The seasonality, diversity and ecology of cavernicolous guano dependent arthropod ecosystems in southern Australia.

Timothy A. Moulds

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy.

Environmental Biology
School of Earth and Environmental Sciences
The University of Adelaide, Adelaide, Australia

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DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Timothy Moulds

Table of Contents

Declaration ..... **ii**

Table of Contents ..... **iii**

Index of Figures ..... **vii**

Index of Tables ..... **xiv**

Index of Tables ..... **xiv**

Acknowledgements ..... **xvii**

Abstract **19**

Chapter 1: Cave ecology and guano ecosystems **21**

1.1 INTRODUCTION TO CAVE ECOLOGY 21

1.1.1 Classifications of cave dependence *22*

1.1.2 The trophic basis of cave ecosystems *23*

1.2 THE EVOLUTION OF TROGLOBITES 24

1.2.1 The evolution of guano dependant animals and ecosystems *26*

1.3 CAVE ECOLOGY IN AUSTRALIA 26

1.4 REVIEW OF THE ECOLOGY OF GUANO ECOSYSTEMS AND GUANOPHILIC INVERTEBRATES 27

1.4.1 Sources and diversity of cave guano *28*

1.4.2 Micro-habitat variation in bat guano *30*

1.4.3 Guano invertebrate classification *31*

1.4.4 Guano ecosystems and food webs *33*

1.5 THE UNIQUE GUANO DEPENDENT COMMUNITY WITHIN THE NARACOORTE CAVES WORLD HERITAGE AREA, SOUTH AUSTRALIA. 34

1.6 PROJECT AIMS 35

Chapter 2: Seasonality, micro-habitat preference and ecology of guano dependent arthropods **37**

2.1 INTRODUCTION 37

2.2 METHODS 39

2.2.1 Arthropod sampling *39*

2.2.2 Guano sampling *42*

2.2.3 Species richness and diversity indices *43*

2.2.4 Quantile regression *44*
2.2.5 Non-metric Multidimensional Scaling (NMS) Ordination *44*
2.2.6 Cluster analysis *45*
2.2.7 Indicator species analysis *45*
2.3.1 RESULTS - GUANO MICRO-HABITAT 45
2.3.2 RESULTS - SPECIES RICHNESS, ABUNDANCE AND BIOLOGY 52
2.3.21 Species richness and abundance of guanophilic arthropods *52*
2.3.22 Biology of key species *59*
2.3.23 Maternity chamber food web *64*
2.3.3 RESULTS - COMMUNITY STRUCTURE 65
2.3.31 Indicator species analysis *68*
2.4 DISCUSSION 70
2.4.1 Spatial variation in arthropod communities *72*
2.4.2 Seasonal variation in arthropod communities *74*
2.4.3 Temperate guano arthropod communities compared with other regions *75*
2.4.4 Conclusions *76*
Chapter 3: Arthropod diversity, seasonality and ecology of Starlight Cave, western Victoria 78
3.1 INTRODUCTION 78
3.2 METHODS 78
3.2.1 Physiography of Starlight Cave *78*
3.2.2 Arthropod sampling *79*
3.2.3 Guano sampling, species richness and diversity indices *80*
3.2.4 Data Analysis *80*
3.3.1 RESULTS - GUANO MICRO-HABITAT CONDITIONS 81
3.3.2 RESULTS - SPECIES RICHNESS AND ABUNDANCE 87
3.3.3 RESULTS - COMMUNITY STRUCTURE 94
3.3.31 Indicator species analysis *96*
3.4 DISCUSSION 98
3.4.1 Spatial variation in arthropod communities *100*
3.4.2 Seasonal variation in arthropod communities *101*
3.4.3 Arthropod community differences between Starlight and Bat Caves *102*
3.4.4 Conclusions *104*

Chapter 4: Phylogeography of the pseudoscorpion genus *Protochelifer* Beier (Cheliferidae) in Australia. 105

4.1 INTRODUCTION 105
4.2 METHODS 107
4.2.1 Survey of caves for Protochelifer *specimens* *107*
4.2.2 Mitochondrial DNA extraction and sequencing *110*
4.2.21 Sequence alignment and analysis 111
4.2.3 Allozyme electrophoresis *112*
4.2.31 Analysis of allozyme data 113
4.3 RESULTS 114
4.3.1 Phylogenetic reconstruction of Protochelifer *populations using mtDNA COI gene* *114*
4.3.2 Results of allozyme analysis *118*
4.6 DISCUSSION 120
4.6.1 Conclusions *123*

Chapter 5: Distribution and dispersal of Australian guano associated arthropods 125

5.1 INTRODUCTION 125
5.2 METHODS 126
5.2.1 Sampling locations and site descriptions *126*
5.2.2 Arthropod and guano sampling *128*
5.3 RESULTS - DIVERSITY PATTERNS OF AUSTRALIAN GUANO ARTHROPODS 129
5.3.1 Flinders Ranges subterranean guano arthropods *129*
5.3.2 Eastern Nullarbor Plain cave guano arthropods *130*
5.3.3 Northern Queensland tropical cave guano arthropods *131*
5.4 DISCUSSION 132
5.4.1 Distribution of Australian guano invertebrates *133*
5.4.2 Potential dispersal mechanisms *138*
5.4.3 Potential endemism *140*

Chapter 6: General discussion - Australian cavernicolous guano associated arthropods 143

6.1 CONSERVATION AND MANAGEMENT OF CAVERNICOLOUS GUANOPHILIC INVERTEBRATE COMMUNITIES 143
6.1.1 Management *145*

6.2 GENERAL DISCUSSION 146

References 149

Appendix 1: Review of Australian cave guano ecosystems with a checklist of guano invertebrates. 163

Appendix 2: Arthropod ecology of Bat Cave, Naracoorte, South Australia. 205

Appendix 3: Bat Cave arthropod abundances 213

Appexdix 4: Bat Cave environmental data 226

Appendix 5: Starlight Cave species abundances 239

Appendix 6: Starlight Cave Environmental Data 243

Appendix 7: Allozyme raw scores for pseudoscorpions 245

Appendix 8: Diversity and Biogeography of Subterranean Guano Arthropod Communities of the Flinders Ranges, South Australia. 247

Appendix 9: The first Australian record of subterranean guano-collecting ants. 257

Index of Figures

Figure 1.1. *The environmental zones of a cave shown in cross section..... 22*

Figure 2.1. *Plan and cross-section of Bat Cave, Naracoorte..... 38*

Figure 2.2. *Pitfall trap locations and sample areas in the maternity chamber of Bat Cave..... 40*

Figure 2.3. *Schematic diagram of sampling design, showing groupings for nested analysis. Red dashed lines show all 18 sample Tops while blue dashed lines show sample Bottoms. The unbroken green lines show the grouping of six Tops and six Bottoms each for the three areas of the maternity chamber, 'Front', 'Central' and 'Rear'. 41*

Figure 2.4. *Guano collecting tray at top of guano pile in the maternity chamber, Bat Cave. Photo A. Branford. 43*

Figure 2.5. *pH of in situ guano at Tops and Bottoms of guano piles in the maternity chamber of Bat Cave. 47*

Figure 2.6. *Moisture content of in situ guano at Tops and Bottoms of guano piles in the maternity chamber of Bat Cave. 47*

Figure 2.7. *Fresh guano deposition on the Tops and Bottoms of guano piles in the maternity chamber of Bat Cave. 48*

Figure 2.8. *Fresh guano deposition from Front, Central and Rear areas of the maternity chamber of Bat Cave. 48*

Figure 2.9. *Linear regression between increasing fresh guano deposition and increasing pH (y = 0.07x + 5.9) 49*

Figure 2.10. *Linear regression between increasing guano deposition and increasing moisture content (y = 0.59x + 44.9)..... 50*

Figure 2.11. *A two-dimensional NMS ordination on environmental variables measured in the maternity chamber. This ordination yielded a stress value of 8.72%, a final instability of 0.00001 and an r^2 value of 0.95 (indicating 95% of the variance in the data is explained by the model). Varimax rotation was invoked to align the maximal explained variance with Axis 1. The r^2 vectors are produced by overlaying the original data on itself. The length of the vector indicates the variance explained by the named variable, and the orientation shows the direction of increase. The vectors in this plot are constrained to r^2 >=0.25. ..... 51*

Figure 2.12. *A two-dimensional NMS ordination on environmental variables measured in the maternity chamber. This ordination yielded a stress value of 10.67%, a final instability of 0.00009 and an* r^2 *value of 0.944 (indicating 94.4% of the variance in the data is explained by the model). Varimax rotation was invoked to align the maximal explained variance with Axis 1. The* r^2 *vectors are produced by overlaying the original data on itself. The length of the vector indicates the variance explained by the named variable, and the orientation shows the direction of increase. The vectors in this plot are constrained to* r^2 *>=0.25. ..... 52*

Figure 2.13. *Rank abundance graph of 13 species collected in the maternity chamber, Bat Cave. A two binding hyperbola was fitted to the data. Species in ascending order are* Uroobovella coprophila *(Urodinychidae),* Ptinus exulans *(Anobiidae),* Protochelifer naracoortensis *(Pseudoscorpionida),* Tomogenius *?*ripicola *(Histeridae),* Speotarus lucifugus *(Carabidae),* Derolathrus sp*. (Jacobsoniidae),* Monopis crocicapitella *(Tineidae),* Apanteles *?*carpartus *(Braconidae),* Phoridae sp*., Nycteribiidae sp.,* Anchicera sp*. (Cryptophagidae),* Porcellio scaber *(Porcellionidae) and* Ixodes simplex simplex *(Ixodidae). Abundances were* log_{10} *transformed prior to analysis. 55*

Figure 2.14. *Average species richness from 12 sample periods in the maternity chamber, Bat Cave. Error bars are standard errors. 56*

Figure 2.15. *Linear regression of moisture content plotted against species richness from Tops and Bottoms of guano piles in the maternity chamber of Bat Cave (y = 0.11x-0.7). 56*

Figure 2.16. *Linear regression of pH plotted against species richness for all pitfall traps regardless of position within the maternity chamber of Bat Cave (y = 0.99x-1.46).....57*

Figure 2.17. *Simpson diversity index values averaged for all pitfall traps regardless of position within the maternity chamber of Bat Cave plotted against pH. The data show little relationship and linear and non-linear regression both show* r^2 *values less than 0.3. ..... 57*

Figure 2.18. *Simpson diversity index values averaged for all pitfall traps regardless of position within the maternity chamber of Bat Cave with fresh guano deposition. Data are fitted with a two site binding hyperbola*

with an r^2 = 0.48, however, when the outlier of 23 g guano deposition is removed this fit improves to r^2 = 0.57. 58

Figure 2.19. *Simpson diversity index values averaged for all pitfall traps regardless of position within the maternity chamber of Bat Cave plotted against moisture content. Quantile regression (Koenker and Bassett 1978) estimates for upper 25th (y = -0.18x+12.32), 50th (y = -0.15x+10.13) and 75th (y = -0.14x+9.39) percentile bands in descending order. 58*

Figure 2.20. a-f. *Average species abundances and standard errors for six key species in the maternity chamber. 61*

Figure 2.21. a. *Average abundances of braconid parasitoids and Monopis moths demonstrating very similar population levels. Error bars are standard errors.* ***b-f.*** *Average abundances for five key species in the maternity chamber. 63*

Figure 2.22. *Simplified food web for arthropods in the maternity chamber, Bat Cave, Naracoorte. Arrows indicate direction of energy flow. Broken lines indicate possible interactions between taxa while continuous lines represent observed or previously published interactions. Bat parasites, including Nycteribiidae spp. and* Ixodes simplex simplex*, have been excluded from the diagram as they only contribute a minor amount of energy to the system due to their low abundances and lack of interaction with most other arthropods present. 65*

Figure 2.23. *A two-dimensional NMS ordination of arthropod community data measured in the maternity chamber. This ordination yielded a stress value of 8.72%, a final instability of 0.00003 and an r^2 value of 0.95 (indicating 95.0% of the variance in the data is explained by the model). Varimax rotation was invoked to align the maximal explained variance with Axis 1. The r^2 vectors are produced by overlaying the original data on itself. The length of the vector indicates the variance explained by the named variable, and the orientation shows the direction of increase. The vectors in this plot are constrained to r^2 >=0.35. ..... 66*

Figure 2.24*. A two-dimensional NMS ordination of arthropod community data measured in the maternity chamber. This ordination yielded a stress value of 10.67%, a final instability of 0.00005 and an r^2 value of 0.944 (indicating 94.4% of the variance in the data is explained by the model).*

Varimax rotation was invoked to align the maximal explained variance with Axis 1. The r^2 vectors are produced by overlaying the original data on itself. The length of the vector indicates the variance explained by the named variable, and the orientation shows the direction of increase. The vectors in this plot are constrained to r^2 >=0.35. 67

Figure 2.25. *Relativised Sorensen cluster dendrogram of community assemblage based on seasonal species diversity and abundance data. 68*

Figure 3.1. *Plan and cross-section of Starlight Cave, Warrnambool western Victoria. Cross-section modified after Gill (1948). Plan view developed from a sketch made in the cave by the author..... 79*

Figure 3.2. *Plan view of Starlight Cave, Warrnambool western Victoria showing pitfall trap locations at five sites in the rear of the cave. Arrows indicate downward slope direction..... 81*

Figure 3.3. *pH of in situ guano at the Tops and Bottoms of guano piles in Starlight Cave, Warrnambool, Victoria. Error bars are standard errors. 83*

Figure 3.4. *Average pH of guano for Tops and Bottoms, summer and winter combined in three areas of Starlight Cave, Warrnambool, western Victoria. Error bars are standard errors..... 83*

Figure 3.5. *Moisture content of in situ guano at the Tops and Bottoms of guano piles in Starlight Cave, Warrnambool, Victoria. Error bars are standard errors..... 84*

Figure 3.6. *Average moisture content of in situ guano from Tops and Bottoms, summer and winter combined in three areas Starlight Cave, Warrnambool, Victoria. Error bars are standard errors..... 84*

Figure 3.7. *Fresh guano deposition at the Tops and Bottoms of guano piles in Starlight Cave, Warrnambool, Victoria. Error bars are standard errors. 85*

Figure 3.8. *Average fresh guano deposition for Tops and Bottoms, summer and winter combined in three areas of Starlight Cave, Warrnambool, Victoria. Error bars are standard errors..... 85*

Figure 3.9. *A three-dimensional NMS ordination of environmental variables measured in Starlight Cave. This ordination yielded a stress value of 15.14%, a final instability of 0.00001 and an r^2 value of 0.839 (indicating 83.9% of the variance in the data is explained by the model). Varimax*

rotation was invoked to align the maximal explained variance with Axis 2. The r^2 vectors are produced by overlaying the original data on itself. The length of the vector indicates the variance explained by the named variable, and the orientation shows the direction of increase. The vectors in this plot are constrained to r^2 >0.25. 86

***Figure 3.10**. Rank abundance graph of 24 taxa collected from Starlight Cave presented as a two binding hyperbola fitted to the data. Taxa in ascending order are* Ptinus exulans *(Anobiidae),* Tomogenius ?ripicola *(Histeridae),* Laelapidae sp*.,* Phoridae sp*.,* Monopis crocicapitella *(Tineidae),* Nycteribiidae sp*.,* Atomaria sp*. (Cryptophagidae),* Cryptinae sp*. (Ichneumonidae),* Staphylinidae *spp.,* Protochelifer australis *(Pseudoscorpionida),* Sciaridae sp*.,* Sphaeroceridae sp*.,* Uroobovella coprophila *(Urodinychidae),* Macrocheles penicilliger *(Macrochelidae), Collembola spp.,* Spinturnix loricata *(Spinturnicidae),* Derolathrus sp*. (Jacobsoniidae), Lygaeoidea sp.,* Sidymella sp*. (Thomisidae),* Speotarus princeps *(Carabidae), Curculionidae sp.,* Porcellio *(Porcellionidae),* Pseudonemadus sp*. (Leiodidae) and* Rhaphidophoridae sp*.. Abundances were log_{10} transformed prior to analysis..... 90*

***Figure 3.11.** Average species richness from Tops and Bottoms of guano piles from 4 sample periods in Starlight Cave. Error bars are standard errors. 91*

***Figure 3.12.** Average species richness for three areas of Starlight Cave, for Tops and Bottoms of all sample periods combined. Error bars are standard errors. 91*

***Figure 3.13.** Moisture content of in situ guano plotted against species richness from 40 pitfall traps and four sample periods in Starlight Cave. The data show a significant correlation ($p<0.05$) although r^2 values for linear regression is 0.11. ..... 92*

***Figure 3.14.** pH plotted against species richness from 40 pitfall traps and four sample periods in Starlight Cave. The data show a significant correlation ($p<0.001$) although r^2 values for linear regression is 0.25. ..... 92*

***Figure 3.15.** pH plotted against Simpson's diversity index from all pitfall traps from all four sample periods combined for Starlight Cave. Quantile regression estimates for upper 25th (y = 0.85x-2.95) and 50th (y = 0.66x-2.21) percentile bands in descending order..... 93*

Figure 3.16. *Moisture content of in situ guano plotted against Simpson's diversity index from 40 pitfall traps and four sample periods, combined for Starlight Cave. A five site binding hyperbola fitted the data with an* r^2 *value of 0.42 although the result was not significant. 93*

Figure 3.17. *Fresh guano deposition plotted against Simpson's diversity index from 40 pitfall traps and four sample periods combined for Starlight Cave. The data show no significant linear correlation (p=0.19) with an* r^2 *value of 0.04. ..... 94*

Figure 3.18. *A three-dimensional NMS ordination of the arthropod assemblage in Starlight Cave. This ordination yielded a stress value of 15.14%, a final instability of 0.00001 and an* r^2 *value of 0.839 (indicating 83.9% of the variance in the data is explained by the model). Varimax rotation was invoked to align the maximal explained variance with Axis 3. The* r^2 *vectors are produced by overlaying the original data on itself. The length of the vector indicates the variance explained by the named variable, and the orientation shows the direction of increase. The vectors in this plot are constrained to* $r^2 > 0.30$. *..... 95*

Figure 3.19. *Relativised Sorensen cluster dendrogram of community assemblage based on seasonal species diversity and abundance data. 96*

Figure 4.1. *Distribution of the five described* Protochelifer *species in Australia using published records. The Otway Basin incorporates the southeast region of South Australia and western Victoria. The cavernicolous Miocene – Oligiocene Gambier Limestone Unit covers much of the onshore area of the Otway Basin from west of Naracoorte to east of Warrnambool.* Protochelifer australis *and P.* brevidigitatus *are recorded from Lady Julia Percy Island but only P.* australis *is recorded from Starlight Cave on the nearby mainland. P.* victorianus *is recorded from under bark in the Otway Ranges and Gippsland, Victoria. 106*

Figure 4.2. *Naracoorte Cave World Heritage Area, showing caves containing* Protochelifer *populations. 110*

Figure 4.3. *Uncorrected genetic distance and transitions. 115*

Figure 4.4. *Uncorrected genetic distance and transversions. 115*

Figure 4.5. Protochelifer *maximum parsimony phylogram. Bootstrap values based on 1000 replicates. 116*

Figure 4.6. *Bayesian phylogram, based on 2 million generations sampling every 100 generations with a burn in of 100 000 generations. Posterior probabilities calculated from percent of tree containing each bipartition from a 50% majority consensus rule. 117*

Figure 4.7. *Neighbour-joining tree depicting genetic distances among cavernicolous* Protochelifer *populations in southern Australia as assessed by allozyme analysis of 30 loci. Bootstrap values are based on 100 pseudoreplicates. 119*

Figure 5.1. *Four Australian karst areas sampled for guano arthropods and used to compare community structure from different climatic zones. The Otway basin in south-east South Australia and western Victoria is the most well sampled of the four areas followed by the Nullarbor Plain..... 126*

Figure 5.2. *Localities of guano sites sampled in the Flinders Ranges. Brachina, Bunyeroo, Chambers, and Weetootla Gorges all contain two sites..... 127*

Figure 5.3. a - d. *Distribution of four species of guano associated arthropods in Australia, showing disjunct patterns (e.g.* Monopis sp.*) and those associated with bat maternity colonies (*Uroobovella coprophila*). 136*

Index of Tables

Table 2.1. *Arthropod species diversity of the maternity chamber, Bat Cave. The first reference to provide the most complete identification of the taxon listed is provided in The Previously Recorded Column. Species richness is shown by the Present Study Column. Note, this study did not encompass all available trapping techniques used in previous studies as its aim was to determine the ecology and small-scale spatial and seasonal variation in the arthropod community. [1]The two species of Nycteribiidae from the maternity chamber were not identified until the conclusion of the study. [2]Juvenile cockroach specimens believed to be N. australis were sighted during the study although none were collected. 53*

Table 2.2. *Arthropod abundance and percent composition of the 13 most abundant species recorded in the in the maternity chamber, Bat Cave. All other species recorded from the maternity chamber were in abundances <10 individuals comprising <0.1% of total abundance excluding Urodinychidae. 54*

Table 2.3. *Significant indicator species for position on guano piles (Top or Bottom) in the maternity chamber of Bat Cave calculated using the method of Dufrene and Legendre (1997) and Monte Carlo significance observed maximum indicator value for each species (1000 permutations). * Anobiidae was included in this table despite the P value > 0.05 as the result was deemed biologically important. 69*

Table 2.4. *Significant indicator species for position within the maternity chamber of Bat Cave (Front, Central and Rear) calculated using the method of Dufrene and Legendre (1997) and Monte Carlo significance observed maximum indicator value for each species (1000 permutations)..... 69*

Table 2.5. *Significant indicator species for seasonal presence within the maternity chamber of Bat Cave (Summer, Winter and October) calculated using the method of Dufrene and Legendre (1997) and Monte Carlo significance observed maximum indicator value for each species (1000 permutations). 70*

Table 3.1. *Arthropod and nematode species recorded from of Starlight Cave, Warrnambool, western Victoria. Forty-three arthropod and nematode*

*species from 39 families and 14 orders were recorded from this and previous studies. * Unpublished data from Hamilton-Smith recorded in Moulds (2004). 88*

***Table 3.2.** Arthropod abundance and percent composition in Starlight Cave. [1]Abundances for the two species of Staphylinidae, Myotyphlus jasoni and Philonthus parcus, and the Collembola, Discocyrtus cinctus and Hypogastrura vernalis were grouped as the species were not identified until after the study was complete. 89*

***Table 3.3.** Significant indicator species for position on guano piles (Top or Bottom) from Starlight Cave calculated using the method of Dufrene and Legendre (1997) and Monte Carlo significance observed maximum indicator value for each species (1000 permutations). 97*

***Table 3.4.** Significant indicator species for the position of guano piles within Starlight Cave (Birthing Chamber, Central Corridor or Terminal Chamber) calculated using the method of Dufrene and Legendre (1997) and Monte Carlo significance observed maximum indicator value for each species (1000 permutations). 97*

***Table 3.5.** Significant indicator species for season (Summer or Winter) from Starlight Cave calculated using the method of Dufrene and Legendre (1997) and Monte Carlo significance observed maximum indicator value for each species (1000 permutations). 98*

***Table 4.1.** Caves in southern Australia sampled for pseudoscorpions and the respective species present. Further information regarding the location and morphology of caves in the Flinders Ranges can be found in (Moulds, 2005). 108*

***Table 5.1.** Arthropods collected from guano deposits in the caves and mines of the Flinders Ranges. Caves are listed alphabetically by the area in which they are found. Some specimens could only be identified to subfamily or genus..... 130*

***Table 5.2.** Guano associated cavernicolous arthropods collected from the eastern Nullarbor Plain during November 2004..... 131*

***Table 5.3.** Species diversity from two caves in the Broken River karst area, west of Townsville, Queensland. The caves were situated on either side*

of Jacks Gorge. Some species could only be identified to order or family. 132

Table 5.4. *Arthropod families found in cave guano deposits from four different regions of Australia. The Otway Basin and Nullarbor Plain have had the most collecting efforts..... 135*

Table 5.5. *Possibly endemic guano dependent species in Australia. These species all show known restricted distributions and a significant degree of guano dependence..... 141*

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Abstract

Guano deposits in caves form a rich food resource supporting diverse arthropod communities. Guano piles consist of distinct micro-habitats, fresh, moist, highly basic guano and older, dry, slightly acidic guano. Micro-habitat variation is strongly controlled by seasonal guano deposition that, in turn, effects the structure of arthropod communities.

The maternity chamber of Bat Cave, Naracoorte, South Australia, contains extensive guano deposits supporting 38 species from three classes and 12 orders. This community was studied to determine spatial and temporal variation of arthropod communities, and biogeographic relationships between different regions in Australia. Species richness forms a positive linear relationship with pH, *in situ* moisture content and guano deposition. Many species show strong associations with fresh guano and hence are strongly seasonal, although some species are present throughout the year. Arthropod community structure in winter was found to be more closely related to prior summer arthropod structure than to subsequent seasons.

Starlight Cave near Warrnambool, western Victoria, the only other maternity site for *Miniopterus schreibersii bassanii*, contained 43 species from 39 families and 14 orders. Seven species are common to both caves. The community structure of Starlight Cave was found to be more homogeneous than Bat Cave with samples clustering by season rather than sample year as was the case at Bat Cave. Different cave morphology was found to significantly alter the micro-habitat conditions and, hence, community structure in Starlight Cave compared with Bat Cave.

Migration of guano associated arthropods at local, regional and continental scales was assessed using mtDNA and allozyme electrophoresis the pseudoscorpion genus *Protochelifer* as a model organism. Phylogenetic tree reconstruction revealed a wide geographic distribution of cavernicolous species across southern Australia. Cave colonisation is believed to have occurred only once, followed by dispersal to the Nullarbor Plain and other caves in south-eastern Australia. Dispersal was possibly phoretic on cave bats or occurred prior to aridification of surface environments that currently restricts migration.

The distribution of guano-associated arthropods from arid, semi-arid and monsoonal karst areas in Australia are compared with temperate south-eastern

Australia. Different climatic areas show large biogeographical differences in community structure, although similar families (Urodinychidae, Reduviidae, Anobiidae, Carabidae and Tineidae) are present in many Australian guano communities. Several potential mechanisms of dispersal are discussed including phoresy, colonisation from soil, terrestrial migration and interstitial cavities. Endemism to specific caves cannot be definitely assigned to any species, although 13 species show restricted distribution.