Habitat use, seasonality and ecology of carabid beetles (Coleoptera: Carabidae) in native forest remnants, North Island, New Zealand

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Abstract

The Carabidae (Insecta: Coleoptera) is one of the largest insect families in New Zealand with an estimated 600 species, 90% of which are endemic. Carabids have received a considerable amount of attention in the Northern Hemisphere, but next to nothing is known about the biology of carabids in New Zealand. The aim of my research was to increase our knowledge about the ecology, population dynamics, and life history of carabids in New Zealand native forests.

The morphology and biology of two species of endemic carabids, *Mecodema oconnori* Broun and *Megadromus capito* (White) was studied in detail. *Mecodema oconnori* was strongly sexually dimorphic, whereas *M. capito* males and females were very similar in size and weight. During the course of the study, I discovered several very small *M. oconnori* males with red legs, and these may belong to a separate species. The habitat use and movement of *M. oconnori* and *M. capito* in a native forest remnant was investigated using several different sampling techniques, including manual searches, live capture pitfall trapping, and harmonic radar tracking. Manual searches of carabid resting sites proved to be the most effective method for locating these beetles, as both species displayed a high degree of site fidelity, and were repeatedly found under the same sites. Harmonic radar tracking was not very successful, largely because I was unable to identify beetles when they were in underground burrows.

The population dynamics and seasonality of several species of carabids were investigated in order to understand more about their life cycles. Manual searches of resting sites were used to estimate the seasonal abundance of *M. oconnori* and *M. capito* throughout the year, and removal pitfall trapping was also carried out for six months. The searches revealed that both *M. oconnori* and *M. capito* were present in all months of the year, in contrast to the results from previous pitfall trapping studies. Females of five species of carabids were dissected to investigate their reproductive phenology. *Mecodema oconnori* had extremely low fecundity, with a mean egg number of only 1.6 eggs per female. In contrast, *M. capito* had the highest fecundity, with up to 28 eggs per female. Both *M. oconnori* and *M. capito* females contained eggs in their ovaries from October to March, suggesting that these species have a long period of reproductive activity. *Megadromus*

capito larvae were caught in all months of sampling (from October to March) and the three instars overlapped temporally, which implies a long period of larval emergence and development. *Megadromus capito* larvae were most abundant in January-February and tenerals were found in February and March, suggesting that this species is a spring breeder. *Mecodema oconnori* also appears to be a spring breeder, although its peak in reproductive activity was slightly later than *M. capito*, in late spring-summer.

The effect of rodent control on carabid beetle assemblages was investigated at Lake Papaitonga Scenic Reserve using paired treatment (poisoned) and non-treatment (non-poisoned) areas. Controlling rodents did not have a significant effect on the carabid assemblages, or on the abundance of other invertebrate taxa, although some carabid species appeared to have benefited from the reduced rodent densities. The abundance of carabids in pitfall traps was significantly correlated with the numbers of amphipods and springtails, which suggests that carabids may aggregate in areas of high prey density. There was also a correlation between carabids and other beetles, but this was more likely to result from a similar response to the environmental characteristics at each trap.

There are many questions still to be answered about the habitat use and ecology of carabids in New Zealand, as well as the effects of introduced predators and environmental factors on carabid population dynamics. Longer-term studies are needed to gather more information on the pre-adult stages and reproductive activity of adults, as this is essential to fully understand the life history of New Zealand carabids.

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This thesis has been an epic journey of challenges and obstacles for me, and is not quite everything I hoped it would be, but I have learnt so much during this study that I don't regret any of it, and it has been an extremely valuable life experience.

Finally, I would like to thank all of the amazing carabid beetles that allowed me to intrude into their daily lives and come away with a bit more understanding of how they live. I would also like to offer a sincere apology to the countless thousands of invertebrates that died in the name of science during my study. I only hope that we can use this information wisely for their future conservation.

"When the last individual of a race of living things breathes no more,
another heaven and another earth must pass before such a one can be again"
William Beebe

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