 14 species documented the Hunt Range (Carina, Carina North, Carina Extended, Chamaeleon and Capella) (see Table 5.1), with 14 and 19 species at the Mount Jackson and Koolyanobbing Ranges, respectively (Bennelongia 2008a,b, unpublished data). However, only one species (the centipede

Chilenophilidae sp. B1) recorded from the YIOP has been recorded at either Mount Jackson Range or Koolyanobbing Range (Table 5.1).

Apart from Chilenophilidae sp. B1, it appears that the troglafauna species recorded during the YIOP troglafauna surveys may range that are restricted on a sub-regional scale, i.e. to the Hunt Range. However, two lines of evidence support the previous suggestion of Bennelongia (2009a) that most troglafauna species are not restricted within the Hunt Range: 1) specimens of the same troglafauna species occur in multiple deposits within the Hunt Range (see Figure 5.2); and 2) troglafauna occur in both mineralized and non-mineralized lithologies within the Hunt Range, so that the ranges appear likely to provide continuous troglafaunal habitat (Table 5.1 and Table 5.2). In the past, it has been suggested that troglafauna have ranges that are tightly restricted to specific geologies, e.g. the pisolitic mesa of the Robe Valley that are essentially ecological islands (Biota 2006). Results of this survey suggest geological specificity has been over-emphasized.

The occurrence of troglafauna in non-mineralized strata is not unexpected considering the extensive fracturing that has occurred along the Mount Dimer Shear Zone (Figure 3.1), which has created fissures and voids in the basalt, chert and ultramafic strata surrounding the mineralized deposits. Zones within the strata are brecciated and weathering has enlarged the fissures and voids within it. Examination of bore logs indicates that there is continuity of basalt and ultramafic strata throughout the YIOP. Troglafauna species are likely to use the weathered strata of both the mineralized and non-mineralized lithologies as one continuous habitat unit.

7. CONCLUSION

This baseline report provides a greater understanding of the troglafauna communities in the vicinity of the Carina Iron Ore Mine, combining all of the troglafauna survey data of the YIOP. Knowledge of troglafauna populations and distributions has been improved.

The 2010 survey data supported the findings the Carina EIA and further documents the occurrence of an unremarkable troglafauna community of low abundance in the YIOP. The troglafauna community consists of about 15 species belonging to eight Orders/Classes. The majority of species in the troglafauna community occur in very low abundance, with fewer than 5 specimens recorded. Isopods and diplurans dominate the community, each providing 27% of the species. The structure of the YIOP troglafauna community is similar to that of the nearby Mount Jackson and Koolyanobbing Ranges at the Order/Class level; with the notable exception that arachnid Orders are absent from the YIOP community.

It appears that the troglafauna species recorded during the YIOP troglafauna surveys may have ranges that are restricted on a sub-regional scale, i.e. to the Hunt Range. However, two lines of evidence suggest that troglafauna species are not restricted within the Hunt Range: 1) specimens of the same troglafauna species occur in multiple deposits within the Hunt Range; and 2) troglafauna occur in both mineralized and non-mineralized lithologies within the Hunt Range, so that troglafaunal habitat is likely to be continuous within the range. It is unlikely, based on both the evidence of field sampling and the geological information about habitat structure; that troglafauna species are restricted the iron ore mineralization that is the focus of mining in the Hunt Range.

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9. APPENDICES

Appendix 1: Bores Sampled for Troglifauna at the Yilgarn Iron Ore Project

Deposit	Bore Code	Latitude	Longitude
Capella	CPRC0009	-30.377361	119.94186
Capella	CPRC0008	-30.377111	119.94217
Capella	CPRC0007	-30.376222	119.93658
Capella	CPRC0006	-30.375972	119.93694
Capella	CPRC0005	-30.373222	119.93558
Capella	CPRC0001	-30.373333	119.93544
Capella	CPRC0004	-30.372139	119.93444
Capella	CPRC0002	-30.371972	119.93478
Capella	CPR0003	-30.371861	119.93508
Carina	CA0065	-30.462722	120.00436
Carina	CA0053	-30.463194	120.00367
Carina	CA0024	-30.462361	120.0035
Carina	CA0009	-30.462639	120.00289
Carina	CA0036	-30.462972	120.0025
Carina	CA0051	-30.461778	120.00158
Carina	CA0050	-30.461556	120.00181
Carina	CA0001	-30.458028	120.00047
Carina	CA0002	-30.458139	120.00011
Carina	CA0005	-30.458806	119.99917
Carina	CA0035	-30.459	119.99883
Carina	CA0058	-30.452917	119.99442
Carina	CA0057	-30.45275	119.99478
Carina	CA0056	-30.452556	119.995
Carina	CA0055	-30.452361	119.99531
Carina	CA0020	-30.454417	119.99506
Carina	CA0019	-30.454028	119.99542
Carina	CA0013	-30.453722	119.99608
Carina	CA0026	-30.453278	119.99672
Carina	CA0040	-30.455389	119.99625
Carina	CA0039	-30.455111	119.99658
Carina	CA0041	-30.454639	119.99736
Carina	CA0042	-30.457194	119.99889
Carina	CA0043	-30.4575	119.99853
Carina	CA0064	-30.457639	119.99819
Carina	CA0011	-30.455806	119.99808
Carina	CA0012	-30.456083	119.99786
Carina	CA0045	-30.459778	120.00039
Carina	CA0047	-30.460278	119.99981
Carina	CA0007	-30.46125	120.00108
Carina	CA0062	-30.451417	119.99269
Carina	CA0060	-30.450917	119.99325
Carina	CA0061	-30.45125	119.99297
Carina	CA0059	-30.450806	119.9935
Carina	CARC0142	-30.451917	119.99342
Carina	CARC0144	-30.451306	119.99414
Carina	CARC0154	-30.450889	119.99475
Carina	CA0018	-30.452028	119.99425
Carina	CARC0162	-30.463472	120.00447
Carina	CARC0161	-30.46325	120.00483
Carina	CA0023	-30.464222	120.00467

Deposit	Bore Code	Latitude	Longitude
Carina	CA0021	-30.463667	120.00569
Carina Extended	CXRC0013	-30.442139	119.98439
Carina Extended	CXRC0012	-30.442083	119.98486
Carina Extended	CXRC0011	-30.441806	119.98497
Carina Extended	CXRC0010	-30.439778	119.98264
Carina Extended	CXRC0009	-30.439528	119.983
Carina Extended	CXRC0008	-30.439278	119.98325
Carina Extended	CXRC0036	-30.438722	119.9815
Carina Extended	CXRC0034	-30.438278	119.98211
Carina Extended	CXRC0032	-30.437917	119.98144
Carina Extended	CXRC0033	-30.438167	119.98097
Carina Extended	CXRC0007	-30.437639	119.98014
Carina Extended	CXRC0005	-30.437361	119.98072
Carina Extended	CXRC0004	-30.437306	119.98094
Carina Extended	CXRC0038	-30.436333	119.97939
Carina Extended	CXRC0031	-30.436361	119.97953
Carina Extended	CXRC0030	-30.436167	119.97989
Carina Extended	CXRC0017	-30.435417	119.97819
Carina Extended	CXRC0016	-30.435306	119.97853
Carina Extended	CXRC0015	-30.435306	119.97853
Carina Extended	CXRC0014	-30.434806	119.97919
Carina Extended	CXRC0039	-30.434889	119.97783
Carina Extended	CXRC0029	-30.434639	119.97792
Carina Extended	CXRC0028	-30.4345	119.97836
Carina Extended	CXRC0027	-30.434222	119.97747
Carina Extended	CXRC0002	-30.433167	119.97658
Carina Extended	CXRC0018	-30.433167	119.97658
Carina Extended	CXRC0001	-30.432611	119.97711
Carina Extended	CXRC0025	-30.432333	119.9755
Carina Extended	CXRC0024	-30.432167	119.97575
Carina Extended	CXRC0023	-30.431444	119.97556
Carina Extended	CXRC0022	-30.430917	119.97497
Carina Extended	CXRC0020	-30.43075	119.97389
Carina Extended	CXRC0019	-30.4305	119.97419
Carina North	CNRC0008	-30.407083	119.94956
Carina North	CNRC0007	-30.406806	119.94883
Carina North	CNRC0005	-30.406806	119.94875
Carina North	CNRC0006	-30.407417	119.94839
Carina North	CNRC0004	-30.40775	119.94911
Carina North	CNRC0001	-30.406722	119.94786
Carina North	CNRC0002	-30.407194	119.94769
Chaemeleon	CH0003	-30.367583	119.90561
Chaemeleon	CH0004	-30.366056	119.90739
Chaemeleon	CH0007	-30.366472	119.90819
Chaemeleon	CH0006	-30.366528	119.90897
Chaemeleon	CH0008	-30.367444	119.90939
Chaemeleon	CH0009	-30.367806	119.90903
Chaemeleon	CH0011	-30.368611	119.90983
Chaemeleon	CH0012	-30.368167	119.91039
Chaemeleon	CH0031	-30.368056	119.91189
Chaemeleon	CH0013	-30.368361	119.91178
Chaemeleon	CH0014	-30.368361	119.91278
Chaemeleon	CH0017	-30.367583	119.91706
Chaemeleon	CH0024	-30.367	119.91592
Chaemeleon	CH0016	-30.36675	119.91631

Deposit	Bore Code	Latitude	Longitude
Chaemeleon	CH0035	-30.36625	119.91567
Chaemeleon	CH0038	-30.365917	119.91592
Chaemeleon	CH0036	-30.365806	119.91636
Chaemeleon	CH0018	-30.367306	119.91753
Chaemeleon	CH0034	-30.365556	119.91539
Chaemeleon	CH0027	-30.365694	119.91519
Chaemeleon	CH0019	-30.366111	119.91456
Chaemeleon	CH0028	-30.366139	119.91247
Chaemeleon	CH0021	-30.365778	119.91325
Chaemeleon	CH0020	-30.365333	119.91358
Chaemeleon	CH0029	-30.363333	119.91386
Chaemeleon	CH0022	-30.363806	119.91317
Chaemeleon	CHUNK01	-30.366833	119.916
Chaemeleon	CHRC0039	-30.366806	119.91597
Chaemeleon	CH0026	-30.366083	119.91594
Chaemeleon	CH0037	-30.366111	119.91597
Chaemeleon	CHRC0041	-30.366083	119.91597
Chaemeleon	CHRC0040	-30.365861	119.91633
Chaemeleon	CHUNK02	-30.365417	119.91539
Chaemeleon	CHRC044	-30.365472	119.91525
Chaemeleon	CHRC045	-30.365722	119.91508
Hadar	HARC0010	-30.37875	119.88567
Hadar	HARC0011	-30.378917	119.88539
Hadar	HARC0008	-30.377917	119.88406
Hadar	HARC0009	-30.378222	119.88383
Hadar	HARC0004	-30.376806	119.88306
Hadar	HARC0005	-30.376944	119.88283
Hadar	HARC0003	-30.384583	119.89292
Hadar	HARC0002	-30.384194	119.89314
Hadar	HARC0001	-30.383972	119.89331
Mount Finnerty	MFRC036	-30.725111	120.18061
Mount Finnerty	MFRC038	-30.725861	120.18131
Mount Finnerty	MFRC039	-30.726833	120.18053
Mount Finnerty	MFRC044	-30.644556	120.12897
Mount Finnerty	MFRC045	-30.640647	120.12663
Mount Finnerty	MFRC050	-30.638886	120.12487
Mount Finnerty	MFRC057	-30.585483	120.08937
Mount Finnerty	MFRC058	-30.585419	120.08975
Mount Finnerty	MFRC059	-30.585367	120.0902
Mount Finnerty	MFRC060	-30.585822	120.08992
Mount Finnerty	MFRC061	-30.585722	120.09034
Mount Finnerty	MFRC062	-30.585597	120.09076
Mount Finnerty	MFRC063	-30.586481	120.09073
Mount Finnerty	MFRC064	-30.586436	120.09123
Mount Finnerty	MFRC065	-30.587575	120.09051
Mount Finnerty	MFRC066	-30.588039	120.08908
Mount Finnerty	MFRC067	-30.587347	120.08908
Mount Finnerty	MFRC069	-30.587347	120.09115
Mount Finnerty	MFRC073	-30.588981	120.09206
Mount Finnerty	MFRC075	-30.588814	120.09269
Mount Finnerty	MFRC078	-30.589678	120.09303
Vela	VE0004	-30.379461	119.69606
Vela	VE0007	-30.383144	119.69371
Vela	VE0013	-30.391161	119.69104
Vela	VE0015	-30.394056	119.68854

Deposit	Bore Code	Latitude	Longitude
Vela	VE0017	-30.396244	119.68865
Vela	VE0009	-30.385944	119.69425
Vela	VE0011	-30.388194	119.69128

Appendix 2. Troglifauna species recorded during the YIOP troglifauna surveys, which are only known from one bore

