

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Native and adventive detritivores in forests of Manawatu-Whanganui



A thesis presented in partial fulfilment of the requirements for the degree of
Master of Science
in
Ecology
at Massey University, Manawatu, New Zealand

Amie Parker

2013

Abstract

Little is known about many New Zealand invertebrates, including detritivores which have a key role in the functioning of ecosystems and are threatened by habitat modification and the addition of adventive species. Detritivores are an abundant group, and, like many other New Zealand taxa, they contain a high level of endemism that needs conserving. Detritivores are so scarcely studied, that it remains unknown how their forest communities are influenced by changes to New Zealand's forest habitats. This study aimed to increase knowledge on the identity, abundance, and distribution of detritivores in forests of Manawatu-Whanganui. Four main questions were addressed: (1) are adventive detritivores capable of invading native forests?, (2) can pine forests provide an alternative forest habitat for native detritivores?, (3) does proximity to forest edge affect native and adventive detritivores?, (4) are native and adventive detritivores co-occurring in the same habitats? Three detritivore groups (Diplopoda, Isopoda, and Amphipoda) were collected from edge and centre plots in six pine forests and ten native forests (including those that are small and close to urban areas) in Manawatu-Whanganui region of New Zealand.

The results show that a number of adventive taxa have spread throughout native forests in Manawatu-Whanganui, which does not support the hypothesis that native forests are resistant to adventive detritivores. Adventive Diplopoda were actually more abundant in native forests, and abundance of adventive Amphipoda and adventive Isopoda was high in both native and pine forests. Some native taxa were less dominant or absent in pine forests, and forest type influenced the community structure of Diplopoda and possibly Isopoda. The likelihood that a randomly collected

detritivore would be an adventive was also influenced by forest type in all three detritivore groups. Human disturbance may have facilitated the invasion and establishment of adventive species, because small, urban, and highly modified native remnants appeared to have higher abundance and diversity of adventive species. Edge proximity had little influence on abundance of detritivores, but did affect the predicted likelihood of encountering an adventive individual in all three groups.

Adventive and native detritivores co-occurred in all forest habitats and it is possible that adventive detritivores will be influencing native species. Native Amphipoda appear to be under the most immediate threat in Manawatu-Whanganui, with adventive Amphipoda having higher abundance and higher probability of being found throughout all investigated forest habitats; there is evidence that adventive *Arcitalitrus* is displacing native species. The presence of adventive species could alter the functioning of native forest ecosystems and further research into the effect of adventive species in native forest is recommended. The data also revealed that for all three investigated taxa pine forests can support as many native detritivores as native forests, suggesting that pine forests contribute to preserving native biodiversity. Pine forests may be used as a tool to conserve native detritivores, but the conditions which promote the establishment of native species need further investigation.

Acknowledgements

Firstly, I would like to thank my thesis supervisor Dr Maria (Masha) Minor for her guidance and help with all aspects of the thesis, including many hours of help in the lab with identification, statistical advice, and finally help with editing. I am thankful to have had a supervisor that was so willing to help with any questions I had throughout the creation of this thesis.

Thanks go to the many helpful land owners and forestry managers who granted me permission to research on their land and provided me with any information I needed: Palmerston North City Council, Department of Conservation, Manawatu District council, Rick Brown, Trish Castle, Peter Wright (Rayonier/Matariki forests), and Pat McCarty (Ernslaw One Limited).

I would also like to thank the Ecology department technicians (Tracy Harris and Cleland Wallace) for providing the equipment needed for field and lab work, Russell Death (Massey University, Ecology – IAE) for statistical advice, and Rick Webber (TePapa Tongarewa Museum) who provided assistance in the identification of amphipods. This thesis was supported by a scholarship from the Ecology Bursary, Massey University.

I am appreciative of the friends that have made the last couple of years a lot more enjoyable and provided me with the support I needed to complete this thesis. Special thanks go to those that even gave up their time to help me with field work, editing, and statistics (Chris Parker, Jess Hiscox, Mike Parker, Leanne Parker, Amanda

Dehoop, Tylee Reedy, Joanne Headly, David Munro, Phoebe Stewart-Sinclair, and Danielle McArley).

Finally, I would like to thank my family not only for the support they have given me throughout the last couple of years (including the many days my mum has given up to spend in the forest helping me) but also for the constant encouragement and support that they have provided me with throughout my life.

Table of contents

1. Introduction	1
1.1. Endemism and origins of New Zealand's native invertebrate fauna: an overview.....	1
1.2. Adventive species in New Zealand: an overview and the impacts of adventive invertebrates.....	9
1.3. Detritivores and the role of soil fauna	17
1.4. Research rationale and questions	23
1.4.1. How many adventive detritivores are out there, and what are their impacts?	23
1.4.2. Are New Zealand's native forests resistant to invasion by adventive invertebrates?	26
1.4.3. Pine forests as a new habitat for native and adventive species.....	29
1.4.4. Do edges and closeness to urban areas facilitate advancement of adventive detritivores?	32
1.5. Summary of research objectives	36
1.6. Thesis structure	39
2. Methods	42
2.1. Study sites.....	42
2.2. Sampling and extraction.....	44
2.3. Sorting and identification	46
2.4. Statistical analysis.....	51
3. Fauna and communities of native and adventive detritivores in the study area...	54
3.1. Introduction.....	54
3.2. Results	56
3.2.1. Diplopoda	56
3.2.2. Isopoda.....	62
3.2.3. Amphipoda.....	66
3.3. Discussion	70
3.3.1. Diplopoda	70
3.3.2. Isopoda.....	81

3.3.3. Amphipoda.....	86
3.4. Summary.....	92
4. Effects of forest type and plot location on abundance and community composition of native and adventive detritivores in the study area	94
4.1. Introduction.....	94
4.2. Results	96
4.2.1. Overall detritivore abundance patterns	96
4.2.2. Diplopoda	97
4.2.3. Isopoda.....	106
4.2.4. Amphipoda.....	110
4.3. Discussion.....	114
4.3.1. Native and adventive detritivore abundance patterns and the effect of forest type.....	114
4.3.2. Edge effects.....	120
4.3.3. Implications for invertebrate biodiversity conservation	123
4.4. Summary.....	126
5. General discussion and conclusions	128
5.1. Importance of the study.....	128
5.2. Improved knowledge of the fauna	129
5.3. Adventive detritivores and the invasion of native forests.....	130
5.4. Pine forests as alternative habitat for detritivores	132
5.5. Edge effects	136
5.6. Threat to native species	137
5.7. Limitations of this study	139
5.8. Future research	141
5.8.1. Investigating competition between native and adventive detritivores ..	141
5.8.2. Investigating threat to ecological function	142
5.9. Summary.....	145
References.....	148
Appendix 1: site descriptions	165
Kitchener Park.....	165
Mt Lees Reserve	167

McCraes Bush.....	169
The Victoria Esplanade.....	170
Bledisloe Park.....	171
The Ashhurst Domain.....	173
Totara Reserve	174
The Manawatu Gorge	176
Waitarere forest.....	178
Santoft forest	179
Hawkey's forest.....	181
Whanganui forest.....	182
Shannon forest.....	184
Kahutarawa	187
Appendix 2: data sheet	190
Appendix 3: key to sites presented on figures in Chapter 4.....	200
Appendix 4: logistic regression model (SAS output).....	201
Diplopoda	201
Isopoda.....	204
Amphipoda.....	207
Appendix 5: the mixed procedure (SAS output)	211
Adventive Diplopoda.....	211
Native Diplopoda.....	212
Adventive Isopoda.....	214
Native Isopoda	215
Adventive Amphipoda.....	217
Native Amphipoda	218

List of figures

Figure 2.1. Map of the North Island (New Zealand) displaying sampling sites.	43
Figure 2.2. Methods used to collect detritivores.....	49
Figure 2.3. Some representative detritivores.....	50
Figure 3.1. Relative abundance of Diplopoda in sampled forest plots, Manawatu-Whanganui, 2012	61
Figure 4.1. Mean abundance of detritivores in a) native forests and b) pine forests	97
Figure 4.2. Box plot showing abundance of a) native Diplopoda and b) adventive Diplopoda in native and pine forests, in plots at the edge and centre of forests.....	99
Figure 4.3. Non-metric multidimensional scaling ordination representing Diplopoda community composition in native and pine forest plots.....	102
Figure 4.4. Non-metric multidimensional scaling ordination (bubble plot) displaying the abundance of <i>C. britannicus</i> (Diplopoda) in sampled forests.....	103
Figure 4.5. Non-metric multidimensional scaling ordination (bubble plot) displaying the abundance of <i>O. pilosus</i> (Diplopoda) in sampled forests	103
Figure 4.6. Non-metric multidimensional scaling ordination (bubble plot) displaying the abundance of Polydesmida morphospecies 5 (Diplopoda) in sampled forests.	104
Figure 4.7. Non-metric multidimensional scaling ordination (bubble plot) displaying the abundance of Polydesmida morphospecies 8 (Diplopoda) in sampled forests	104
Figure 4.8. Non-metric multidimensional scaling ordination (bubble plot) displaying the abundance of Polydesmida morphospecies 11 (Diplopoda) in sampled forests.	105
Figure 4.9. Non-metric multidimensional scaling ordination (bubble plot) displaying the abundance of Polydesmida morphospecies 15 (Diplopoda) in sampled forests	105
Figure 4.10. The probabilities that a randomly collected Diplopoda individual would be adventive depending on forest type (native forest or pine forest) and plot location (forest edge or centre) (logistic regression).	106
Figure 4.11. Box plot showing abundance of a) native Isopoda and b) adventive Isopoda in native and pine forests, in plots at the edge and centre of forests).	108

Figure 4.12. The probabilities that a randomly collected Isopoda individual would be adventive depending on forest type (native forest or pine forest) and plot location (forest edge or centre) (logistic regression).	110
Figure 4.13. Box plot showing abundance of a) native Amphipoda and b) adventive Amphipoda in native and pine forests, in plots at the edge and centre of forests.....	112
Figure 4.14. The probabilities that a randomly collected Amphipoda individual would be adventive depending on forest type (native forest or pine forest) and plot location (forest edge or centre) (logistic regression).....	113

List of tables

Table 3.1. Detritivore taxa found in forests of Manawatu-Whanganui.	69
Table 4.1. The effect of forest type (pine and native), plot location (edge and centre), and interaction between the two factors on Diplopoda abundance (ANOVA).....	100
Table 4.2. The effect of forest type (pine and native), plot location (edge and centre), and interaction between the two factors on Isopoda abundance (ANOVA).....	109
Table 4.3. The effect of forest type (pine and native), plot location (edge and centre), and interaction between the two factors on Amphipoda abundance (ANOVA).....	113