Biota Environmental Sciences

Mesa A and Robe Valley Mesas Troglobitic Fauna Survey

Subterranean Fauna Assessment

Prepared for
Robe River Iron Associates

Prepared by
Biota Environmental Sciences Pty Ltd

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Mesa A and Robe Valley Troglofauna Survey

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1.0 Introduction

1.1 Mesa A Development Project Description

Robe River Iron Associates (Robe) currently produces pisolite ore from the Mesa J mine site, located approximately 15 km southwest of the town of Pannawonica in the Pilbara region of Western Australia (Figure 1.1). Current projections show that the Mesa J deposit will be mined to its maximum extent by the end of this decade. Production from the Mesa J mine site is predicted to begin to decline in 2007/2008 as the quality of the available ore at Mesa J decreases.

The Mesa A deposit (some 43 km west of Pannawonica, on the eastern side of the North West Coastal Highway) has been identified as the next key deposit for the development of the company's operations in the Robe Valley. The Warramboo deposit (northwest of Mesa A, on the western side of the North West Coastal Highway) has also been identified as a potential development area (see Figure 1.1).

1.2 Background to this Study

Sampling for subterranean fauna was first completed by Biota (2004) at Mesa A as part of exploration stage environmental surveys. This work was focussed on stygofauna; groundwater-inhabiting aquatic fauna (Humphreys 2000). No stygofauna were collected from the boreholes sampled, but an unexpected component of the subterranean biota was recovered from the plankton net hauls. Four troglobitic taxa (obligate, subterranean terrestrial fauna) were collected from two of the sampled bores.

The collection of troglobitic fauna from Mesa A during this initial study was recognised as an outcome of considerable significance. Troglobitic fauna had never before been documented from mesa formations on the mainland Pilbara region and had previously only been recorded in Western Australia from karstic limestone systems (at Cape Range, Barrow Island and in the Kimberley; Harvey 1988, Biota 2002, Humphreys 2001). The specimens from the 2003 survey were the first documented record of such a fauna occurring in a pisolitic mesa formation. Biota (2004) suggested that the humid, dark, fractured and vuggy environment indicated by drill logs from Mesa A were analogous to the habitats occupied by troglobites in karstic limestone formations.

Troglobitic fauna species have the potential to have restricted distributions. Short-range endemism (*sensu* Harvey 2002) is common in this fauna, with some species only known from single cave systems (e.g. the millipede *Stygiochiropus peculiaris* from Cameron's Cave at Cape Range; Humphreys and Shear 1993). In the arid zone, the troglobitic fauna is generally considered to be relictual rainforest litter fauna, having arisen from tropical fauna lineages that descended into subterranean environments during the aridification of Australia (during the late Miocene; Humphreys 1993). This is inferred primarily from affinities of the taxonomic groups represented amongst the troglofauna with other extant taxa.

Given the propensity for genetic differentiation in this fauna, it was realised that the potential existed for species to be spatially restricted by geological and geographical barriers. The clearest potential mechanism in this case was the isolated and patchy nature of the mesa formations along the length of the Robe River valley. With the degree and period of separation, and apparent lack of suitable intervening habitat, it was postulated that some of these taxa could be restricted to individual mesa formations (Biota 2004).

Investigating this hypothesis clearly represented an important environmental assessment issue in respect of proposed development of mining operations at Mesa A. To address this a more comprehensive sampling and research programme was recommended, targeting troglobitic fauna (Biota 2004).

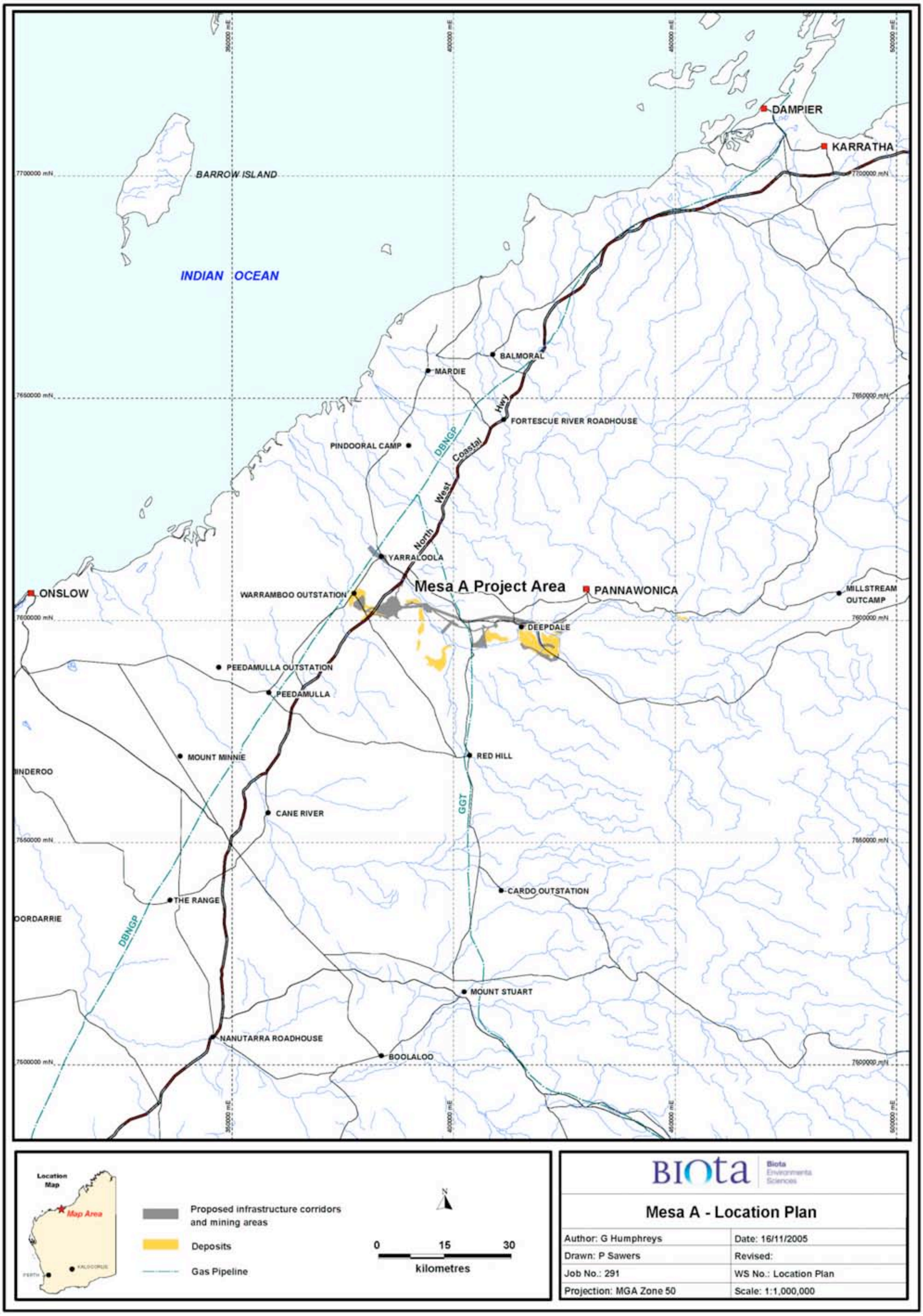

Figure 1.1: Locality map for the Mesa A project area.

1.3 Scope and Role of this Report

The proposal to develop an iron ore mine at Mesa A (and associated infrastructure) was referred to the Environmental Protection Authority (EPA) during early 2005 for a level of assessment to be set under the *Environmental Protection Act 1986*. The EPA determined that the proposal would be formally assessed at the level of Public Environmental Review (PER). An Environmental Scoping Document was subsequently prepared for the PER, including identification of troglobitic fauna as a relevant environmental assessment factor for the proposal.

This report documents the sampling design, implementation and outcomes to date of the troglofauna studies completed for the proposed development of mining operations at Mesa A. It has been prepared as a supporting technical document for the Mesa A proposal PER.

2.0 Methodology

2.1 Approach to Sampling Programme Design

The troglobitic fauna sampling programme was designed by reference to similar subterranean fauna programmes undertaken elsewhere (particularly Cape Range; Biota 2004).

The objectives of the troglofauna survey were to:

1. complete targeted sampling for troglofauna within the Mesa A project impact area;
2. complete contextual sampling within similar reference areas along the Robe valley (other mesa formations);
3. assess species level representation of troglofauna within the Mesa A impact area against the reference site collections and any other records;
4. complete impact assessment based on the outcomes of point 3. and analyse project impact mechanisms; and
5. collect baseline data to document this previously unknown component of Western Australia's subterranean fauna.

An intensive sampling effort was undertaken, focussing on Mesa A, but also including 10 other study areas (seven mesas, and three other areas with similar geology but without the mesa landform). The overall approach and methods used were consistent with the guidance provided in EPA Guidance Statement No. 54 (EPA 2005).

2.2 Study Team

Field subterranean fauna sampling was undertaken as three campaigns for the current study (see Section 2.4). The field surveys were all completed by Biota Environmental Sciences, with the field personnel comprising Mr Garth Humphreys, Mr Dan Kamien, Mr Michael Greenham and Mr Todd Williamson. Pilbara Iron staff provided information on bore locations and drill logs where available.

Sorting of recovered litter traps was completed by Mr Dan Kamien, Mr Lee Mould, Ms Leah Beesley, Ms Zoe Hamilton and Mr Garth Humphreys. Further identification of troglofauna specimens was conducted at the sorting stage by the sorting team and Dr Mark Harvey of the Western Australian Museum.

Species level identification of troglofauna specimens was primarily completed by Dr Mark Harvey and Ms Karen Edward (both of the Western Australian Museum). Dr David Walter, a specialist mite taxonomist, completed identifications of the Acarina collected during this study and Ms Penny Greenslade identified the Collembola. DNA analyses of schizomid and mite specimens were undertaken by Dr Oliver Berry, post-doctoral research fellow at the UWA School of Animal Biology. Doug Blandford (DC Blandford & Associates) provided advice on the geomorphic history of the Robe valley and its mesa landforms. Field maps and figures for this report were prepared by Mr Paul Sawers (Biota). Photos used were taken by Garth Humphreys and Karen Edward.

2.3 Sampling Techniques

Troglofauna were sampled by means of custom-built litter traps suspended within boreholes in each of the various study areas. Drill logs were reviewed, where available, to identify areas where fracture zones or cavities occurred in the profile. Traps were suspended within each hole sampled to align with these more prospective zones.

Traps were constructed from 60 mm internal diameter PVC stormwater pipe cut to a length of 120 mm. The external diameter of the completed trap was such that it fit closely against the interior of the sampled bore once installed, facilitating fauna entry into the trap. Both ends were sealed with 10 mm spacing aviary mesh after the tubing was filled with wet leaf litter.

Leaf litter material was gathered locally from the ground surface on the island, particularly from the bases of *Acacia* shrubs. The collected litter was soaked in water and irradiated in a microwave oven on maximum power setting (to kill any surface invertebrates present and assist in break-down). Litter was added to the traps wet and kept in sealed containers until immediately prior to insertion into the boreholes. After the installation of each trap, the opening of each borehole was sealed to maintain humidity and to minimise the input of surface fauna into the traps. Traps were left in the ground for approximately six weeks to allow sufficient time for troglofauna colonisation (see Section 2.4). Traps were then recovered and stored in labelled zip lock bags for return to Perth for sorting.

2.4 Survey Effort

Sampling for troglofauna was conducted over three main phases during this study. Details of survey timing specific to each of the 11 study areas are provided in Table 2.1. Troglofauna litter traps were left installed for a period of approximately six weeks after installation during each phase at each study site. Due to large rainfall events during phase 2 (and associated access issues), actual site installation dates varied for some of the less accessible mesas.

Table 2.1: Timing of survey phases and installed and recovery of traps in the various study areas.

	Site										
Date	Mesa A	Mesa B	Mesa C	Mesa F	Mesa G	Mesa H	Mesa J	Mesa K	Middle Robe	Warra-mboo	Todd Bore
Phase 1											
Installed	21/11/04	-	-	-	21/11/04	21/11/04	21/11/04	-	-	-	-
Recovered	20/1/05	-	-	-	20/1/05	20/1/05	20/1/05	-	-	-	-
Phase 2											
Installed	7/4/05	8/4/05	8/4/05	4/7/05	8/4/05	-	-	2/5/05	8/4/05	21/1/05	7/4/05
Recovered	25/5/05	26/5/05	26/5/05	28/7/05	26/5/05	-	-	28/7/05	26/5/05	20/3/05	26/5/05
Phase 3											
Installed	26/7/05	-	-	-	-	-	-	-	-	26/7/05	-
Recovered	8/9/05	-	-	-	-	-	-	-	-	8/9/05	-

An overview of the distribution of the boreholes sampled for troglofauna during the study is shown in Figure 2.1. Enlargements showing detailed distribution of individual bores within each mesa follow in Figure 2.2 to Figure 2.5. Other information on bore specifics for the sampling locations is provided in Appendix 1. An overall total of 186 bores was sampled for troglofauna during the survey, with 40% of these holes located on Mesa A (see Table 2.2).

Table 2.2: Summary of troglofauna sampling effort in the various study areas (number of boreholes).

	Phase			
Study Area	**1**	**2**	**3**	**Total**
Mesa A	11	14	49	74
Mesa B		11		11
Mesa C		4		4
Mesa F		13		13
Mesa G	6	11		17
Mesa H	6			6
Mesa J	2			2
Mesa K		12		12
Middle Robe		15		15
Todd Bore		3		3
Warramboo		5	24	29
Total:	**25**	**88**	**73**	**186**

The 186 bores were sampled with a total of 597 litter traps. The apportionment of these traps amongst the 11 study sites is summarised in Table 2.3, with details on the sampled bores provided in Appendix 1.

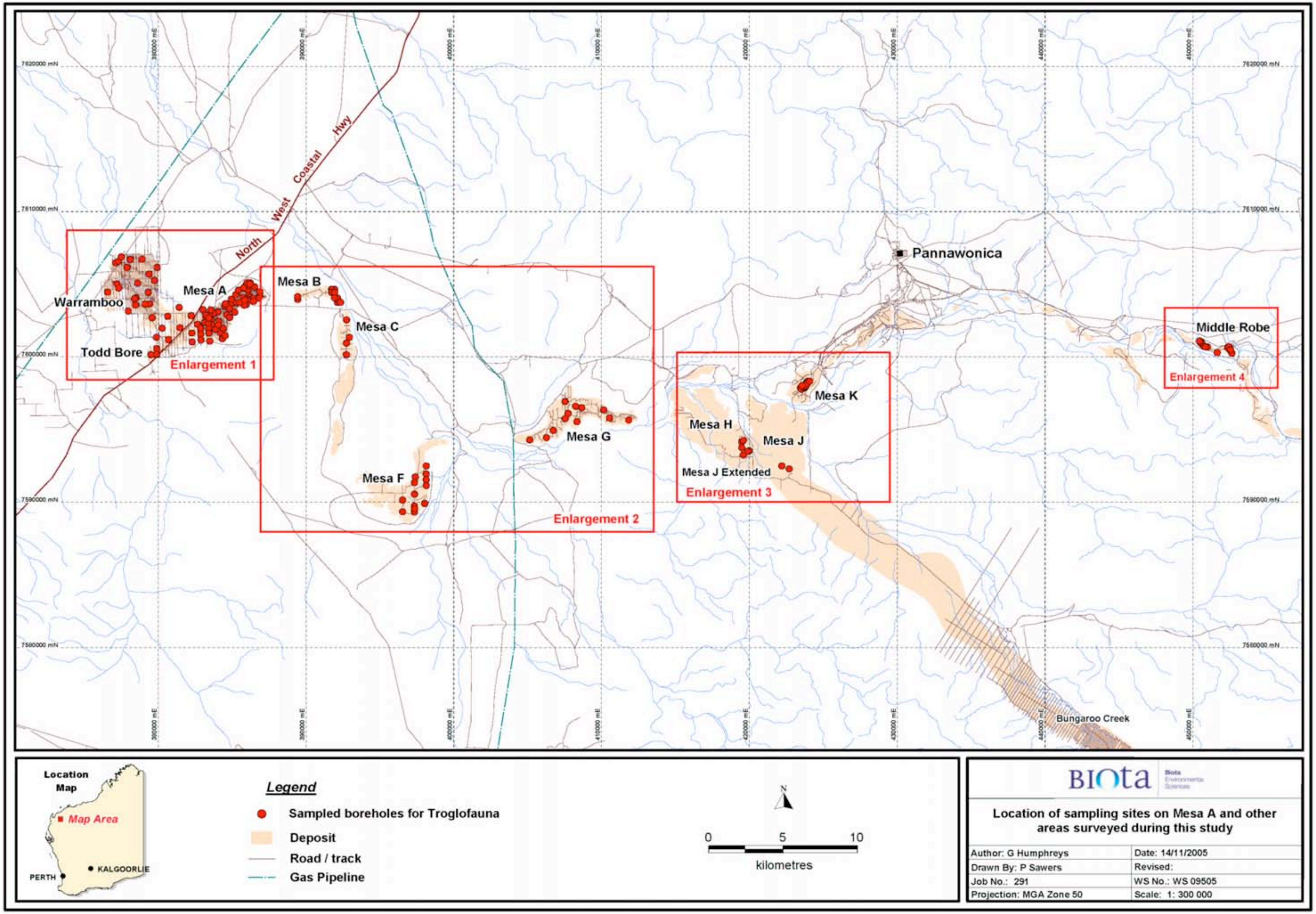

Figure 2.1: Overview of sampling sites on Mesa A and other areas surveyed during this study.

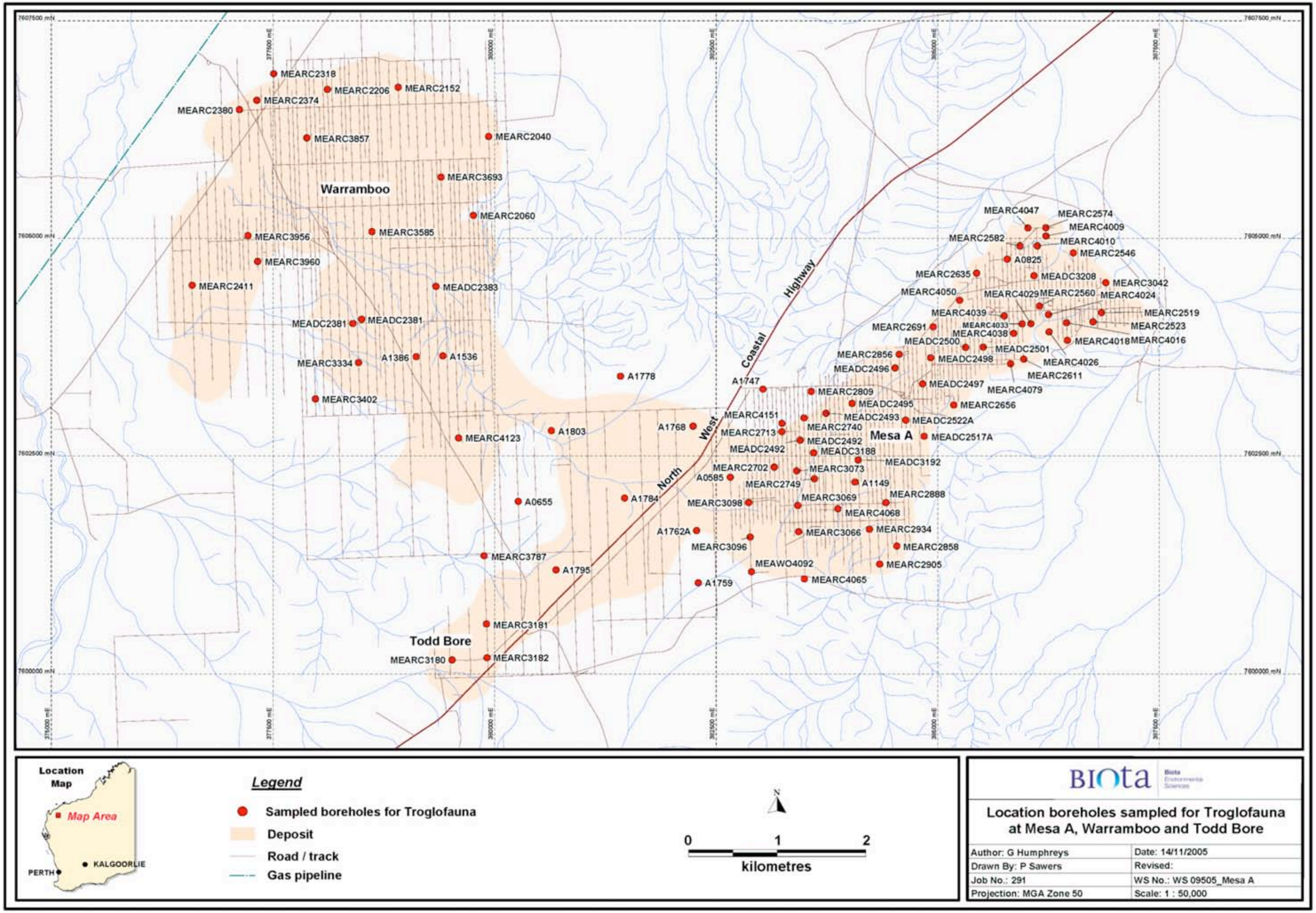

Figure 2.2: Detail of locations sampled for troglofauna at Mesa A, Warramboo and Todd Bore.

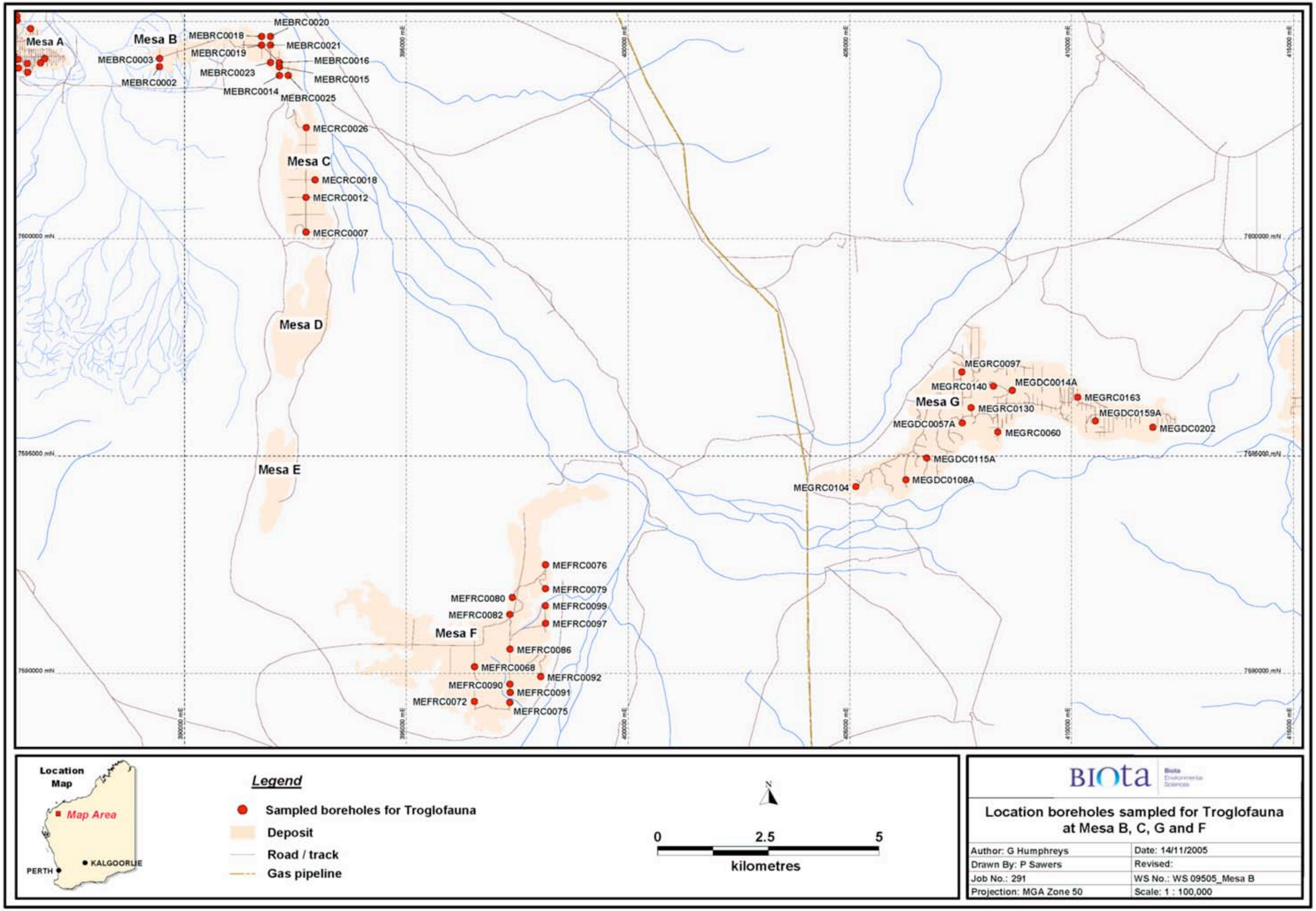

Figure 2.3: Detail of locations sampled for troglofauna at Mesa B, C, F and G.

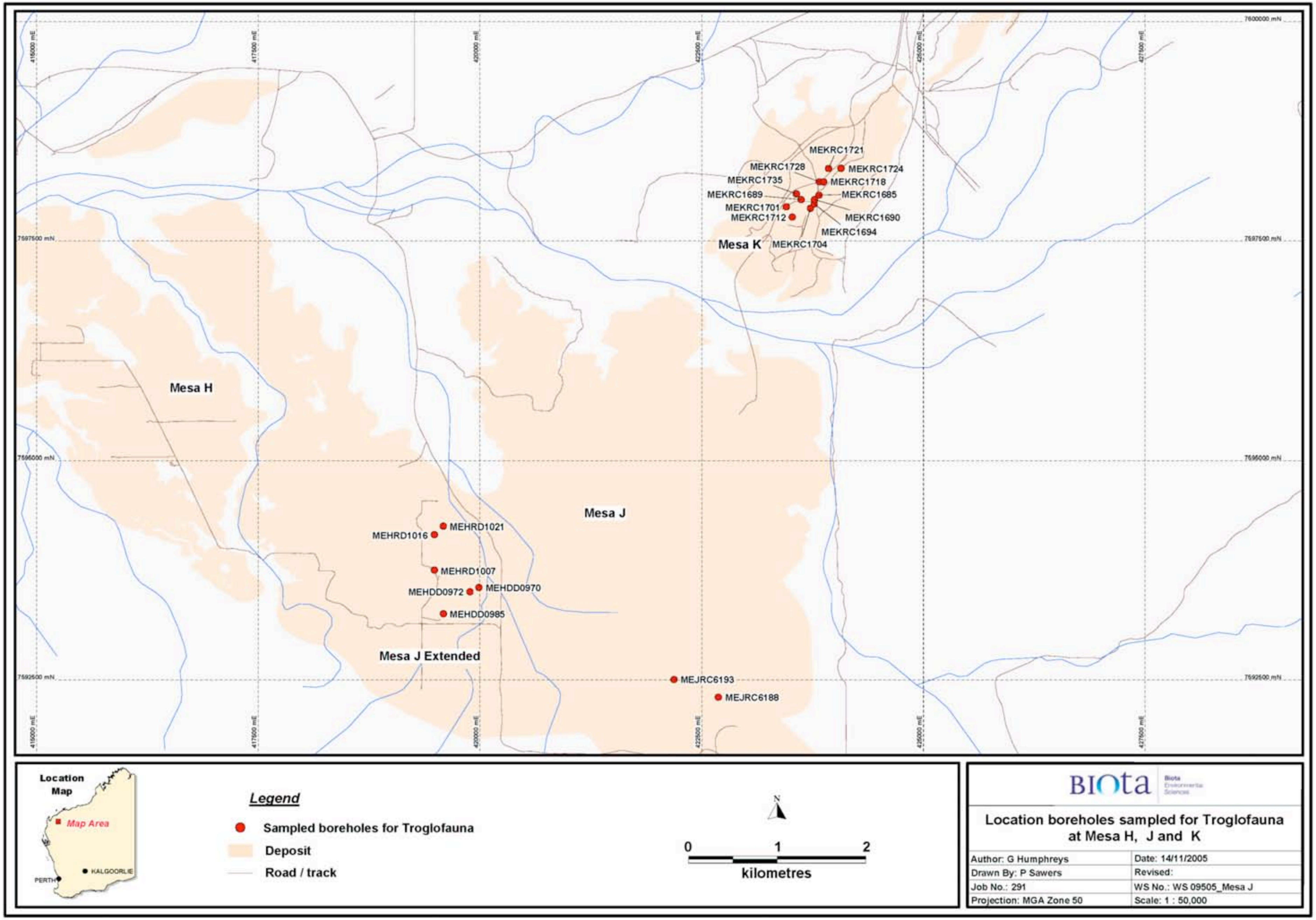

Figure 2.4: **Detail of locations sampled for troglofauna at Mesa H, J and K.**

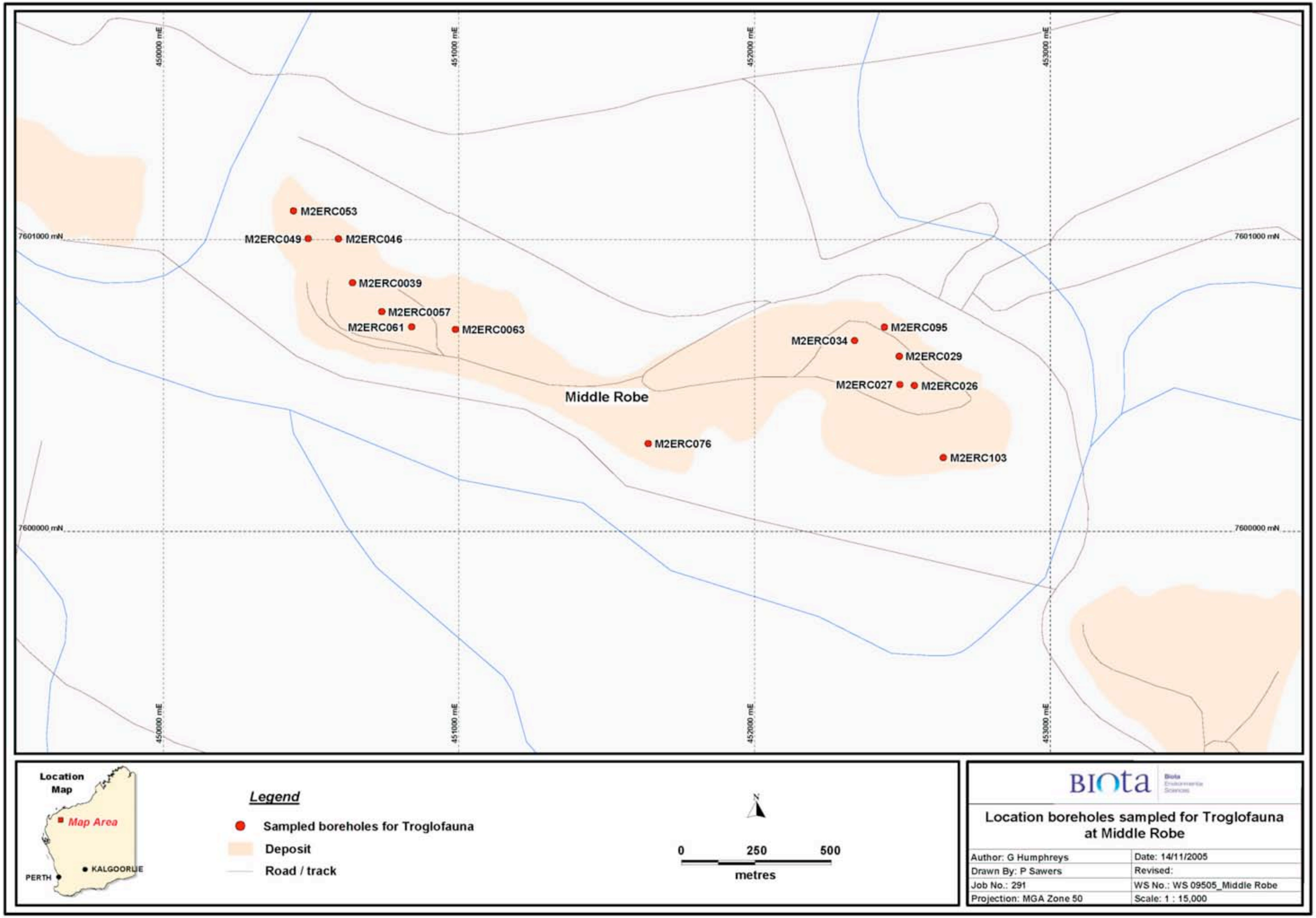

Figure 2.5: Detail of locations sampled for troglofauna at Middle Robe.

Table 2.3: Summary of troglofauna sampling effort in the various study areas (number of litter traps).

	Phase			
Project Area	**1**	**2**	**3**	**Total**
Mesa A	39	40	156	235
Mesa B		30		30
Mesa C		13		13
Mesa F		47		47
Mesa G	24	37		61
Mesa H	14			14
Mesa J	8			8
Mesa K		41		41
Middle Robe		57		57
Todd Bore		11		11
Warramboo		15	65	80
Total:	**85**	**291**	**221**	**597**

2.5 Specimen Sorting, Curation and Data Management

Troglofauna litter traps were sorted in a laboratory in Perth, with recovered specimens curated in 100% ethanol (with subsequent transfer to 70% where appropriate). Any specific curation requirements for the various taxonomic groups were confirmed in liaison with the WA Museum.

All specimens collected during the study were tracked with a specifically designed data management procedure, involving field data forms (for sampling collection details) and specimen curation forms (to track collection location, date, sample number and specimen numbers throughout the duration of the study). All collected specimens were lodged with the WA Museum once preliminary sorting, data entry and identifications were completed.

All spatial data utilised in this study uses GDA94 datum.

3.0 Subterranean Fauna Habitat

3.1 Description of the Project Study Areas

Mesa A is located close to the North-western Coastal Highway, some 140 km south-west of Karratha and ~50 km west of Pannawonica (see Figure 1.1). The location of Mesa A (and the various other mesas and study areas sampled) is shown in Figure 2.1. Representative photos of the mesas sampled are shown in Plate 3.1 to Plate 3.6.

The mesa study sites were flat-topped hills, typically rising 30-50 m in elevation above the adjoining valley floor. The surface of the mesas, which comprised a hard lateritised goethite cap up to 10 m in thickness, has eroded to produce a free face around the edge of the landform (Plate 3.2 and Plate 3.3). This bluff-like surface form is a characteristic feature of mesas in this area. The outer edge of the free-face is cavernous and displays strong jointing sets.

Plate 3.1: Mesa A (eastern boundary).

Plate 3.2: Mesa A (northern boundary).

Plate 3.3: Mesa B (northern boundary).

Plate 3.4: Mesa C (south-eastern boundary).

Plate 3.5: Mesa C (valley).

Plate 3.6: Mesa G (southern boundary).

The northern boundary of Mesa A (Plate 3.2) typifies the surface morphology of the Robe Valley mesas, where the free-face sits stratigraphically above a debris slope generally comprising a zone of rock-fall accumulation and a lower colluvial zone (see Plate 3.3). The base of the colluvial zone may contain a smaller alluvial zone before the slope grades into the adjacent plain. Some mesas contain a more complex surface morphology where the outer slope contains a number of free-faces separated by small debris slopes (e.g. Mesa C; Plate 3.6).

Stratigraphically, the mesa cap is typically underlain by layers of varying grade pisolite, which represent the iron ore resource of interest to the proposed mining operation (see Figure 3.1). Pisolitic ore comprises a combination of the iron minerals goethite and hematite. The majority of the pisolite is made up of spherical accretions of iron minerals called pisoliths (Ramanaidou et al. 2003, Robe 2005). These formations are also frequently vuggy, fractured and may contain small-scale caverns. The small interstices present in these strata are likely to be of sufficient size to accommodate troglofauna. Small gaps, holes and fractures were evident on the inside wall of many of the uncased drill holes sampled during this study. The pisolitic strata can be interspersed with layers of clay, silica and schists, before a basement of basal pisolite is reached overlaying the Ashburton Formation at valley floor level (Figure 3.1).

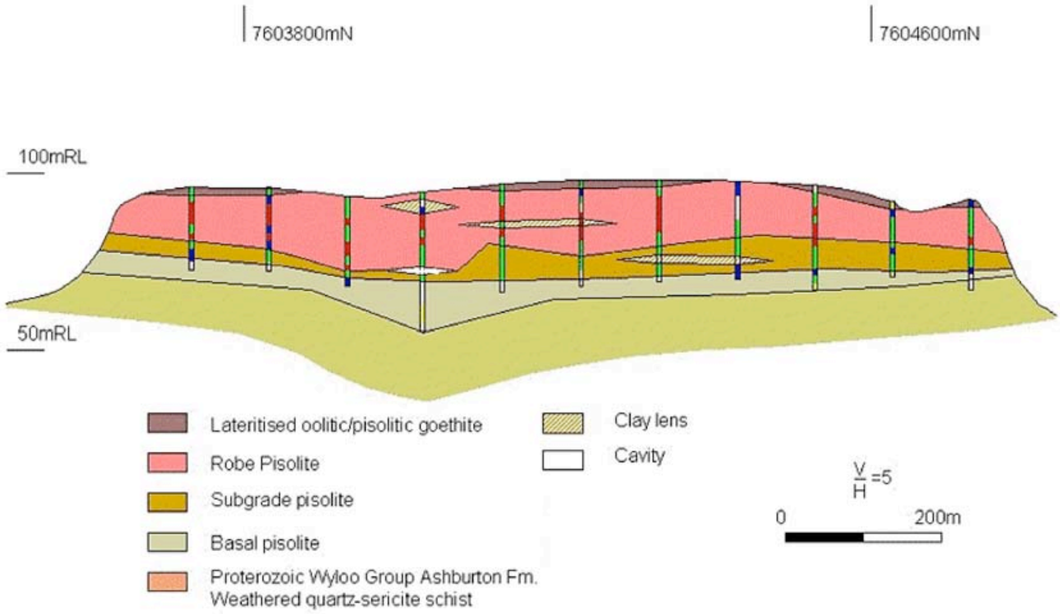

Figure 3.1: Schematic cross-section of the Robe valley mesas (modified from an original schematic sourced from Robe (2005)).

Nine of the study areas considered in this project were true mesa landforms. In the remaining three areas, Warramboo, Todd Bore and 'Mesa' H, the strata are not horizontal but dip below the floor of the valley to form low-angle cuestas or tilted plateaux. Mesa formations were not present in these areas. A summary of the landform type, current status and area of extent of each study area is provided in Table 3.1. Aerial photography views of the main mesa landform sites sampled during this study are shown in Plate 3.7 to Plate 3.11.

Table 3.1: Summary of landform type, status and area of extent of each study area.

Project Area	Landform	Status	Area (ha)
Mesa A	Mesa	Exploration area; proposed for mining	573
Mesa B	Mesa	Exploration area	173
Mesa C	Mesa	Exploration area	227
Mesa F	Mesa	Exploration area	935
Mesa G	Mesa	Exploration area	989
Mesa H	Undulating low hills	Exploration area	1,749
Mesa J	Mesa	Current mining area	1,429
Mesa K	Mesa	Historical mining area	306
Middle Robe	Mesa	Historical mining area	89
Todd Bore	Undulating low hills	Exploration area	-
Warramboo	Undulating low hills	Exploration area; proposed for mining	1,979

Plate 3.7: **Aerial photograph of Mesa A.**

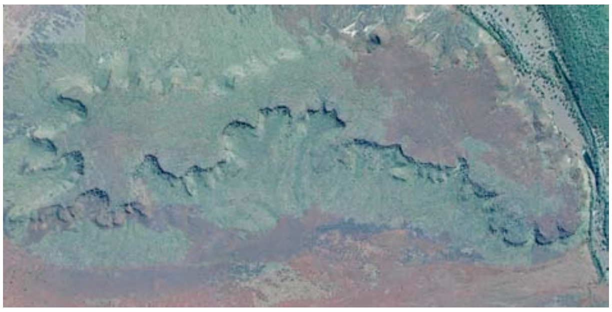

Plate 3.8: **Aerial photograph of Mesa B.**

Plate 3.9: **Aerial photograph of Mesa C.**

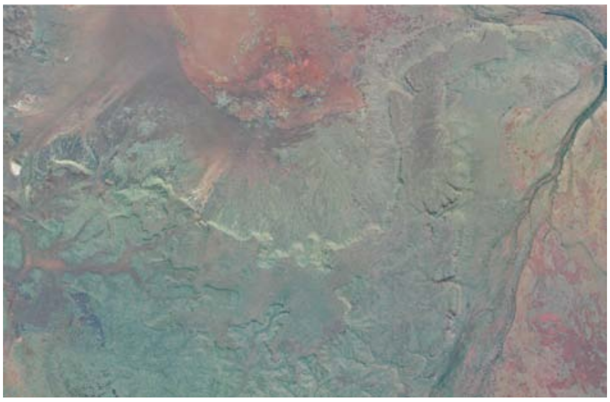

Plate 3.10: **Aerial photograph of Mesa F.**

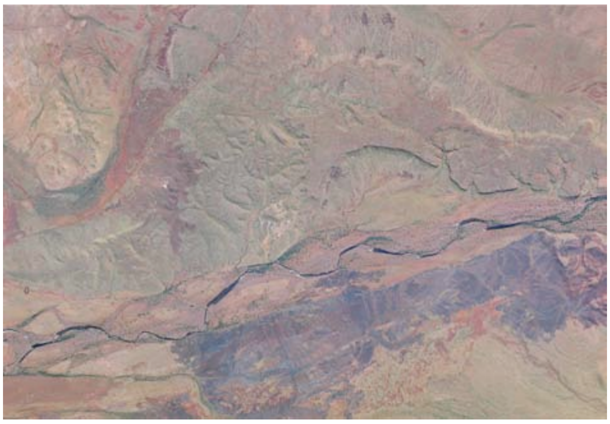

Plate 3.11: **Aerial photograph of Mesa G.**

3.2 Geohistory of the Study Area

The mesas of the Robe River area are remnants of old valley infill deposits of the palaeo Robe River. These deposits, which were laid down in an ancient valley (and possibly lacustrine landscape), had their source area in the surrounding Proterozoic highlands of the ancient Pilbara landscape. The conceptual sequence of geological change that led to the formation of the current mesas in shown in Figure 3.2.

The palaeo Robe River cut down into the older conglomerates of the late Cretaceous age (~100 million years Before Present (BP)) and by about 40 million years BP, the palaeo valley was filled with clays, silts and pebbles. The nature of the contemporary valley sediments suggests that the catchment areas and the more immediate slopes were well forested, as a greater particle size range would be expected if erosion was not prevented by forests.

This period of the Cainozoic was well known for its rather extreme climatic conditions and during this period the iron was precipitated that formed the iron ore deposits that are now being mined. This period was then followed by rejuvenation of the drainage system, which started to erode the old valley and its now iron-impregnated sediments. This erosion would have been a slow process as the material would have been quite resistant to erosion.

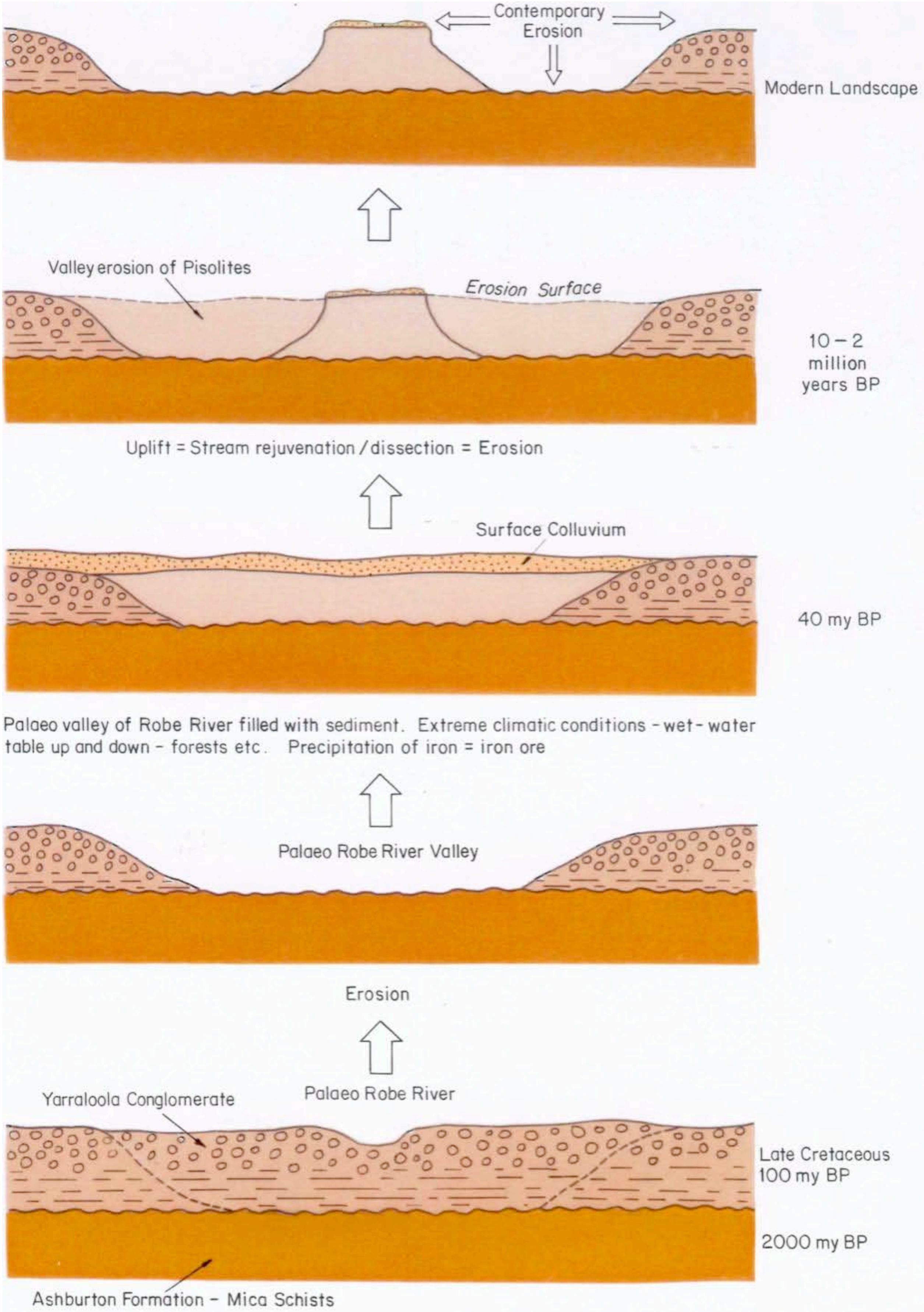

Figure 3.2: **Conceptual geohistory of mesa form development along the Robe valley** (not to scale, sources: various (see Section 6.0); figure prepared by DC Blandford).

More significant erosion of the valley deposits was occurring about 10 million years ago and between then and about 2 million years BP, gentle uplift occurred, resulting in further rejuvenation of the drainage system. These processes have continued to the present time.

Based on the available evidence, it appears that the dissection process that formed and separated the mesas started some ~10 million years ago and is still continuing (but at a reduced rate due to the onset of aridity).

3.3 Groundwater Regime

Water occurs in the bottom of the deeper bores in Mesa A and the presence of water at this depth is most likely associated with spatially discrete clay zones of reduced permeability within the overall mesa stratigraphy. Groundwater recharge within the mesa is almost certainly dominated by rainfall events where the highly fractured and jointed goethitic cap provides a zone of enhanced infiltration to the underlying strata. The potential for water mounding through the base of the Mesa and contributory recharge via flooding of the adjacent valley floor have not been confirmed at this stage.

Once water accumulates on the surface and infiltrates towards the lower strata, the depth of penetration and flow-paths will be dependent on a range of sub-surface conditions and processes. Well-developed joint sets and fracture zones will provide primary pathways for water movement. Detention and storage will occur at depth when the water is allowed to seep into vugs and small cavities below the depth of evaporation influence.

The presence of zones of decreased permeability, resulting from materials with elevated clay contents, will contribute to sub-surface water movement. These zones will act as zones of storage and may also prevent or reduce further vertical water movement into underlying strata.

The primary troglobitic fauna habitat within mesas is the humidified pisolitic strata. Accordingly, the maintenance of a humid microclimate within the mesas will be central to the suitability of this environment for troglofauna

4.0 Results

4.1 Overview

The troglofauna surveys yielded a total of 3,892 invertebrate specimens, representing 23 orders (see Table 4.1). A summarised order level break-down of specimens collected by borehole locations in Mesa A and on other study areas in the Robe valley is provided in Table 4.1.

Table 4.1: Overview of combined troglofauna sampling results from three phases of sampling at Mesa A and other study sites in the Robe valley (groups containing troglobitic specimens shown in bold; systematic hierarchy after Harvey and Yen (1997)).

Taxon					
Phylum	**Class**	**Order (and Common Name)**	**Total Individuals**	**No. of Bores on Mesa A**	**No. of Bores at other sites**
Annelida	Oligochaeta	Haplotaxida (Earthworms)	472	35	22
Nematoda		(Nematodes)	132	1	-
Chelicerata	Arachnida	**Schizomida (Schizomids)**	**115**	**19**	**24**
		Pseudoscorpionida (Pseudoscorpions)	**11**	**2**	**6**
		Opilionida (Harvestmen)	3	-	3
		Acarina (Mites)	1,759	59	61
		Aranae (Spiders)	**28**	**2**	**2**
		Scorpionida (Scorpions)	1	1	-
Crustacea	Malacostraca	Isopoda (Slaters)	43	3	4
Uniramia	Chilopoda	**Scolopendrida (Centipedes)**	**9**	**5**	**2**
		Scutigerida (House centipedes)	15	3	4
	Diplopoda	**Polydesmida (Millipedes)**	**6**	**1**	**1**
		Polyxenida (Pincushion millipedes)	6	2	1
	Collembola	Collembola (Springtails)	711	43	44
	Diplura	**Diplura (Diplurans)**	**10**	**6**	**4**
	Insecta	**Thysanura (Silverfish)**	**11**	**6**	**4**
		Blattodea (Cockroaches)	**7**	**-**	**4**
		Isoptera (Termites)	100	8	5
		Embioptera (Web-spinners)	1	-	1
		Hemiptera (Bugs)	8	-	4
		Coleoptera (Beetles)	57	2	6
		Diptera (Flies)	263	13	20
		Hymenoptera (Ants, Bees, Wasps)	2	1	1
		Undetermined (larval/damaged)	122	2	2
		Total individuals:	**3,892**		

Eight of the 23 orders represented contained specimens which were troglobitic (see Table 4.1). These troglobitic groups (Schizomida, Pseudoscorpionida, Araneae, Scolopendrida, Polydesmida, Diplura, Thysanura and Blattodea), are also representative of the key orders in the subterranean fauna of Barrow Island and Cape Range (Biota 2002, Humphreys 2001). These groups are discussed in more detail in Section 4.2. An overview of the distribution of the troglofauna collected during this study is shown in Figure 4.1.

Specimens from several other taxonomic groups were also subject to more detailed identification and analysis on the basis that they:

- include troglobitic taxa in other locations (Opilionida, Hymenoptera, Hemiptera); and/or
- their edaphobitic (deep soil and litter) ecology and distribution could also lead to the potential for short-range distributions (Acarina, Collembola) (see Section 4.3).

This report gives no further consideration to the remainder of the specimens collected as most clearly represented epigean (surface) forms and are at low risk of species-level spatial restriction. This includes all collected representatives of the Oligochaeta, Scorpionida, Scutigerida, Polyxenida, Isoptera, Embioptera, Coleoptera and Diptera.

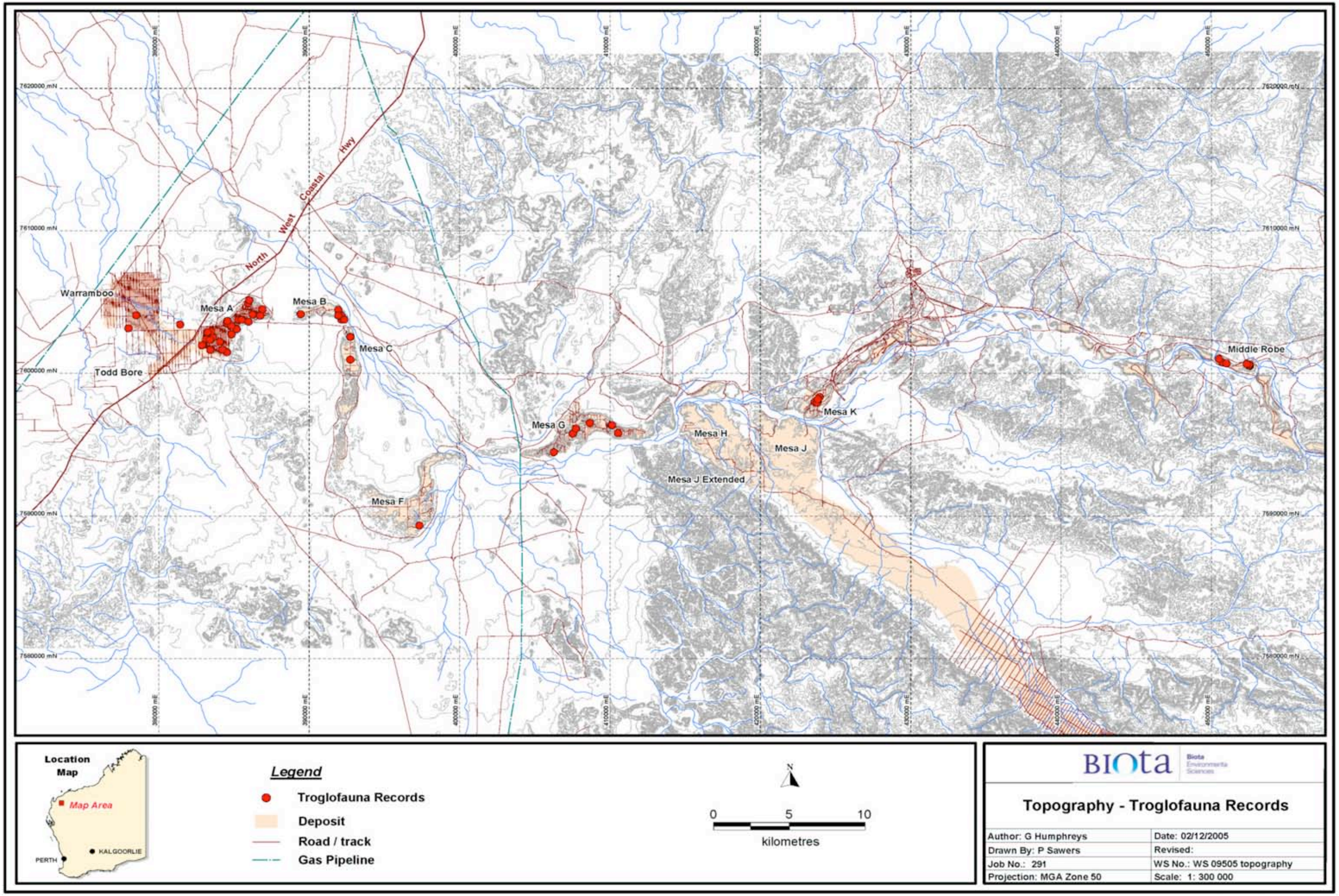

Figure 4.1: Overview of troglofauna records from Mesa A and other study areas along the Robe Valley.

4.2 Account of the Troglobitic Fauna

A summary of the troglofauna identifications completed as part of this study is provided for higher order taxonomic groups in the following annotated list. As noted in Section 4.1, only taxonomic groups that contained troglobitic specimens have been considered here.

ORDER SCHIZOMIDA (Schizomids)

Schizomids are fast moving, predatory arachnids that mostly live in tropical climates (Harvey 2000). They superficially resemble spiders but have a tail-like structure at the end of the abdomen (the flagellum) and long, sensory front legs (Harvey and Yen 1997; Plate 4.1 to Plate 4.3). There are currently 48 species of schizomids described from Australia, all of which belong to a single family; the Hubbardiidae (Harvey 1992, 2001). The Western Australian fauna contains eight described species, all of which occur in subterranean habitats in the north west of the State (Cape Range, Barrow Island and the Kimberley; Harvey 1988, 1992, 2001).

A single schizomid specimen was the first troglobitic animal collected from Mesa A during sampling for stygofauna in 2003 (see Section 1.2), signalling that terrestrial subterranean fauna exists within the mesa.

A total of 115 schizomid specimens was collected during the three phases of troglofauna sampling carried out in this study (see Table 4.2). All specimens collected were identified as belonging to the genus *Draculoides* (Schizomida : Hubbardiidae). This schizomid genus is also represented in subterranean habitats on Cape Range and Barrow Island (Harvey 2001, Biota 2005). Of the true troglobitic fauna, the schizomids were the numerically dominant group, accounting for 58% of the troglobitic specimens recorded (see Table 4.1). This may be attributable to their high mobility as active predators (Harvey and Yen 1997).

Table 4.2: Schizomids recorded from Mesa A and other sites during this study (n = number of individuals; see Figure 4.5 for locations; * DNA sequence data suggest a divergent lineage within mesa).

Site	Bore	Family	Species	n	
Mesa A	A1149	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEADC2492	Hubbardiidae	*Draculoides* sp. 'Mesa A'	2	
Mesa A	MEADC2497	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEADC2500	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEADC2501	Hubbardiidae	*Draculoides* sp. 'Mesa A'	8	
Mesa A	MEADC2517A	Hubbardiidae	*Draculoides* sp. 'Mesa A'	4	
Mesa A	MEADC2582	Hubbardiidae	*Draculoides* sp. 'Mesa A'	3	
Mesa A	MEADC3188	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC2497	Hubbardiidae	*Draculoides* sp. 'Mesa A'	2	
Mesa A	MEARC2582	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC2611	Hubbardiidae	*Draculoides* sp. 'Mesa A'	5	
Mesa A	MEARC2702	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC2858	Hubbardiidae	*Draculoides* sp. 'Mesa A'	2	
Mesa A	MEARC2934	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC3066	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC3073	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC4151	Hubbardiidae	*Draculoides* sp. 'Mesa A'	1	
Mesa A	MEARC3042	Hubbardiidae	*Draculoides* sp. 'Mesa A'	3	**39**
Mesa B	MEBRC0014	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	1	
Mesa B	MEBRC0015	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	2	
Mesa B	MEBRC0016	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	15	
Mesa B	MEBRC0021	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	4	
Mesa B	MEBRC0023	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	1	
Mesa B	MEBRC0025	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	1	
Mesa C	MECRC0012	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	3	
Mesa C	MECRC0026	Hubbardiidae	*Draculoides* sp. 'Mesa B/C'	2	**29**
Mesa G	MEGDC0014A	Hubbardiidae	*Draculoides* sp. 'Mesa G' *	3	
Mesa G	MEGDC0159A	Hubbardiidae	*Draculoides* sp. 'Mesa G' *	10	
Mesa G	MEGDC0057A	Hubbardiidae	*Draculoides* sp. 'Mesa G'	2	
Mesa G	MEGRC0130	Hubbardiidae	*Draculoides* sp. 'Mesa G'	5	
Mesa G	MEGRC0163	Hubbardiidae	*Draculoides* sp. 'Mesa G'	2	**22**
Mesa K	MEKRC1685	Hubbardiidae	*Draculoides* sp. 'Mesa K'	4	
Mesa K	MEKRC1689	Hubbardiidae	*Draculoides* sp. 'Mesa K'	1	
Mesa K	MEKRC1694	Hubbardiidae	*Draculoides* sp. 'Mesa K'	4	
Mesa K	MEKRC1721	Hubbardiidae	*Draculoides* sp. 'Mesa K'	2	
Mesa K	MEKRC1728	Hubbardiidae	*Draculoides* sp. 'Mesa K'	1	**12**

Site	Bore	Family	Species	n	
Middle Robe	M2ERC0063	Hubbardiidae	*Draculoides* sp. 'Middle Robe'	2	
Middle Robe	M2ERC026	Hubbardiidae	*Draculoides* sp. 'Middle Robe'	1	
Middle Robe	M2ERC027	Hubbardiidae	*Draculoides* sp. 'Middle Robe'	3	
Middle Robe	M2ERC029	Hubbardiidae	*Draculoides* sp. 'Middle Robe'	1	
Middle Robe	M2ERC034	Hubbardiidae	*Draculoides* sp. 'Middle Robe'	2	**9**
Warramboo	MEARC2381	Hubbardiidae	*Draculoides* sp. 'Warramboo'	4	**4**

The greatest numbers of schizomids were collected from Mesas A, B and G (see Table 4.2). This is partially a function of relative sample effort amongst the survey sites (see Sections 4.4 and 2.4).

The Schizomida was the most thoroughly studied of the troglobitic orders collected during this study. Both detailed morphological and genetic studies were completed on the *Draculoides* specimens from the various study areas (see Section 2.0; Berry (2005)). This work resulted in the identification of six as yet undescribed species from amongst the *Draculoides* specimens collected from the Robe valley (see Table 4.2). The current understanding of the distribution of these schizomid species is shown in Figure 4.5. Examples of the new *Draculoides* species are shown in Plate 4.1 to Plate 4.3, with illustrations of the male and female flagella (a key diagnostic feature) shown in Figure 4.2 to Figure 4.4. The male flagellum is central to mating behaviour in schizomids (Harvey and Yen 1997) and consistent differences in structure and spine configuration have been used to delineate species in previous studies (Harvey 1988, 1990, 1992).

Plate 4.1: *Draculoides* sp. 'Mesa A' (female).

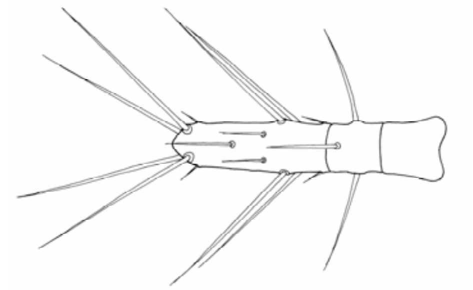

Figure 4.2: Dorsal detail of flagellum of female *Draculoides* sp. 'Mesa A' (drawn: K. Edward).

Plate 4.2: *Draculoides* sp. 'Mesa B/C' (male).

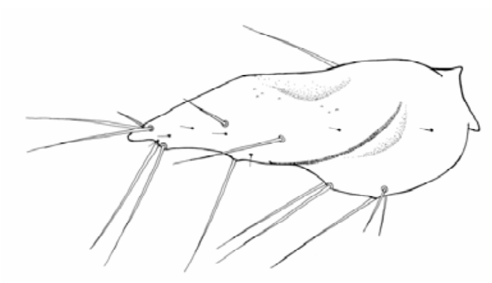

Figure 4.3: Lateral detail of flagellum of male *Draculoides* sp. 'Mesa B/C' (drawn: K. Edward).

Plate 4.3: *Draculoides* sp. 'Mesa K' (male).

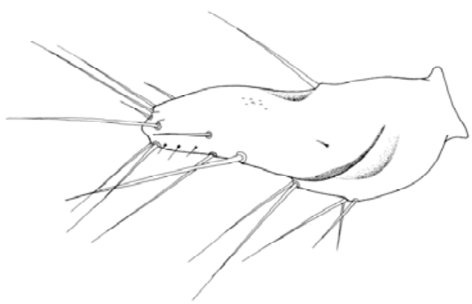

Figure 4.4: Lateral detail of flagellum of male *Draculoides* sp. 'Mesa K' (drawn: K. Edward).

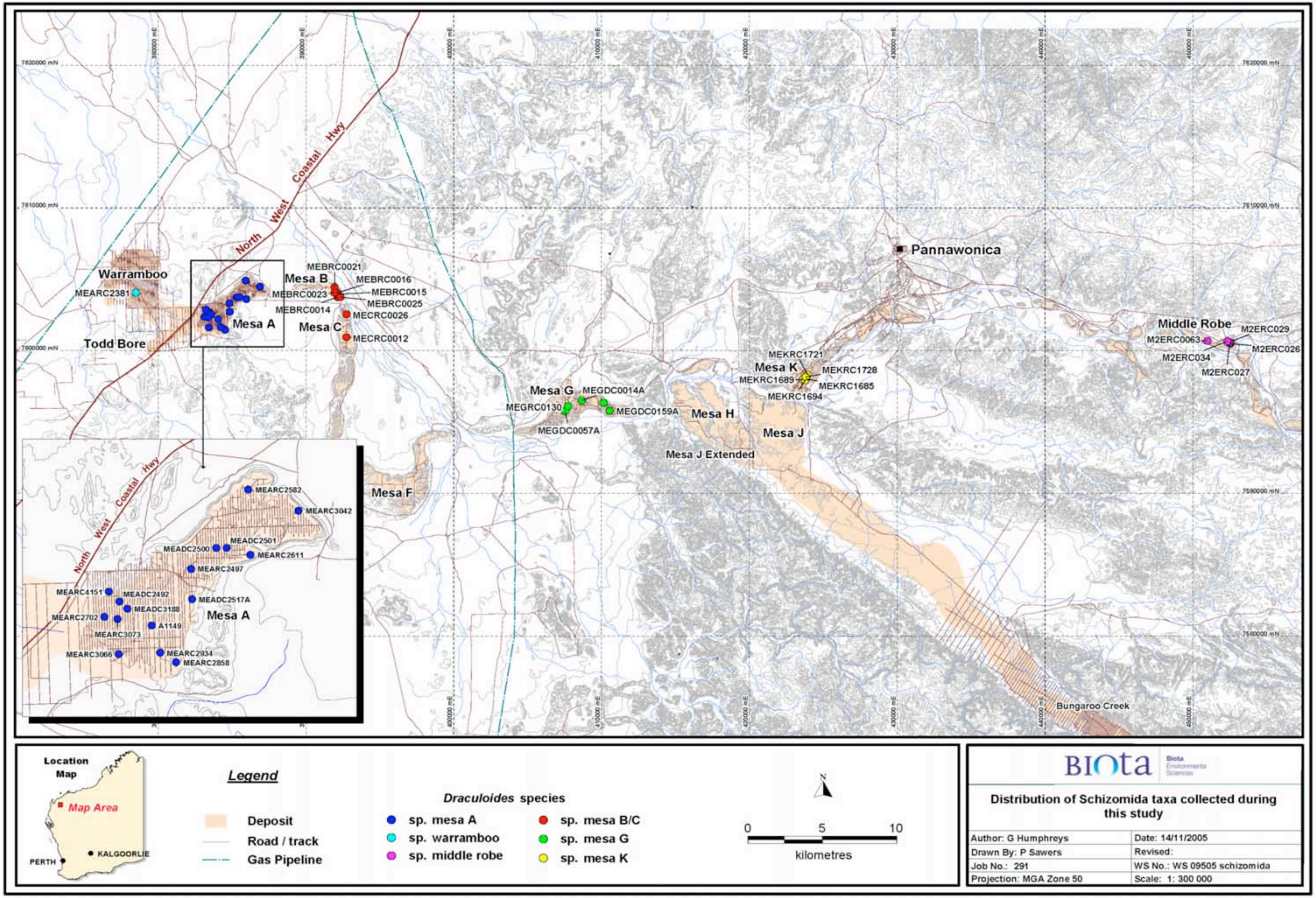

Figure 4.5: **Distribution of the six species of *Draculoides* recorded from Mesa A and other mesas of the Robe Valley.**

DNA sequencing was completed on 59 individual schizomids by Berry (2005), including representatives from all of the study areas where schizomids occurred (Figure 4.5). Two genes were sequenced from these specimens: CO1 (692 base pairs) and 12s (402 base pairs). The analyses also included 13 *Draculoides bramstokeri* specimens from Barrow Island, four *D. julianneae* and seven *D. vinei* (from Cape Range), to provide an assessment of the level of genetic divergence between these described species. Two surface-dwelling outgroup schizomid species from Queensland were also included in the analysis.

A total of 56 unique mitochondrial DNA sequences (haplotypes) were recovered, including 34 from the Robe valley study areas. No DNA sequences were shared between schizomids from the Robe River catchment and either Cape Range or Barrow Island (Berry 2005). The DNA sequences from the Robe valley were highly genetically divergent from those from both Cape Range and Barrow Island, with uncorrected percentage genetic differences of ~14% and corrected differences of ~30% (Berry 2005).

No DNA sequences were shared between schizomids from different mesas. Schizomids from each mesa typically had highly divergent sequences from those occurring on other mesas (uncorrected differences generally > 9% and corrected distances generally >12 %; Berry 2005). There were two notable exceptions to this pattern. First, there was very little genetic divergence between schizomids collected from Mesa B and Mesa C (0.7%), indicating that the same species of *Draculoides* occurred in both mesas. Second, there was a very high level of divergence between schizomids from Mesas A, B, C, G, K and Warramboo, and those from the Middle Robe (>15% uncorrected, > 35% corrected; Berry (2005)). The possible implications of these patterns are discussed further in Section 4.4.

In most cases little genetic diversity was detected within the schizomids from each mesa: uncorrected percent genetic divergence between haplotypes was on average 1.2% within mesas (Berry 2005). Some genetic structuring was evident within Mesas A and G, with individuals representing two different lineages occurring within each mesa (see Figure 4.5). The levels of divergence within Mesa A (4.9% corrected) and Mesa G (4.5%) are, however, somewhat lower than the typical species level divisions within this group (ranging from 7.2% to 35% corrected divergence; Berry 2005). This is suggestive of an ongoing process of genetic divergence within each mesa (possibly as a result of population separations brought about by local geomorphic change within the mesa (see Section 5.1)), rather than sympatric species.

The results of the DNA study demonstrated that genetically isolated populations of *Draculoides* occur in almost all of the separate mesaform study areas (Berry 2005). The exception was the adjacent Mesas B and C, which had the same *Draculoides* species (see Section 4.4.2). The levels of genetic divergence between the populations, and the generally low genetic variation within the population sampled on each mesa, indicate that a different schizomid taxon occurs within each of the isolated mesas. Detailed morphological examination of the schizomid material was also conducted to provide a complementary assessment of morphological variation within and between mesas. Where material permitted, genitalia from mature specimens from each study area were examined slide-mounted and described consistent with the approach of Harvey (1992, 2001). Many of the collected specimens were juvenile, but reliable differences in flagellum structure and spine configuration were found between adults where available from the different mesas. This character variation was of a similar order to that previously used to separate schizomid species in earlier taxonomic studies (Harvey 1992, 2001).

There was therefore a high degree of concordance between the genetic analyses and the morphology-based taxonomy. This consistency of key morphological characters, combined with the high levels of sequence divergence between study areas, showed that each isolated mesa contains a thus far unique species of *Draculoides*. This effectively supports the hypothesis arising from the earlier work of Biota (2004), at least for the schizomid fauna (see Sections 1.2 and 5.2). A comparison showing the phylogenetic tree arising from the DNA analyses with flagellum morphology in the schizomid species defined by this study is provided in Figure 4.6.

As a result of the combined genetic and morphological investigations, six new putative species of *Draculoides* have now been identified. These are *Draculoides* sp. 'Mesa A', *Draculoides* sp. 'Mesa B/C', *Draculoides* sp. 'Mesa G', *Draculoides* sp. 'Mesa K', *Draculoides* sp. 'Middle Robe' and *Draculoides* sp. 'Warramboo' (see Table 4.2 and Figure 4.5). Note that the status of *D*. sp. 'Warramboo' should still be viewed as provisional, given the single location and small number of specimens. Some genetic structuring was also evident within Mesas A and G but mature specimens will be needed to place this into better taxonomic context.

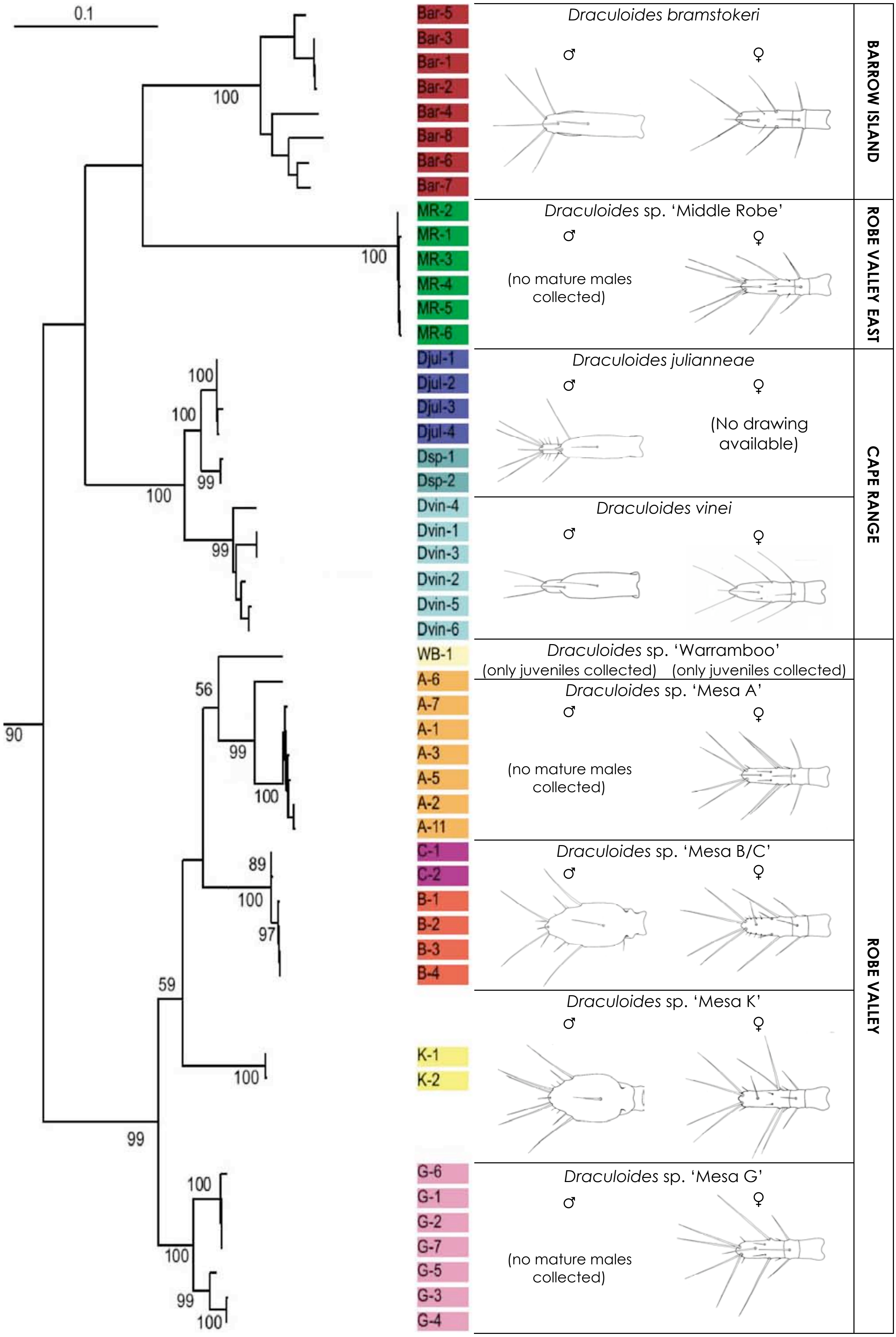

Figure 4.6: Comparison of *Draculoides* DNA phylogenetic tree with key morphological characters (tree modified from Berry (2005); numbers = bootstrap values; flagellum drawings by K. Edward and M. Harvey).

ORDER PSEUDOSCORPIONIDA (Pseudoscorpions)

Pseudoscorpions are small arachnids that superficially resemble scorpions, but lack the stinging tail. Ten pseudoscorpion specimens were collected during the study, all from the western end of the Robe valley. Two were collected from Mesa A and the remainder from Mesa B and Warramboo (see Table 4.3; Figure 4.7). Almost all of the pseudoscorpions collected were troglobitic, with one of the 11 specimens from Warramboo being a surface form (family Olpiidae; Appendix 2).

Table 4.3: Troglobitic pseudoscorpions recorded from Mesa A and other sites during this study (n = number of individuals; see Figure 4.7 for bore locations).

Site	Bore	Family	Species	n
Mesa A	MEARC4047	Chthoniidae	*Tyrannochthonius* sp. nov.	1
Mesa A	MEARC2856	Syarinidae	*Ideoblothrus* sp. nov.	1
Mesa B	MEBRC0003	Chthoniidae	*Tyrannochthonius* sp. nov.	1
Mesa B	MEBRC0015	Syarinidae	*Ideoblothrus* sp. nov.	1
Mesa B	MEBRC0016	Syarinidae	*Ideoblothrus* sp. nov.	1
Mesa B	MEBRC0021	Syarinidae	*Ideoblothrus* sp. nov.	4
Warramboo	MEADC2380	Chthoniidae	*Tyrannochthonius* sp. nov.	1

Two families were represented amongst the troglobitic Pseudoscorpionida; the Chthoniidae and the Syarinidae, both of which have troglobitic representatives on Cape Range. Each family was represented by a single genus; *Tyrannochthonius* (Chthoniidae) and *Ideoblothrus* (Syarinidae; Plate 4.4). None of the pseudoscorpions correspond to existing described members of these genera.

Plate 4.4: The troglobitic pseudoscorpion *Ideoblothrus* sp. nov.

With the available material, it was not possible to determine if the *Ideoblothrus* sp. nov. recorded from Mesa B and the specimen from Mesa A were the same taxon (the latter animal was a nymph and adults are required). The situation was unfortunately similar with the *Tyrannochthonius* sp. nov., which was recorded from Mesa A, B and Warramboo (Table 4.3). A male was collected from Mesa A, a female from B and a nymph from Warramboo; preventing any direct comparisons to determine if they represented the same undescribed species.

ORDER ARANEAE (Spiders)

Twenty-eight spiders were collected from four locations during the sampling (two on Mesa A and two elsewhere; Table 4.1). With a single exception, these were all surface animals (family Miturgidae (*Miturga* sp.) and Pholcidae (*Trichocyclus* sp.); Appendix 2), collected as accidentals.

One specimen collected from Mesa G, however, was clearly troglobitic (see Plate 4.5). This previously undescribed member of the genus *Opopaea* has been given the manuscript name 'ectognophus' ('out of darkness') and was collected from bore MEGRC01030. No troglobitic spiders were collected from Mesa A during the work to date.

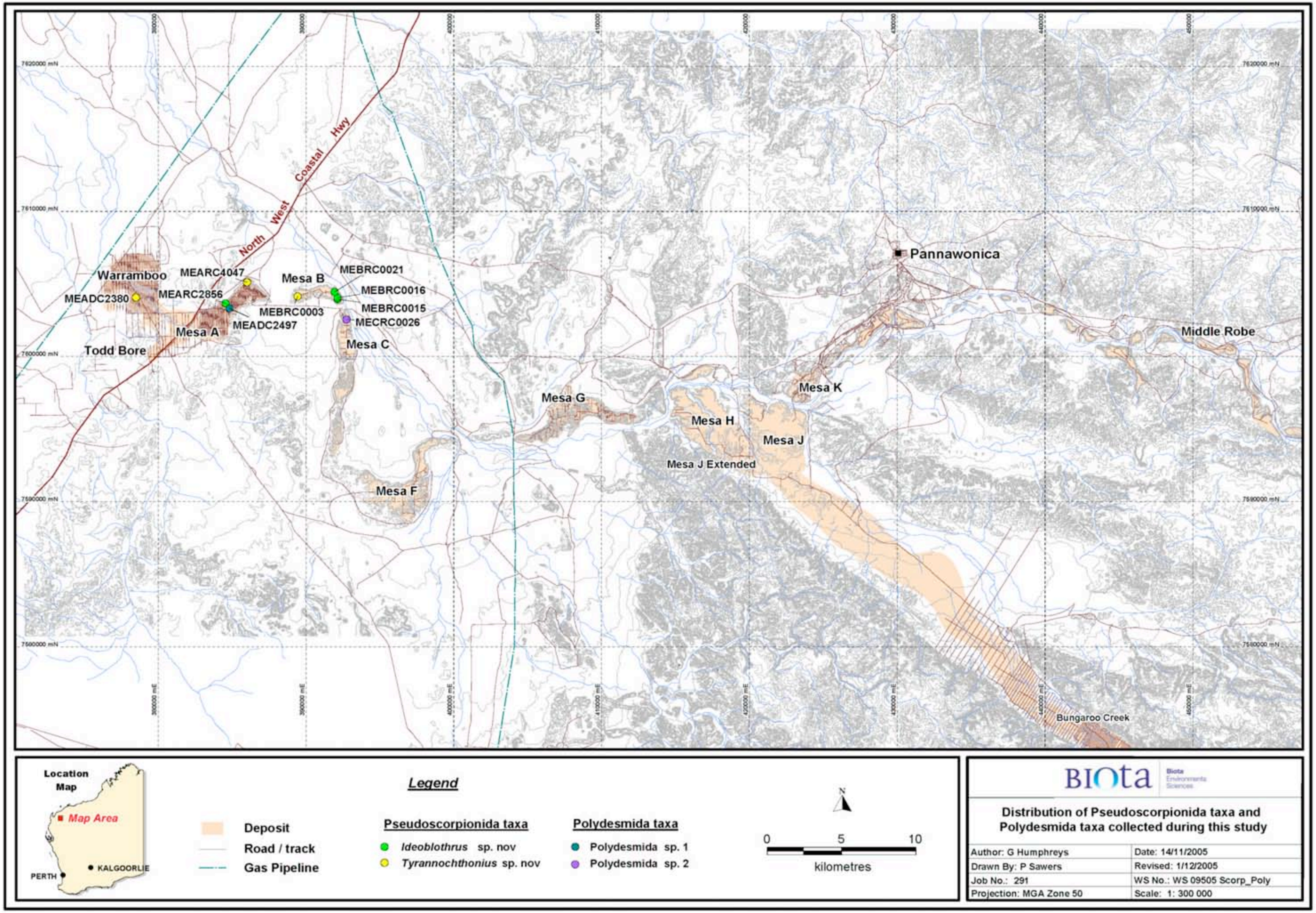

Figure 4.7: Distribution of the pseudoscorpion and polydesmid millipede taxa recorded from Mesa A and other mesas of the Robe Valley.

Plate 4.5: **The troglobitic spider *Opopaea* 'ectognophus' sp. nov.**

ORDER POLYDESMIDA (Millipedes)

A troglobitic millipede belonging to the family Haplodesmidae (order Polydesmida) was amongst the first troglofauna opportunistically collected from bore MEADC2497 on Mesa A during 2003 (see Section 1.2; Plate 4.7). Unfortunately, this proved to be a difficult group to obtain better collections, with only a single additional haplodesmid millipede collected during the subsequent trapping programme (see Figure 4.7). This latter specimen was collected from Mesa C (bore MECRC0026; Appendix 2) and represented a different species from the animal originally collected from Mesa A (see Plate 4.6).

The specimens are the only known representatives of the Halpodesmidae in the Pilbara region, with this family previously known from the wet south coast of the State.

Plate 4.6: **The troglobitic millipede Haplodesmidae sp. nov. 1 (male)**

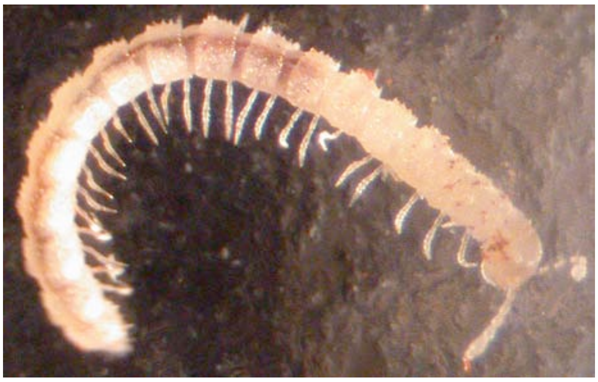

Plate 4.7: **The troglobitic millipede Haplodesmidae sp. nov. 2 (female)**

ORDER SCOLOPENDRIDA (Centipedes)

Five troglobitic centipedes were collected during the study, with specimens from Mesa A, B and G (see Table 4.4; Figure 4.8; Plate 4.8). All these specimens belonged to the family Cryptopidae; a subterranean taxon represented on Cape Range (Biota 2004) and from caves on the Nullarbor Plain (Edgecombe 2005). The specimens belonged to the same genus as these previous records (*Cryptops*) but are unlike any of the previous observed taxa and presumably represent undescribed species. With the available material it is not yet been possible to determine if the *Cryptops* sp. nov. occurring in Mesa A is the same species as that present in Mesas B and G.

Table 4.4: **Troglobitic cryptopid centipedes recorded from Mesa A and other sites during this study** (n = number of individuals).

Site	Bore	Family	Species	n
Mesa A	MEADC2500	Cryptopidae	*Cryptops* sp. nov.	1
Mesa A	MEARC2858	Cryptopidae	*Cryptops* sp. nov.	1
Mesa B	MEBRC0015	Cryptopidae	*Cryptops* sp. nov.	1
Mesa G	MEGDC0057A	Cryptopidae	*Cryptops* sp. nov.	2

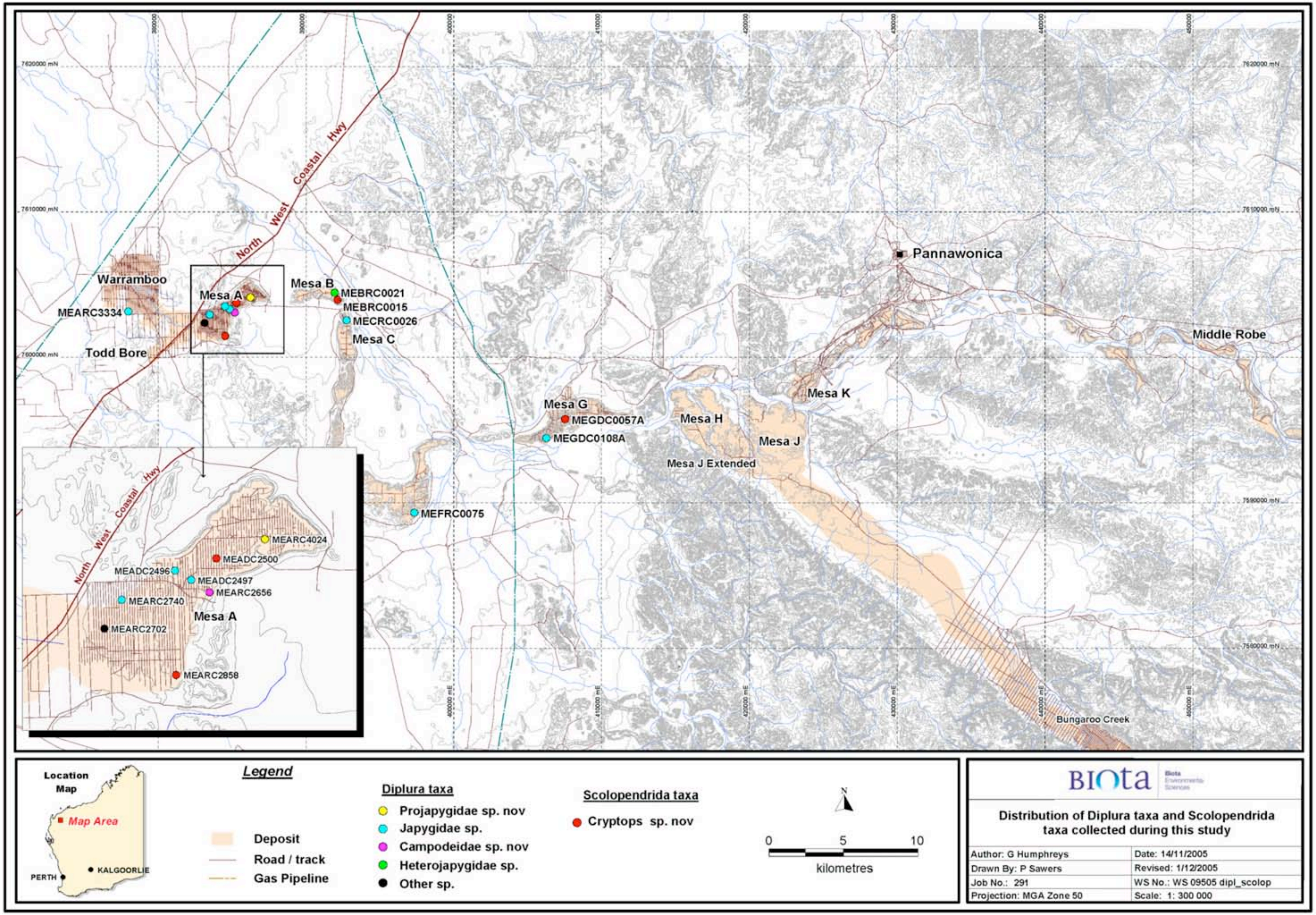

Figure 4.8: Distribution of cryptopid centipede and dipluran taxa recorded from Mesa A and other mesas of the Robe Valley.

Plate 4.8: **The troglobitic centipede *Cryptops* sp. nov. (Mesa A).**

Plate 4.9: **The troglobitic centipede *Cryptops* sp. nov. (Mesa G).**

ORDER DIPLURA (Diplurans)

Eleven dipluran specimens were collected during the study, all as single individuals from different bores. Diplurans superficially resemble earwigs (order Demaptera) but differ in having a single-segmented tarsus (the final leg segment; Harvey and Yen 1997). All the diplurans collected during the programme were troglobitic. Diplura were collected from six of the study areas, with more than half of the records coming from Mesa A (see Table 4.5).

Table 4.5: **Records of troglobitic diplurans from Mesa A and other sites during this study** (n = number of individuals).

Site	Bore	Family	Species	n
Mesa A	MEARC2656	Campodeidae	New genus sp. nov.	1
Mesa A	MEADC2497	Japygidae	*Japyx* sp.	1
Mesa A	MEADC2496	Japygidae	Damaged; unidentifiable	1
Mesa A	MEARC2740	Japygidae	*Japyx* sp.	1
Mesa A	MEARC4024	Projapygidae	New genus sp. nov.	1
Mesa A	MEARC2702	-	Damaged; unidentifiable	1
Mesa B	MEBRC0021	Heterojapygidae	*Heterojapyx* sp. (juvenile)	1
Mesa C	MECRC0026	Japygidae	*Japyx* sp. (juvenile)	1
Mesa F	MEFRC0075	Japygidae	*Japyx* sp. (juvenile)	1
Mesa G	MEGDC0108A	Japygidae	*Japyx* sp.	1
Warramboo	MEARC3334	Japygidae	*Japyx* sp.	1

The dipluran fauna was relatively diverse at higher taxonomic levels, with four of the five families described from Australia represented amongst the collected material (see Table 4.6).

Table 4.6: **Representation of dipluran families and comments on wider status** (n = number of individuals).

Family	n	Study Areas	Comments on Family and Specimens	Plate
Campodeidae	1	Mesa A	Only two known species in the State (*Metriocampa spinigera spinigera* and *Notocampa westraliense*), both from the southern coast	Plate 4.10
Projapygidae	1	Mesa A	Only two species known from Australia: one from Queensland (*Symphylurinus swani*) and the other (undescribed) from Western Australia (Houston 1994)	Plate 4.11
Japygidae	7	Mesa A, C, F, Warramboo	No mature specimens so further identification is limited. Seven species, belonging to two genera, are known from Western Australia. All have south coast distributions (Houston 1994)	Plate 4.12
Heterojapygidae	1	Mesa B	One juvenile specimen. No heterojapygid diplurans have been described in Western Australia. Four species occur in Queensland, with coastal distributions (Houston 1994)	Plate 4.13

Plate 4.10: Troglobitic dipluran Campodeidae sp. nov. (Mesa A).

Plate 4.11: Troglobitic dipluran Projapygidae sp. nov. (Mesa A).

Plate 4.12: Troglobitic dipluran Japygidae sp. nov. (Mesa A, C, F and Warramboo).

Plate 4.13: Troglobitic dipluran Heterojapygidae sp. nov. (Mesa B) (detail of cerci).

Little recent taxonomic work has been completed on this order and taxonomic resolution is not likely to be available beyond that provided here in the near future. The specimens have been lodged with the WA Museum to allow for the future description of the new taxa collected from this study.

ORDER THYSANURA (Silverfish)

Eleven troglobitic thysanurans were collected during the survey, from four of the study areas (see Table 4.7; Plate 4.14). All the thysanurans collected belonged to the family Nicoletiidae, a group characterised by troglomorphies (blind and non- or weakly pigmented Smith 1998). The genus *Trinemura* (to which all the specimens belonged) occurs over much of western and northern Australia, with four species described (including *T. troglophila* from Cape Range). No mature males were amongst the specimens collected during the current survey and these are required to make species identifications. It is therefore not possible to determine if the *Trinemura* sp. nov. from Mesa A are the same as those elsewhere on the Robe Valley (or how they relate to *T. troglophila* from Cape Range).

Table 4.7: Records of troglobitic thysanurans from Mesa A and other sites during this study (n = number of individuals).

Site	Bore	Family	Species	n
Mesa A	MEADC2517A	Nicoletiidae	*Trinemura* sp. nov.	1
Mesa A	MEADC2496	Nicoletiidae	*Trinemura* sp. nov.	1
Mesa A	MEADC2501	Nicoletiidae	*Trinemura* sp. nov.	1
Mesa A	MEADC2523	Nicoletiidae	*Trinemura* sp. nov.	1
Mesa A	MEADC2582	Nicoletiidae	*Trinemura* sp. nov.	1
Mesa A	MEARC3098	Nicoletiidae	*Trinemura* sp. nov.	2
Mesa B	MEBRC0015	Nicoletiidae	*Trinemura* sp. nov.	1
Middle Robe	M2ERC0057	Nicoletiidae	*Trinemura* sp. nov.	1
Middle Robe	M2ERC034	Nicoletiidae	*Trinemura* sp. nov.	1
Warramboo	A1778	Nicoletiidae	*Trinemura* sp. nov.	1

Plate 4.14: **Troglobitic thysanuran (*Trinemura* sp. nov.) collected from Mesa A.**

ORDER BLATTODEA (Cockroaches)

Six troglobitic cockroaches (order Blattodea) were collected during the survey, two from Mesa G and the remainder from Middle Robe (see Table 4.8; Figure 4.9). There were two taxa present, separated on the basis of vestigial eyespots on one specimen from Mesa G (Plate 4.15). This is a very poorly studied group and there is little taxonomic framework available to refine these identifications. No troglobitic Blattodea were collected from Mesa A during this study.

Table 4.8: **Records of troglobitic Blattodea from Mesa G and Middle Robe during this study** (n = number of individuals).

Site	Bore	Family	Species	n
Mesa G	MEGDC0014A	Blatellidae	Sp. 1 (Blind, unidentifiable, juvenile)	1
		Blatellidae	Sp. 2 (Small eye spots)	1
Middle Robe	M2ERC0063	Blatellidae	Sp. 1 (Blind, unidentifiable, juvenile)	2
Middle Robe	M2ERC049	Blatellidae	Sp. 1 (Blind, unidentifiable, juvenile)	2

Plate 4.15: **The troglobitic cockroach Blattellidae sp. 2 (Mesa G).**

Plate 4.16: **The troglobitic cockroach Blattellidae sp. 1 (Middle Robe).**

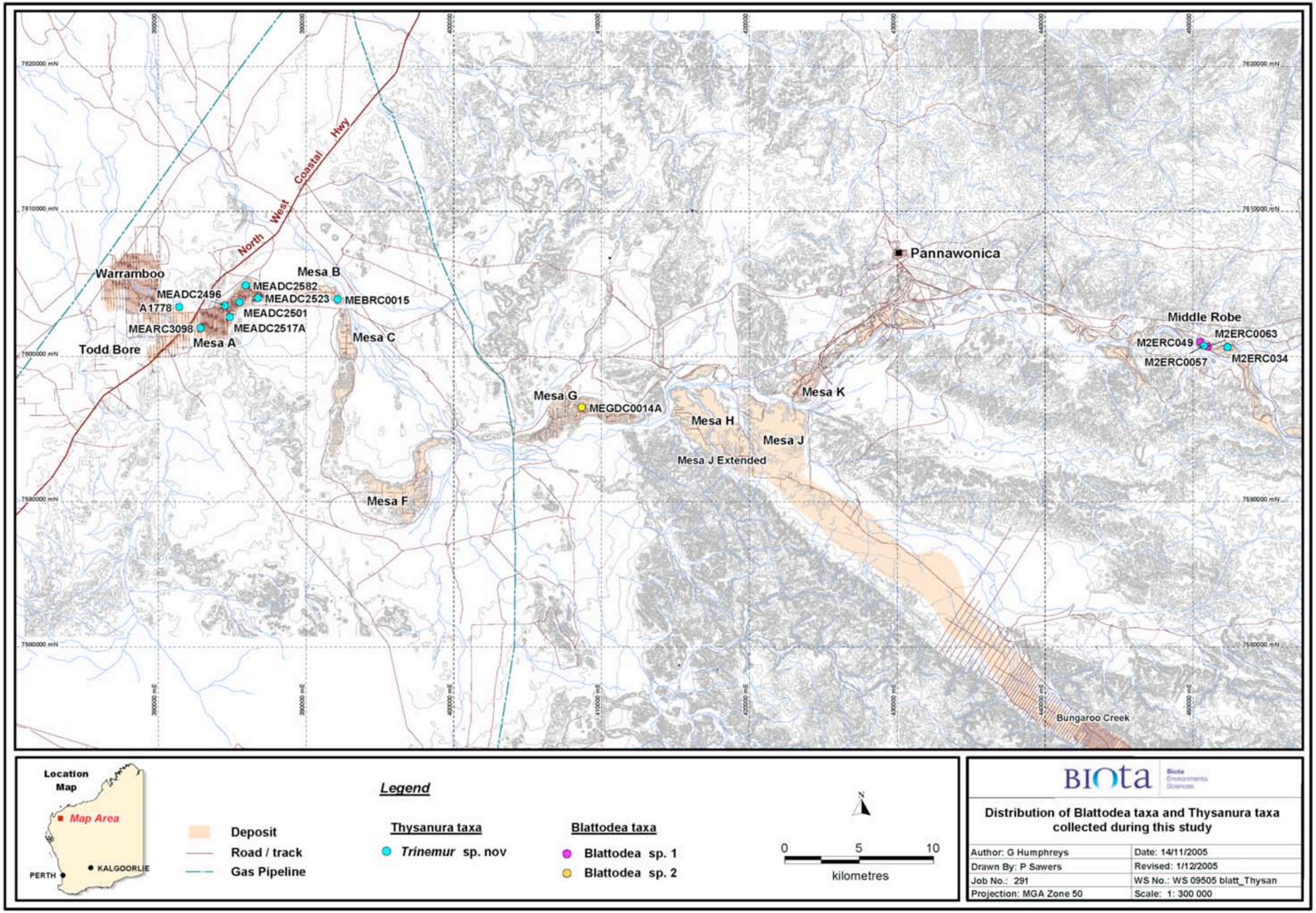

Figure 4.9: Distribution of Thysanura and Blattodea taxa recorded from Mesa A and other mesas of the Robe Valley.

4.3 Account of the Edaphobitic and Troglophilic Fauna

The fauna considered in this section consists of the orders that were initially identified as having the potential to include troglobitic taxa. Further investigation of these groups however indicated that the collected animals were actually edaphobitic (deep-soil and litter dwelling), troglophilic (facultative rather than obligate users of subterranean habitats) or epigean (surface forms).

ORDER ACARINA (Mites)

Mites were by far the most abundant fauna collected during the trapping programme, with 1,759 specimens recorded (45% of the fauna; Table 4.1). Mites were collected from all sites sampled during this study, and, allowing for disproportionate sampling effort between sites, were relatively evenly distributed in abundance across the mesas (see Table 4.9).

Table 4.9: Summary of number of mite specimens collected from the various study sites and the number of bore locations yielding mites within each site.

Site	Total n	No. of Bores
Warramboo	377	15
Mesa A	811	42
Mesa B	36	7
Mesa C	65	4
Mesa F	30	1
Mesa G	269	8
Mesa J	2	1
Mesa K	30	5
Middle Robe	85	10

The collected mites were morphologically identified by Dr Dave Walter (see Section 2.2). This work revealed a total of at least 26 species, making the mites the most taxonomically diverse group collected during this study. Most of these belonged to the 'dry-land' mite fauna and most species recorded are cosmopolitan in distribution or occur Australia-wide (D. Walter, pers. comm. 2005) (see Table 4.10).

Table 4.10: Taxonomic summary of number of mite taxa identified during this study and their occurrence across survey sites (Taxa categorised by order, family, genus).

Taxa	Comments	Study Sites
Mesostigmata (13 species)		
Laelapidae	Most Australian species undescribed, free-living predators in soil	
Geolaelaps sp. 1	Most bisexual (one known parthenogen) Species complex	Mesa A, C, Middle Robe
Geolaelaps sp. 2		Mesa A, C, K, Todd Bore
Geolaelaps ?spp.	Probable species complex	Mesa A, C, K, Todd Bore
Cosmolaelaps ?sp.	Species complex, common in rainforest, free-living predators	Mesa A, B, C, F, G, H, J, Todd Bore and Middle Robe
Pseudoparasitus sp.		Warramboo
Ololaelaps sp.	Mammal nest-associated	Mesa A
Ascidae		
Asca sp. nov.	Common in dryland soils, ~80 described species in the genus	Mesa A
Protogamasellus mica.	Dryland soil fauna, all female populations occur, Cosmopolitan	Mesa A, Warramboo
Protogamasellus dispar	Known from South Africa	Mesa A and C
Protogamasellus massula	Pantropical, Queensland to North Africa	Mesa A, Warramboo
Rhodacaridae		
Protogamasellopsis sp.	First record for Australia	Mesa G, Warramboo
Ameroseiidae		
Ameroseius plumosus	Cosmopolitan, fungivore	Mesa A
Uropodoideae		
Oplitis sp.	Ant-associated	Mesa C
Prostigmata (7 species)		
Pterygosomatidae		
Pterygosomatidae sp. 1	Reptile commensals	Warramboo

Taxa	Comments	Study Sites
Eupodidae		
Eupodidae sp. 1	Range of habitats from the Antarctic to the intertidal zone	Mesa A, G, H, K, Middle Robe and Warramboo
Rhagidiidae		
Rhagidiidae sp. 1	Free-living predators, range of habitats including soil and caves	Mesa A and K
Trombidioidae		
'Trombidioid' sp. 1	Parasitic, probably surface fauna	Mesa A
Cunaxidae	Ambush predators, occur in vegetation and soil	Mesa A
Coleoscirus sp.		Mesa A, Warramboo
Cunaxa sp.		Mesa H
Oribatida (4 species)		
Oppioidea sp.1		Mesa A, H, Middle Robe, Warramboo
Oppioidea sp.2		Mesa A, H, Middle Robe, Warramboo
Galumnoidea sp.	Particulate feeding fungivore	Mesa A, Warramboo
Ceratozetoidea sp.		Warramboo
Astigmata (1 species)		
Astigmata sp. 1	Nest associated (birds, mammals)	Mesa A, B, C, G, H, Middle Robe
Endeostigmata (1 species)		
Granjeanicus cf. *theroni*	Previously recorded from Queensland	Mesa A

The majority of the mite fauna is commensal or parasitic on vertebrates or predators of other arthropods in soil and surface environments (see Table 4.10). Many of the taxa recorded are known to have ranges extending across Australia and internationally. This was not suggestive of the restricted dispersal and obligate subterranean characteristics of the true troglofauna (see Section 4.2).

To further investigate this, and to compare with patterns observed amongst the schizomid fauna, DNA analysis of a representative range of mite specimens was completed by Dr Oliver Berry (see Section 2.2; Berry 2005). This work targeted specimens provisionally identified by Dave Walter as belonging to the genera *Cosmolaelaps* and *Geolaelaps* (two of the better collected and most widely distributed taxa; occurring on most mesas (Table 4.10)).

DNA sequences from the COI mitochondrial gene were again obtained from 47 laelapid mite specimens, representing 10 of the study sites (Mesa A, B, C, F, G, H, J, K, Todd Bore, Warramboo and Middle Robe). Similar analyses to those completed on the Schizomida were then undertaken to examine phylogenetic groupings and examine their relationship with the various study areas. This work identified that multiple, highly divergent lineages existed amongst the mite fauna (Berry 2005). The groupings were broadly consistent with the determinations based on morphology (*Cosmolaelaps* and *Geolaelaps*), with the amount of divergence suggestive of two genera, each containing representatives of several species. (Berry 2005).

The spatial distribution of these nominal species showed a markedly different pattern from that of the troglobitic schizomids (where distinct species were restricted to each mesa; Section 4.2). In the mite fauna many of the species were recorded on several mesas and most mesas contained multiple lineages (representing different species). This result appears to indicate that the collected mites are more edaphobitic (deep soil and litter dwellers) rather than relictual troglobites. Patterns inferred from the molecular data were therefore consistent with the known distributions and ecological attributes of this fauna (Table 4.10), suggesting that the mites are capable of extensive dispersal and do not appear to be restricted by the discontinuous nature of the mesas (Berry 2005).

ORDER COLLEMBOLA (Collembolans)

Collembolans were the second most abundant group after the mites, accounting for 18% of the collected fauna (711 specimens; Table 4.1). These were identified by Ms Penny Greenslade; a specialist on this group (see Section 2.2). Fifteen species of collembolans were identified from amongst the collected specimens, representing seven families (see Table 4.11).

Table 4.11: Taxonomic summary of number of collembolan taxa identified during this study and their occurrence across survey sites (Taxa categorised by family then genus).

Taxa	Comments	Study Sites (No. of specimens)
Neanuridae		
Pseudachorutella sp. nov.	Arid zone leaf litter species	Mesa A, C (2)
Tullbergiidae		
Mesaphorura sp. indet.	Possible cosmopolitan species	Mesa C (1)
Isotomidae		
Folsomides exiguus	Pantropical soil species	Mesa A (40)
Folsomina onychiurina	Pan tropical deep soil species	Mesa A, C, G, K, Warramboo (53)
Hemisotoma thermophila spp.	White with grey speckles	Mesa A, B, C, G, K (115)
Entomobryidae		
Pseudosinella sp. 1	4 + 4 eyes,	Mesa A (2)
Pseudosinella sp. 2	Two small eye spots 3 + 3 eyes	Warramboo (3)
Pseudosinella sp. 3	Tiny eye spot or1 + 1 eyes	Mesa A, Warramboo (2)
Pseudosinella sp. 4	No pigmented eye patch	Mesa A (2)
Lepidosira sp.	Epigean (surface) habitats	Mesa K, Warramboo (2)
cf *Lepidocyrtus* sp.	Pale grey blue, 6 + 6 eyes, humus dwellers	Mesa A, Middle Robe, Warramboo (16)
indet. Entomobryidae	Immature or lacking diagnostic features	Mesa A, B, C, F, G, H. J, K, Middle Robe, Warramboo
Cyphoderidae		
Cyphoda sp. cf. *nichollsi*	Found in associated with ants	Mesa A, C, F, G, K (17)
Neelidae		
Megalothorax sp.	Soil living species	Mesa A, K (8)
Sminthurididae		
Sphaeridia sp.	Arid zone leaf litter species	Mesa A, B, G, Middle Robe (64)

Most species collected were represented by only a few individuals, but some of the species were abundant and widespread across the study areas (Table 4.11). The patterns observed in collembolan species distributions, and the observations on their ecology, were very similar to the mites. Three-quarters of the collembolan species recorded (11 of the 15), occurred on multiple mesas, with two of the remaining four species being at least pantropical soil-dwellers (see Table 4.11). Most mesas also contained multiple species.

ORDER OPILIONIDA (Harvestmen)

Troglobitic opiliones have been collected from several previous studies (Humphreys 2001, Biota 2002). Only three Opiliones were collected during the current study (from Mesas C, G and K; Appendix 2) and all the specimens were pigmented and had eye spots (see Plate 4.17). None of these specimens were fully troglobitic, although their long legs, pale colouration and small eyes demonstrates adaptation consistent with long isolation from epigean environments.

The specimens are referrable to the family Assamiidae, a large and highly diverse assemblage of Australasian opilionids that are abundant in rainforest habitats. Within Western Australia, assamiids are found in vine thickets and rainforests of the Kimberley region, but *Dampetrus isolatus* has been recorded from caves on Cape Range (Shear, 2001). As discussed by Shear (2001), all Australian assamiids are likely to belong to the genus *Dampetrus*. The mesa specimens are specifically distinct from *D. isolatus* and from any other named species of the genus. The material has been lodged with the WA Museum but more detailed identifications have not been made as part of the current study.

Plate 4.17: Opilionida specimen collected from Mesa K.

4.4 Relationship between Troglofauna Distribution and Habitat Variables

4.4.1 Tectonic Units and Regional Geology

The distribution of all the troglobitic fauna specimens collected during this study was overlain on regional geology mapping in MapInfo Professional GIS v7.0 (MapInfo). This allowed for spatial analysis of the troglofauna distribution against tectonic units as delineated on 1:500,000 scale regional geology. The outcomes of this are shown in Figure 4.11.

There is some broad correspondence with the spatial distribution of the various mesas on these geological units and the groupings which arose from the schizomid phylogenetic analysis (see Figure 4.10):

- Mesas A, B and C – Ashburton Basin: group out together as part of the same lineage on the phylogenetic tree (see Figure 4.10);
- Mesa G – Carnarvon Basin: a distinct lineage from Mesa A, B and C (Ashburton) and the Hamersley Basin sites (Middle Robe and Mesa K); and
- Middle Robe and Mesa K – Hamersley Basin: separate out as a distinct lineages from the other mesa populations.

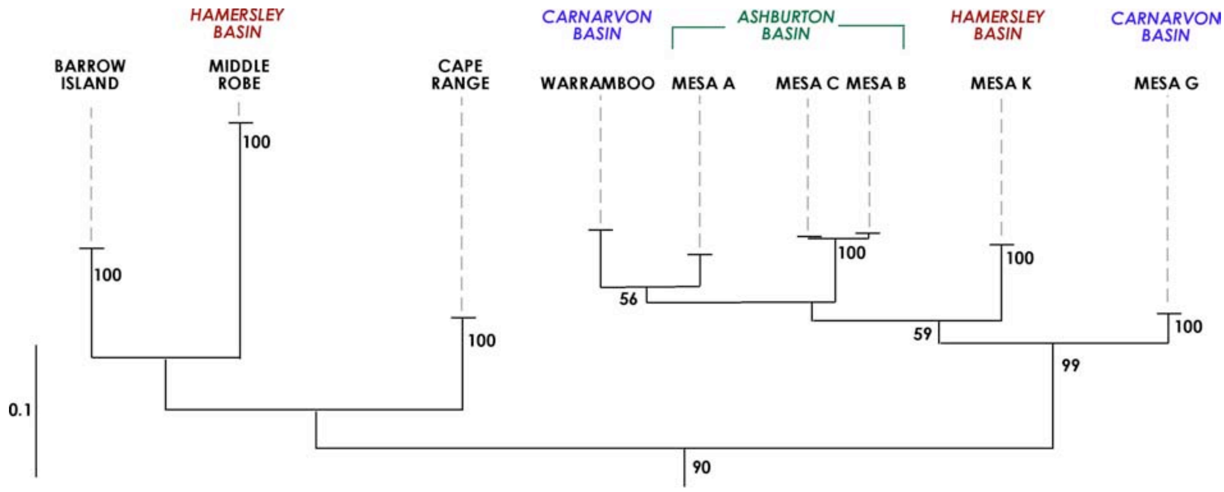

Figure 4.10: Summarised phylogenetic tree for the schizomid genus *Draculoides*, showing relationships with underlying tectonic units (tree modified from Berry (2005); numbers=bootstrap values).

The linkage between the groupings based on DNA sequence data was not entirely consistent with the spatial distribution of the sites on tectonic units. If the tectonic unit origin of the mesa was the only factor determining phylogeography, then Mesa G would be expected to cluster with the other sites in the Ashburton Basin (Mesas A, B and C). Mesa K and Middle Robe would also have been expected to show greater affinities.

Additional sample sites and the sequencing of further specimens may clarify this, but it is likely that other biogeographic factors have overlain any influence arising from site tectonic origin, contributing to the genetic structuring observed today. This is discussed further in Section 4.4.2.

4.4.2 Geomorphology and Biogeography

Results of DNA analysis can be interpreted in terms of a 'molecular clock', to provide an estimate of the period of time that populations have been isolated. Based on the *Draculoides* data, the schizomid populations present in the various mesas appear to have been separated for several million years (Berry 2005). This is consistent with the general timeframes identified for regional aridification and the erosion and uplift processes which began separating the mesa landforms from each other at the end of the Miocene (10-15 million years ago; Section 3.2; Figure 3.2).

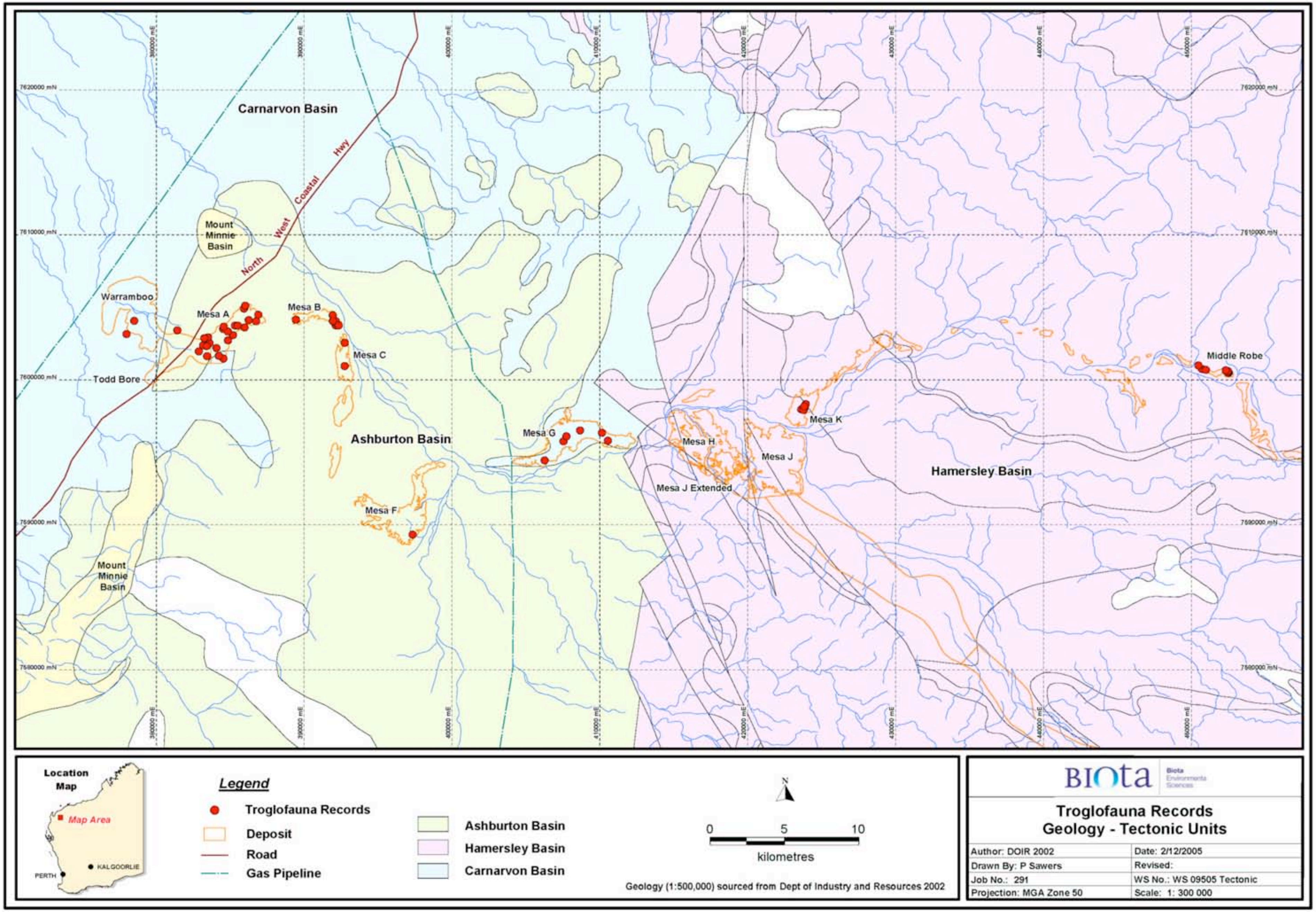

Figure 4.11: Distribution of troglofauna records against regional geology tectonic units.

The contemporary mesa formations that provide habitat to the troglofauna arose from the depositional environment of the palaeo Robe River (see Section 3.2). This occurred in a much warmer and wetter climate than the present day arid conditions in the Pilbara. Tropical rainforest covered much of northern Australia until the beginning of the Miocene (20 million years bp) (Trusswell 1990). Given the currently ecology and distribution of the surface representatives of the troglobitic orders (particularly the Schizomida and Diplura), it has been inferred that the ancestors of the current subterranean fauna were surface dwellers in this tropical environment (see Humphreys 1993 for a discussion in regards to Cape Range).

Ongoing aridification of northern Australia occurred into the Pleistocene and rainforest habitats gradually retreated over the ensuing period to their current, limited distribution in the east and north of the continent. It may be speculated that the gradual reduction of these rainforest habitats would have occurred initially as a contraction into the more mesic and fluvial habitats provided by the major drainage systems of the time (including the Robe palaeo river). The tropical rainforest fauna would presumably have also become concentrated into these localities and begun to descend into the humid refugia provided by the pisolite of the mesa formations developing at this time. Increasing aridity and total retreat of rainforest habitat from the Pilbara would have subsequently lead to the decline of the surface fauna, leaving the subterranean lineages as the only regional representatives. The processes of uplift and erosion would have then acted to separate the mesa formations from one another, leading to the configuration present today (see Section 3.2).

The rate of potential isolation of the various mesas would have been a function of two key factors: erosion through stream action and the degree of structural integrity within the massive structure. It is likely that the isolation of Mesa A from Mesa B is a function of stream activity in combination with an intense vertical joint set in Mesa B. A local catchment is evident from aerial photography (Plate 4.18), which would have driven the erosion separating Mesa A from B. The lesser degree of separation between Mesa B and C is not associated with a major drainage system, with the only erosion due to localised run-off from the mesas (see Plate 4.19). The geomorphological evidence suggests that the isolation between these latter two mesas would have been more recent. This is supported by the findings of the molecular study, which identified only a small sequence divergence between the *Draculoides* specimens from Mesa B and C (<1%), suggesting that restrictions in gene flow between the populations has been much more recent than between A and B.

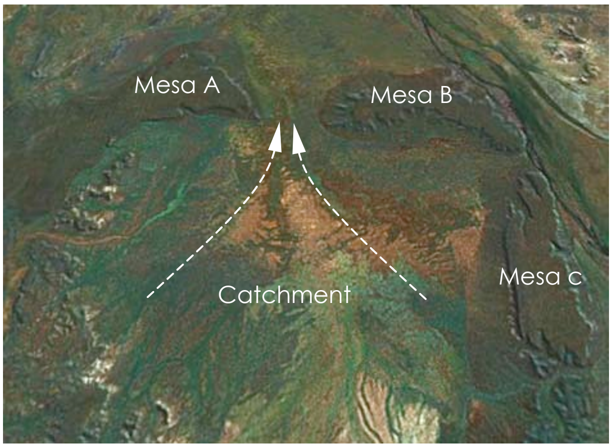

Plate 4.18: Oblique aerial view of drainage catchment separating Mesa A from B (source: Google Earth 2005).

Plate 4.19: View from Mesa B south across small valley to Mesa C (main channel of the Robe River visible at left).

This type of relatively recent process would not, however, account for the very large genetic differences observed between Middle Robe and the balance of the mesas (up to 35%; Section 4.2). It appears unlikely that any particularly strong selection pressure or major subterranean environmental difference exists between Middle Robe and the other mesas. All the mesas are of similar geology and lithology (M. Brand, Robe River Iron, pers. comm.), and presumably provide similar dark, humid and low-energy environments inside the structure.

The large genetic separations may instead be associated with vicariance events or pre-existing genetic divides that pre-date the mesa erosion and separation process. Inspection of satellite imagery and contemporary river systems suggest that this model could help explain the large difference between the Middle Robe *Draculoides* and the balance of the mesas (see Section 4.4.1). The Middle Robe mesas are located on the Hamersley Basin (a separate tectonic unit than the majority of the remaining mesas), but this alone does not appear to account for the degree of separation (particularly from Mesa K; see Section 4.4.1). Given that the mesa formations arose from iron-rich deposits in palaeodrainage systems, it is worth considering the historical configuration of the Robe and the Fortescue paleo rivers. These two regional drainages are still in close proximity today as shown on a Landsat satellite scene in Figure 4.13.

Middle Robe is located in the eastern part of the present day Robe drainage system, in relatively close proximity to the Fortescue River drainage on the Hamersley Basin. The large divergence of this schizomid population from the balance of the Robe valley could have arisen if this upper catchment part of the Robe drainage system was once part of the palaeo Fortescue River. Stream capture occurs when erosional processes or structural control such as faulting leads to the upper catchment of one drainage system becoming entrained into another adjacent system (Mather et al. 2000). Under this model, the large genetic differences may then reflect pre-existing species distributions and differences between the surface schizomids of the palaeo Fortescue and Robe basins.

This presumes that the different major drainage basins of the period supported distinct assemblages of tropical litter fauna (or at least allopatric schizomid species). Given that the geology of the two areas is quite different (Geological Survey of Western Australia 1972), this appears to be at least a reasonable supposition. This then suggests that the large divergence between the Middle Robe fauna and that of the western mesas may be due to different surface fauna origins. The subsequent isolation of the relictual fauna in the mesa formations would then have enhanced any pre-existing genetic provinces. A review of satellite imagery suggests that this connection is a possibility, with valleys and fault lines providing potential palaeodrainage connections between the two drainages (see notional connection dashed in on Figure 4.13). The path of the palaeo Robe River is today indicated by the presence of Robe pisolite. This may be in the form of the erosional remains of a palaeosurface (such as the mesa formations), but this can also occur below the current ground level (such as in the Bungaroo Creek valley). If pisolitic geology follows an area of structural control leading from the Middle Robe locality toward the Fortescue catchment, then this may signal some support for this hypothesis.

The preceding review highlights that the distribution of the troglobitic taxa and assemblages present today is the outcome of very long-term biogeographic processes. These processes have operated at the landscape scale, driven by climatic change and geomorphology, and are currently still ongoing. There is evidence of these ongoing processes in the schizomid fauna of both Mesa A and G. Genetic differentiation at the infrataxon level was recorded within these populations and this is probably due to local geomorphic and structural features within these mesas. The clearest example of this was in Mesa G, where the *Draculoides* specimens from the eastern end of the mesa grouped out as genetically distinct from those at the western end (Figure 4.12). This end of the mesa is almost separated from the western portion by gorge development, presumably presenting barriers to gene flow in the schizomids living within the structure.

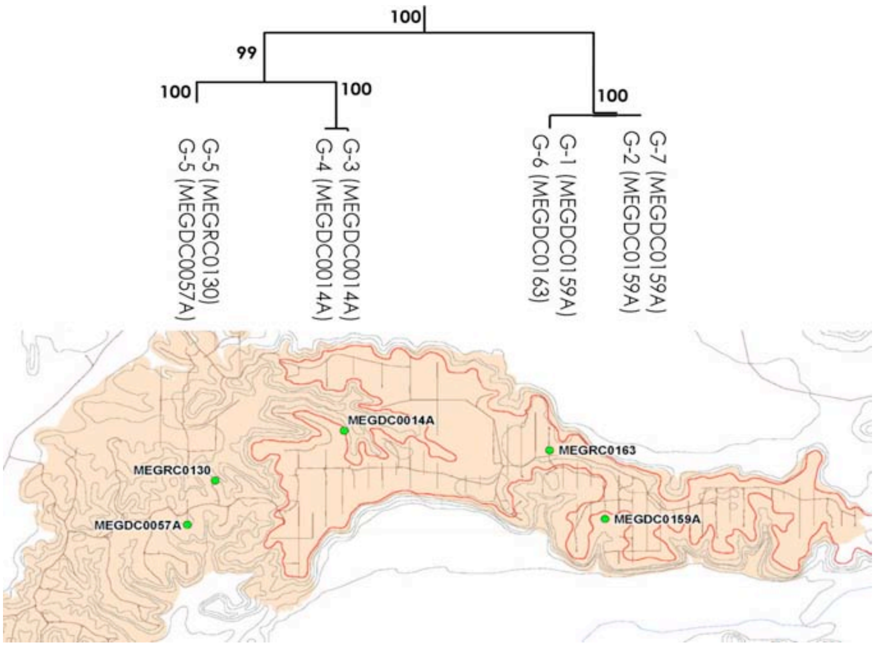

Figure 4.12: Comparison of *Draculoides* genetic units within Mesa G with topographic features.

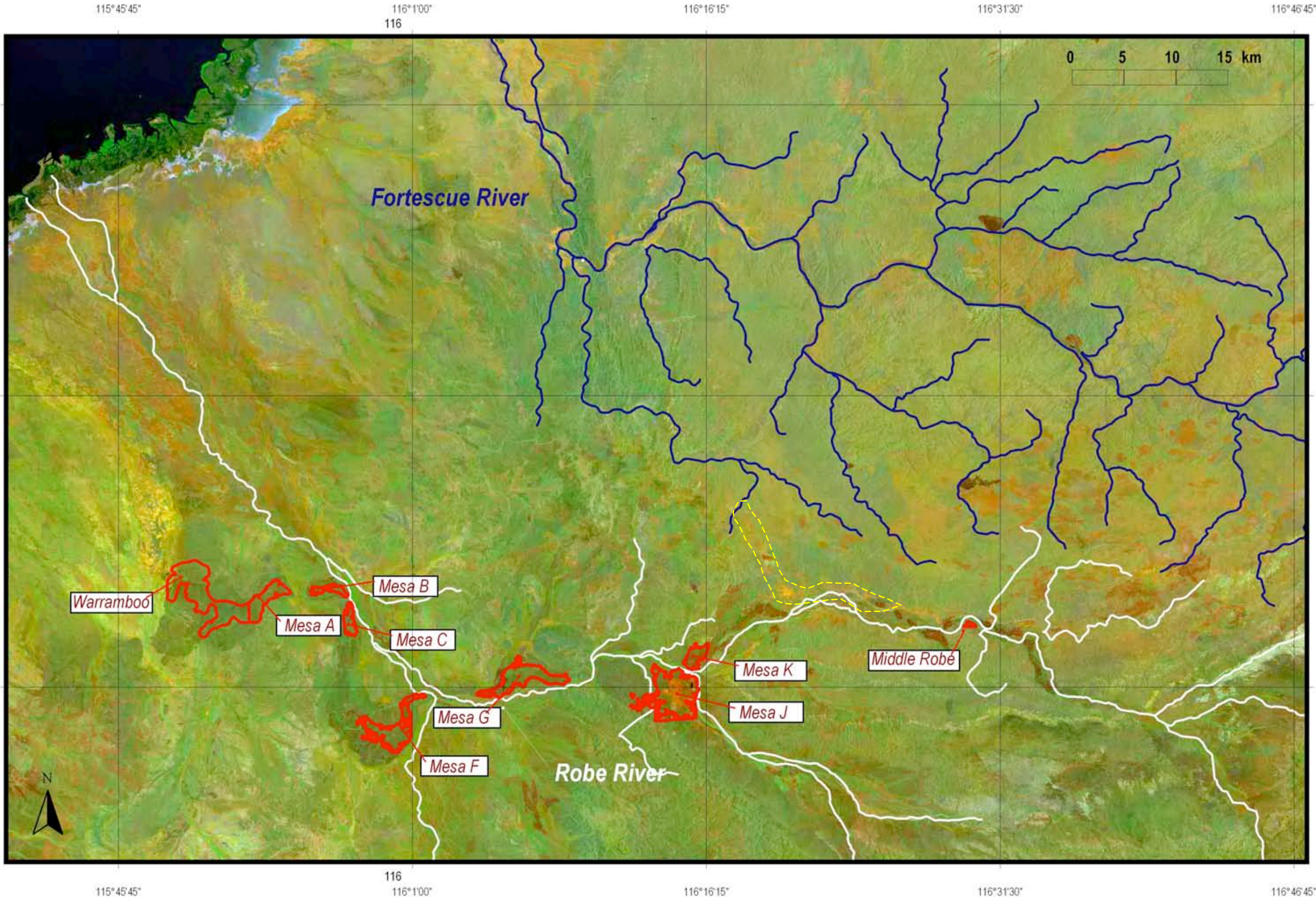

Figure 4.13: Locations of mesas along the contemporary Robe and Fortescue River drainage systems (dashed yellow line = notional connection of Middle Robe drainage with the Fortescue drainage basin).

4.4.3 Depth Below Mesa Surface

The results from the various trap depths within each sampled bore were examined to identify any consistent patterns in the vertical distribution of the fauna records. The traps were uniformly referred to as trap '1' being the shallowest, down to trap '4' (the deepest). Plots of the percentage of the total records for each order at each trap depth were compiled from lumped data for all study areas. This provided an overall 'profile' of the relative abundance by depth as indicated by trapping results. The orders containing only surface or soil fauna were separated out from the troglobitic groups (see Figure 4.14).

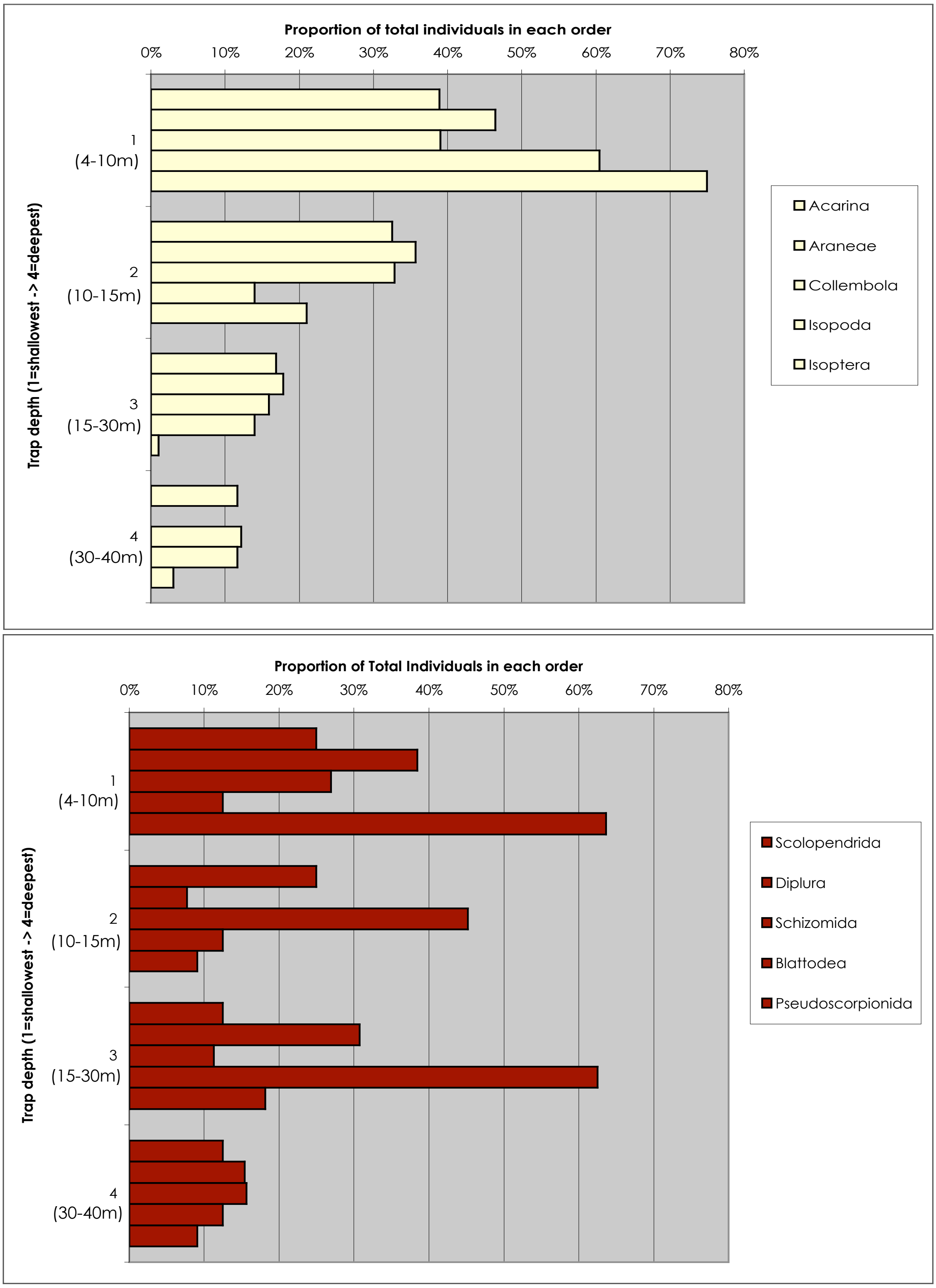

Figure 4.14: Percentage of total collections by different taxonomic groups with increasing depth below the mesa surface (surface fauna orders shown above in cream, troglofauna shown below in red; vertical sequence of bars on graphs follow sequence shown in key; orders with small total numbers of individuals not shown).

The results shown here should be interpreted with caution, as the distribution of fauna records within boreholes cannot be definitely linked to the depth at which they were recorded. The fauna in question are mobile and are likely to move up or down within a borehole they may encounter from the adjacent stratigraphy. Fauna can also accrue in the traps due to a 'pitfall' type effects, meaning that animals may also fall from higher traps to lower ones. Finally, the lowest traps (number '4') were frequently quite wet (presumably from groundwater) and may have not sampled as effectively as the intermediate level traps.

Recognising these limitations, some patterns are still evident from Figure 4.14. The taxa containing surface and soil forms were collected predominantly from the uppermost traps, with few, if any, records from the deepest traps. The troglobitic groups, however, did not show any consistent pattern in vertical distribution. Some of the troglobitic orders, including the Schizomida and the Blattodea, showed the greatest proportion of captures at intermediate and deeper traps. These results show some degree of consistency with the ecology implied by the specimens' morphological characters. At this broad level of review, the animals determined as surface or soil fauna occur in the upper portion of the profile, with the troglobitic fauna deeper into the mesa structure. With the ecological sampling effects that apply to this dataset, and the other confounding factors noted above, it would not be valid to carry out a more detailed analysis of the vertical occurrence of troglofauna within individual bores.

4.4.4 Effect of Rainfall

Rainfall events result in recharge of the mesa formations and inputs of water and organic matter (in both particulate and dissolved forms). Work completed by Humphreys (1991) has shown that inputs of water into dry superficial strata can stimulate increased activity in troglofauna. There was some evidence of a similar response in the troglobitic fauna within the Robe mesas, based on the abundance of fauna collected during the various phases of the survey.

To assess this, the total number of troglobitic specimens collected during each phase was related to monthly rainfall during 2005 (see Figure 4.15). Abundances were standardised by sample effort to facilitate an unbiased comparison between phases. The data were also limited to the Mesa A study area to remove variation arising from different study areas.

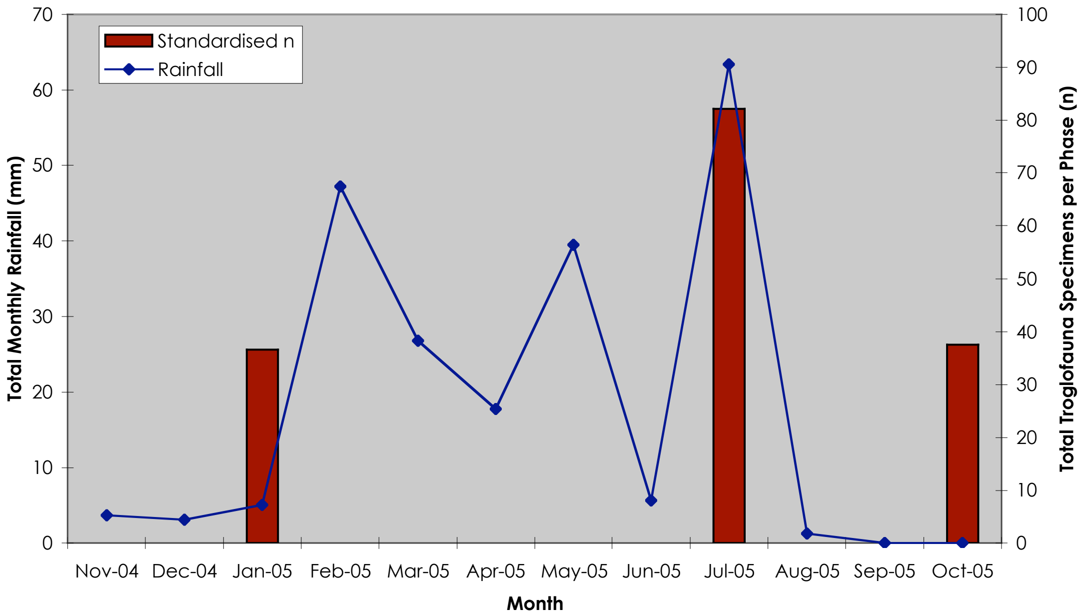

Figure 4.15: Relationship between rainfall events during the survey period and total troglofauna catch from Mesa A across the three phases (values for each phase standardised to n per 100 litter traps; data lumped for all troglobitic orders collected from Mesa A).

While the data are limited, the standardised yields from the sampling programme show a marked response to the rainfall events experienced mid-year in the Robe valley (see Figure 4.15). This is presumably due to increased activity in the fauna under the wet conditions, including moving into strata which may have been drier earlier and later in the year (and therefore suboptimal habitat). This trend should be borne in mind in the timing of future sampling efforts targeting this fauna.

4.4.5 Mesa Size, Structure and Troglofauna Occurrence

Ecologically, the mesas are effectively islands in regards to the populations of troglofauna occurring within them. It may therefore be informative to examine the relationship between the size of the mesa and the abundance and diversity of the fauna within them. Sampling effort was not equal amongst the various study areas, however, being strongly skewed toward Mesa A and, to a lesser extent, Warramboo (see Table 4.12). To adjust for this, the total abundance of troglofauna and species richness were standardised to 10 bores per study area. Note that with the asymptotic effect of species accumulation, this would not account entirely for the effect of differential sampling effort on species richness.

The simplest measure considered was the 'strike rate' for each study area (the percentage of the sampled holes that contained troglofauna). Mesas B and C showed the highest proportion of bores with troglofauna (see Table 4.12). These sites also showed the highest standardise abundances of troglofauna and amongst the highest species richness.

Table 4.12: Relationship between mesa size, strike rate (% of holes sampled containing troglofauna), troglofauna abundance and taxonomic richness (sites listed from highest strike rate to lowest).

Study Area	Holes sampled	Holes with fauna	Strike rate	Raw n	Raw No. of taxa	Standardised n	Standardised No. of taxa	Area (ha)
Mesa B	11	7	64%	34	5	30.9	4.5	173.0
Mesa C	4	2	50%	7	2	17.5	5.0	227.5
Middle Robe	15	7	47%	15	2	10.0	1.3	89.3
Mesa K	12	5	42%	12	1	10.0	0.8	306.2
Mesa A	74	26	35%	57	8	7.7	1.1	573.2
Mesa G	17	5	29%	27	4	15.9	2.4	989.0
Warramboo	29	4	14%	7	3	2.4	1.0	1,979.4
Mesa F	13	1	8%	1	1	0.8	0.8	935.3

Significantly, Middle Robe, which has been disturbed by historical mining, had the next highest strike rate (Table 4.12). Mesa A, the main focus of this study, yielded troglofauna from approximately a third of the bores sampled during the programme. While Mesa A has the most troglobitic taxa of any of the sites, this is probably a function of the additional sampling effort invested there (consider the relatively low standardised richness for this site compared to Mesa B and C; Table 4.12).

The presence of a true mesa landform also appears to affect the likelihood of troglofauna occurrence. Mesa H and Todd Bore, which both lacked this geomorphology (Table 3.1), yielded no troglobites. Warramboo was also the second poorest of all sites that yielded troglofauna, despite having the second greatest sampling effort (Table 4.12). This supports the view that the massive structure of the mesa landform, and the nature of its hydrogeology, is important in providing suitable humid habitats for troglobitic fauna. There was also a relationship between mesa size and frequency of recording troglofauna, although, interestingly, the trend was for the smallest mesas to yield the best results (see Table 4.12).

Troglofauna abundance and diversity was also reviewed at the scale of bores within each mesa (see Table 4.13). Interpretative notes on drill logs were not available for many of the best yielding bores (or provided no comment on degree of fracturing or the presence of cavities or vugs). However, for those bores where this detail was available, there were generally indications of cavities or fracture zones; consistent with core habitat for troglofauna. The bores in Table 4.13 that yielded the greatest abundance and diversity of troglofauna will provide a focus for ongoing work in the study area. This is planned to include down-hole video camera investigations and additional sampling work.

Table 4.13: Summary of taxonomic richness and abundance in boreholes containing troglofauna (Total n= total of all troglofauna specimens from that bore; Study area Richness totals show total number of taxa; Trap effort=total number of litter traps across all phases).

Study Area	Bore	Richness	Total n	Trap Effort
Mesa A *	MEARC2497	2	4	11
	MEADC2501	2	9	9
	MEADC2517A	1	5	3
	MEADC2582	1	4	10
	MEADC2500	1	3	8
	MEARC2858	1	3	2
	MEARC2702	1	2	3
	MEARC2611	1	5	4
	MEARC3042	1	3	3
	MEADC2492	1	2	8
	MEARC3098	1	2	3
	Mesa A Totals:	**8**	**57**	**132**
Mesa B	MEBRC0015	3	5	3
	MEBRC0021	2	9	3
	MEBRC0016	1	16	3
	MEBRC0025	1	1	4
	MEBRC0003	1	1	3
	MEBRC0023	1	1	2
	MEBRC0014	1	1	1
	Mesa B Totals:	**5**	**34**	**19**
Mesa C	MECRC0026	2	4	2
	MECRC0012	1	3	3
	Mesa C Totals:	**2**	**7**	**5**
Mesa F	MEFRC0075	1	1	3
	Mesa F Totals:	**1**	**1**	**3**
Mesa G	MEGDC0014A	2	5	4
	MEGDC0057A	2	4	6
	MEGRC0130	1	6	8
	MEGDC0159A	1	10	7
	MEGRC0163	1	2	4
	Mesa G Totals:	**4**	**27**	**29**
Mesa K	MEKRC1685	1	4	3
	MEKRC1694	1	4	4
	MEKRC1721	1	2	3
	MEKRC1689	1	1	4
	MEKRC1728	1	1	3
	Mesa K Totals:	**1**	**12**	**17**
Middle Robe	M2ERC0063	2	4	4
	M2ERC034	1	3	4
	M2ERC049	2	2	4
	M2ERC027	1	3	3
	M2ERC0057	1	1	4
	M2ERC026	1	1	8
	M2ERC029	1	1	3
	Middle Robe Totals:	**2**	**15**	**30**
Warramboo	MEARC2381	1	4	6
	A1778	1	1	3
	MEADC2380	1	1	3
	MEARC3334	1	1	3
	Warramboo Totals:	**3**	**7**	**15**
	Grand total:	**19**	**160**	**250**

* An additional 15 bores that yielded single troglobitic specimens from Mesa A not shown; details provided in Appendix 2.

5.0 Conclusions and Management

5.1 Consolidation of Findings

The key question for this assessment relates to the potential for any of the taxa recorded to be restricted in distribution to Mesa A. A summary of the findings of this survey for the troglobitic taxa recorded from Mesa A is presented in Table 5.1.

Table 5.1: Summary of troglobitic taxa collected from locations on Mesa A, with comments on their status and distribution (n = number of specimens; see Section 4.2 for more detail on taxa).

Taxa	Sites on Mesa A	Status and wider distribution
Schizomida		
Draculoides sp. 'Mesa A'	A1149, MEADC2492, MEADC2497, MEADC2500 MEADC2501, MEADC2517A, MEADC2582, MEADC3188, MEARC2497, MEARC2582, MEARC2611, MEARC2702, MEARC2858, MEARC2934 MEARC3066, MEARC3073, MEARC4151 (n=39 in total)	Not recorded from outside Mesa A. Collected from 17 locations on Mesa A, covering a total range of 385 ha.
Pseudoscorpionida		
Tyrannochthonius sp. nov.	MEARC4047 (n=1 in total)	Other members of this genus collected from Mesa B and Warramboo, but it is unconfirmed if they represent the same taxon. Currently only known from one site on Mesa A. Likely to be more widespread within Mesa A.
Ideoblothrus sp. nov.	MEARC2856 (n=1 in total)	Others members of this genus collected from Mesa B, but it is unconfirmed if they represent the same taxon. Currently only known from one site on Mesa A. Likely to be more widespread within Mesa A.
Polydesmida		
Haplodesmidae sp. 1	MEADC2497 (n= 1 in total)	Currently only known from one site on Mesa A. Likely to be more widespread within Mesa A.
Scolopendrida		
Cryptops sp. nov.	MEADC2500, MEARC2858 (n=2 in total)	Others members of this genus collected from Mesas B and G, but it is unconfirmed if they represent the same taxon. Collected from two locations on Mesa A, covering a distance of 2.4 km.
Diplura		
Campodeidae sp. nov.	MEAR2656 (n= 1 in total)	Currently only known from one site on Mesa A. Likely to be more widespread within Mesa A.
Japyx sp.	MEADC2497, MEADC2496, MEARC2740 (n=3 in total)	Others members of this genus collected from Mesas C and F, and Warramboo, but it is unconfirmed if they represent the same taxon. Collected from three locations on Mesa A, covering a total range of 18 ha.
Projapygidae sp. nov.	MEARC4024 (n=1 in total)	Currently only known from one site on Mesa A. Likely to be more widespread within Mesa A.
Thysanura		
Trinemura sp. nov.	MEADC2517A, MEADC2496, MEADC2501, MEADC2523, MEADC2582, MEARC3098 (n=7 in total)	Others members of this genus collected from Mesa B, Middle Robe and Warramboo, but it is unconfirmed if they represent the same taxon. Currently known from six locations on Mesa A, covering a total range of 252 ha.

From this review there are at least nine troglobitic taxa now documented from Mesa A (Table 5.1). Based on the available data, none of these occur outside of Mesa A (although members of the same genera are more widely distributed in most cases). This means that it cannot currently be demonstrated that any of the taxa occurring in Mesa A occur in the other mesas sampled during this study and the precautionary principle suggests they should be treated as endemic to Mesa A. The balance of this section, which deals with conservation significance and the predicted impacts of this proposal, is therefore focussed to the 'within Mesa A' spatial context.

5.2 Conservation Significance

5.2.1 Conservation Context

The troglobitic fauna documented in this study represents a previously unrecorded component of the subterranean fauna of Western Australia. Other, similar subterranean fauna communities occur on Cape Range and Barrow Island, both of which are within the conservation estate. Some of the troglobitic species occurring at Cape Range, and on Barrow Island, are formally listed as Threatened Fauna (see Table 5.2).

Table 5.2: Troglobitic species currently listed as Threatened Fauna under State legislation.

Schedule 1 (Rare and endangered Fauna)	
Draculoides bramstokeri	
Speleostrophus nesiotes	
Stygiochiropus isolatus	
Stygiochiropus peculiaris	Camerons Cave Millipede
Stygiochiropus sympatricus	
Bamazomus subsolanus	Eastern Cape Range Bamazomus
Bamazomus vespertinus	Western Cape Range Bamazomus
Draculoides bramstokeri	Barrow Island Draculoides
Draculoides brooksi	Northern Cape Range Draculoides
Draculoides julianneae	Western Cape Range Draculoides
Hyella sp. (BES#1154, 2525, 2546)	Camerons Cave Pseudoscorpion
Priority 2 Species (Taxa with few, poorly known populations on conservation lands)	
Nocticola flabella	Cape Range Blind Cockroach
Draculoides vinei	Cape Range Draculoides

The listing in Table 5.2 represents many of the troglobitic fauna species described in recent years. Most of these species have been listed on the basis that they have restricted spatial distributions and only occur in particular habitat types.

These listed species include the same genera (particularly the Schizomid genus *Draculoides*) and several of the orders represented amongst the fauna collected from Mesa A (including the Polydesmida and the Pseudoscorpionida).

5.2.2 Conservation Attributes of the Troglofauna of the Study Area

With the available data, most of the troglobitic taxa documented by this study would probably be considered 'data deficient' in terms of a definitive determination of conservation status. The new *Draculoides* species detailed in this study are perhaps the exception to this, given their relatively good sample size and that genetic studies and detailed morphological work have been completed. A precautionary approach should therefore be adopted in considering the conservation significance of the other less thoroughly studied and less-well collected troglobitic taxa. The distribution and phylogeography of the schizmoids can be used as a guide to the likely distribution of taxa in the other core troglobitic groups (Pseudoscorpionida, Scolopendrida, Polydesmida, Thysanura and Blattodea; see Section 4.2)

The fauna recorded has the following attributes of relevance to assessing the conservation significance of the subterranean species and fauna assemblages recorded:

- species with very short range distributions based on available data; each species currently appears to be restricted to its individual mesa (or possibly immediately adjacent mesas in the case of mesas B and C);
- relictual fauna representative of very old lineages; the lineages from which the contemporary troglofauna arose was present in subterranean habitats since the late Miocene (at least the last 10 million years);

- higher tiers of biodiversity involved; the species present are the only known representatives of orders and families in the Pilbara bioregion; and
- it is probable that other, currently uncollected species occur in the mesas which also have restricted distributions.

With these attributes, it is likely that the troglobitic species occurring in the mesas would be assigned a similar conservation status to the other, previously described troglobitic species endemic to Cape Range (see Section 5.2.1). The individual mesas then, which current data suggest contain troglobitic communities with a high degree of endemicity, would also be considered localised centres of biodiversity for this component of the regional biota (see Culver and Sket 2000, Sharrat et al. 2000).

5.3 Predicted Impacts and Planned Management

Attempting to predict the impacts of the proposed Mesa A development on subterranean fauna requires consideration of:

- the available distribution data which indicate that some troglobitic species occurring on Mesa A do not appear to occur on any of the other nearby mesas (and are therefore unlikely to occur further afield) (see Section 5.2);
- the current understanding of the ecosystem processes in troglobitic communities;
- key biophysical parameters thought to be central to maintaining the suitability of subterranean habitat for troglofauna; and
- review of the aspects of the project that may affect the mesa landforms and the trogobitic fauna habitat.

Within this context, the predicted impacts on troglofauna associated with the proposed Mesa A mine may be divided into two components:

1. impacts on troglofauna occurring in the proposed mine disturbance area; and
2. impacts on troglofauna occurring in retained areas of Mesa A adjoining the mine area.

These are discussed separately in Sections 5.3.1 and 5.3.2 respectively.

5.3.1 Impacts within the Mine Footprint on Mesa A

1. Direct Habitat Removal

This is the clearest and most direct impact on the troglofauna of Mesa A. The Robe pisolite proposed to be mined for the project is also the core habitat for the troglobitic species occurring within Mesa A. Given that most of the subterranean species in question are slow-moving and occur in microhabitats that have been relatively stable for an extended period, the assumption is that any populations currently present in the mine area will be lost. At present, there appears to be no evidence that any troglobitic taxa are restricted specifically to the proposed pit area itself (as opposed to the balance of Mesa A). Although some infrataxon genetic structuring is present, the evidence from the schizomid fauna suggests that a single species occurs across the mesa (see Section 4.2). The development of this pit area could then proceed without the immediate extinction of any of the troglobitic fauna species occurring within Mesa A. This assumes that an adequate portion of the remainder of Mesa A is set aside and not developed (see discussion under point 6 below).

A key question that arises from this impact is the viability of the remaining populations of the troglobitic fauna species endemic to Mesa A. This is likely to be a function of the extent, configuration and intactness of the portions of the mesa formation left undisturbed by future mining activities (see Section 5.3.2). This issue will be addressed in the PER to be prepared for the Mesa A proposal. A specific Subterranean Fauna Management Plan will also be prepared for the project as a separate document and Section 5.3.2 of the current report provides an overview of planned management actions to address each the impacts of the development.

5.3.2 Impacts on Adjacent Retained Areas of Mesa A

The existing habitats in which troglofauna occur are typically characterised by:

- a subterranean network of mesocaverns, fracture zones and cavities;
- darkness or near-darkness;
- stable, cool-moderate temperatures (Humphreys 2001; Paquin and Hedin 2004);
- high relative humidity (approaching 100%; Humphreys 2001);
- relatively high carbon dioxide levels (Culver and Sket 2000); and
- relatively low energy levels with autotrophic organic carbon entering the system from surface sources, particularly during flood events (Culver 1985, Humphreys 1991).

The ongoing suitability of habitat to support troglofauna in areas adjacent to mining operations is therefore linked to the maintenance of these core biophysical conditions and processes.

A central component of the Mesa A project planning and management is the retention of a proportion of Mesa A to provide for the preservation of the troglobitic species currently only known from Mesa A. Aspects of the proposed development that may directly or indirectly impact on the value of the retained area to continue to support troglofauna include:

1. Changes to Surface Hydrology

Humidity levels within the mesas are ultimately sustained by periodic surface water input and recharge during rainfall events. Alteration to surface hydrology, particularly in regards to sealing of recharge areas, could therefore affect underlying subterranean habitats. Increases in surface erosion could also lead to sedimentation of interstices and the filling (and thereby degradation or loss) of microhabitat space utilised by troglofauna within the mesa (James 1993).

To address these issues, project infrastructure, access roads and other ground disturbance will be excluded from the portion of the mesa set aside for troglofauna habitat. Any access roads that follow the margins of these retained areas will have sediment traps installed as part of drainage treatments to prevent any sediment mobilised during storm events entering subterranean habitats.

2. Changes to Subterranean Microclimate

Reduction in the key microclimate parameters, particularly humidity levels, could lead to changes in troglofauna use of the retained habitat. Troglobitic fauna have been shown to be far more sensitive to water loss than their surface analogues. Hadley et al. (1981) found that troglobitic lycosid spiders lost significantly more water than their surface congeners (up to 10 times the water loss rate at 0% relative humidity; mainly due to wax content differences in the cuticle). Humphreys (1991) also demonstrated that troglobitic fauna communities tend to contract in distribution into deeper habitats as humidity levels fall in more superficial areas. These physiological and ecological responses signal sensitivities in this fauna to drying of strata and reductions in subterranean relative humidity levels.

A potential impact mechanism relating to this is presented by the exposure of openings in the mine pit wall leading to deeper fractured strata in adjoining mesa habitat. The likelihood of this causing humidity reductions or other microclimate change in subterranean habitat in the retained area will reduce with increasing distance from the pit wall. This would suggest that very small or narrow mesa remnants are more likely to dry out and become unsuitable for troglofauna use. Equally, larger areas of retained mesa habitat are likely to continue to provide microclimate conditions suitable for troglobitic communities, at least in the short to medium term. There is some support for this with the collection of troglobites from remnant mesa areas at Middle Robe and Mesa K, both of which were historically mined (see point 6 below).

Data loggers will be installed in bores surrounding the pit to monitor humidity levels during mining operations. This programme will include monitoring of similar habitats on a nearby analogue site (probably Mesa B) to enable any regional changes in mesa humidity levels to be identified from changes specific to Mesa A. In the event that localised reductions in humidity are recorded, consideration will be given to employing down-hole trickle irrigation to offset drying effects from the pit wall exposure. Other, larger scale re-injection of groundwater into the base of the mesa may also be trialled if wider-scale declines in relative humidity levels are recorded.

3. Surface and Ground Water Contamination

The potential exists for the subterranean environment to be degraded by spills of hydrocarbons or wastewater (e.g. Hubbard and Balfour 1993). Diesel and other hydrocarbons will be used on a routine basis during mining, presenting both operational (e.g. refuelling) and storage risks.

These risks are relatively straight forward to manage through established project design, infrastructure and operational procedures. Hydrocarbon storage for the project will be situated off the retained mesa areas and will comprise current best practice facilities. All servicing will be carried out at dedicated facilities off the mesa remnants, and no refuelling of plant or equipment will be conducted on the areas of the mesa retained for troglofauna habitat.

4. Reduction in Organic Inputs

All organic carbon inputs to troglobitic ecosystems ultimately stem from surface sources. Clearing of vegetation beyond the mine footprint therefore has the potential to reduce nutrient influx to the underlying mesa remnants.

This will be addressed through the implementation of dedicated vegetation clearing control procedures during the life of the project. This would comprise delineation of all vegetation clearing boundaries on design plans and surveying of these boundaries in the field, prior to written approval to proceed with clearing from the project environmental manager. Vegetation clearing would be prohibited within the area retained for troglofauna habitat.

5. Vibration

Blasting activities during mining have the potential to cause collapses of strata and other features such as mesocaverns in the remnant mesa formation. This is a difficult impact to quantify, but Robe will develop a geophysical monitoring programme to identify the extent to which any effects may be extending into the adjoining retained mesa habitat.

6. Extent of Retained Habitat and Viable Population Sizes

This last factor integrates consideration of many of the factors discussed above. With the planned management measures for this project, it appears likely that most of the extraneous impacts discussed previously could be effectively managed through proper project design or operational procedures. The key issue for the Mesa A troglobitic assemblage then becomes whether the size and configuration of the mesa habitat left intact is adequate to ensure the viability of the Mesa A troglofauna species. "How much reserve area is enough?" is a difficult ecological question to address even in relatively well-studied terrestrial systems.

The current understanding of the ecology of these subterranean ecosystems is preliminary only, which also limits our ability to make confident predictions in regards to these factors. However, some guidance can be obtained in this respect from:

- the size of other, smaller mesas known to contain similar troglobitic assemblages (such as Mesa B);
- the size and configuration of habitat remnants in other areas subject to historical mining disturbance that still support troglofauna (Mesa K and Middle Robe); and
- data from other sites where mining activity has encroached into troglobitic fauna habitat (principally the Exmouth Limestone mine at Cape Range; Biota (2004)).

Mesa B, which contained a similar abundance and diversity of troglofauna to Mesa A (Section 4.4.5), at 173 ha, is roughly a third of the size of Mesa A (573 ha; Table 3.1). This smaller extent of habitat has clearly been large enough to sustain troglofauna in the long term, with at least five taxa representing four troglobitic orders extant in the mesa today (see Section 4.2). Mesa B is, however, an undisturbed landform that has a relatively optimal area to boundary ratio (see Figure 2.3). Therefore, while some comparisons can be drawn, It is not entirely valid to directly equate this smaller area with the extent of habitat that would remain in Mesa A.

The distribution and extent of original mesa habitat in the disturbed areas of Mesa K and Middle Robe may be similar to the retained area of Mesa A once mining is complete. Mesa K was originally of a similar size to Mesa A (306 ha compared to 573 ha), and has now largely been disturbed by historical mining activities. Mining ceased at Mesa K in 1996, after a project life of eight years, leaving some 44% (137 ha) of the original mesa formation intact. Middle Robe (lease 2402E) provides a similar analogue, but was originally smaller in size than Mesa A (89 ha). Lease 2402E at Middle Robe was mined for a period of 12 years, ending in 1983 (22 years prior to the sampling reported in this study). Approximately 24 ha of Middle Robe was left un-mined, representing 27% of the original extent of this mesa (see Figure 5.1).

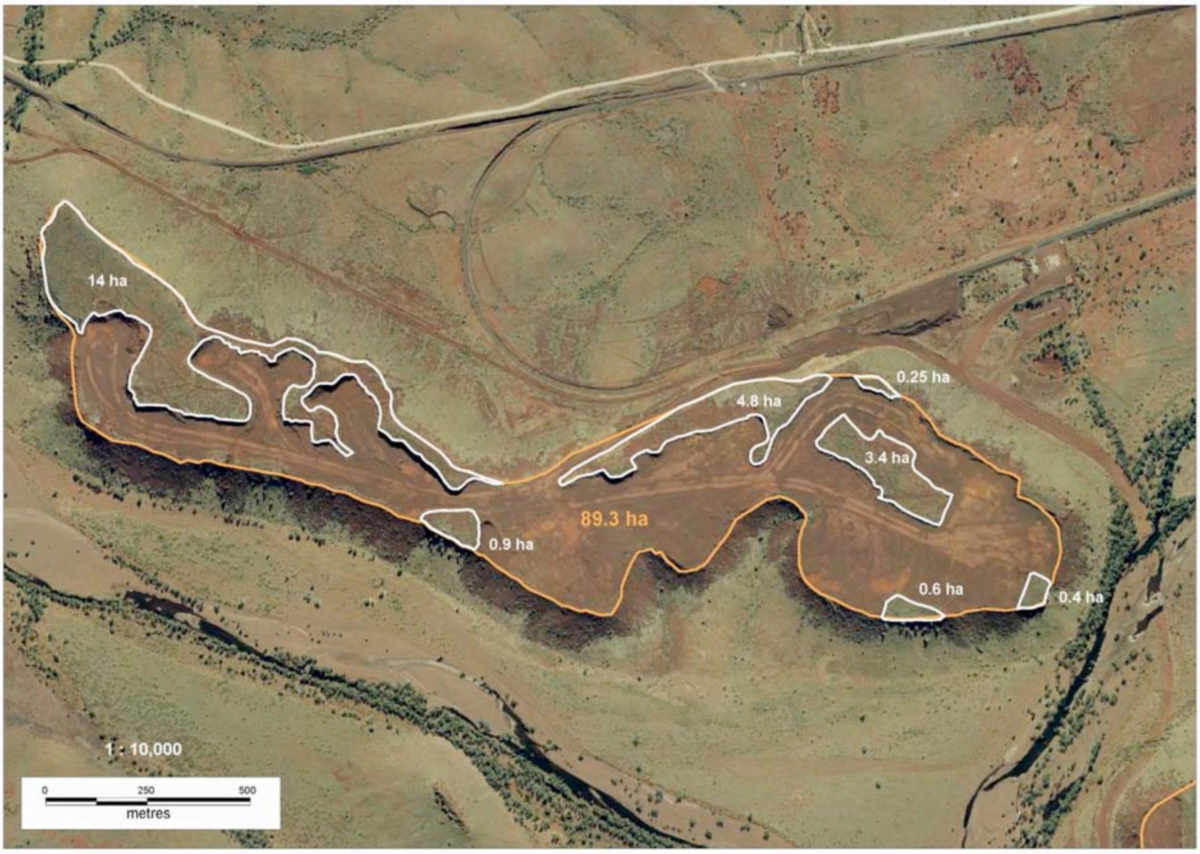

Figure 5.1: Aerial view of Middle Robe (lease 2402E), highlighting original extent (in orange) and areas left undisturbed by mining (bounded in white).

Schizomids belonging to the same genus as those in Mesa A (*Draculoides*) were recorded from remnant mesa habitat at both Middle Robe and Mesa K (see Section 4.2). This apparently more easily collected group could be treated as an 'indicator' that other troglofauna may also still occur in these historically disturbed mesas. The presence of troglobitic cockroaches at Middle Robe offers some support for this.

Excavation operations at the Exmouth Limestone mine on Cape Range also provide some guidance as to the sensitivity of troglofauna to mining in nearby areas. Sampling at this project's bore RC29 (less than 50 m from the pit wall; Figure 5.2) showed the continued presence of troglofauna over three years after the commencement of mining (Biota 2002). A troglobitic pseudoscorpion was also recently collected on the edge of an active mining area in limestone geology at Ludlow (Biota 2005). These observations suggest that any influence of mining on adjoining troglofauna habitats is not immediate or that fauna have some tolerance (at least in the short term) to any microclimate changes that do occur.

Figure 5.2: Location of bore RC29 immediately adjacent to the Exmouth Limestone mine on Cape Range (source: Biota 2002).

There is some evidence then that areas of undisturbed mesa habitat retained at Mesa A will still support troglofauna for at least the 10-20 year post-closure timeframes suggested by Middle Robe and Mesa K. The available information from other sites indicates that mining can approach relatively close to undisturbed troglofauna habitat without necessarily resulting in local population extinctions. The long-term effect of the overall population reductions that will occur in Mesa A will be more difficult to predict. The schizomids and other fauna occurring within the mesa will be effectively forced through a genetic and demographic bottleneck. The ability of the troglofauna to establish a new population equilibrium that would be stable and viable in the long-term, or their ability to recolonise any mined out areas, is difficult to assess on the basis of current knowledge. Persistence of these populations in the longer term is likely to be determined primarily by the extent and configuration of the portion of Mesa A that is quarantined from mining.

An ongoing research programme addressing the troglobitic fauna of the Robe valley mesas will be undertaken by Robe as part of the implementation of the Mesa A project. This will include monitoring of relevant subterranean habitat characteristics and additional sampling of troglobitic fauna. Further genetics studies and additional morphological and taxonomic descriptive work will also be funded as part of this initiative. The establishment of facilities for DNA analyses at the Western Australian Museum (to better investigate phylogenetic relationships and assist in species-level identification and taxonomic work) will be funded as part of offsets currently planned to accompany the development of the Mesa A proposal. Finally, additional research into the ecology and ecosystem processes for these communities will also form an important component of the planned programme. The additional data arising from this work will allow some of the questions raised and judgements made in this report to be reassessed and validated against an improved knowledge base.

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Appendix 1

Details of Boreholes Sampled During this Study

Phase	Installed	Recovered	Project Area	Hole	Easting	Northing	No. traps	Trap Depths	Depth (m)	Year installed	Comments
1	5/12/04	20/1/05	Mesa A	MEARC2519	386846	7604148	4	10, 27, 35, 42	66		Water @ 45.75m
1	5/12/04	20/1/05	Mesa A	MEARC2523	386750	7604043	4	10, 25, 30, 40	58		Water @ 45.23m
1	5/12/04	20/1/05	Mesa A	MEARC2582	385926	7604914	4	11, 16, 20, 29	34		Dry - 30.8m
1	5/12/04	20/1/05	Mesa A	MEADC2492	383446	7602683	2	10, 18	58.3		Water @ 42.08m
1	5/12/04	20/1/05	Mesa A	MEADC2493	383739	7602993	4	8, 19, 25, 39	65		Water @ 44.77m
1	5/12/04	20/1/05	Mesa A	MEADC2495	384033	7603106	4	11, 22, 33, 38	63.5		Water @ 45.55m
1	5/12/04	20/1/05	Mesa A	MEADC2496	384518	7603514	4	8, 15, 24, 35	62		Water @ 46.96m
1	5/12/04	20/1/05	Mesa A	MEADC2497	384828	7603330	3	3, 8, 15	53		Dry - 16.0m
1	5/12/04	20/1/05	Mesa A	MEADC2498	384919	7603629	4	4, 8, 25, 40	52.5		Dry - 47.1m
1	5/12/04	20/1/05	Mesa A	MEADC2500	385313	7603749	4	8, 16, 23, 35	63.2		Water @ 46.9m
1	5/12/04	20/1/05	Mesa A	MEADC2501	385512	7603752	2	8, 15	61.6		Dry - 16.3m
1	5/12/04	20/1/05	Mesa G	MEGDC0014A	408663	7596511	4	4, 15, 25, 37	50		Dry - 49.63
1	5/12/04	20/1/05	Mesa G	MEGDC0057A	407537	7595763	4	10, 20, 30, 40	46		Dry - 45.5m
1	5/12/04	20/1/05	Mesa G	MEGDC0108A	406265	7594454	4	5, 15, 20, 29	36		Water @ 31.08m
1	5/12/04	20/1/05	Mesa G	MEGDC0115A	406735	7594955	4	10, 20, 29, 40	45.5		Water @ 44.09m
1	5/12/04	20/1/05	Mesa G	MEGDC0159A	410538	7595809	4	12, 25, 35, 45	50		Dry - 46.42m
1	5/12/04	20/1/05	Mesa G	MEGRC0130	407737	7596114	4	10, 20, 30, 39	50		Dry - 47.09m
1	5/12/04	20/1/05	Mesa H	MEHDD0970	419988	7593554	3	5, 10, 15	48.1		Water @ 16.36m TD 16.7m
1	5/12/04	20/1/05	Mesa H	MEHDD0972	419888	7593504	2	5, 10	37.9		Dry - 12.24m
1	5/12/04	20/1/05	Mesa H	MEHDD0985	419588	7593254	2	5, 10	40.8		Dry - 11.77m
1	5/12/04	20/1/05	Mesa H	MEHRD1007	419486	7593752	3	5, 10, 15	36.5		Water @ 20.85m TD 35.07m
1	5/12/04	20/1/05	Mesa H	MEHRD1016	419487	7594155	2	5, 10	36.5		Water @ 14.38m TD 34.72m
1	5/12/04	20/1/05	Mesa H	MEHRD1021	419588	7594252	2	5, 11	20		Water @ 14.40m TD 19.67m
1	5/12/04	20/1/05	Mesa J	MEJRC6188	422688	7592304	4	8, 16, 24, 31	32		still to be checked
1	5/12/04	20/1/05	Mesa J	MEJRC6193	422188	7592504	4	8, 18, 25, 32	34		still to be checked
2	31/3/05	27/5/05	Todd Bore	MEARC3180	379521	7600160	4	12, 25, 35, 45	58	2003	No cavities mentioned in comments
2	31/3/05	27/5/05	Todd Bore	MEARC3181	379909	7600573	3	10, 20, 30	58	2003	No cavities mentioned in comments
2	31/3/05	27/5/05	Todd Bore	MEARC3182	379915	7600184	4	10, 20, 30, 40	56	2003	No cavities mentioned in comments
2	31/3/05	27/5/05	Mesa A	MEADC2492	383446	7602683	3	10, 20, 30	58.3	-	Water @ 42.08m
2	31/3/05	27/5/05	Mesa A	MEADC2493	383739	7602993	4	10, 20, 30, 40	65	-	Water @ 44.77m
2	31/3/05	27/5/05	Mesa A	MEADC2496	384518	7603514	4	10, 20, 30, 39	62	-	Water @ 46.96m
2	31/3/05	27/5/05	Mesa A	MEADC2497	384828	7603330	4	10, 20, 30, 40	53	-	Dry - 16.0m
2	31/3/05	27/5/05	Mesa A	MEADC2500	385313	7603749	4	10, 20, 30, 40	63.2	-	Water @ 46.9m
2	31/3/05	27/5/05	Mesa A	MEADC2501	385512	7603752	3	8, 15, 25	61.6	-	Dry - 16.3m
2	31/3/05	27/5/05	Mesa A	MEADC2517A	384847	7602728	3	8, 15, 25	18.5	2002	Cavity 14.6 - 15.2m
2	31/3/05	27/5/05	Mesa A	MEADC2522A	384638	7602913	3	8, 15, 25	22.5	2002	Cavity 10.3 - 12.2m
2	31/3/05	27/5/05	Mesa A	MEADC3188	383599	7602538	2	10, 20	58.1	2004	Cavity 20.8 - 21.0, 45.2 - 45.6m, 50.2 - 50.6, 51.3 - 52.8
2	31/3/05	27/5/05	Mesa A	MEADC3192	384100	7602456	2	10, 20	24.3	2004	
2	31/3/05	27/5/05	Mesa A	MEADC3208	386085	7604573	1	10	42.3	2004	
2	31/3/05	27/5/05	Mesa A	MEARC2519	386846	7604148	2	10, 20	66	-	Water @ 45.75m
2	31/3/05	27/5/05	Mesa A	MEARC2523	386750	7604043	2	10, 20	58	-	Water @ 45.23m
2	31/3/05	27/5/05	Mesa A	MEARC2582	385926	7604914	3	8, 15, 25	34	-	Dry - 30.8m
2	31/3/05	27/5/05	Mesa B	MEBRC0002	389435	7603957	3	8, 15, 25	44	1999	Edge of Mesa B closest to Mesa A
2	31/3/05	27/5/05	Mesa B	MEBRC0003	389438	7604147	3	8, 15, 25	54	1999	Edge of Mesa B closest to Mesa A
2	31/3/05	27/5/05	Mesa B	MEBRC0014	392138	7603755	1	10	70	2004	Deepest hole in recent drilling programe.
2	31/3/05	27/5/05	Mesa B	MEBRC0015	392138	7603955	3	8, 15, 25	52	2004	cavity only at 8m-10m depth.
2	31/3/05	27/5/05	Mesa B	MEBRC0016	392137	7604057	3	8, 15, 25	50	2004	cavity only at 8m - 10m depth

Phase	Installed	Recovered	Project Area	Hole	Easting	Northing	No. traps	Trap Depths	Depth (m)	Year installed	Comments
2	31/3/05	27/5/05	Mesa B	MEBRC0018	391736	7604656	2	8, 15	38	2004	TPM from 20m to 30m
2	31/3/05	27/5/05	Mesa B	MEBRC0019	391736	7604455	3	10, 20, 30	40	2004	
2	31/3/05	27/5/05	Mesa B	MEBRC0020	391937	7604656	3	10, 20, 30	34	2004	cavity 12-14m
2	31/3/05	27/5/05	Mesa B	MEBRC0021	391937	7604456	3	10, 20, 30	40	2004	cavity 8m-10m depth8m
2	31/3/05	27/5/05	Mesa B	MEBRC0023	391937	7604056	2	10, 18	58	2004	
2	31/3/05	27/5/05	Mesa B	MEBRC0025	392337	7603757	4	8, 19, 25, 39	38	2004	
2	31/3/05	27/5/05	Mesa C	MECRC0007	392737	7600152	4	8, 15, 24, 35	52	1999	Additional hole for broad spread across Mesa
2	31/3/05	27/5/05	Mesa C	MECRC0012	392738	7600953	3	3, 8, 15	54	1999	Deeper hole
2	31/3/05	27/5/05	Mesa C	MECRC0018	392942	7601355	4	8, 16, 23, 35	54	1999	Deeper hole
2	31/3/05	27/5/05	Mesa C	MECRC0026	392744	7602557	2	8, 15	50	1999	Edge of Mesa C closest to Mesa B
2	31/3/05	27/5/05	Mesa G	MEGDC0057A	407537	7595763	2	8, 15	46	-	Dry - 45.5m
2	31/3/05	27/5/05	Mesa G	MEGDC0108A	406265	7594454	3	6, 11, 18	36	-	Water @ 31.08m
2	31/3/05	27/5/05	Mesa G	MEGDC0115A	406735	7594955	3	21, 30, 45	45.5	-	Water @ 44.09m
2	31/3/05	27/5/05	Mesa G	MEGDC0159A	410538	7595809	3	10, 20, 30	50	-	Dry - 46.42m
2	31/3/05	27/5/05	Mesa G	MEGDC0202	411833	7595663	3	10, 20, 30	43.8	2004	Additional hole to spread sampling density
2	31/3/05	27/5/05	Mesa G	MEGRC0060	408338	7595555	3	10, 27, 35	58	1999	
2	31/3/05	27/5/05	Mesa G	MEGRC0097	407526	7596934	4	10, 25, 30, 40	38	1999	
2	31/3/05	27/5/05	Mesa G	MEGRC0104	405138	7594298	4	11, 16, 20, 29	50	2001	Additional hole to spread sampling density
2	31/3/05	27/5/05	Mesa G	MEGRC0130	407737	7596114	4	10, 20, 30, 40	50	-	Dry - 47.09m
2	31/3/05	27/5/05	Mesa G	MEGRC0140	408240	7596610	4	10, 20, 30, 40	56	2001	Additional hole to spread sampling density
2	31/3/05	27/5/05	Mesa G	MEGRC0163	410140	7596355	4	10, 25, 40, 50	56	2001	Additional hole to spread sampling density
2	31/3/05	27/5/05	Middle Robe	M2ERC0039	450640	7600852	4	10, 20, 30, 40	30	2001	Mesa Top - West
2	31/3/05	27/5/05	Middle Robe	M2ERC0057	450739	7600753	4	10, 20, 30, 40	28	2001	Mesa Top - West
2	31/3/05	27/5/05	Middle Robe	M2ERC0063	450988	7600692	4	10, 22, 28, 40	28	2001	Mesa Top - West.
2	31/3/05	27/5/05	Middle Robe	M2ERC026	452540	7600500	4	10, 20, 30, 40	22	2001	Mesa Top - East. Cavity 16 - 18m
2	31/3/05	27/5/05	Middle Robe	M2ERC027	452491	7600503	3	8, 13, 25	22	2001	Mesa Top - East. Cavity 10 - 12m
2	31/3/05	27/5/05	Middle Robe	M2ERC029	452489	7600600	3	9, 20, 30	24	2001	Mesa Top - East
2	31/3/05	27/5/05	Middle Robe	M2ERC034	452338	7600654	4	10, 20, 30, 40	22	2001	Mesa Top - East. Cavity 10 - 12m, 16-18m
2	31/3/05	27/5/05	Middle Robe	M2ERC095	452439	7600700	3	10, 20, 30	14	2001	Mesa Top - East
2	31/3/05	27/5/05	Middle Robe	M2ERC026	452540	7600500	4	10, 20, 30, 40	22	2001	Mesa Top - East
2	31/3/05	27/5/05	Middle Robe	M2ERC046	450592	7601002	4	10, 20, 30, 40	28	2001	Mesa Top - West
2	31/3/05	27/5/05	Middle Robe	M2ERC049	450490	7601003	4	10, 20, 30, 40	26	2001	Mesa Top - West
2	31/3/05	27/5/05	Middle Robe	M2ERC076	451640	7600301	4	10, 20, 30, 40	6	2001	Pit Floor
2	31/3/05	27/5/05	Middle Robe	M2ERC053	450440	7601098	4	10, 20, 30, 40	26	2001	Mesa Top - West
2	31/3/05	27/5/05	Middle Robe	M2ERC061	450840	7600701	4	5, 15, 20, 29	30	2001	Mesa Top - West. Cavity 6-8m
2	31/3/05	27/5/05	Middle Robe	M2ERC103	452638	7600253	4	10, 20, 29, 40	16	2001	Pit Floor
2	31/3/05	27/5/05	Warramboo	MEARC2318	377509	7606893	3	5, 10, 15	16		14-16m large cavity, abundant water
2	31/3/05	27/5/05	Warramboo	MEADC2381	378401	7604023	3	5, 10, 15	-		
2	31/3/05	27/5/05	Warramboo	MEARC2380	377122	7606480	3	5, 10, 15	20		Wet, 15 - 16m = cavity,14-15 cavity on log
2	31/3/05	27/5/05	Warramboo	A1311	379417	7603652	3	5, 10, 15	18		Cavity 18-21m
2	31/3/05	27/5/05	Warramboo	A1536	379417	7603652	3	5, 10, 15	-		
2	12/6/05	31/7/05	Mesa K	MEKRC1701	423454	7597892	4	10, 20, 30, 40	40		Dry
2	12/6/05	31/7/05	Mesa K	MEKRC1712	423521	7597774	4	10, 20, 30, 40	51		45
2	12/6/05	31/7/05	Mesa K	MEKRC1704	423726	7597874	2	5, 10	12		Blocked
2	12/6/05	31/7/05	Mesa K	MEKRC1694	423769	7597923	4	10, 20, 30, 40	43		40
2	12/6/05	31/7/05	Mesa K	MEKRC1689	423622	7597973	4	10, 20, 30, 40	49		38
2	12/6/05	31/7/05	Mesa K	MEKRC1690	423772	7597973	3	5, 10	19		Blocked

Phase	Installed	Recovered	Project Area	Hole	Easting	Northing	No. traps	Trap Depths	Depth (m)	Year installed	Comments
2	12/6/05	31/7/05	Mesa K	MEKRC1685	423823	7598023	3	10, 20, 30	38		38
2	12/6/05	31/7/05	Mesa K	MEKRC1728	423826	7598175	3	10, 20, 30	40		Dry
2	12/6/05	31/7/05	Mesa K	MEKRC1718	423876	7598174	4	10, 20, 30, 40	46		43
2	12/6/05	31/7/05	Mesa K	MEKRC1724	424071	7598330	4	10, 20, 30, 40	45		42
2	12/6/05	31/7/05	Mesa K	MEKRC1721	423931	7598327	3	10, 20, 30	37		35
2	12/6/05	31/7/05	Mesa K	MEKRC1735	423568	7598037	3	5, 10, 15	18		Dry
2	12/6/05	31/7/05	Mesa F	MEFRC0068	396538	7590154	3	8, 15, 25	30	1999	Additional holes near transport corridor
2	12/6/05	31/7/05	Mesa F	MEFRC0072	396536	7589355	4	10, 25, 35, 45	60	1999	Deeper hole
2	12/6/05	31/7/05	Mesa F	MEFRC0075	397333	7589332	3	10, 20, 30	46	1999	Close to Mesa edge. Next to hole w cavities
2	12/6/05	31/7/05	Mesa F	MEFRC0076	398139	7592502	4	10, 20, 30, 40	50	1999	Deeper hole
2	12/6/05	31/7/05	Mesa F	MEFRC0079	398137	7591951	4	10, 20, 30, 40	52	1999	Deeper hole
2	12/6/05	31/7/05	Mesa F	MEFRC0080	397390	7591748	3	10, 20, 30	32	1999	Additional holes near transport corridor
2	12/6/05	31/7/05	Mesa F	MEFRC0082	397337	7591359	4	10, 20, 30, 40	40	1999	Additional holes near transport corridor
2	12/6/05	31/7/05	Mesa F	MEFRC0086	397339	7590559	3	10, 20, 30	34	1999	Additional holes near transport corridor
2	12/6/05	31/7/05	Mesa F	MEFRC0090	397337	7589751	4	10, 20, 30, 40	54	1999	Deeper hole. Near incision on Mesa. CAV 38-40m?
2	12/6/05	31/7/05	Mesa F	MEFRC0091	397342	7589559	4	10, 20, 30, 40	50	1999	Deeper hole. Near incision on Mesa. CAV 36-40m
2	12/6/05	31/7/05	Mesa F	MEFRC0092	398033	7589927	3	10, 20, 30	30	1999	Additional holes near transport corridor
2	12/6/05	31/7/05	Mesa F	MEFRC0097	398140	7591152	4	10, 20, 30, 40	54	1999	Deeper hole
2	12/6/05	31/7/05	Mesa F	MEFRC0099	398136	7591558	4	10, 20, 30, 40	52	1999	Deeper hole
3	1/8/05	15/9/05	Warramboo	MEARC2411	376589	7604463	3	5, 10, 15	18	2001	
3	1/8/05	15/9/05	Warramboo	MEARC3956	377219	7605033	3	5, 10, 15	22	2004	
3	1/8/05	15/9/05	Warramboo	MEARC2374	377319	7606587	3	5, 10, 15	22	2000	
3	1/8/05	15/9/05	Warramboo	MEARC3960	377328	7604737	3	5, 10, 15	26	2004	
3	1/8/05	15/9/05	Warramboo	MEARC2318	377509	7606893	3	5, 10, 15	16	2000	
3	1/8/05	15/9/05	Warramboo	MEARC3857	377883	7606155	3	5, 10, 15	22	2004	
3	1/8/05	15/9/05	Warramboo	MEARC3402	377979	7603158	1	5	8	2004	
3	1/8/05	15/9/05	Warramboo	MEARC2206	378115	7606712	3	5, 10, 15	18	1999	
3	1/8/05	15/9/05	Warramboo	MEARC3334	378466	7603575	3	5, 10, 15	18	2004	
3	1/8/05	15/9/05	Warramboo	MEADC2381	378501	7604073	3	5, 10, 15	23	2000	
3	1/8/05	15/9/05	Warramboo	MEARC3585	378617	7605079	3	5, 10, 15	40	2004	
3	1/8/05	15/9/05	Warramboo	MEARC2152	378914	7606737	2	5, 10	14	1999	
3	1/8/05	15/9/05	Warramboo	A1386	379117	7603642	3	5, 10, 15	20	1994	
3	1/8/05	15/9/05	Warramboo	MEADC2383	379339	7604450	3	5, 10, 15	15	2000	
3	1/8/05	15/9/05	Warramboo	MEARC3693	379397	7605705	3	5, 10, 15	16	2004	
3	1/8/05	15/9/05	Warramboo	MEARC4123	379595	7602709	1	5	8	2005	
3	1/8/05	15/9/05	Warramboo	MEARC2060	379762	7605265	3	5, 10, 15	16	1999	
3	1/8/05	15/9/05	Warramboo	MEARC2040	379933	7606171	2	5, 10	12	1999	
3	1/8/05	15/9/05	Warramboo	A0655	380268	7601980	2	5, 10	10	1991	
3	1/8/05	15/9/05	Warramboo	A1803	380642	7602793	3	5, 10, 15	16	1997	
3	1/8/05	15/9/05	Warramboo	A1795	380693	7601194	3	5, 10, 15	22	1997	
3	1/8/05	15/9/05	Warramboo	A1778	381422	7603418	3	5, 10, 15	16	1997	
3	1/8/05	15/9/05	Warramboo	A1784	381467	7602019	3	10, 20, 30	34	1997	
3	1/8/05	15/9/05	Warramboo	A1768	382240	7602844	3	10, 20, 30	40	1997	
3	1/8/05	15/9/05	Mesa A	A1762A	382279	7601645	3	5, 10, 15	20	1997	
3	1/8/05	15/9/05	Mesa A	A1759	382298	7601046	3	10, 20, 30	32	1997	
3	1/8/05	15/9/05	Mesa A	A0585	382659	7602258	3	10, 20, 30	40	1991	
3	1/8/05	15/9/05	Mesa A	MEARC3096	382883	7601571	3	5, 10, 15	24	2003	

Phase	Installed	Recovered	Project Area	Hole	Easting	Northing	No. traps	Trap Depths	Depth (m)	Year installed	Comments
3	1/8/05	15/9/05	Mesa A	MEAWO4092	382898	7601172	4	10, 20, 30, 40	76	2004	
3	1/8/05	15/9/05	Mesa A	A1747	383027	7603270	3	5, 10, 15	28	1997	
3	1/8/05	15/9/05	Mesa A	MEARC2702	383154	7602374	3	10, 20, 30	46	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2713	383241	7602781	3	10, 20, 30	46	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4151	383242	7602877	3	5, 10, 15	-	-	
3	1/8/05	15/9/05	Mesa A	MEARC3073	383407	7602331	3	10, 20, 30	32	2003	
3	1/8/05	15/9/05	Mesa A	MEARC3069	383420	7601933	3	5, 10, 15	24	2003	
3	1/8/05	15/9/05	Mesa A	MEARC3066	383430	7601632	3	10, 20, 30	30	2003	
3	1/8/05	15/9/05	Mesa A	MEADC2492	383446	7602683	3	5, 10, 15	-	-	
3	1/8/05	15/9/05	Mesa A	MEARC2740	383490	7602939	3	5, 10, 15	30	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4065	383495	7601089	3	5, 10, 15	22	2004	
3	1/8/05	15/9/05	Mesa A	MEARC2809	383572	7603243	3	5, 10, 15	16	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2749	383607	7602240	3	5, 10, 15	26	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4068	383872	7601896	3	5, 10, 15	22	2004	
3	1/8/05	15/9/05	Mesa A	A1149	384066	7602203	3	5, 10, 15	22	1994	
3	1/8/05	15/9/05	Mesa A	MEARC2934	384229	7601661	3	5, 10, 15	26	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2905	384344	7601260	3	5, 10, 15	16	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2888	384415	7601966	1	5	8	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2858	384537	7601468	2	5, 10	14	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2856	384564	7603670	3	10, 20, 30	40	2003	
3	1/8/05	15/9/05	Mesa A	MEADC2497	384828	7603330	4	10, 20, 30, 40	53	2001	
3	1/8/05	15/9/05	Mesa A	MEARC2691	384948	7603985	3	10, 20, 30	46	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2656	385180	7603088	3	5, 10, 15	28	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4050	385246	7604290	4	10, 20, 30, 40	58	2004	
3	1/8/05	15/9/05	Mesa A	MEARC2635	385438	7604602	3	10, 20, 30	30	2003	
3	1/8/05	15/9/05	Mesa A	MEADC2501	385512	7603752	4	10, 20, 30, 40	62	2001	
3	1/8/05	15/9/05	Mesa A	MEARC4039	385749	7604110	3	5, 10, 15	28	2004	
3	1/8/05	15/9/05	Mesa A	A0825	385783	7604762	3	10, 20, 30	38	1994	
3	1/8/05	15/9/05	Mesa A	MEARC4079	385821	7603561	3	5, 10, 15	30	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4038	385856	7603910	4	10, 20, 30, 40	52	2004	
3	1/8/05	15/9/05	Mesa A	MEARC2582	385926	7604914	3	10, 20, 30	34	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4033	385951	7604019	4	10, 20, 30, 40	46	2004	
3	1/8/05	15/9/05	Mesa A	MEARC2611	385969	7603614	4	10, 20, 30, 40	54	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4047	386016	7605121	3	10, 20, 30	34	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4029	386050	7604021	4	10, 20, 30, 40	58	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4010	386123	7604915	3	10, 20, 30	36	2004	
3	1/8/05	15/9/05	Mesa A	MEARC2560	386147	7604224	3	5, 10, 15	28	2003	
3	1/8/05	15/9/05	Mesa A	MEARC2574	386218	7605123	3	10, 20, 30	40	2003	
3	1/8/05	15/9/05	Mesa A	MEARC4009	386220	7605028	4	10, 20, 30, 40	58	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4024	386249	7604125	4	10, 20, 30, 40	52	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4026	386255	7603927	4	10, 20, 30, 40	62	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4016	386452	7604032	4	10, 20, 30, 40	64	2004	
3	1/8/05	15/9/05	Mesa A	MEARC4018	386460	7603830	3	10, 20, 30	42	2004	
3	1/8/05	15/9/05	Mesa A	MEARC2546	386527	7604834	3	10, 20, 30	40	2003	
3	1/8/05	15/9/05	Mesa A	MEARC3042	386894	7604492	3	10, 20, 30	34	2003	

Appendix 2

Details of All Specimens Collected During this Study

Phase	Date	Study Area	Bore	Easting	Northing	Trap	Specimen No.	n	Class	Order
0	17/12/03	Mesa A	MEADC2497	384828	7603330	Haul net	MA2496-100	1	Diplura	Diplura
0	17/12/03	Mesa A	MEADC2497	384828	7603330	Haul net	MEA2500-101	1	Diplopoda	Polydesmida
0	17/12/03	Mesa A	MEADC2500	385313	7603749	Haul net	MA2500-100	1	Arachnida	Schizomida
0	17/12/03	Mesa A	MEADC2500	385313	7603749	Haul net	MA2496-101	2	Chilopoda	Scolopendrida
1	21/3/05	Warramboo	A1536	379417	7603652	1	A1536-1	10	Arachnida	Acari
1	21/3/05	Warramboo	A1536	379417	7603652	1	A1536-2	1	Arachnida	Acari
1	21/3/05	Warramboo	A1536	379417	7603652	3	A1536-4	8	Arachnida	Acari
1	21/3/05	Warramboo	A1536	379417	7603652	3	A1536-5	2	Arachnida	Acari
1	21/3/05	Warramboo	A1536	379417	7603652	3	A1536-6	8	Insecta	Collembola
1	21/3/05	Warramboo	MEADC2380	378501	7604073	1	DC2380-1	11	Arachnida	Acari
1	21/3/05	Warramboo	MEADC2380	378501	7604073	1	DC2380-3	6	Arachnida	Acari
1	21/3/05	Warramboo	MEADC2380	378501	7604073	2	DC2380-6	13	Arachnida	Acari
1	21/3/05	Warramboo	MEADC2380	378501	7604073	1	DC2380-4	1	Insecta	Collembola
1	21/3/05	Warramboo	MEADC2380	378501	7604073	2	DC2380-5	2	Insecta	Collembola
1	21/3/05	Warramboo	MEADC2380	378501	7604073	1	MEADC2380-1	1	Arachnida	Pseudoscorpiones
1	21/3/05	Warramboo	MEADC2381	378401	7604023	3	DC2381-3	4	Arachnida	Acari
1	21/3/05	Warramboo	MEADC2381	378401	7604023	2	DC2381-1	4	Arachnida	Acari
1	21/3/05	Warramboo	MEADC2381	378401	7604023	3	DC2381-4	4	Arachnida	Acari
1	21/3/05	Warramboo	MEADC2381	378401	7604023	3	DC2381-2	1	Insecta	Blattodea
1	20/1/05	Mesa A	MEADC2492	383446	7602683	1	MA2492-1	15	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2492	383446	7602683	1	MA2492-2	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2492	383446	7602683	2	MA2492-6	30	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2492	383446	7602683	1	MA2492-4	1	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2493	383739	7602993	2	MA2493-3	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2493	383739	7602993	3	MA2493-5	15	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2493	383739	7602993	4	MA2493-9	15	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2493	383739	7602993	2	MA2493-4	1	Arachnida	Araneae
1	20/1/05	Mesa A	MEADC2493	383739	7602993	3	MA2493-6	3	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2495	384033	7603106	2	MA2495-4	1	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2495	384033	7603106	3	MA2495-6	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2495	384033	7603106	2	MA2495-3	6	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2495	384033	7603106	3	MA2495-5	6	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2495	384033	7603106	1	MA2495-1	10	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2496	384518	7603514	4	MA2496-10	3	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2496	384518	7603514	1	MA2496-2	5	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2496	384518	7603514	2	MA2496-4	5	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2496	384518	7603514	3	MA2496-6	6	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2496	384518	7603514	4	MA2496-8	30	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2496	384518	7603514	3	MA2496-5	1	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2496	384518	7603514	4	MA2496-9	1	Insecta	Thysanura
1	20/1/05	Mesa A	MEADC2497	384828	7603330	3	MA2497-3	15	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2497	384828	7603330	3	MA2497-4	3	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2498	384919	7603629	2	MA2498-1	1	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2498	384919	7603629	4	MA2498-2	5	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2498	384919	7603629	3	MA2498-1	1	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2500	385313	7603749	4	MA2500-10	8	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2500	385313	7603749	2	MA2500-2	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2500	385313	7603749	2	MA2500-3	2	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2500	385313	7603749	3	MA2500-6	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2500	385313	7603749	4	MA2500-9	2	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2500	385313	7603749	3	MA2500-7	1	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2501	385512	7603752	2	MA2501-5	4	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2501	385512	7603752	2	MA2501-6	2	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2501	385512	7603752	2	MA2501-3	1	Arachnida	Schizomida
1	20/1/05	Mesa A	MEADC2501	385512	7603752	2	MA2501-4	1	Arachnida	Schizomida
1	20/1/05	Mesa A	MEADC2501	385512	7603752	2	MA2501-7	1	Arachnida	Schizomida
1	20/1/05	Mesa A	MEADC2501	385512	7603752	1	MA2501-2	1	Insecta	Thysanura
1	20/1/05	Mesa A	MEADC2519	386846	7604148	1	MA2519-1	6	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2519	386846	7604148	1	MA2519-2	2	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2519	386846	7604148	2	MA2519-3	5	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2519	386846	7604148	3	MA2519-4	3	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2519	386846	7604148	4	MA2519-5	8	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2523	386750	7604043	1	MA2523-1	3	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2523	386750	7604043	4	MA2523-10	4	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2523	386750	7604043	2	MA2523-5	11	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2523	386750	7604043	3	MA2523-8	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2523	386750	7604043	1	MA2523-2	1	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2523	386750	7604043	4	MA2523-9	1	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2523	386750	7604043	3	MA2523-7	2	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2523	386750	7604043	2	MA2523-6	6	Insecta	Collembola
1	20/1/05	Mesa A	MEADC2523	386750	7604043	1	MA2523-4	1	Insecta	Thysanura
1	20/1/05	Mesa A	MEADC2582	385926	7604914	2	MA2582-5	10	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2582	385926	7604914	3	MA2582-7	6	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2582	385926	7604914	4	MA2582-9	7	Arachnida	Acari
1	20/1/05	Mesa A	MEADC2582	385926	7604914	4	MA2582-10	1	Insecta	Collembola

Phase	Date	Study Area	Bore	Easting	Northing	Trap	Specimen No.	n	Class	Order
1	20/1/05	Mesa A	MEADC2582	385926	7604914	2	MA2582-6	1	Arachnida	Schizomida
1	20/1/05	Mesa A	MEADC2582	385926	7604914	4	MA2582-11	1	Arachnida	Schizomida
1	20/1/05	Mesa A	MEADC2582	385926	7604914	4	MA2582-12	1	Arachnida	Schizomida
1	20/1/05	Mesa A	MEADC2582	385926	7604914	1	MA2582-2	1	Insecta	Thysanura
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	1	MG0014-1	1	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	3	MG0014-12	4	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	1	MG0014-3	9	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	1	MG0014-4	1	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	2	MG0014-7	3	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	2	MG0014-10	1	Insecta	Blattodea
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	4	MG0014-15	1	Insecta	Blattodea
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	2	MG0014-6	1	Insecta	Collembola
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	4	MG0014-16	1	Insecta	Collembola
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	4	MG0014-14	2	Insecta	Collembola
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	1	MG0014-5	1	Arachnida	Opiliones
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	2	MG0014-8	1	Arachnida	Schizomida
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	2	MG0014-9	1	Arachnida	Schizomida
1	20/1/05	Mesa G	MEGDC0014A	408663	7596511	4	MG0014-13	1	Arachnida	Schizomida
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	4	AG057-11	5	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	1	AG057-2	4	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	1	AG057-4	10	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	2	AG057-5	13	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	2	AG057-8	13	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	3	AG057-9	9	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	2	AG057-6	1	Arachnida	Schizomida
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	4	AG057-12	1	Arachnida	Schizomida
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	2	AG057A-7	1	Chilopoda	Scolopendrida
1	20/1/05	Mesa G	MEGDC0057A	407537	7595763	4	AG057A-13	1	Chilopoda	Scolopendrida
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	4	MG0108-12	8	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	1	MG0108-2	2	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	2	MG0108-5	10	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	3	MG0108-7	4	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	3	MG0108A T3-10	5	Arachnida	Araneae
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	2	MG0108A T2-4	7	Arachnida	Araneae
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	1	MG0108A T1-1	13	Arachnida	Araneae
1	20/1/05	Mesa G	MEGDC0108A	406265	7594454	3	MG0108-11	1	Diplura	Diplura
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	1	MG0159-1	6	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	2	MG0159-3	11	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	2	MG0159-4	3	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	3	MG0159-6	14	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	3	MG0159-7	5	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	4	MG0159-8	4	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	4	MG0159-9	7	Arachnida	Acari
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	4	MG0159-10	2	Insecta	Collembola
1	20/1/05	Mesa G	MEGDC0159A	410538	7595809	2	MG0159-5	3	Insecta	Collembola
1	20/1/05	Mesa G	MEGRC0130	407737	7596114	1	MG0130-1	4	Arachnida	Acari
1	20/1/05	Mesa G	MEGRC0130	407737	7596114	2	MG0130-4	11	Arachnida	Acari
1	20/1/05	Mesa G	MEGRC0130	407737	7596114	3	MG0130-5	12	Arachnida	Acari
1	20/1/05	Mesa G	MEGRC0130	407737	7596114	4	MG0130-8	11	Arachnida	Acari
1	20/1/05	Mesa G	MEGRC0130	407737	7596114	3	MG0130-6	1	Insecta	Collembola
1	20/1/05	Mesa H	MEHDD0970	419988	7593554	1	MEH970-1	10	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0970	419988	7593554	2	MEH970-2	20	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0970	419988	7593554	3	MEH970-3	15	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0972	419888	7593504	1	MEH971-1	1	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0972	419888	7593504	2	MEH971-2	4	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0985	419588	7593254	1	MH985-1	3	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0985	419588	7593254	2	MH985-2	4	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0985	419588	7593254	2	MH985-3	1	Arachnida	Acari
1	20/1/05	Mesa H	MEHDD0985	419588	7593254	2	MH985-4	1	Arachnida	Acari
1	20/1/05	Mesa H	MEHRD1016	419487	7594155	1	MEH1016-1	15	Arachnida	Acari
1	20/1/05	Mesa H	MEHRD1016	419487	7594155	2	MEH1016-5	5	Arachnida	Acari
1	20/1/05	Mesa H	MEHRD1016	419487	7594155	2	MEH1016-3	2	Insecta	Collembola
1	20/1/05	Mesa H	MEHRD1021	419588	7594252	1	MEH1021-1	4	Arachnida	Acari
1	20/1/05	Mesa H	MEHRD1021	419588	7594252	2	MEH1021-2	1	Arachnida	Acari
1	20/1/05	Mesa J	MEJRC6193	422188	7592504	3	MJ138-3	1	Arachnida	Acari
1	20/1/05	Mesa J	MEJRC6193	422188	7592504	4	MJ138-5	1	Arachnida	Acari
1	20/1/05	Mesa J	MEJRC6193	422188	7592504	3	MJ138-2	1	Insecta	Collembola
1	20/1/05	Mesa J	MEJRC6193	422188	7592504	4	MJ138-4	1	Insecta	Collembola
1	20/1/05	Mesa J	MEJRC6193	422188	7592504	1	MJ138-1	5	Insecta	Collembola
2	30/5/05	Middle Robe	M2ERC0039	450640	7600852	1	M2ERC0039 T1-21	1	Arachnida	Acari
2	30/5/05	Middle Robe	M2ERC0039	450640	7600852	2	M2ERC0039 T2-23	1	Insecta	Collembola
2	30/5/05	Middle Robe	M2ERC0039	450640	7600852	3	M2ERC0039 T3-21	1	Insecta	Collembola
2	30/5/05	Middle Robe	M2ERC0039	450640	7600852	2	M2ERC0039 T2-21	5	Insecta	Collembola
2	27/5/05	Middle Robe	M2ERC0057	450739	7600753	1	M2ERC0057 T1-23	2	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC0057	450739	7600753	2	M2ERC0057 T2-28	2	Arachnida	Acari

Phase	Date	Study Area	Bore	Easting	Northing	Trap	Specimen No.	n	Class	Order
2	27/5/05	Middle Robe	M2ERC0057	450739	7600753	2	M2ERC0057 T2-27	4	Insecta	Collembola
2	27/5/05	Middle Robe	M2ERC0057	450739	7600753	1	M2ERC0057 T1-20	7	Insecta	Collembola
2	27/5/05	Middle Robe	M2ERC0057	450739	7600753	1	M2ERC0057 T1-21	1	Insecta	Thysanura
2	1/6/05	Middle Robe	M2ERC0063	450988	7600692	2	M2ERC0063 T2-21	4	Arachnida	Acari
2	1/6/05	Middle Robe	M2ERC0063	450988	7600692	3	M2ERC0063 T3-22	2	Insecta	Blattodea
2	1/6/05	Middle Robe	M2ERC0063	450988	7600692	1	M2ERC0063 T1-20	1	Arachnida	Schizomida
2	1/6/05	Middle Robe	M2ERC0063	450988	7600692	3	M2ERC0063 T3-23	1	Arachnida	Schizomida
2	27/5/05	Middle Robe	M2ERC026	452540	7600500	1	M2ERC026 T1-20	8	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC026	452540	7600500	2	M2ERC026 T2-22	2	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC026	452540	7600500	1	M2ERC026 T1-21	1	Arachnida	Schizomida
2	30/5/05	Middle Robe	M2ERC027	452491	7600503	1	M2ERC027 T1-21	7	Arachnida	Acari
2	30/5/05	Middle Robe	M2ERC027	452491	7600503	2	M2ERC027 T2-21	2	Insecta	Collembola
2	30/5/05	Middle Robe	M2ERC027	452491	7600503	1	M2ERC027 T1-20	1	Arachnida	Schizomida
2	30/5/05	Middle Robe	M2ERC027	452491	7600503	1	M2ERC027 T1-22	1	Arachnida	Schizomida
2	30/5/05	Middle Robe	M2ERC027	452491	7600503	2	M2ERC027 T2-20	1	Arachnida	Schizomida
2	27/5/05	Middle Robe	M2ERC029	452489	7600600	1	M2ERC029 T1-22	4	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC029	452489	7600600	1	M2ERC029 T1-23	4	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC029	452489	7600600	1	M2ERC029 T1-24	10	Insecta	Collembola
2	27/5/05	Middle Robe	M2ERC029	452489	7600600	1	M2ERC029 T1-20	1	Arachnida	Schizomida
2	26/5/05	Middle Robe	M2ERC034	452338	7600654	1	M2ERC034 T1-20	3	Arachnida	Acari
2	26/5/05	Middle Robe	M2ERC034	452338	7600654	1	M2ERC034 T1-24	1	Insecta	Collembola
2	26/5/05	Middle Robe	M2ERC034	452338	7600654	2	M2ERC034 T2-26	3	Insecta	Collembola
2	26/5/05	Middle Robe	M2ERC034	452338	7600654	1	M2ERC034 T1-23	1	Arachnida	Schizomida
2	26/5/05	Middle Robe	M2ERC034	452338	7600654	2	M2ERC034 T2-25	1	Arachnida	Schizomida
2	26/5/05	Middle Robe	M2ERC034	452338	7600654	1	M2ERC034 T1-22	1	Insecta	Thysanura
2	26/5/05	Middle Robe	M2ERC046	450592	7601002	2	M2ERC046 T2-21	4	Arachnida	Acari
2	26/5/05	Middle Robe	M2ERC046	450592	7601002	3	M2ERC046 T3-20	4	Arachnida	Acari
2	26/5/05	Middle Robe	M2ERC046	450592	7601002	1	M2ERC046 T1-21	1	Insecta	Collembola
2	26/5/05	Middle Robe	M2ERC046	450592	7601002	2	M2ERC046 T2-20	2	Insecta	Collembola
2	27/5/05	Middle Robe	M2ERC049	450490	7601003	1	M2ERC049 T1-20	10	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC049	450490	7601003	2	M2ERC049 T2-25	10	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC049	450490	7601003	3	M2ERC049 T3-22	10	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC049	450490	7601003	3	M2ERC049 T3-23	2	Insecta	Blattodea
2	27/5/05	Middle Robe	M2ERC049	450490	7601003	3	M2ERC049 T3-24	1	Insecta	Collembola
2	27/5/05	Middle Robe	M2ERC049	450490	7601003	2	M2ERC049 T2-26	1	Insecta	Collembola
2	26/5/05	Middle Robe	M2ERC095	452439	7600700	1	M2ERC095 T1-20	5	Arachnida	Acari
2	27/5/05	Middle Robe	M2ERC095	452439	7600700	2	M2ERC095 T2-21	5	Arachnida	Acari
2	30/5/05	Mesa A	MEADC2492	383446	7602683	1	MEADC2492 T1-20	2	Arachnida	Acari
2	27/5/05	Mesa A	MEADC2492	383446	7602683	2	MEADC2492 T2-21	1	Arachnida	Acari
2	27/5/05	Mesa A	MEADC2492	383446	7602683	2	MEADC2492 T2-20	1	Arachnida	Schizomida
2	30/5/05	Mesa A	MEADC2492	383446	7602683	1	MEADC2492 T1-21	1	Arachnida	Schizomida
2	7/6/05	Mesa A	MEADC2493	383739	7602993	2	MEADC2493 T2-20	13	Arachnida	Acari
2	7/6/05	Mesa A	MEADC2493	383739	7602993	3	MEADC2493 T3-20	4	Arachnida	Acari
2	7/6/05	Mesa A	MEADC2493	383739	7602993	4	MEADC2493 T4-20	3	Arachnida	Acari
2	7/6/05	Mesa A	MEADC2493	383739	7602993	3	MEADC2493 T3-21	2	Insecta	Collembola
2	26/5/05	Mesa A	MEADC2496	384518	7603514	3	MEADC2496 T3-20	1	Arachnida	Acari
2	26/5/05	Mesa A	MEADC2496	384518	7603514	1	MEADC2496 T1-21	1	Insecta	Collembola
2	26/5/05	Mesa A	MEADC2496	384518	7603514	2	MEADC2496 T2-20	3	Insecta	Collembola
2	26/5/05	Mesa A	MEADC2496	384518	7603514	4	MEADC2496 T4-20	5	Insecta	Collembola
2	26/5/05	Mesa A	MEADC2496	384518	7603514	1	MEADC2496 T1-20	1	Diplura	Diplura
2	27/5/05	Mesa A	MEADC2497	384828	7603330	2	MEADC2497 T2-20	6	Arachnida	Acari
2	27/5/05	Mesa A	MEADC2497	384828	7603330	3	MEADC2497 T3-22	1	Arachnida	Schizomida
2	7/6/05	Mesa A	MEADC2500	385313	7603749	1	MEADC2500 T1-22	2	Arachnida	Acari
2	7/6/05	Mesa A	MEADC2500	385313	7603749	2	MEADC2500 T2-23	4	Arachnida	Acari
2	7/6/05	Mesa A	MEADC2500	385313	7603749	4	MEADC2500 T4-27	5	Arachnida	Acari
2	7/6/05	Mesa A	MEADC2500	385313	7603749	3	MEADC2500 T3-25	2	Insecta	Collembola
2	7/6/05	Mesa A	MEADC2500	385313	7603749	1	MEADC2500 T1-20	10	Insecta	Collembola
2	25/5/05	Mesa A	MEADC2501	385512	7603752	1	MEADC2501 T1-22	4	Insecta	Collembola
2	25/5/05	Mesa A	MEADC2501	385512	7603752	2	MEADC2501 T2-20	1	Arachnida	Schizomida
2	25/5/05	Mesa A	MEADC2501	385512	7603752	1	MEADC2501 T1-23	1	Arachnida	Schizomida
2	25/5/05	Mesa A	MEADC2501	385512	7603752	1	MEADC2501 T1-25	1	Arachnida	Schizomida
2	25/5/05	Mesa A	MEADC2501	385512	7603752	2	MEADC2501 T2-21	2	Arachnida	Schizomida
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	1	MEADC2517A T1-20	6	Arachnida	Acari
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	2	MEADC2517A T2-27	8	Arachnida	Acari
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	2	MEADC2517A T2-26	1	Arachnida	Araneae
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	2	MEADC2517A T2-28	3	Insecta	Collembola
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	1	MEADC2517A T1-21	1	Arachnida	Schizomida
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	1	MEADC2517A T1-24	1	Arachnida	Schizomida
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	1	MEADC2517A T1-25	1	Arachnida	Schizomida
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	2	MEADC2517A T2-29	1	Arachnida	Schizomida
2	26/5/05	Mesa A	MEADC2517A	384847	7602728	1	MEADC2517A T1-22	1	Insecta	Thysanura
2	26/5/05	Mesa A	MEADC2522A	384638	7602913	1	MEADC2522 T1-20	2	Arachnida	Acari
2	27/5/05	Mesa A	MEADC2522A	384638	7602913	3	MEADC2522 T3-20	5	Arachnida	Acari
2	8/6/05	Mesa A	MEADC3188	383599	7602538	1	MEADC3188 T1-20	1	Arachnida	Schizomida
2	31/5/05	Mesa A	MEADC3192	384100	7602456	1	MEADC3192 T1-20	5	Arachnida	Acari

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2	31/5/05	Mesa A	MEADC3192	384100	7602456	2	MEADC3192 T2-23	3	Arachnida	Acari
2	31/5/05	Mesa A	MEADC3192	384100	7602456	3	MEADC3192 T3-24	5	Insecta	Collembola
2	26/5/05	Mesa A	MEADC3208	386085	7604573	1	MEADC3208 T1-20	8	Arachnida	Acari
2	26/5/05	Mesa A	MEADC3208	386085	7604573	1	MEADC3208 T1-21	4	Insecta	Collembola
2	8/6/05	Mesa A	MEARC2519	386846	7604148	2	MEARC2519 T2-20	8	Arachnida	Acari
2	8/6/05	Mesa A	MEARC2523	386750	7604043	1	MEARC2523 T1-21	3	Arachnida	Acari
2	8/6/05	Mesa A	MEARC2523	386750	7604043	2	MEARC2523 T2-20	8	Arachnida	Acari
2	8/6/05	Mesa A	MEARC2523	386750	7604043	3	MEARC2523 T3-20	4	Arachnida	Acari
2	7/6/05	Mesa A	MEARC2582	385926	7604914	2	MEARC2582 T2-20	1	Arachnida	Acari
2	7/6/05	Mesa A	MEARC2582	385926	7604914	3	MEARC2582 T3-20	1	Arachnida	Acari
2	7/6/05	Mesa A	MEARC2582	385926	7604914	4	MEARC2582 T4-20	3	Arachnida	Acari
2	7/6/05	Mesa A	MEARC2582	385926	7604914	1	MEARC2582 T1-21	1	Insecta	Collembola
2	7/6/05	Mesa A	MEARC2582	385926	7604914	4	MEARC2582 T4-21	1	Arachnida	Schizomida
2	27/5/05	Todd Bore	MEARC3180	379521	7600160	3	MEARC3180 T3-21	2	Arachnida	Acari
2	27/5/05	Todd Bore	MEARC3180	379521	7600160	3	MEARC3180 T3-20	3	Insecta	Collembola
2	30/5/05	Todd Bore	MEARC3181	379909	7600573	1	MEARC3181 T1-20	1	Arachnida	Acari
2	30/5/05	Todd Bore	MEARC3181	379909	7600573	2	MEARC3181 T2-21	1	Arachnida	Acari
2	27/5/05	Todd Bore	MEARC3182	379915	7600184	1	MEARC3182 T1-22	1	Arachnida	Acari
2	27/5/05	Todd Bore	MEARC3182	379915	7600184	2	MEARC3182 T2-20	1	Arachnida	Acari
2	27/5/05	Todd Bore	MEARC3182	379915	7600184	3	MEARC3182 T3-21	1	Arachnida	Acari
2	27/5/05	Todd Bore	MEARC3182	379915	7600184	2	MEARC3182 T2-21	3	Insecta	Collembola
2	27/5/05	Todd Bore	MEARC3182	379915	7600184	1	MEARC3182 T1-20	4	Insecta	Collembola
2	3/6/05	Mesa B	MEBRC0003	389438	7604147	4	MEBRC0003 T4-23	1	Arachnida	Acari
2	3/6/05	Mesa B	MEBRC0003	389438	7604147	1	MEBRC0003 T1-21	3	Insecta	Collembola
2	3/6/05	Mesa B	MEBRC0003	389438	7604147	3	MEBRC0003 T3-22	3	Insecta	Collembola
2	3/6/05	Mesa B	MEBRC0003	389438	7604147	2	MEBRC0003 T2-21	4	Insecta	Collembola
2	3/6/05	Mesa B	MEBRC0003	389438	7604147	4	MEBRC0003 T4-22	6	Insecta	Collembola
2	3/6/05	Mesa B	MEBRC0003	389438	7604147	1	MEBRC0003 T1-22	1	Arachnida	Pseudoscorpiones
2	3/6/05	Mesa B	MEBRC0014	392138	7603755	3	MEBRC0014 T3-20	5	Arachnida	Acari
2	3/6/05	Mesa B	MEBRC0014	392138	7603755	3	MEBRC0014 T3-21	1	Arachnida	Schizomida
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	3	MEBRC0015 T3-26	4	Arachnida	Acari
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	4	MEBRC0015 T4-28	5	Arachnida	Acari
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	1	MEBRC0015 T1-21	1	Crustacea	Isopoda
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	2	MEBRC0015 T2-23	2	Crustacea	Isopoda
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	4	MEBRC0015 T4-27	4	Crustacea	Isopoda
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	3	MEBRC0015 T3-25	6	Crustacea	Isopoda
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	4	MEBRC0015 T4-29	1	Arachnida	Pseudoscorpiones
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	2	MEBRC0015 T2-22	2	Arachnida	Schizomida
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	2	MEBRC0015 T2-24	1	Chilopoda	Scolopendrida
2	2/6/05	Mesa B	MEBRC0015	392138	7603955	1	MEBRC0015 T1-20	1	Insecta	Thysanura
2	1/6/05	Mesa B	MEBRC0016	392137	7604057	1	MEBRC0016 T1-23	1	Arachnida	Pseudoscorpiones
2	1/6/05	Mesa B	MEBRC0016	392137	7604057	1	MEBRC0016 T1-22	1	Arachnida	Schizomida
2	1/6/05	Mesa B	MEBRC0016	392137	7604057	1	MEBRC0016 T1-21	4	Arachnida	Schizomida
2	2/6/05	Mesa B	MEBRC0016	392137	7604057	4	MEBRC0016 T4-28	4	Arachnida	Schizomida
2	1/6/05	Mesa B	MEBRC0016	392137	7604057	2	MEBRC0016 T2-25	6	Arachnida	Schizomida
2	31/5/05	Mesa B	MEBRC0018	391736	7604656	4	MEBRC0018 T4-20	4	Arachnida	Acari
2	31/5/05	Mesa B	MEBRC0018	391736	7604656	3	MEBRC0018 T3-20	1	Insecta	Collembola
2	31/5/05	Mesa B	MEBRC0019	391736	7604455	3	MEBRC0019 T3-20	4	Insecta	Collembola
2	31/5/05	Mesa B	MEBRC0019	391736	7604455	4	MEBRC0019 T4-20	4	Insecta	Collembola
2	2/6/05	Mesa B	MEBRC0020	391937	7604656	2	MEBRC0020 T2-20	4	Arachnida	Acari
2	30/5/05	Mesa B	MEBRC0021	391937	7604456	1	MEBRC0021 T1-20	4	Arachnida	Acari
2	30/5/05	Mesa B	MEBRC0021	391937	7604456	1	MEBRC0021 T1-23	1	Diplura	Diplura
2	30/5/05	Mesa B	MEBRC0021	391937	7604456	1	MEBRC0021 T1-21	1	Arachnida	Pseudoscorpiones
2	30/5/05	Mesa B	MEBRC0021	391937	7604456	1	MEBRC0021 T1-24	1	Arachnida	Pseudoscorpiones
2	31/5/05	Mesa B	MEBRC0021	391937	7604456	3	MEBRC0021 T3-28	2	Arachnida	Pseudoscorpiones
2	31/5/05	Mesa B	MEBRC0021	391937	7604456	2	MEBRC0021 T2-26	2	Arachnida	Schizomida
2	31/5/05	Mesa B	MEBRC0021	391937	7604456	3	MEBRC0021 T3-27	2	Arachnida	Schizomida
2	3/6/05	Mesa B	MEBRC0023	391937	7604056	3	MEBRC0023 T3-21	3	Arachnida	Acari
2	3/6/05	Mesa B	MEBRC0023	391937	7604056	2	MEBRC0023 T2-20	1	Arachnida	Schizomida
2	31/5/05	Mesa B	MEBRC0025	392337	7603757	1	MEBRC0025 T1-20	6	Arachnida	Acari
2	31/5/05	Mesa B	MEBRC0025	392337	7603757	3	MEBRC0025 T3-20	1	Arachnida	Schizomida
2	1/6/05	Mesa C	MECRC0007	392737	7600152	1	MECRC0007 T1-21	3	Arachnida	Acari
2	2/6/05	Mesa C	MECRC0007	392737	7600152	2	MECRC0007 T2-20	13	Arachnida	Acari
2	2/6/05	Mesa C	MECRC0007	392737	7600152	4	MECRC0007 T4-20	5	Arachnida	Acari
2	2/6/05	Mesa C	MECRC0007	392737	7600152	4	MECRC0007 T4-24	2	Insecta	Collembola
2	2/6/05	Mesa C	MECRC0007	392737	7600152	3	MECRC0007 T3-22	3	Insecta	Collembola
2	2/6/05	Mesa C	MECRC0007	392737	7600152	4	MECRC0007 T4-22	7	Insecta	Collembola
2	2/6/05	Mesa C	MECRC0007	392737	7600152	4	MECRC0007 T4-25	1	Arachnida	Opiliones
2	7/6/05	Mesa C	MECRC0012	392738	7600953	1	MECRC0012 T1-20	4	Arachnida	Acari
2	7/6/05	Mesa C	MECRC0012	392738	7600953	2	MECRC0012 T2-20	7	Arachnida	Acari
2	8/6/05	Mesa C	MECRC0012	392738	7600953	3	MECRC0012 T3-20	6	Arachnida	Acari
2	8/6/05	Mesa C	MECRC0012	392738	7600953	4	MECRC0012 T4-21	3	Arachnida	Acari
2	7/6/05	Mesa C	MECRC0012	392738	7600953	2	MECRC0012 T2-22	2	Insecta	Collembola
2	8/6/05	Mesa C	MECRC0012	392738	7600953	4	MECRC0012 T4-20	9	Insecta	Collembola
2	8/6/05	Mesa C	MECRC0012	392738	7600953	3	MECRC0012 T3-21	15	Insecta	Collembola

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2	7/6/05	Mesa C	MECRC0012	392738	7600953	2	MECRC0012 T2-23	1	Arachnida	Schizomida
2	8/6/05	Mesa C	MECRC0012	392738	7600953	3	MECRC0012 T3-23	1	Arachnida	Schizomida
2	8/6/05	Mesa C	MECRC0012	392738	7600953	4	MECRC0012 T4-23	1	Arachnida	Schizomida
2	31/5/05	Mesa C	MECRC0018	391736	7604656	3	MECRC0018 T3-23	5	Arachnida	Acari
2	1/6/05	Mesa C	MECRC0018	391736	7604656	4	MECRC0018 T4-20	11	Arachnida	Acari
2	31/5/05	Mesa C	MECRC0018	391736	7604656	2	MECRC0018 T2-20	3	Insecta	Collembola
2	31/5/05	Mesa C	MECRC0018	391736	7604656	1	MECRC0018 T1-20	7	Insecta	Collembola
2	31/5/05	Mesa C	MECRC0018	391736	7604656	3	MECRC0018 T3-21	8	Insecta	Collembola
2	1/6/05	Mesa C	MECRC0018	391736	7604656	4	MECRC0018 T4-21	12	Insecta	Collembola
2	30/5/05	Mesa C	MECRC0026	392744	7602557	1	MECRC0026 T1-21	1	Arachnida	Acari
2	30/5/05	Mesa C	MECRC0026	392744	7602557	2	MECRC0026 T2-20	3	Arachnida	Acari
2	30/5/05	Mesa C	MECRC0026	392744	7602557	3	MECRC0026 T3-22	2	Arachnida	Acari
2	31/5/05	Mesa C	MECRC0026	392744	7602557	4	MECRC0026 T4-21	2	Arachnida	Acari
2	30/5/05	Mesa C	MECRC0026	392744	7602557	1	MECRC0026 T1-20	1	Insecta	Collembola
2	30/5/05	Mesa C	MECRC0026	392744	7602557	3	MECRC0026 T3-20	1	Insecta	Collembola
2	30/5/05	Mesa C	MECRC0026	392744	7602557	2	MECRC0026 T2-21	2	Insecta	Collembola
2	31/5/05	Mesa C	MECRC0026	392744	7602557	4	MECRC0026 T4-22	2	Insecta	Collembola
2	31/5/05	Mesa C	MECRC0026	392744	7602557	4	MECRC0026 T4-20	1	Diplura	Diplura
2	30/5/05	Mesa C	MECRC0026	392744	7602557	1	MECRC0026 T1-22	1	Diplopoda	Polydesmida
2	30/5/05	Mesa C	MECRC0026	392744	7602557	2	MECRC0026 T2-22	1	Arachnida	Schizomida
2	31/5/05	Mesa C	MECRC0026	392744	7602557	4	MECRC0026 T4-24	1	Arachnida	Schizomida
2	13/7/05	Mesa F	MEFRC0068	396538	7590154	2	MEF0068 T2-1	5	Insecta	Collembola
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	1	MEF0075 T1-2	10	Arachnida	Acari
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	2	MEF0075 T1-4	10	Arachnida	Acari
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	3	MEF0075 T1-7	10	Arachnida	Acari
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	1	MEF0075 T1-1	2	Insecta	Collembola
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	2	MEF0075 T1-6	2	Insecta	Collembola
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	3	MEF0075 T1-9	2	Insecta	Collembola
2	11/7/05	Mesa F	MEFRC0075	397333	7589332	3	MEF0075 T1-8	1	Diplura	Diplura
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	1	MEGDC0057A T1-20	6	Arachnida	Acari
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	2	MEGDC0057A T2-20	10	Arachnida	Acari
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	3	MEGDC0057A T3-20	5	Arachnida	Acari
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	4	MEGDC0057A T4-20	5	Arachnida	Acari
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	2	MEGDC0057A T2-21	1	Insecta	Collembola
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	1	MEGDC0057A T1-23	2	Insecta	Collembola
2	8/6/05	Mesa G	MEGDC0057A	407537	7595763	1	MEGDC0057A T1-25	2	Crustacea	Isopoda
2	2/6/05	Mesa G	MEGDC0108A	406265	7594454	2	MEGDC0108A T2-21	2	Arachnida	Acari
2	3/6/05	Mesa G	MEGDC0159A	410538	7595809	4	MEGDC0159A T4-23	1	Arachnida	Acari
2	2/6/05	Mesa G	MEGDC0159A	410538	7595809	3	MEGDC0159A T3-21	1	Insecta	Collembola
2	3/6/05	Mesa G	MEGDC0159A	410538	7595809	4	MEGDC0159A T4-22	3	Insecta	Collembola
2	2/6/05	Mesa G	MEGDC0159A	410538	7595809	3	MEGDC0159A T3-22	1	Arachnida	Schizomida
2	3/6/05	Mesa G	MEGDC0159A	410538	7595809	4	MEGDC0159A T4-25	1	Arachnida	Schizomida
2	3/6/05	Mesa G	MEGDC0159A	410538	7595809	4	MEGDC0159A T4-24	2	Arachnida	Schizomida
2	2/6/05	Mesa G	MEGDC0159A	410538	7595809	1	MEGDC0159A T1-20	3	Arachnida	Schizomida
2	2/6/05	Mesa G	MEGDC0159A	410538	7595809	2	MEGDC0159A T2-22	3	Arachnida	Schizomida
2	1/6/05	Mesa G	MEGDC0202	411833	7595663	1	MEGDC0202 T1-21	3	Arachnida	Acari
2	1/6/05	Mesa G	MEGDC0202	411833	7595663	3	MEGDC0202 T3-21	1	Arachnida	Acari
2	1/6/05	Mesa G	MEGDC0202	411833	7595663	3	MEGDC0202 T3-22	1	Insecta	Collembola
2	1/6/05	Mesa G	MEGDC0202	411833	7595663	2	MEGDC0202 T2-21	2	Insecta	Collembola
2	1/6/05	Mesa G	MEGDC0202	411833	7595663	1	MEGDC0202 T1-20	1	Crustacea	Isopoda
2	1/6/05	Mesa G	MEGDC0202	411833	7595663	2	MEGDC0202 T2-22	1	Crustacea	Isopoda
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	1	MEGRC0104 T1-22	4	Arachnida	Acari
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	2	MEGRC0104 T2-20	7	Arachnida	Acari
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	3	MEGRC0104 T3-22	10	Arachnida	Acari
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	4	MEGRC0104 T4-20	11	Arachnida	Acari
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	3	MEGRC0104 T3-20	3	Insecta	Collembola
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	4	MEGRC0104 T4-22	6	Insecta	Collembola
2	1/6/05	Mesa G	MEGRC0104	405138	7594298	2	MEGRC0104 T2-21	3	Crustacea	Isopoda
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	1	MEGRC0130 T1-21	2	Arachnida	Acari
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	2	MEGRC0130 T2-27	1	Arachnida	Araneae
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	2	MEGRC0130 T2-26	2	Insecta	Collembola
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	3	MEGRC0130 T3-28	5	Insecta	Collembola
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	4	MEGRC0130 T4-32	5	Insecta	Collembola
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	4	MEGRC0130 T4-29	2	Arachnida	Schizomida
2	1/6/05	Mesa G	MEGRC0130	407737	7596114	2	MEGRC0130 T2-23	3	Arachnida	Schizomida
2	31/5/05	Mesa G	MEGRC0140	408240	7596610	2	MEGRC0140 T2-21	4	Arachnida	Acari
2	31/5/05	Mesa G	MEGRC0140	408240	7596610	3	MEGRC0140 T3-20	6	Arachnida	Acari
2	31/5/05	Mesa G	MEGRC0140	408240	7596610	4	MEGRC0140 T4-21	8	Arachnida	Acari
2	27/5/05	Mesa G	MEGRC0163	410140	7596355	2	MEGRC0163 T2-20	1	Insecta	Collembola
2	27/5/05	Mesa G	MEGRC0163	410140	7596355	4	MEGRC0163 T4-22	1	Insecta	Collembola
2	27/5/05	Mesa G	MEGRC0163	410140	7596355	4	MEGRC0163 T4-20	4	Insecta	Collembola
2	27/5/05	Mesa G	MEGRC0163	410140	7596355	4	MEGRC0163 T4-21	2	Arachnida	Schizomida
2	13/7/05	Mesa K	MEKRC1685	423823	7598023	3	MEK1685 T3-5	3	Insecta	Collembola
2	13/7/05	Mesa K	MEKRC1685	423823	7598023	1	MEK1685 T1-1	4	Insecta	Collembola
2	13/7/05	Mesa K	MEKRC1685	423823	7598023	1	MEK1685 T1-2	1	Arachnida	Schizomida

Phase	Date	Study Area	Bore	Easting	Northing	Trap	Specimen No.	n	Class	Order
2	13/7/05	Mesa K	MEKRC1685	423823	7598023	1	MEK1685 T1-3	1	Arachnida	Schizomida
2	13/7/05	Mesa K	MEKRC1685	423823	7598023	2	MEK1685 T2-4	2	Arachnida	Schizomida
2	13/7/05	Mesa K	MEKRC1689	423622	7597973	1	MEK1689 T1-1	10	Arachnida	Acari
2	13/7/05	Mesa K	MEKRC1689	423622	7597973	2	MEK1689 T2-2	1	Arachnida	Schizomida
2	12/7/05	Mesa K	MEKRC1694	423769	7597923	1	MEK1694 T1-1	1	Arachnida	Acari
2	14/7/05	Mesa K	MEKRC1694	423769	7597923	1	MEK1694 T1-1	3	Arachnida	Acari
2	12/7/05	Mesa K	MEKRC1694	423769	7597923	2	MEK1694 T2-3	1	Insecta	Collembola
2	12/7/05	Mesa K	MEKRC1694	423769	7597923	3	MEK1694 T3-6	1	Arachnida	Opiliones
2	12/7/05	Mesa K	MEKRC1694	423769	7597923	1	MEK1694 T1-2	1	Arachnida	Schizomida
2	12/7/05	Mesa K	MEKRC1694	423769	7597923	2	MEK1694 T2-5	3	Arachnida	Schizomida
2	13/7/05	Mesa K	MEKRC1712	423521	7597774	2	MEK1712 T2-2	4	Arachnida	Acari
2	13/7/05	Mesa K	MEKRC1712	423521	7597774	3	MEK1712 T3-3	2	Insecta	Collembola
2	12/7/05	Mesa K	MEKRC1718	423876	7598174	1	MEK1718 T1-1	10	Arachnida	Acari
2	12/7/05	Mesa K	MEKRC1718	423876	7598174	3	MEK1718 T3-3	1	Arachnida	Acari
2	12/7/05	Mesa K	MEKRC1718	423876	7598174	1	MEK1718 T1-2	1	Insecta	Collembola
2	12/7/05	Mesa K	MEKRC1721	423931	7598327	2	MEK1721 T2-1	1	Insecta	Collembola
2	12/7/05	Mesa K	MEKRC1721	423931	7598327	2	MEK1721 T2-2	1	Arachnida	Schizomida
2	12/7/05	Mesa K	MEKRC1721	423931	7598327	3	MEK1721 T3-3	1	Arachnida	Schizomida
2	12/7/05	Mesa K	MEKRC1728	423826	7598175	3	MEK1728 T3-4	1	Arachnida	Acari
2	12/7/05	Mesa K	MEKRC1728	423826	7598175	1	MEK1728 T1-1	2	Insecta	Collembola
2	12/7/05	Mesa K	MEKRC1728	423826	7598175	3	MEK1728 T3-3	4	Insecta	Collembola
2	12/7/05	Mesa K	MEKRC1728	423826	7598175	1	MEK1728 T1-2	1	Arachnida	Schizomida
3	14/9/05	Mesa A	A0585	382659	7602258	1	MEA0585 T1-1	3	Insecta	Collembola
3	14/9/05	Mesa A	A1149	384066	7602203	1	A1149 T1-39	15	Arachnida	Acari
3	14/9/05	Mesa A	A1149	384066	7602203	1	A1149 T1-40	3	Insecta	Collembola
3	14/9/05	Mesa A	A1149	384066	7602203	1	A1149 T1-42	1	Arachnida	Schizomida
3	15/9/05	Mesa A	A1747	383027	7603270	1	A1747 T1-73	8	Arachnida	Acari
3	15/9/05	Mesa A	A1747	383027	7603270	2	A1747 T2-76	15	Arachnida	Acari
3	15/9/05	Mesa A	A1747	383027	7603270	1	A1747 T1-75	1	Insecta	Collembola
3	15/9/05	Mesa A	A1747	383027	7603270	2	A1747 T2-78	1	Insecta	Collembola
3	14/9/05	Mesa A	A1759	382298	7601046	1	A1759 T1-30	3	Arachnida	Acari
3	14/9/05	Mesa A	A1759	382298	7601046	2	A1759 T2-35	8	Arachnida	Acari
3	14/9/05	Mesa A	A1759	382298	7601046	1	A1759 T1-32	10	Insecta	Collembola
3	14/9/05	Mesa A	A1759	382298	7601046	2	A1759 T2-34	10	Insecta	Collembola
3	15/9/05	Mesa A	A1759	382298	7601046	3	A1759 T3-59	2	Arachnida	Acari
3	15/9/05	Mesa A	A1759	382298	7601046	3	A1759 T3-58	7	Insecta	Collembola
3	15/9/05	Mesa A	A1762A	382279	7601645	1	A1762 T1-3	1	Arachnida	Acari
3	15/9/05	Mesa A	A1762A	382279	7601645	1	A1762 T1-2	2	Insecta	Collembola
3	15/9/05	Mesa A	A1762A	382279	7601645	1	A1762 T1-1	20	Crustacea	Isopoda
3	12/9/05	Warramboo	A1768	382240	7602844	1	A1768 T1-2	2	Arachnida	Acari
3	12/9/05	Warramboo	A1768	382240	7602844	2	A1768 T2-5	1	Arachnida	Acari
3	12/9/05	Warramboo	A1768	382240	7602844	3	A1768 T3-8	2	Arachnida	Acari
3	12/9/05	Warramboo	A1768	382240	7602844	2	A1768 T2-4	5	Insecta	Collembola
3	12/9/05	Warramboo	A1768	382240	7602844	1	A1768 T1-3	6	Insecta	Collembola
3	13/9/05	Warramboo	A1778	381422	7603418	1	A1778 T1-2	1	Insecta	Thysanura
3	13/9/05	Warramboo	A1784	381467	7602019	1	A1784 T1-1	1	Arachnida	Pseudoscorpiones
3	16/9/05	Mesa A	MEADC2492	383446	7602683	2	MEA2492 T2-84	2	Arachnida	Acari
3	16/9/05	Mesa A	MEADC2492	383446	7602683	2	MEA2492 T2-84	2	Arachnida	Acari
3	16/9/05	Mesa A	MEADC2492	383446	7602683	1	MEA2492 T1-79	4	Insecta	Collembola
3	16/9/05	Mesa A	MEADC2492	383446	7602683	2	MEA2492 T2-81	14	Insecta	Collembola
3	13/9/05	Warramboo	MEARC2040	379933	7606171	1	MEA2040 T1-1	8	Arachnida	Acari
3	13/9/05	Warramboo	MEARC2152	378914	7606737	1	MEA2152 T1-8	70	Arachnida	Acari
3	13/9/05	Warramboo	MEARC2152	378914	7606737	1	MEA2152 T1-10	10	Insecta	Collembola
3	13/9/05	Warramboo	MEARC2206	378115	7606712	1	MEA2206 T1-19	6	Arachnida	Acari
3	14/9/05	Warramboo	MEARC2318	377509	7606893	1	MEA2318 T1-1	1	Arachnida	Acari
3	13/9/05	Warramboo	MEARC2381	378501	7604073	1	MEA2381 T1-1	1	Arachnida	Acari
3	13/9/05	Warramboo	MEARC2381	378501	7604073	2	MEA2381 T2-4	30	Arachnida	Acari
3	13/9/05	Warramboo	MEARC2381	378501	7604073	2	MEA2381 T2-2	30	Insecta	Collembola
3	13/9/05	Warramboo	MEARC2381	378501	7604073	2	MEA2381 T2-3	4	Arachnida	Schizomida
3	20/9/05	Mesa A	MEARC2497	384828	7603330	1	MEA2497 T1-110	5	Arachnida	Acari
3	20/9/05	Mesa A	MEARC2497	384828	7603330	2	MEA2497 T2-113	5	Arachnida	Acari
3	20/9/05	Mesa A	MEARC2497	384828	7603330	3	MEA2497 T3-116	6	Arachnida	Acari
3	20/9/05	Mesa A	MEARC2497	384828	7603330	4	MEA2497 T4-119	6	Arachnida	Acari
3	20/9/05	Mesa A	MEARC2497	384828	7603330	3	MEA2497 T3-118	1	Insecta	Collembola
3	20/9/05	Mesa A	MEARC2497	384828	7603330	1	MEA2497 T1-111	2	Insecta	Collembola
3	20/9/05	Mesa A	MEARC2497	384828	7603330	2	MEA2497 T2-114	3	Insecta	Collembola
3	20/9/05	Mesa A	MEARC2497	384828	7603330	1	MEA2497 T1-112	1	Arachnida	Schizomida
3	20/9/05	Mesa A	MEARC2497	384828	7603330	3	MEA2497 T3-115	1	Arachnida	Schizomida
3	28/9/05	Mesa A	MEARC2546	386527	7604834	2	MEA2546 T2-4	1	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2546	386527	7604834	1	MEA2546 T1-1	7	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2546	386527	7604834	2	MEA2546 T2-4	4	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2546	386527	7604834	2	MEA2546 T2-5	1	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2546	386527	7604834	3	MEA2546 T3-7	7	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2546	386527	7604834	4	MEA2546 T4-10	10	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2546	386527	7604834	1	MEA2546 T1-2	3	Insecta	Collembola

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3	28/9/05	Mesa A	MEARC2546	386527	7604834	4	MEA2546 T4-11	4	Insecta	Collembola
3	28/9/05	Mesa A	MEARC2546	386527	7604834	2	MEA2546 T2-3	5	Insecta	Collembola
3	27/9/05	Mesa A	MEARC2560	386147	7604224	2	MEA2560 T2-3	2	Arachnida	Acari
3	27/9/05	Mesa A	MEARC2560	386147	7604224	1	MEA2560 T1-2	1	Chilopoda	Scolopendrida
3	28/9/05	Mesa A	MEARC2574	386218	7605123	1	MEA2574 T1-1	8	Arachnida	Acari
3	28/9/05	Mesa A	MEARC2574	386218	7605123	2	MEA2574 T2-3	12	Arachnida	Acari
3	27/9/05	Mesa A	MEARC2611	385969	7603614	2	MEA2611 T2-2	5	Arachnida	Acari
3	27/9/05	Mesa A	MEARC2611	385969	7603614	2	MEA2611 T2-1	5	Arachnida	Schizomida
3	19/9/05	Mesa A	MEARC2656	385180	7603088	1	MEA2656 T1-109	16	Arachnida	Acari
3	19/9/05	Mesa A	MEARC2656	385180	7603088	3	MEA2656 T3-101	2	Arachnida	Acari
3	19/9/05	Mesa A	MEARC2656	385180	7603088	3	MEA2656 T3-113	5	Arachnida	Acari
3	19/9/05	Mesa A	MEARC2656	385180	7603088	3	MEA2656 T3-115	1	Diplura	Diplura
3	20/9/05	Mesa A	MEARC2691	384948	7603985	1	MEA2691 T1-1	5	Arachnida	Acari
3	20/9/05	Mesa A	MEARC2691	384948	7603985	2	MEA2691 T2-1	7	Arachnida	Acari
3	15/9/05	Mesa A	MEARC2702	383154	7602374	1	MEA2702 T1-3	1	Arachnida	Acari
3	15/9/05	Mesa A	MEARC2702	383154	7602374	4	MEA2702 T4-7	1	Arachnida	Acari
3	15/9/05	Mesa A	MEARC2702	383154	7602374	2	MEA2702 T2-5	3	Insecta	Collembola
3	15/9/05	Mesa A	MEARC2702	383154	7602374	4	MEA2702 T4-8	5	Insecta	Collembola
3	15/9/05	Mesa A	MEARC2702	383154	7602374	1	MEA2702 T1-2	7	Insecta	Collembola
3	15/9/05	Mesa A	MEARC2702	383154	7602374	4	MEA2702 T4-9	1	Diplura	Diplura
3	15/9/05	Mesa A	MEARC2702	383154	7602374	1	MEA2702 T1-1	2	Crustacea	Isopoda
3	15/9/05	Mesa A	MEARC2702	383154	7602374	3	MEA2702 T3-6	1	Arachnida	Schizomida
3	15/9/05	Mesa A	MEARC2740	383490	7602939	1	MEA2740 T1-64	18	Arachnida	Acari
3	15/9/05	Mesa A	MEARC2740	383490	7602939	2	MEA2740 T2-66	15	Arachnida	Acari
3	15/9/05	Mesa A	MEARC2740	383490	7602939	1	MEA2740 T1-65	1	Insecta	Collembola
3	15/9/05	Mesa A	MEARC2740	383490	7602939	2	MEA2740 T2-68	1	Insecta	Collembola
3	15/9/05	Mesa A	MEARC2740	383490	7602939	2	MEA2740 T2-67	1	Diplura	Diplura
3	16/9/05	Mesa A	MEARC2749	383607	7602240	2	MEA2749 T2-2	1	Arachnida	Acari
3	16/9/05	Mesa A	MEARC2749	383607	7602240	1	MEA2749 T1-1	1	Insecta	Collembola
3	19/9/05	Mesa A	MEARC2809	383572	7603243	1	MEA2809 T1-103	18	Arachnida	Acari
3	16/9/05	Mesa A	MEARC2856	384564	7603670	2	MEA2856 T2-5	3	Arachnida	Acari
3	16/9/05	Mesa A	MEARC2856	384564	7603670	2	MEA2856 T2-3	1	Arachnida	Pseudoscorpiones
3	14/9/05	Mesa A	MEARC2858	384537	7601468	1	MEA2858 T1-45	7	Arachnida	Acari
3	14/9/05	Mesa A	MEARC2858	384537	7601468	1	MEA2858 T1-44	2	Arachnida	Schizomida
3	14/9/05	Mesa A	MEARC2858	384537	7601468	1	MEA2858 T1-47	1	Chilopoda	Scolopendrida
3	15/9/05	Mesa A	MEARC2888	384415	7601966	1	MEA2888 T1-54	13	Arachnida	Acari
3	15/9/05	Mesa A	MEARC2888	384415	7601966	1	MEA2888 T1-55	9	Insecta	Collembola
3	14/9/05	Mesa A	MEARC2905	384344	7601260	1	MEA2905 T1-37	10	Arachnida	Acari
3	14/9/05	Mesa A	MEARC2905	384344	7601260	1	MEA2905 T1-36	8	Insecta	Collembola
3	15/9/05	Mesa A	MEARC2934	384229	7601661	1	MEA2934 T1-1	1	Arachnida	Schizomida
3	27/9/05	Mesa A	MEARC3042	386894	7604492	1	MEA3042 T1-1	1	Arachnida	Acari
3	27/9/05	Mesa A	MEARC3042	386894	7604492	2	MEA3042 T2-5	1	Arachnida	Acari
3	27/9/05	Mesa A	MEARC3042	386894	7604492	2	MEA3042 T2-3	1	Arachnida	Schizomida
3	27/9/05	Mesa A	MEARC3042	386894	7604492	3	MEA3042 T3-6	2	Arachnida	Schizomida
3	16/9/05	Mesa A	MEARC3066	383430	7601632	1	MEA3066 T1-92	16	Arachnida	Acari
3	16/9/05	Mesa A	MEARC3066	383430	7601632	2	MEA3066 T2-97	8	Arachnida	Acari
3	16/9/05	Mesa A	MEARC3066	383430	7601632	1	MEA3066 T1-94	2	Insecta	Collembola
3	16/9/05	Mesa A	MEARC3066	383430	7601632	2	MEA3066 T2-98	11	Insecta	Collembola
3	16/9/05	Mesa A	MEARC3066	383430	7601632	1	MEA3066 T1-95	1	Arachnida	Schizomida
3	15/9/05	Mesa A	MEARC3069	383420	7601933	1	MEA3069 T1-70	4	Arachnida	Acari
3	15/9/05	Mesa A	MEARC3069	383420	7601933	1	MEA3069 T1-69	6	Insecta	Collembola
3	16/9/05	Mesa A	MEARC3073	383407	7602331	1	MEA3073 T1-3	7	Arachnida	Acari
3	16/9/05	Mesa A	MEARC3073	383407	7602331	2	MEA3073 T2-5	2	Arachnida	Acari
3	16/9/05	Mesa A	MEARC3073	383407	7602331	3	MEA3073 T3-9	7	Arachnida	Acari
3	16/9/05	Mesa A	MEARC3073	383407	7602331	2	MEA3073 T2-7	1	Insecta	Collembola
3	16/9/05	Mesa A	MEARC3073	383407	7602331	3	MEA3073 T3-10	2	Insecta	Collembola
3	16/9/05	Mesa A	MEARC3073	383407	7602331	2	MEA3073 T2-6	3	Insecta	Collembola
3	16/9/05	Mesa A	MEARC3073	383407	7602331	2	MEA3073 T2-8	1	Arachnida	Schizomida
3	16/9/05	Mesa A	MEARC3073	383407	7602331	1	MEA3073 T1-1	1	Chilopoda	Scolopendrida
3	15/9/05	Mesa A	MEARC3098	382867	7601967	1	MEA3098 T1-48	18	Arachnida	Acari
3	15/9/05	Mesa A	MEARC3098	382867	7601967	2	MEA3098 T2-51	14	Arachnida	Acari
3	15/9/05	Mesa A	MEARC3098	382867	7601967	3	MEA3098 T3-61	8	Arachnida	Acari
3	15/9/05	Mesa A	MEARC3098	382867	7601967	2	MEA3098 T2-52	4	Insecta	Collembola
3	15/9/05	Mesa A	MEARC3098	382867	7601967	3	MEA3098 T3-60	4	Insecta	Collembola
3	15/9/05	Mesa A	MEARC3098	382867	7601967	1	MEA3098 T1-49	5	Insecta	Collembola
3	15/9/05	Mesa A	MEARC3098	382867	7601967	2	MEA3098 T2-50	1	Insecta	Thysanura
3	15/9/05	Mesa A	MEARC3098	382867	7601967	3	MEA3098 T3-63	1	Insecta	Thysanura
3	13/9/05	Warramboo	MEARC3334	377979	7603158	1	MEA3402 T1-3	4	Arachnida	Acari
3	13/9/05	Warramboo	MEARC3334	377979	7603158	1	MEA3402 T1-4	7	Insecta	Collembola
3	13/9/05	Warramboo	MEARC3334	377979	7603158	1	MEA3402 T1-2	1	Diplura	Diplura
3	13/9/05	Warramboo	MEARC3693	379397	7605705	1	MEA3693 T1-6	50	Arachnida	Acari
3	13/9/05	Warramboo	MEARC3693	379397	7605705	1	MEA3693 T1-7	30	Insecta	Collembola
3	13/9/05	Warramboo	MEARC3787	379881	7601356	1	MEA3787 T1-11	40	Arachnida	Acari
3	13/9/05	Warramboo	MEARC3787	379881	7601356	2	MEA3787 T2-15	60	Arachnida	Acari
3	13/9/05	Warramboo	MEARC3787	379881	7601356	1	MEA3787 T1-12	40	Insecta	Collembola

Phase	Date	Study Area	Bore	Easting	Northing	Trap	Specimen No.	n	Class	Order
3	13/9/05	Warramboo	MEARC3787	379881	7601356	2	MEA3787 T2-16	50	Insecta	Collembola
3	14/9/05	Warramboo	MEARC3857	377883	7606155	1	MEA3857 T1-21	16	Arachnida	Acari
3	14/9/05	Warramboo	MEARC3857	377883	7606155	2	MEA3857 T2-23	1	Arachnida	Acari
3	14/9/05	Warramboo	MEARC3857	377883	7606155	1	MEA3857 T1-20	5	Insecta	Collembola
3	14/9/05	Warramboo	MEARC3956	377219	7605033	1	MEA3956 T1-26	12	Arachnida	Acari
3	14/9/05	Warramboo	MEARC3956	377219	7605033	1	MEA3956 T1-27	10	Insecta	Collembola
3	13/9/05	Warramboo	MEARC3960	377328	7604737	1	MEA3960 T1-1	3	Insecta	Collembola
3	21/9/05	Mesa A	MEARC4009	386220	7605028	1	MEA4009 T1-1	5	Insecta	Collembola
3	28/9/05	Mesa A	MEARC4010	386123	7604915	2	MEA4010 T2-2	3	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4010	386123	7604915	3	MEA4010 T3-4	3	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4010	386123	7604915	1	MEA4010 T1-1	2	Insecta	Collembola
3	28/9/05	Mesa A	MEARC4010	386123	7604915	3	MEA4010 T3-3	4	Insecta	Collembola
3	28/9/05	Mesa A	MEARC4016	386452	7604032	1	MEA4016 T1-1	5	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4016	386452	7604032	2	MEA4016 T2-3	3	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4016	386452	7604032	3	MEA4016 T3-5	5	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4016	386452	7604032	3	MEA4016 T3-7	1	Chilopoda	Scolopendrida
3	28/9/05	Mesa A	MEARC4018	386460	7603830	2	MEA4018 T2-1	3	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4024	386249	7604125	2	MEA4024 T2-2	2	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4024	386249	7604125	4	MEA4024 T4-4	3	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4024	386249	7604125	2	MEA4024 T2-3	1	Insecta	Collembola
3	28/9/05	Mesa A	MEARC4024	386249	7604125	1	MEA4024 T1-1	1	Diplura	Diplura
3	28/9/05	Mesa A	MEARC4026	386255	7603927	2	MEA4026 T2-1	1	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4026	386255	7603927	4	MEA4026 T4-3	5	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4029	386050	7604021	1	MEA4029 T1-2	1	Arachnida	Acari
3	27/9/05	Mesa A	MEARC4029	386050	7604021	2	MEA4029 T2-3	5	Arachnida	Acari
3	27/9/05	Mesa A	MEARC4029	386050	7604021	3	MEA4029 T3-6	7	Arachnida	Acari
3	27/9/05	Mesa A	MEARC4029	386050	7604021	4	MEA4029 T4-9	4	Arachnida	Acari
3	28/9/05	Mesa A	MEARC4033	385951	7604019	2	MEA4033 T2-1	1	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4038	385856	7603910	2	MEA4038 T2-4	1	Arachnida	Acari
3	27/9/05	Mesa A	MEARC4038	385856	7603910	1	MEA4038 T1-3	4	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4038	385856	7603910	2	MEA4038 T2-5	5	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4038	385856	7603910	4	MEA4038 T4-9	1	Crustacea	Isopoda
3	21/9/05	Mesa A	MEARC4039	385749	7604110	1	MEA4039 T1-2	2	Arachnida	Acari
3	21/9/05	Mesa A	MEARC4039	385749	7604110	2	MEA4039 T2-3	5	Arachnida	Acari
3	21/9/05	Mesa A	MEARC4039	385749	7604110	1	MEA4039 T1-1	1	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4047	386016	7605121	1	MEA4047 T1-3	4	Arachnida	Acari
3	27/9/05	Mesa A	MEARC4047	386016	7605121	2	MEA4047 T2-5	2	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4047	386016	7605121	1	MEA4047 T1-2	3	Insecta	Collembola
3	27/9/05	Mesa A	MEARC4047	386016	7605121	1	MEA4047 T1-4	1	Arachnida	Pseudoscorpiones
3	19/9/05	Mesa A	MEARC4050	385246	7604290	1	MEA4050 T1-105	4	Arachnida	Acari
3	19/9/05	Mesa A	MEARC4050	385246	7604290	2	MEA4050 T2-107	7	Arachnida	Acari
3	13/9/05	Mesa A	MEARC4065	383495	7601089	1	MEA4065 T1-1	3	Arachnida	Acari
3	14/9/05	Warramboo	MEARC4123	379595	7602709	1	MEA4123 T1-1	3	Arachnida	Acari
3	14/9/05	Warramboo	MEARC4123	379595	7602709	1	MEA4123 T1-3	2	Insecta	Collembola
3	14/9/05	Warramboo	MEARC4123	379595	7602709	1	MEA4123 T1-2	3	Insecta	Collembola
3	16/9/05	Mesa A	MEARC4151	383242	7602877	1	MEA4151 T1-86	3	Arachnida	Acari
3	16/9/05	Mesa A	MEARC4151	383242	7602877	2	MEA4151 T2-88	1	Arachnida	Acari
3	16/9/05	Mesa A	MEARC4151	383242	7602877	1	MEA4151 T1-87	1	Insecta	Collembola
3	16/9/05	Mesa A	MEARC4151	383242	7602877	2	MEA4151 T2-89	12	Insecta	Collembola
3	16/9/05	Mesa A	MEARC4151	383242	7602877	2	MEA4151 T2-90	1	Arachnida	Schizomida