EFFECTS OF VOLCANIC ASH ON THE INSECT FOOD OF THE MONTSERRAT ORIOLE *ICTERUS OBERI* LAWRENCE 1880

by

Katharine Ann Marske

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Entomology

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2004

APPROVAL

of a thesis submitted by

Katharine Ann Marske

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

Dr. Michael A. Ivie

Approved for the Department of Entomology

Dr. Gregory D. Johnson

Approved for the College of Graduate Studies

Dr. Bruce R. McLeod

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library.

If I have indicated my intention to copyright this thesis by including a copyright notice page, copying is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U.S. Copyright Law. Requests for permission for extended quotation from or reproduction of this thesis in whole or in parts may be granted only by the copyright holder.

Katharine Ann Marske

01 July 2004

ACKNOWLEDGEMENTS

This thesis would not have been possible without the support of my advisor, Michael A. Ivie, who provided endless hours of advice on all matters academic and otherwise, or my committee members, Sue Blodgett and Billie Kerans. In Montserrat, most of the field work was conducted by the Montserrat Forestry Division: L. Martin, J. Boatswain, J. Martin, J. Daley, L. Aymer and C. Fenton. Field assistance was also provided by J. Madden, M. Hulme, B. Dalsgaard, P. Murrain, B. Beattie, A. Krakower, R. Burrows, D. Gibbons, C. Bowden, R. Allcorn, and P. Orchard. Vital aid was granted by G Hilton, G. Gray, S. Macnamara, J. White and A. Graham in Montserrat and by the Orchard family in St. Kitts. Advice and equipment were shared by K. O'Neill, X. Ni, M. Bateson, D. Weaver, J. Littlefield, P. Denke, J. Banfield, L. Ivie and R. Hurley. Orthoptera identifications and ornithological consultation were provided by T. Walker (Florida), D. Otte (Philadelphia), D. Perez (Smithsonian) and W. Arendt (Puerto Rico). My fellow students J. Giersch, A. Ramsdale, T. Scheer, T. Hansen, S. Medrano, I. Foley, J. Allewalt and J. Fultz were always encouraging, and my parents, Doug and Mary Marske, provided constant support and motivation. Finally, I am indebted to Ken Puliafico for all of his encouragement and advice, and for keeping me sane during the writing of my thesis. Without his support, this project would have taken much longer to complete.

My studies were funded by the Royal Society for the Protection of Birds, the United Kingdom Foreign and Commonweath Office, the Montserrat National Trust, NSF Grant GEO9903098, Montana State University, the Montana Agricultural Experiment Station and the Montserrat Forestry Division.

TABLE OF CONTENTS

1. INTRODUCTION 1

2. EFFECTS OF VOLCANIC ASH ON THE FOREST CANOPY INSECTS OF MONTSERRAT 14

INTRODUCTION 14
MATERIALS AND METHODS 17
  Study Areas 17
    Montserrat 17
    St. Kitts 18
  Insect Protocol 20
    Insect Sampling 20
    Insect Processing 21
  Ash Protocol 22
    Ash Sampling 22
    Ash Processing 23
  Analysis 24
RESULTS 26
DISCUSSION 44

3. FEEDING ECOLOGY OF THE MONTSERRAT ORIOLE 53

INTRODUCTION 53
MATERIALS AND METHODS 61
  Montserrat Oriole Nest Observations 61
  Insect Sampling Protocol 64
RESULTS 67
  Prey Identification 67
  Prey Size 68
  Foraging Microhabitats 69
  Seasonal Influence 71
  Effects of Volcanic Ash 74
  Oriole Feeding Rates 79
DISCUSSION 80

4. THE ORTHOPTERA OF MONTSERRAT, INCLUDING THE PHASMIDS AND BLATTIDS 89

INTRODUCTION 89
METHODS 90
ANNOTATED CHECKLIST TO THE ORTHOPTERA OF MONTSERRAT 91
  Order Phasmida 92
  Order Orthoptera 92
  Order Blattaria 99
  Rejected Records 101

Discussion 102

5. CONCLUSION 108

LITERATURE CITED 111

APPENDICES 118

APPENDIX A 119

APPENDIX B 174

LIST OF FIGURES

Figure Page

1.1. Map of the Greater and Lesser Antilles 2

1.2. Map of Montserrat, West Indies 2

2.1. Map of Montserrat, with sampling sites indicated 18

2.2. Map of St. Kitts, with sampling sites indicated 19

2.3. Total arthropods (>2.5 mm), by location and sample date 27

2.4. Relative abundance of individual arthropods (>2.5 mm) by taxon 27

2.5. Abundance of arthropods by size 28

2.6. Regression plots of total Coleoptera, with Coleoptera less than 2.5 mm included and excluded 29

2.7. Untransformed scatter of total arthropods (>2.5 mm) and ash measurements (mg/m^2 leaf area) for all four Centre Hills fogging sites 30

2.8. Averages of total arthropods (>2.5 mm) and ln ash (mg/m^2 leaf area) for each sampling period 31

2.9. Foliar ash totals (mg/m^2 leaf area), by sample 32

2.10. Total insects (>2.5 mm) versus ash from all four Centre Hills sites and the two high ash sites 33

2.11. Total insects (>2.5 mm) versus ash for each Centre Hills sampling site........ 34

2.12. Regressions of taxa with a significant response to volcanic ash 37

2.13. Regressions for total arthropods, and for total arthropods with ants excluded, against volcanic ash-all sites. 39

2.14. Regressions for total arthropods, and for total arthropods excluding ants, against ash-high ash sites only 39

2.15. Range of total arthropod (>2.5 mm) counts from each fogging site, and for Montserrat and St. Kitts 42

2.16. Regressions of total arthropods (>2.5 mm) versus volcanic ash, with values from St. Kitts included and excluded 43

2.17. Comparison of relative abundance of individual arthropods (>2.5 mm) by taxon for Montserrat and St. Kitts 43

3.1. Map of Montserrat 54

3.2. Identity of prey delivered to Montserrat Oriole nests in 2002 and 2003.......... 68

3.3. Size of prey delivered to Montserrat Oriole nests in 2002 and 2003 69

3.4. Average of total arthropods (>2.5 mm) from all fogging sites by sampling period, with precipitation totals.. 74

3.5. Average of total arthropods (>2.5 mm) from all fogging sites for each sampling period, 30-day precipitation totals and average ash measurements for each sampling period... 76

3.6. Untransformed scatterplot of total arthropods (>2.5 mm) and ash measurements (mg/m^2 leaf area) for all four fogging sites............................... 77

3.7. Untransformed scatterplot of total Orthoptera (>2.5 mm) and ash measurements (mg/m^2 leaf area) for all four fogging sites............................... 77

3.8. Nestling Montserrat Oriole feeding rates by chick age (in days), before and after the beginning of the volcanic eruption 80

LIST OF TABLES

Table Page

2.1. Results of linear regression for individual taxa versus volcanic ash 36

2.2. Results of linear regression for different size classes of arthropods versus volcanic ash 41

3.1. Montserrat Oriole nest observation sites, with number of days and hours observed 61

3.2. Results of the regressions of individual arthropod taxa and size classes versus total rainfall 15 and 30 days prior to fogging 73

4.1. Collecting records for the Orthoptera of Montserrat 103

4.2. Number of Orthoptera species on West Indian islands for which catalogs, checklists or expedition reports exist.. 105

4.3. Comparison of Montserratian Orthoptera with species from the neighboring islands of Guadeloupe, St. Kitts and Antigua............................. 107

ABSTRACT

The Montserrat Oriole, *Icterus oberi* Lawrence, endemic to the West Indian island of Montserrat, has grown critically endangered since volcanic eruption began on that island in 1995. The Soufrière Hills Volcano has devastated much of the oriole's native habitat, and populations within intact forests have plummeted in recent years.

One hypothesized cause for the Montserrat Oriole's decline is that low insect prey numbers during the nesting season, as a result of volcanic ash in the environment, is resulting in increased nest failure. The hypothesis of a negative effect of ash on canopy arthropods was tested. Four sites, varying in the level of ash deposition they typically receive, were sampled via canopy fogging over a 14-month period. Results indicate that ash is having a significant negative impact on canopy arthropods, particularly at the sampling sites closest to the volcano, but that that the decline is limited to a few insect taxa.

To investigate whether the arthropod taxa utilized by the Montserrat Oriole were among those negatively affected by volcanic ash, observational studies were conducted to identify the main insect prey types and sizes brought to oriole nests, and to examine whether nestling feeding rates have declined since the onset of volcanic eruption. Ortoptera, which were not significantly affected by volcanic ash, were the most important nestling food resources utilized in 2002 and 2003. The most frequently delivered size of prey item was calculated at bill length long (approx. 2 cm), and were not significantly affected by ash. Orioles appear to be selecting their prey from the portion of the insect fauna that is least affected by ash in the environment. Oriole nestling feeding rates appear to have declined since 1995, but this may not be strictly due to reduced insect prey numbers.

Montserrat's Orthoptera (including Phasmida and Blattaria) were catalogued. Thirty-seven species were reported for the island, including several new species and at least 16 new distribution records for the island.

CHAPTER 1

INTRODUCTION

The Montserrat Oriole (*Icterus oberi* Lawrence) has grown critically endangered since the 1995 onset of volcanic eruption on the tiny West Indian island of Montserrat, which comprises its entire historic range. To date, approximately 60% of the island's hill forests have been destroyed by volcanic activity (Hilton et al. 2003), and Montserrat's remaining forest habitats are constantly exposed to wind-borne volcanic ash, which persists in the environment for long periods of time. Volcanic ash has been demonstrated to be harmful to insects (Edwards and Schwartz 1981), and low quantities of insect food during the oriole breeding season, due to volcanic ash in the environment, has been hypothesized as a possible cause for the Montserrat Oriole decline. The goals of this project are threefold: to investigate how the regular deposition of volcanic ash on an otherwise intact habitat affects arthropod communities; to explore how the feeding ecology of the Montserrat Oriole may have changed as a result of the eruption; and to characterize the portion of the arthropod fauna most heavily utilized by the Montserrat Oriole.

Montserrat (16º40-50'N, 62º09-15'W, 102 km^2, figures 1.1 and 1.2), a United Kingdom Overseas Territory, is one of twenty-three volcanic islands in the inner arc of the Lesser Antilles. The island consists of six old volcanic cones, ranging in age from late Miocene to late Pleistocene, modified into four hill ranges reaching 700-900 m (MacGregor 1938). While the current eruption of the Soufrière Hills Volcano is the first within historic times, it is one of five major volcanic eruptions within the Lesser Antilles in the last century alone (St. Vincent, 1902-1903; Martinique, 1902-1907 and 1929-1932; Guadeloupe, 1976-1977; Montserrat, 1995-present).

Figure 1.1. Map of the Greater and Lesser Antilles, with Montserrat indicated.

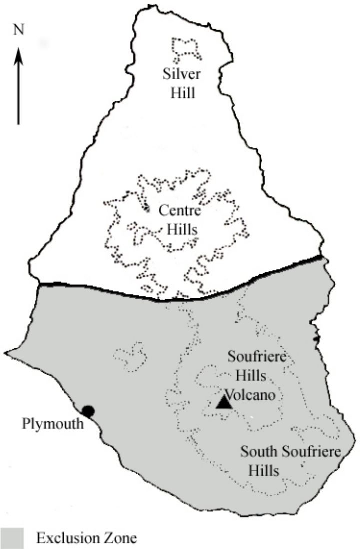

Figure 1.2. Montserrat, West Indies. Major hill ranges, former capital city, volcano and volcanic exclusion zone, indicating the portion of the island closed to human access, are shown. Exclusion boundary is drawn as of October 2002.

Montserrat has a tropical climate, with an average temperature of 26°C and yearly rainfall varying from 1,000 mm on the dry northeast coast to 2,050 mm in the mountains of the south (Johnson 1988). Vegetation is mostly secondary, ranging from dry scrub woodlands at the lower altitudes of the northeast to secondary wet tropical forest, palm brake and elfin woodland as elevation increases and wind exposure decreases (Beard 1949). The island was nearly completely deforested for colonial agriculture and wood harvest. Only 40 hectares of primary rainforest were left by 1830, and all forest regeneration has occurred since 1834 (Beard 1949, Stevens and Waldmann 2001). Silver Hill, at the north end of the island, was deforested to provide wood for shipbuilding in Antigua (Stevens and Waldmann 2001) and now supports only dry scrub. Prior to 1995, the Centre Hills, Soufrière Hills and South Soufrière Hills were covered with secondary wet tropical forest above 300 m (Stevens and Waldmann 2001, Hilton et al. 2003).

The invertebrate fauna of Montserrat is poorly known. Most of the insects occurring on Montserrat are previously unrecorded for the island, and most existing reports on the island's insect fauna are for species of agricultural importance (Ballou 1912, Fennah 1947, Irving 1978). Aside from the butterflies (Schwartz and Jimenez 1982), most other species records are scattered through the literature (Rehn 1905, Robson 1906, Cooter 1983, Woodruff et al.1998). The first checklist of the fauna, released in 2001 (Stevens and Waldmann 2001), failed to account for many of the species recorded and includes species which, although widespread, have not actually been detected on the island. However, that checklist is currently the most comprehensive published report on the insect fauna of Montserrat and catalogs 281 insect species found on the island, predicts the occurrence of many widely distributed species not yet collected on the island, and lists eleven insects endemic to Montserrat (Stevens and Waldmann 2001). Our work has so far more than doubled their number, just in the Coleoptera, and much more work remains to be done.

The vertebrate fauna is much better known. Montserrat is home to three amphibians, eleven terrestrial reptiles, 40 resident breeding birds, and ten bat species (Stevens and Waldmann 2001). Many of these are endemic to the West Indies, and several (four bats, five birds, one amphibian) are endemic to Montserrat and a few surrounding islands (Stevens and Waldmann 2001). Montserrat has six single-island endemic subspecies and three endemic species, the Montserrat Oriole, the Montserrat Galliwasp (*Diploglossus montserrati* Underwood) and the Montserrat Anole (*Anolis lividis* Garman) (Gibbons et al. 1998, Stevens and Waldmann 2001). While many vertebrates on Montserrat are of conservation interest, only the Montserrat Oriole is critically endangered (ICUN 2003).

The Montserrat Oriole is medium-sized (~35 g) and sexually dimorphic in plumage. The males are black with bright yellow breast and rump, and the females and juveniles are yellow- to olive-green with reddish-brown on the wings. Montserrat Orioles are habitat generalists and have been found in nearly all major forest types on Montserrat (Arendt and Arendt 1984, Atkinson et al. 1999). Faaborg and Arendt (1985) found oriole populations to be most abundant in the hygrophytic forest and elfin woodlands of the South Soufrière Hills (up to 8 breeding pairs/km), with lower concentrations in the meso- and hygrophytic forests of the Centre Hills (3 pairs/km).

Montserrat Orioles weave basket-shaped nests under the leaves of *Heliconia caribbaea*, but will also use banana (*Musa acuminata*) and a variety of broad-leafed species (Arendt and Arendt 1984, K. A. Marske, Montana State University, pers. obs.). Their breeding season typically extends from April to August, and the maximum number of successful broods per pair is two per season (Atkinson et al. 1999, G. M. Hilton, Royal Society for the Protection of Birds [RSPB], pers. comm.). However, most pairs are not this successful, and will attempt anywhere from zero to five nests per season, depending on their nest failure rate (G. M. Hilton, pers. comm.).

Montserrat Orioles follow the pattern of generalist parents with insectivorous young observed in other oriole species (Bent 1965). The adults are gleaning insectivores and, to a lesser extent, nectar feeders, but have occasionally been observed eating fruit (Arendt and Arendt 1984, Atkinson et al. 1999, M. F. Hulme, RSPB field assistant, pers. comm.). Nestlings are fed by the female via regurgitation for the first four days in the nest, but are fed strictly intact animal matter after that, with one or both parents bringing prey items to the nest (Arendt and Arendt 1984, Atkinson et al. 1999). The exact identity of the nestling orioles' food is unknown. Arendt and Arendt (1984) found that Lepidoptera, Coleoptera and Hymenoptera were the most common prey items at the three nests they observed, while Atkinson et al. (1999) found that the most common prey items at six nests were insect larvae and small spiders, with occasional Lepidoptera and Coleoptera. Observations in 2001 indicated a preference for large Orthoptera (Hilton 2001, M. A. Ivie, Montana State University, pers. comm.), but the delivery of a frog to a nest in 2003 (E. B. Massiah, RSPB volunteer, pers. comm.) demonstrated that foraging adults may not be specialized to any particular taxon.

Very little baseline data exists for Montserrat Oriole populations prior to 1995. Arendt and Arendt (1984) undertook the first comprehensive study of its biology, looking at population densities, relative abundance, habitat use and reproductive ecology. They proposed a conservative estimate of 1,000 to 1,200 individuals on the entire island. After Hurricane Hugo, Arendt (1990) found orioles abundant throughout the Soufrière Hills, and although no population estimates were made at that time, it was apparent that the population was, conservatively, in the hundreds. An emergency oriole census conducted in December 1997, following high levels of volcanic activity, estimated that 4,000 individual orioles inhabited the Centre Hills alone, indicating that the 1984 number may have been far too low (Arendt et al. 1999). Thus, no reliable estimate of how many orioles the island supported before 1995 exists.

Although the Montserrat Oriole population appeared stable even as late as 1997 (Arendt et al. 1999), the species already faced the growing threat of habitat loss before the eruption (Collar and Andrew 1988). The impact of forest clearing for agriculture was repeatedly documented, and recommendations were made for environmental education and conservation of forest habitats (Arendt and Arendt 1984, Faaborg and Arendt 1985, Collar and Andrew 1988, Arendt 1990). Of special concern were proposed road-building activities in the Soufrière Hills, regarded at the time as the best Montserrat Oriole habitat (Arendt 1990). Habitat loss has been implicated in the decline of the closely related Martinique Oriole [*Icterus bonana* (Linnaeus)], by rendering that species increasingly vulnerable to brood parasitism by the Shiny Cowbird [*Molothrus bonariensis* (Gmelin)] (Lovette et al. 1999). While the role of anthropogenic habitat loss and alteration in the decline of the Montserrat Oriole has yet to be clarified, it undoubtedly increased the species' vulnerability to natural disasters like volcanic activity (Lovette et al. 1999).

The current eruption of Montserrat's Soufrière Hills Volcano began on 18 July 1995 with explosions of steam and ash from Castle Peak (Robertson et al. 2000). Like most ash volcanoes, this eruption is characterized by the continual building and collapse of a lava dome resulting in pyroclastic flows—high-speed avalanches of ca. 500ºC rock and ash—which travel up to 60 meters per second (Montserrat Volcano Observatory Team 1997, Cole et al. 1998, Stone 2003). Pyroclastic flows are accompanied by hot gas and ash surges (Montserrat Volcano Observatory Team 1997) and lofting ash plumes reaching high into the atmosphere (Cole et al. 1998). These ash plumes then rain down on Montserrat and, in some cases, on surrounding islands. After an explosive eruption on 17 September 1996, an eruption column 14 km high deposited 1-2 mm ash on the island of Guadeloupe, 60 km away (Young et al. 1998). Dome growth began in November 1995 and continued, punctuated by dome collapses and pyroclastic flows, until a major eruption in September 1997 (Robertson et al. 2000).

Dome growth slowed in 1998, but several collapses, leading up to a massive one on 20 March 2000, buried much of the southern end of the island, including Montserrat's capital city and airport (Robertson et al. 2000, Matthews et al. 2002). Dome growth then proceeded almost continuously for sixteen months until another major dome collapse on 29 July 2001 released 45 million cubic meters of lava, deposited ash and pumice over the entire island, and lowered the volcano's summit by 150 m (Matthews et al. 2002). By 2003, however, the lava dome was bigger than it had ever been before, and by March 2003 the dome held 200 million cubic meters of lava (Stone 2003). The largest dome collapse to date occurred on 12-13 July 2003, releasing more than 120 million cubic meters of lava (Montserrat Volcano Observatory 2004a) and depositing 1.2 million tons of ash over inhabited parts of Montserrat (Montserrat Volcano Observatory 2004b). As of April 2004, new dome growth has not yet been initiated (Montserrat Volcano Observatory 2004a).

The impact of the current eruption on the island's fauna is currently unknown, although field teams from Montserrat and elsewhere are scurrying to quantify the damage. As a result of volcanic activity from 1995 to the present, the southern two-thirds of Montserrat are either buried under rock, ash and mud, or carved into isolated habitat fragments between pyroclastic flow deposits. Approximately 60% of Montserrat's 3,000 hectares of forest were lost (Hilton et al. 2003), and remaining forests are repeatedly ashed during explosive events and by ash blowing from the volcano's flanks. Most aquatic habitats and the island's only mangrove swamp have been destroyed, and many of Montserrat's beaches have been buried under several meters of ash and mud.

What is known about the fate of Montserrat's wildlife is generally grim. Three bat species, *Tadarida brasiliensis antillularum* (Shamel), *Noctilio leporinus mastivus* (Vahl) and *Sturnira thomasi vulcanensis* Genoways, have not been seen on the island since eruption began and are feared locally extinct (G. G. Kwiecinski, University of Scranton, pers. comm., Stevens and Waldmann 2001). The last of those three species, a

Montserrat endemic, was known only from the slopes of the volcano and may have already been extinct at the time of its description (Genoways 1998). Several frugivorous bats, including *Ardops nichollsi montserratensis* (Thomas), *Arbitus jamaicensis jamaicensis* Leach and *Brachyphylla cavernarum cavernarum* Gray, captured since 1995 have exhibited signs of abnormally worn teeth, thinned fur and heavy ectoparasite loads (Pedersen 2001, G. G. Kwiecinski, pers. comm.). While the regionally endemic Mountain Chicken (*Leptodactylus fallax* Müller) has weathered the eruption better than expected, there are indications that reproduction has been suppressed as the forest floor becomes increasingly acidified by volcanic ash (Daltry and Gray 1999). Mountain Chickens on Dominica, the only other island with an extant population, are being pushed toward extinction through a combination of overhunting and the fatal fungal disease *Chytridiomycosis*, making the Montserrat population even more important in the global conservation of the species (Fauna and Flora International 2004). Feral animals, whose impact escalated after large-scale evacuations of the southern half of the island resulted in livestock abandonment, are reaching populations large enough to wreak havoc on remaining forest habitat. Feral pigs have been observed to root up the underground burrows of the Mountain Chicken, tip over the *Heliconia* in which the Montserrat Oriole nests, and attack Montserrat Forestry Division personnel in the field (J. Daley, Montserrat Forestry Division, pers. comm.).

The Montserrat Oriole has suffered massive habitat loss as a result of the eruption. Most orioles in the Soufrière and South Soufrière Hills were destroyed along with their habitat, and nearly 80% of the world’s population is now confined to the Centre Hills, approximately five km from an active volcano (Arendt et al. 1999). It was thought that all wildlife in the Soufrière Hills and South Soufrière Hills had perished in pyroclastic flows, but in 2001 an intact forest patch of about 200 hectares was identified by M. A. Ivie in a former oriole hotspot in the South Soufrière Hills. Exploration of this forest remnant revealed a surviving population of Montserrat Orioles less than one km from the rim of the volcano (Bowden et al. 2001, Hilton et al. 2003), and the population appeared intact during a second visit in July 2002 (J. R. Madden, RSPB field assistant, and J. Daley, pers. comm.). However, this population is effectively isolated from orioles in the Centre Hills by several km of pyroclastic flow deposits, and as long as the volcano remains active, the fate of the orioles beneath its rim will remain unknown.

Although the Montserrat Oriole population of the Centre Hills appeared secure during an emergency survey in 1997, continued monitoring has revealed a population in steep decline (Hilton 2001, Bowden et al. 2001, Hilton et al. 2003). The latest count data (2004) are still being collected and analyzed, but the most recent published estimate places the Montserrat Oriole population at 100-400 breeding pairs, declining at a rate of 17-52% per year (Hilton et al. 2003). If this trend continues, assuming there are currently 400 breeding pairs, there may be only 44 to 227 breeding pairs left in three years' time. A 52% decline per year, from a starting point of 400 pairs, would result in extinction in less than a decade. Adults observed and captured during the censuses and breeding study appeared to be healthy (Atkinson et al. 1999), but reproductive success rates were only 0.88 chicks per territorial female in 1998 (Atkinson et al. 1999) and declined to 0.52 chicks per territorial female in 2001 (Hilton 2001). This trend suggests that decreased recruitment through increased nest failure rates, rather than adult mortality, are responsible for the oriole's decline. Two possible explanations are currently under investigation: increased nest predation by rats (*Rattus* spp.) and Pearly-Eyed Thrashers [*Margarops fuscatus* (Vieillot)], which thrive in disturbed habitats, and low quantities of insect food during the breeding season, due to volcanic ash in the environment. This thesis will address primarily the latter hypothesis.

While Montserrat Orioles inhabiting the Centre Hills are protected from pyroclastic flows and most explosive volcanic events, Montserrat's standing forests are regularly subject to volcanic ash deposition, and ash has repeatedly been shown to have a negative impact on insects (Wille and Fuentes 1975, Edwards and Schwartz 1981). Butcher (1981) concluded that the most severe effect of the Mount St. Helens ashfall on avifauna was the interruption of feeding resulting from insect mortality, and reported that small insectivorous species and birds with nestlings to feed were the most affected by this interruption (Butcher 1981). On Montserrat, Atkinson et al. (1999) observed a feeding rate half of that recorded before the eruption (Arendt and Arendt 1984) during a period of high eruptive activity with regular ash deposition, and the insect prey provided to nestling orioles at that time consisted mainly of small items (Hilton 2001).

Laboratory studies have identified several ash-related mechanisms of insect mortality. The main cause of insect mortality after exposure to Mount St. Helens ash was desiccation from abrasion of the insect cuticle and (Wille and Fuentes 1975, Edwards and Schwartz 1981, Brown and bin Hussain 1981). Spiracular occlusion, salivation from excess grooming and the disruption of digestive activity through the accumulation of ash in the gut also resulted in mortality (Edwards and Schwartz 1981, Wille and Fuentes 1975). Mortality was greatly affected by the length and extent of exposure to ash. Edwards and Schwartz (1981) found that house crickets [*Acheta domesticus* (L.)] survived when exposed to ash if they were then removed or provided with in-cage retreats, but those continually in contact with ash died. Shanks and Chase (1981) found that placing ash on leaves inhibited feeding by herbivorous insects, eventually resulting in mortality. Certain taxa were more susceptible than others. Flies (*Musca domestica* L.), cockroaches [*Supella longipalpa* (Fabricius)] and honey bees (*Apis melifera* L.) were all highly susceptible to water loss or ash entrapment, while grasshoppers [*Melanoplus differentialis* (Thomas)] were more resilient (Brown and bin Hussain 1981).

The effects of volcanic ash on insects in natural and agricultural ecosystems are highly variable and localized, as was observed after the eruptions of Irazú (Costa Rica, 1963-1965) and Mount St. Helens (Washington, 1980). In wheat, Klostermeyer et al. (1981) reported effects equivalent to a short-term, broad-spectrum insecticide application after the Mount St. Helens eruption, while Wille and Fuentes (1975) reported a long-term disruption of herbivore-predator-parasitoid equilibria in coffee after eruption of the Irazú Volcano. Heavy late-spring infestations of *Otiorhynchus ovatus* (L.) and *O. sulcatus* (Fabricius) (Coleoptera: Curculionidae) completely disappeared in blueberry fields subjected to 1-2 cm of Mount St. Helens ash, and no larvae were found that autumn or the following spring (Shanks and Chase 1981). In contrast, rain after ash was particularly important for the survival of ground-living insects. *Formica* spp. (Hymenoptera: Formicidae) were able to forage over the surface of ash compacted by rain without picking up particles, and after rain, ash became incorporated into the soil of their nests with no ill affects (Akre et al.1981).

Edwards and Schwartz (1981) predicted that the environmental persistence of dry ash might begin to have consequences on host plants, pollination syndromes and insectivorous vertebrates which rely on arthropods for their own success. This concern is keenly felt on Montserrat, where ash deposits are rarely as heavy as those of the Mount St. Helens eruption, but where ash is a semi-permanent environmental feature in many areas. In order to determine whether the effects of volcanic ash on insects are partially or wholly responsible for the Montserrat Oriole's decline, forest canopy insects and ash residue on leaves were sampled from functioning habitats which aside from the ash appeared normal. Montserrat Oriole nests within these habitats were observed to determine which taxa were the most heavily utilized for nestling feeding, and the diversity of these taxa on the island were catalogued and their responses to ash quantified. For the first time, the impacts of volcanic ash will be assessed on an entire forest canopy community, rather than a few species at a time.

CHAPTER 2

EFFECTS OF VOLCANIC ASH ON THE FOREST CANOPY INSECTS OF MONTSERRAT

Introduction

Eruption of the Soufrière Hills volcano on the West Indian Island of Montserrat has provided a unique opportunity to investigate how the regular deposition of volcanic ash on an otherwise intact habitat affects the arthropod communities of the forest canopy. Since the onset of eruption, approximately 60% of the island's hill forests, all in the southern half of the island, have been destroyed (Hilton et al. 2003). Remaining wildlife habitat in the north is pressed up against areas of increased habitat alteration, as the island's human population attempts to rebuild necessary infrastructures destroyed by the volcano. Montserrat's remaining forest habitats are repeatedly exposed to wind-borne volcanic ash, which is persistent in the environment, causing concern over the fate of Montserrat's insect fauna and the insectivorous species which depend on it.

Montserrat (16ºN, 62ºW, 102 km^2), a United Kingdom Overseas Territory, lies in the inner, volcanic arc of the Lesser Antilles. It has a tropical climate, with rainfall varying between 1,070 mm on the dry northwest coast to 2,050 mm in the mountains (Johnson 1988). Vegetation ranges from dry scrub woodlands at the leeward, lower altitudes to secondary rainforest, palm brake and elfin woodland as elevation and wind exposure increase (Beard 1949). The island consists of six old volcanic cones, modified into four hill ranges (MacGregor 1938). Three of these, the Centre, Soufrière and South

Soufrière Hills, reach 700-900 m and, prior to the onset of volcanic activity, were mostly covered with secondary wet tropical forest above 300 m (Hilton et al. 2003).

Montserrat's Soufrière Hills eruption, which began in 1995, is the first to occur on the island within historical times, but is only the latest in a long line that goes back to the origin of the island. The eruption, like that of most ash volcanoes, is characterized by the continual building and collapse of a lava dome resulting in pyroclastic flows—high-speed avalanches of ca. 500ºC block and ash—which travel up to 60 meters per second (Montserrat Volcano Observatory Team 1997, Cole et al. 1998, Stone 2003). Pyroclastic flows are accompanied by hot gas and ash surges (Montserrat Volcano Observatory Team 1997) and lofting ash plumes reaching up to 10 km high (Cole et al. 1998). These ash plumes then rain down on Montserrat and, in some cases, on surrounding islands, closing airports as far away as San Juan, Puerto Rico (Thomas Crosbie Media 2001, M. A. Ivie, pers. exp.). The current eruption of the Soufrière Hills volcano began on 18 July 1995 with the explosive venting of steam and ash from Castle Peak, and as of January 2004 had experienced six major and several minor dome collapses, the last on 12-13 July 2003 (see Chapter 1). As a result, the southern two-thirds of the island are either buried under rock, ash and mud, or carved into tiny habitat fragments between pyroclastic flow deposits.

Ash volcanoes have had a profound influence on the planet's biota, with effects ranging from catastrophic to subtle and localized. The effects of volcanic ash from the Irazú Volcano (Costa Rica, 1963-1965) and Mount St. Helens (Washington, 1980) on insects ranged from the equivalent of a short-term, broad-spectrum insecticide application

(Klostermeyer et al. 1981) to the long-term disruption of herbivore-predator-parasitoid equilibria (Wille and Fuentes 1975). The main cause of insect mortality after exposure to volcanic ash was desiccation, resulting from abrasion of the insect cuticle (Edwards and Schwartz 1981, Brown and bin Hussain 1981). Spiracular occlusion, salivation from excess grooming and the disruption of digestive activity through the accumulation of ash boli in the gut also resulted in mortality, although to a lesser extent (Edwards and Schwartz 1981, Wille and Fuentes 1975). Insect mortality rates were found to vary by taxon and life stage (Akre et al.1981, Brown and bin Hussain 1981, Johansen et al. 1981, Shanks and Chase 1981). Mortality was also greatly affected by the duration and extent of exposure to volcanic ash particles, with the presentation of ash-coated food greatly increasing mortality and the availability of shelter or assisted escape reducing mortality levels (Edwards and Schwartz 1981, Shanks and Chase 1981).

The 1980 Mount St. Helens eruption dropped 1500 to 2000 m^3 ash in an 80 km-wide swath over the course of a single day (Cook et al. 1981, Foster and Myers 1981), and the Irazú Volcano deposited 500 g of ash per m^2 ash per day over a brief period in January 1963 (Wille and Fuentes 1975). While Montserrat's Centre Hills rarely, if ever, receive this level of ash deposition, Cook et al. (1981) observed that ash can cling tenaciously to leaf surfaces, resulting in exposure to canopy dwellers long after an actual ashfall event. The goal of the present study is to investigate how regular low levels of volcanic ash deposition on an otherwise intact habitat affects the resident forest canopy arthropod communities. Edwards and Schwartz (1981) hypothesized that the environmental persistence of volcanic ash might begin to have consequences on host plants, pollination syndromes and insectivorous vertebrates which rely on arthropods for their own success. This concern is keenly felt on Montserrat, where populations of three rare insectivorous species may be at risk. The single-island endemic Montserrat Oriole (*Icterus oberi* Lawrence) has been in decline since the eruption began (Chapter 3), the regionally endemic Mountain Chicken (*Leptodactylus fallax* Müller) is being strictly monitored (Daltry and Gray 1999), and the fate of the extremely rare, endemic Montserrat Galliwasp (*Diploglossus montserrati* Underwood) is unknown.

Materials and Methods

Study Areas

Montserrat. Four sampling sites in Montserrat's Centre Hills were selected along an ash depositional gradient, varying in distance from the volcano and in wind direction, so that two sites regularly receive light to moderate dustings of ash due to prevailing wind patterns (designated the high ash sites), and two are protected from all but large ash-fall events (designated the low ash sites). The two high ash sites are at Hope Ghaut (16˚45.169'N, 62˚12.736'W, 315 m), above Salem, and Cassava Ghaut (16˚45.749'N, 62˚12.473'W, 263 m) at Woodlands. The low ash sites are at Fogarty (16˚46.235'N, 62˚12.529'W, 367 m) and Underwood Ghaut, at Underwood Estate (16˚46.327'N, 62˚11.734'W, 369 m). The sites range from as close to the volcano as allowed by the authorities to the northern edge of the hill forest range. On a more localized scale, sites were chosen based on their similarity to the foraging habitat of the Montserrat Oriole (see Chapter 3), and on their similarity to each other in elevation, rainfall, and canopy height, depth, maturity and heterogeneity (Figure 2.1). A 10m x 10m plot was cleared of underbrush at each site and was maintained throughout the duration of the project.

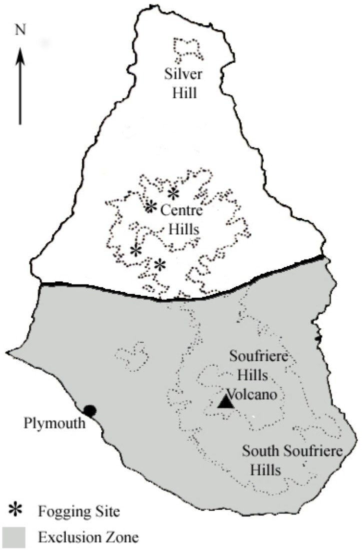

Figure 2.1. Map of Montserrat, with hill ranges, insect sampling sites, volcano and volcanic exclusion zone, indicating the portion of the island closed to human access. Fogging sites are, from north to south, Underwood, Fogarty, Cassava and Hope. Exclusion boundary is drawn as of October 2002.

St. Kitts. For comparison purposes, four sites were also sampled on the nearby island of St. Kitts (17ºN, 62ºW, 109 km²), which lies just 60 km northeast of Montserrat and is similar in climate and rainfall, but has not recently been exposed to recurring deposits of volcanic ash. Also volcanic in origin, St. Kitts has not experienced an eruption since 1692 (MacGregor 1938). Vegetation has been cleared from sea level to approximately 350 m for the cultivation of sugar cane, but above 350 m the mountains, which reach 1,000-1,150 m, are forested, and have been since the creation of a forest reserve in 1903 (Earle 1926, Beard 1949). St. Kitts retains two small patches of virgin rainforest, and maintains extensive areas covered by secondary wet tropical forest, palm brake, and dry tropical forest where land was previously under cultivation, with elfin woodlands and dry thorn scrub at the highest and lowest elevations, respectively (Beard 1949). The St. Kitts sampling sites were proposed by local volunteer Paul Orchard and were selected based on their similarity to the Montserrat sites in moisture and canopy characteristics (figure 2.2). Three sites were selected in St. Thomas Middle Island Parish, including Wingfield Valley (17˚20.167'N, 62˚47.819'W, 330 m), the Peter Manning Trail in Wingfield National Park (17˚19.704'N, 62˚47.784'W, 180 m), and Phillips Level/ Old Military Trail (17˚20.572'N, 62˚47.272'W, 390 m). One site was selected in St. Peter Basseterre Parish, near the Bayford's radio mast (17˚20.036'N, 62˚44.539'W, 310 m).

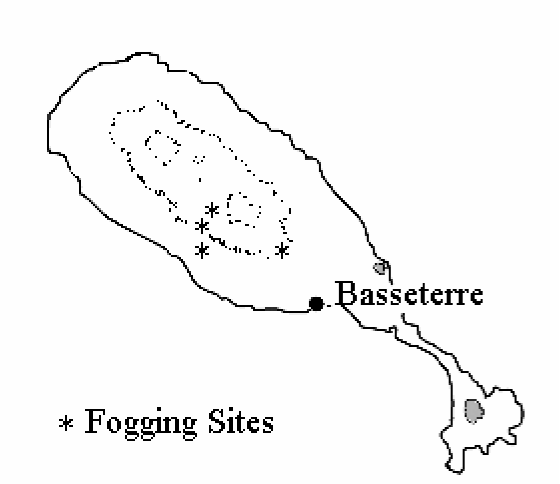

Figure 2.2. Map of St. Kitts, with hill ranges and sampling sites indicated. The cluster of three sites is in the Wingfield River drainage, and the lone site is at Bayford's.

Insect Protocol

Insect Sampling. Sampling was performed by fogging 10m x 10m blocks of forest canopy with Prentox® Pyronyl^{TM} Crop Spray (6% pyrethrins and 60% Piperonyl Butoxide, EPA Reg. No. 655-489) mixed with 10% propylene glycol, delivered by a Curtis Dyna-fog Golden Eagle® thermal fogger (Curtis Dyna-fog, Ltd., Dayton, Ohio). Sampling occurred every four weeks from May to August 2002, and about every eight weeks after that until August 2003, at daybreak (approximately 06:00) on mornings with little wind following nights with very little or no rain. Fogging should ideally be conducted at dawn while the air column is still, and only after dry nights so that the thermal spray is not lost in humidity and the insects do not stick to wet leaves (Roberts 1973, Kitching et al. 1993, Stork and Hammond 1997). In Montserrat, however, perfectly still mornings do not exist, and there is generally a light sprinkling of rain at approximately 0400. Fogging proceeded if winds were light and intermittent and if the morning showers did not visibly wet foliage, lasted less than 15 minutes, and finished by 0500. Pesticide delivery continued until the canopy was visibly filled with fog (approximately five minutes), and insects were collected on large plastic sheets arranged in a 10m x 10m square for three hours following the completion of fogging (Kitching et al. 1993). Plastic sheets were then swept with camel-hair drafting brushes, and the insects and debris were transferred to Whirlpacs® and preserved in 70% ethanol. Only one site was sampled per day.

The four St. Kitts sites were sampled from 03-05 July 2003, using the protocol described for Montserrat. Two sites were sampled simultaneously on 04 July 2003, with the second fogging beginning at approximately 0700. Each St. Kitts site was sampled only once.

Insect Processing. Two insect samples from Montserrat were cleaned entirely by hand, with every arthropod removed from the accompanying debris and saved for measurement and identification. As handling these two samples alone took approximately 120 days, all other samples were washed and fractioned to improve the speed and ease with which they could be processed. Each sample was poured into a U.S.A. Standard Testing (soil) Sieve #8 (2.36 mm) which was nested inside a #60 (250 micrometers) sieve. The sample was then gently flushed with water to separate the large arthropods and debris items from the smaller items, and so that volcanic ash, dirt and other small particulate matter would be washed away. Each sieved portion was then emptied into its own dish and handled separately. Leaves and other large debris items were discarded after being thoroughly searched for insects, and residues from the small sieves were saved in 70% ethanol.

Length measurements (head to posterior end of body or wings, if held roof-like over the body) were recorded for all arthropods longer than 2.5 mm (and all arthropods below 2.5 mm for the two hand-cleaned samples). Because the object of this study was tied to the food resources of nestling Montserrat Orioles (see Chapter 3), individuals <2.5 mm were not used in the analysis because they are not utilized by the Montserrat Oriole to feed chicks. Elimination of these tiny arthropods cut processing time for each sample by approximately 50%, making the results available in time to be useful to the Montserrat Oriole conservation effort. Measurements were made using an ocular grid or a small ruler with a dissecting microscope, and insects were assigned to a size class. As the ocular grid was not in mm increments, grid measurements had to be converted, so that the smaller size classes are not in even mm increments.

All measured arthropods were then identified to order, except in the cases of ants (Hymenoptera: Formicidae) and insect larvae. Ants typically fill a different ecological niche within an environment than the other Hymenoptera, justifying their separate treatment. Insect larvae, in this case, typically Lepidoptera, Coleoptera and Neuroptera, also typically fill a different ecological niche than the adults of their respective species. Insect larvae above a certain size are also important food items for nestlings of the Montserrat Oriole (see Chapter 3), regardless of their taxon, which is why all insect larvae were treated as a single taxon. The total number of individuals of each size class (>2.5 mm, except for the two hand-cleaned samples) within each taxon were then tallied, and the number of arthropod individuals (>2.5 mm) from each complete sample, size class and taxon were calculated. All Coleoptera, regardless of their size class, were measured and tallied. Data are presented in Appendix 1, Table 1. Arthropods in curatable condition were pinned or preserved in 70% ethanol after measurement. Those less than 2.5 mm were left in ethanol with the small-fraction debris.

Ash Protocol

Ash Sampling. Foliage samples were collected at the fogging sites during each sampling on Montserrat, so that levels of foliar ash could be compared from site-to-site and from month-to-month. When possible, individual leaves came from *Piper* sp. (known locally as joint bush), an under-story shrub common throughout the Centre Hills.

Where *Piper* were unavailable, leaves were selected that were similar in size, shape and texture. Five to ten leaves were plucked from the perimeter of the chosen tree and preserved in Whirlpacs® of 70% ethanol. Foliage samples were not collected on St. Kitts because the island has not been subjected to volcanic ash deposition.

Ash Processing. Leaves from each sampling site were removed from solution, rinsed in ethanol and dried in a plant press. They were then scanned on an HP ScanJet ADF® with a 1 cm square for scale, and the images were traced in Auto-Montage® X.1 to determine surface area, using the 1 cm square for calibration. The rinse solution was transferred into plastic 50 mL centrifuge tubes and centrifuged for 5 minutes at 4360 Gs at 4.0ºC. The ethanol solution was then pipetted off, leaving an ash pellet in the bottom of the tube. When necessary, after removal of the ethanol, separate fractions of a single sample were combined and centrifuged again to obtain a single pellet. The pellet was then resuspended in a few mL of ethanol and transferred, in fractions where necessary, into microfuge tubes. The tubes were microfuged for 5 minutes at 15,800 Gs at 4.0ºC. Where possible, multiple portions of a single sample were combined again to form a single pellet. The remaining ethanol was drawn off with a pipette and the ash pellets were placed in a Savant® DNA Speed Vac Concentrator (DNA 120) and spun for 45 minutes, with the heat set on 65ºC (high) for the first 30 minutes. The dried ash pellets were weighed inside the tubes, the tubes were emptied and brushed out with a Q-Tip® brand cotton swab, and the empty tubes were weighed again to obtain a tare. The tare was then subtracted from the weight of the tube with ash to obtain the mass of each ash sample. These data were then compared to the leaf upper surface area measures for each site to obtain a measure of mg ash per m² leaf surface area. Data are presented in Appendix 1, Table 1.

Analysis

Although this project was designed to be analyzed using analysis of variance with repeated measures, that test could not be performed due to missing samples, resulting from rainfall occurring after the fogging and before the completion of insect collecting at some sites. Because of the unbalanced nature of the data, other statistical methods had to be used. Therefore, to test the effects of volcanic ash on forest canopy insects, a series of linear regressions were performed using total arthropods (>2.5 mm) as the response variable, with foliar ash (mg per m^2 leaf area) as the predictor.

To examine how the effects of ash are distributed throughout the arthropod community, separate regressions were conducted using total specimens (>2.5 mm) within the ten most abundant arthropod taxa and within eleven size categories (2.5-3.25 mm, 3.26-5.0 mm, 5.1-6.25 mm, 6.26-7.5 mm, 7.6-9.0 mm, 9.1-10.0 mm, 10.1-15.0 mm, 15.1-25.0 mm, and >25.0 mm) as response variables. In order to identify any bias added to the analyses by eliminating arthropods less than 2.5 mm long, regressions for the order Coleoptera were conducted using the totals from all size categories, including the smallest, as well as just the specimens greater than 2.5 mm in length. Slopes of these two regression formulae were compared using a t-test, $\alpha=0.05$, as outlined by Fowler et al. (1998), to determine whether exclusion of the smallest size classes from analysis significantly changed the results. Regressions were also performed using total arthropods minus the number of ants, the best represented group of arthropods in the canopy, in case their numbers might be overwhelming the effects of ash on the rest of the canopy fauna, and slopes were compared to those of the total arthropod regressions.

Regressions of all response variables were performed using values from all four sites, values only from the high ash sites and, when possible, from only the low ash sites, and comparisons of model parameters were made using a t-test. Total arthropod (>2.5 mm) regressions were performed for each site individually, but as all four sites yielded ten or fewer samples for analysis, individual site regressions were not performed for individual taxa or size categories because of the risk of error.

Several response variables, identified using the Anderson-Darling Normality Test, had to be transformed to satisfy the assumption of normal distribution required in regression ($P>0.05$). Values for total arthropods and nine of the ten arthropod taxa were transformed by taking the natural log. Orthoptera were normally distributed without transformation. For regression of the various size classes, data were transformed by taking the square-root. Where this failed to normalize the response variables from all three tests (all sites, high ash sites, low ash sites), the natural log transformations were used. Ash measurements were transformed by taking the natural log, to reduce the influence of one particularly large ash measurement. When data included zeros, one was added to all arthropod totals/ ash measurements before the natural log transformation was performed. For each regression, the transformations used are indicated, and $\alpha=0.1$ was used. All regression analyses were performed using MINITAB® ver. 14.

Because total arthropods (>2.5 mm) from the low ash sites were not normally distrubuted even after transformation, contingency tables were utilized to determine whether numbers of arthropods (grouped by taxon, size classes or collecting period) were independent of the site's ash deposition (high or low). Arthropod totals from the low ash sites were compared against totals from the high ash sites. The faunae of Montserrat and St. Kitts were also compared using contingency tables, grouping the data by taxon or size class. All contingency tables used $\alpha=0.1$.

Results

A total of 46,683 Montserrat forest canopy arthropods from thirty-four samples were counted, measured and used in analysis during the course of this study. Total arthropods (>2.5 mm) from each sample are shown in figure 2.3. For tests on the effect of volcanic ash on these arthropods to be meaningful, the composition of the forest canopy arthropod community must first be understood. Figure 2.4 illustrates how the individuals within a sample break down by taxa. Ants, on average, constitute the largest single portion of the arthropod fauna at 31.13%, Psocoptera and Orthoptera are the only other taxa making up >10% of the total (21.08% and 10.72% respectively), and only seven taxa each comprise more than 5% of the canopy fauna. The distribution of arthropod individuals into size categories is heavily skewed toward the smaller sizes, with 84% of the fauna being 5 mm or less in length. The average size distribution from all samples, as well as the size distribution of the two samples counted in their entirety, is shown in figure 2.5.

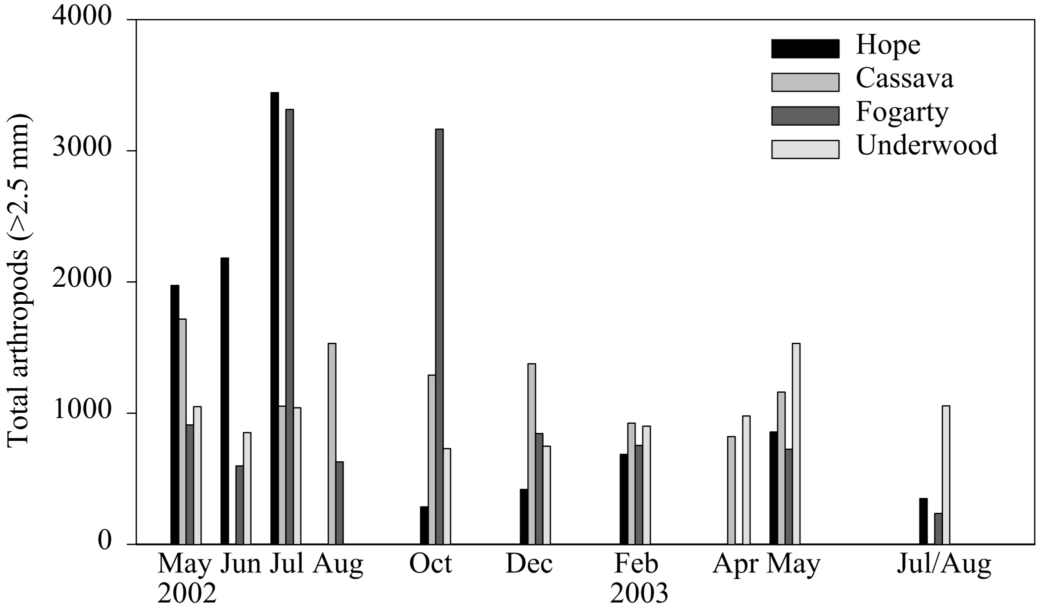

Figure 2.3. Total arthropods (>2.5 mm), by location and sample dates. Missing bars indicate samples excluded from analyses because of rain during the three hours following fogging.

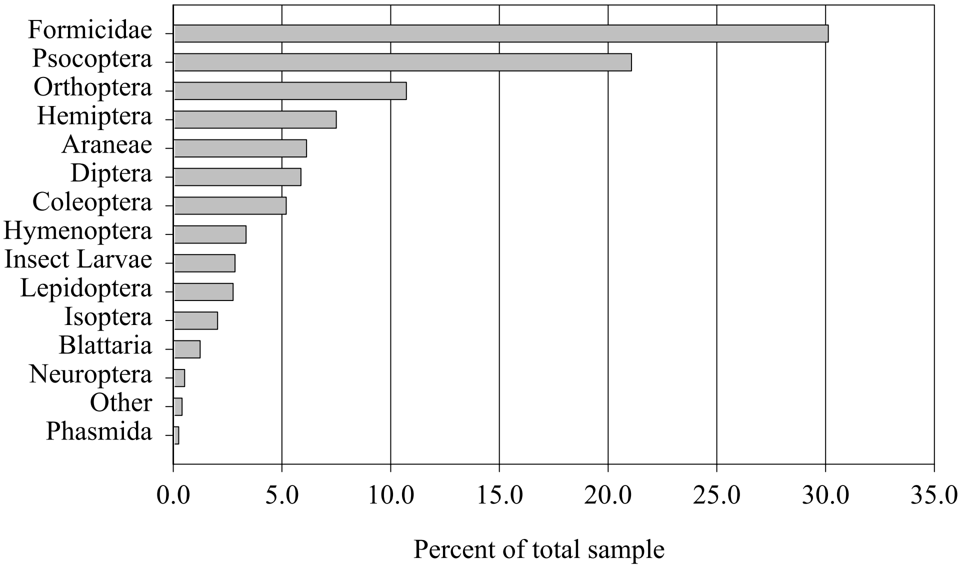

Figure 2.4. Relative abundance of individual arthropods (>2.5 mm) by taxon, averaged from all Montserrat samples. Percent Hymenoptera exclude Formicidae.

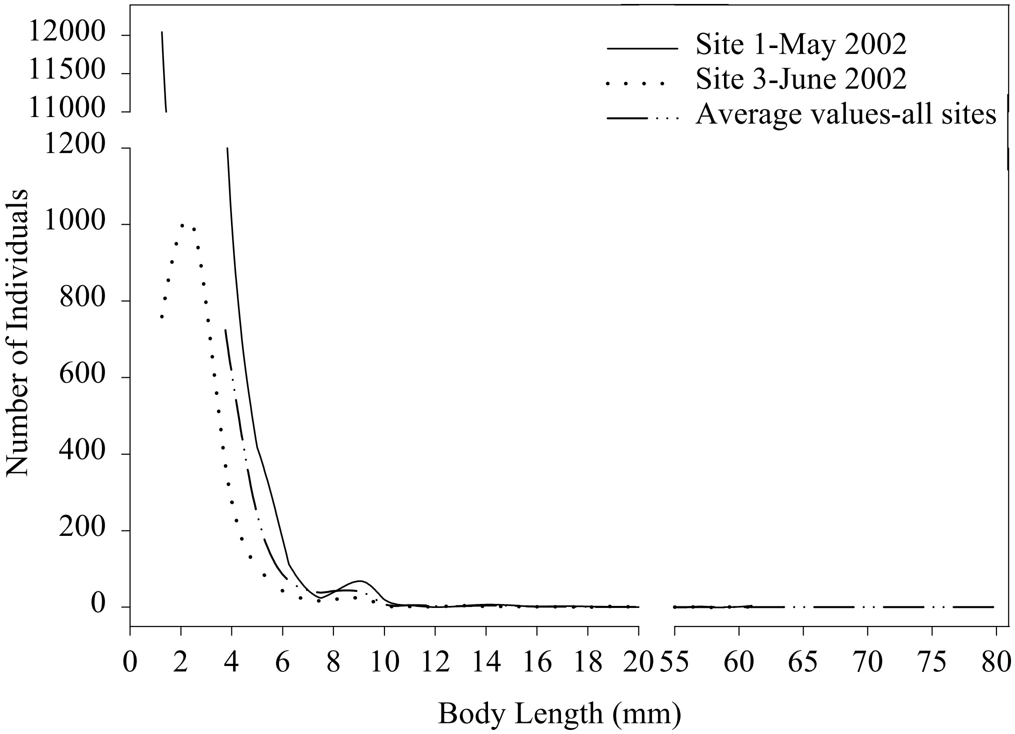

Figure 2.5. Abundance of arthropods by size, from the two samples counted in their entirety and averaged for all Montserrat samples.

Results of the regressions of Coleoptera from all samples versus ash are comparable to those using only Coleoptera greater than 2.5 mm in both slope of the regression and in the explanative power of the regression formula. The responses of Coleoptera greater than 2.5 mm and all Coleoptera to ash deposition were both significant (P=0.012, [ln y]=4.60 – 0.157[ln x], R^2=0.180 and P=0.009, [ln y]=6.02 – 0.132[ln x], R^2=0.194, respectively), and the slopes were not significantly different (α=0.05, t=0.055, 64 df, figure 2.6). The responses of Coleoptera greater than 2.5 mm and all Coleoptera to ash deposition were also both significant at the high ash sites (P=0.036, [ln y]=4.68 – 0.161[ln x], R^2=0.278 and P=0.005, [ln y]=6.29 – 0.167[ln x], R^2=0.440, respectively), and their slopes were not significantly different (α= .05, t=0.766, 28 df). Neither

Coleoptera greater than 2.5 mm nor all Coleoptera were significantly affected by ash at the low ash sites (P=0.221, [ln y]=4.67 – 0.183[ln x], R^2=0.092 and P=0.740, [ln y]=5.533 – 0.040[ln x], R^2=0.007). Because of the agreement between the portion of the Coleoptera greater than 2.5 mm and the complete Coleoptera samples, I felt confident that excluding insects less than 2.5 mm in length did not greatly change the nature of my results.

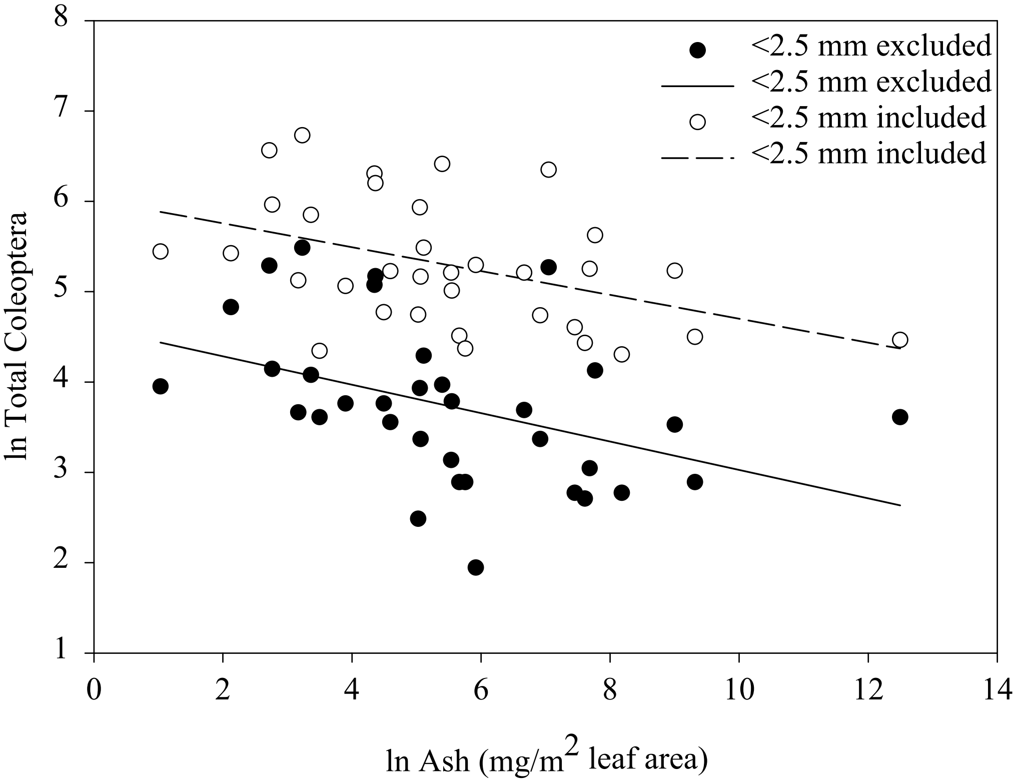

Figure 2.6. Regression plots of total Coleoptera, with Coleoptera less than 2.5 mm included and excluded. Samples from all four fogging sites are shown.

Analysis indicated that volcanic ash had a significant negative affect on total canopy arthropod numbers (P=0.013, [ln y]=7.50-0.113[ln x], R^2=0.178, figure 2.7). Total arthropods (>2.5 mm) versus ash are shown, untransformed, in figure 2.7. The range of total arthropods (>2.5 mm) and foliar ash measurements over the course of this study are shown in figure 2.8. Major volcanic events included small dome collapses accompanied by ash plumes in September/October 2002 and December 2002, and the largest dome collapse of the present eruption, accompanied by explosive activity, in July 2003.

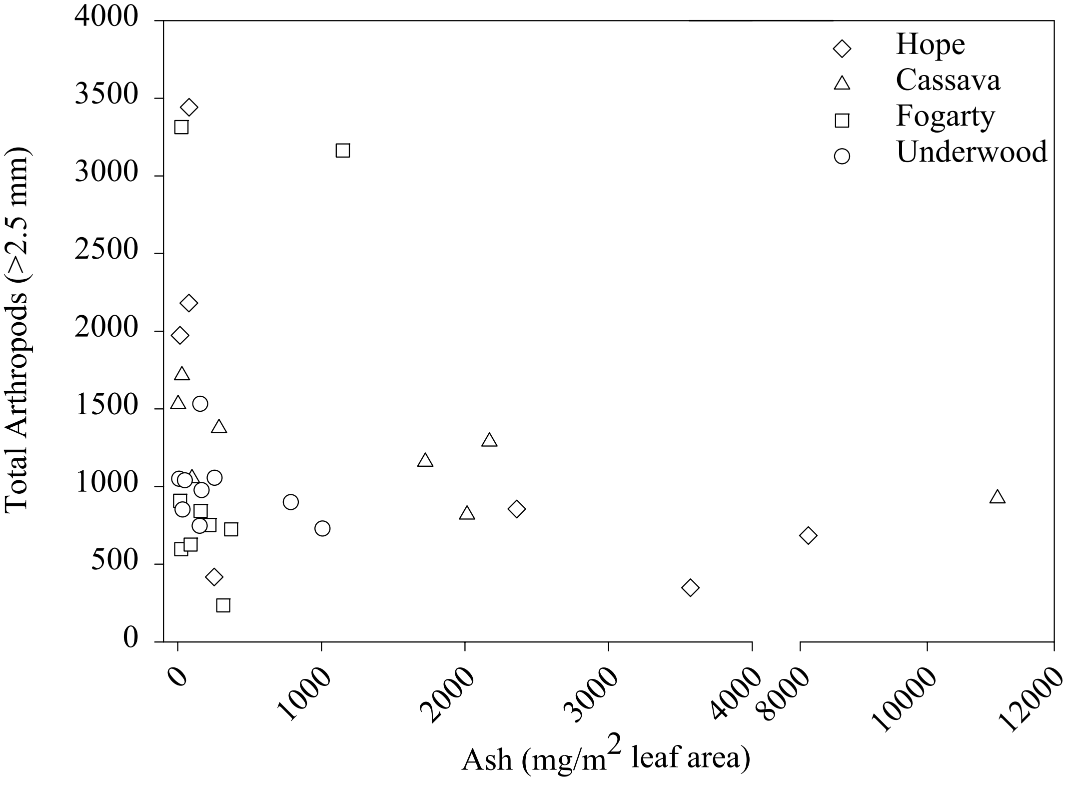

Figure 2.7. Untransformed scatter of total arthropods (>2.5 mm) and ash measurements (mg/m^2 leaf area) for all four Centre Hills fogging sites. Coordinates for the sample with the highest ash measurement were excluded so that the spread in ash measurements could be more easily portrayed. Those coordinates are 266,804.98 mg volcanic ash versus 285 arthropods >2.5 mm for Hope Ghaut, 08 October 2002.

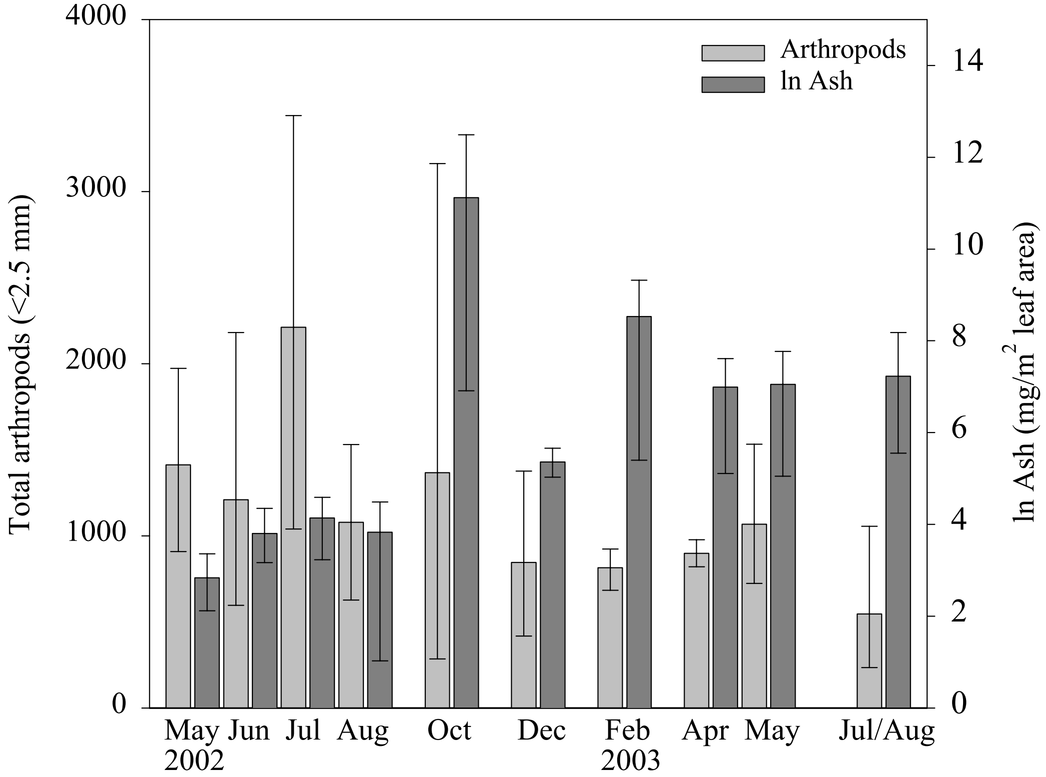

Figure 2.8. Averages of total arthropods (>2.5 mm) and ln ash (mg/m^2 leaf area) for each sampling period. Arthropod totals should be read from the left axis, and ash measurements should be read from the right axis.

The impact of ash on arthropods is not the same for all sites in the Centre Hills, but is higher closer to the volcano, as ash deposition and variation in foliar ash levels increase. The two sites proximate to the volcano (high ash sites) did, on average, receive higher levels of ash deposition than at either of the low ash sites. Average ash measurements for Hope and Cassava were 281,289.42 mg/m^2 leaf area (2,069.21 mg with October 2002 removed) and 2,179.09 mg, respectively, while average ash measurements for Fogarty and Cassava were an order of magnitude lower—263.17 mg and 290.55 mg, respectively (figure 2.9).

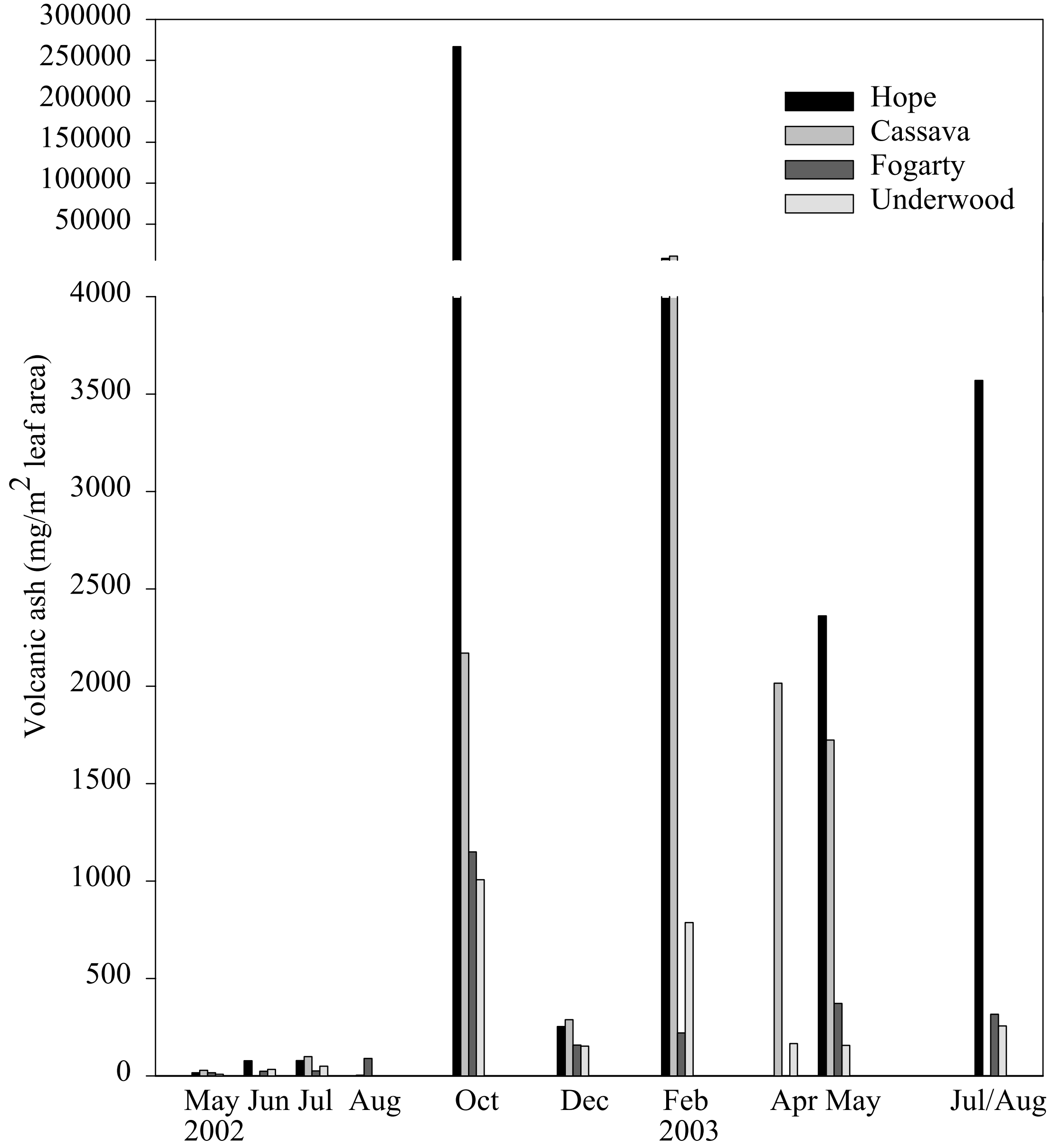

Figure 2.9. Foliar ash totals (mg/m^2 leaf area), by sample. Missing bars indicate samples excluded from analyses because of rain during the three hours following fogging, except in the case of Cassava, August 2002, which, at a measurement of 2.81 mg, is too low to be shown at the scale of this graph. Hope and Cassava ash totals for February 2003 are 8,128.86 mg and 11,107.03 mg, respectively.

The magnitude of the arthropod decline is nearly the same for the high ash sites (Hope and Cassava) as for the entire Centre Hills, as slopes of the regression of arthropod numbers by ash deposition from the two high ash sites is not significantly greater than for the four sites combined (α=0.05, t=0.843, 46 df, figure 2.10). However, ash accounts for much more variability in arthropod populations at the high ash sites (Hope and Cassava, P=0.002, [ln y]= 7.98 - 0.165[ln x], R^2=0.497) than across the entire Centre Hills. When the sites are considered separately, volcanic ash appears to have a greater impact on arthropod populations at Hope (P=0.022, [ln y]=8.35-0.230[ln x], R^2=0.612) than at Cassava (P=0.047, [ln y]=7.47-0.0659[ln x], R^2=0.510). The slope of these two lines is significantly different at α=0.1 but not at α=0.05 (t=2.068, 12 df, figure 2.11).

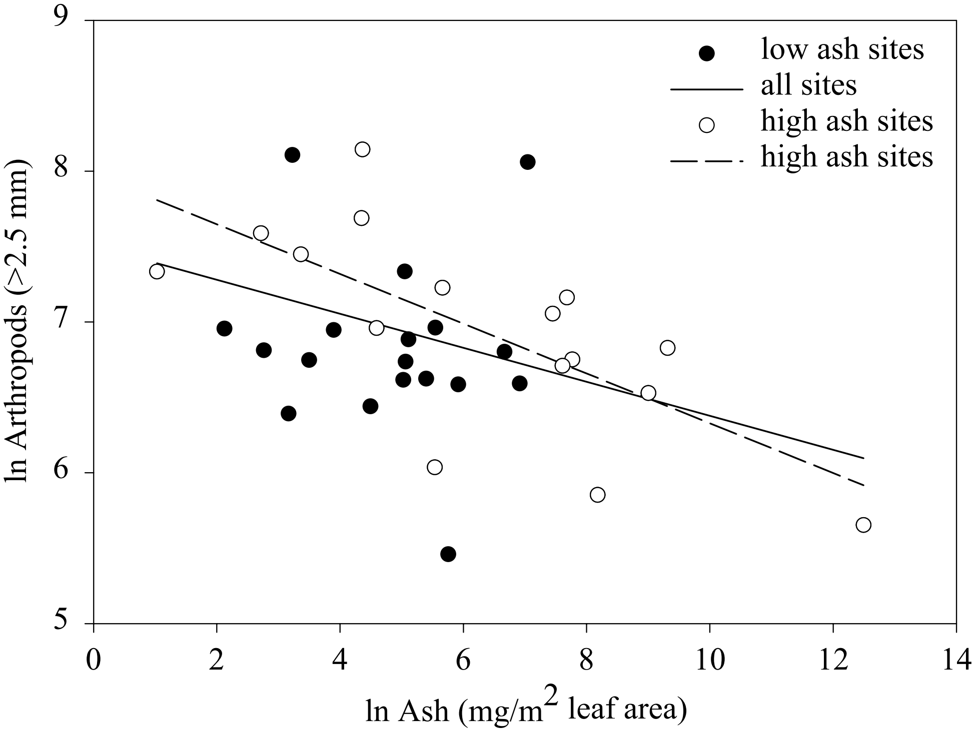

Figure 2.10. Total insects (>2.5 mm) versus ash from all four Centre Hills sites and the two high ash sites, Hope and Cassava.

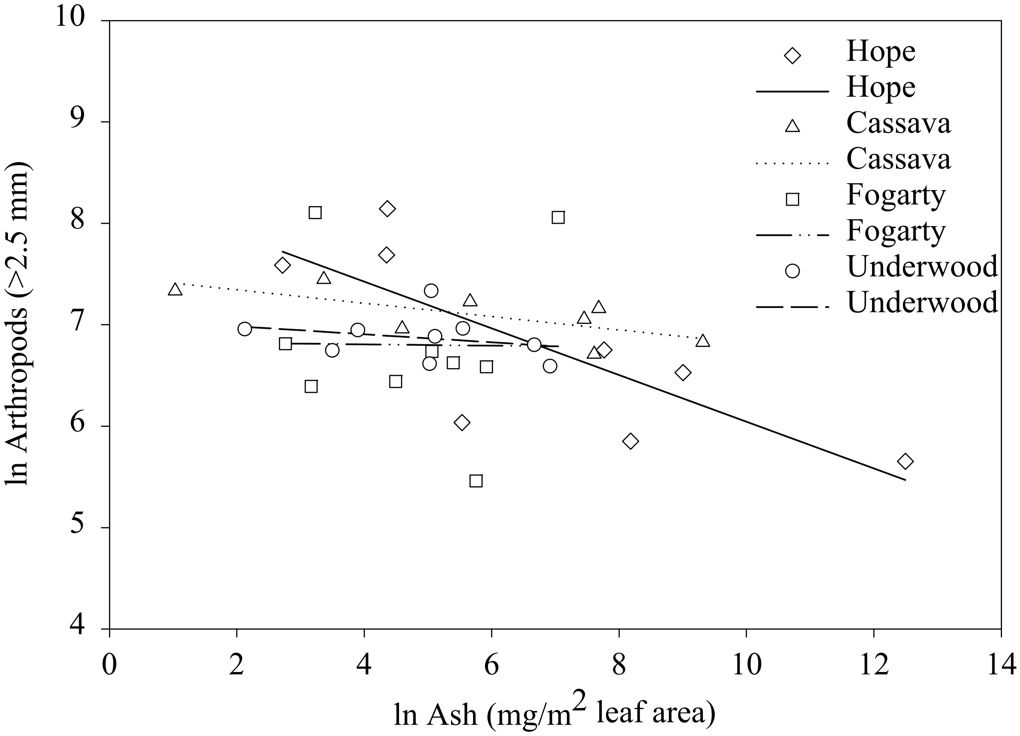

Figure 2.11. Total insects (>2.5 mm) versus ash for each sampling site on Montserrat.

While transformation of the response variable (arthropods >2.5 mm) for the low ash sites (Fogarty and Underwood together) was not sufficient to normalize its distribution, treating the sites individually indicates that total arthropod numbers are not significantly affected by ash at either site (P=0.976, [ln y]=6.83-0.007[ln x], R^2=0.000; P=0.487, [ln y]= 7.06 - 0.0394[ln x], R^2=0.071, figure 2.11). Because regression analysis of the two sites together could not be statistically justified, a contingency table was used to compare numbers of total arthropods (>2.5 mm) for the high ash sites versus the low ash sites, with the data grouped by collecting period. Contingency analysis indicated that total numbers of arthropods collected during each round of sampling were not independent of whether high or low sites were being sampled (α=0.1, χ^2=1,877.27, 9 df). While there are pronounced differences over time, as anticipated due to the random nature of ashfall events, there is also a difference in arthropod numbers between high and low ash sites.

In order to examine how different arthropod taxa respond to volcanic ash, linear regressions were performed using the ten most abundant taxa from figure 2.4 versus ash. Results are summarized in table 2.1. Of the ten groups tested, seven groups showed a negative response to volcanic ash, but only four, Hemiptera, Coleoptera, Lepidoptera and Formicidae, showed a significant negative response (figure 2.12). When the tests were repeated using only values from the high ash sites, four more taxa, Psocoptera, Diptera, Hymenoptera (excluding Formicidae) and insect larvae showed a significant negative response to ash, in addition to those in the previous analysis. Regression of all ten taxa using only the data from the low ash sites did not yield any significant negative responses to volcanic ash. However, two groups, Diptera and insect larvae, appeared to show a significant positive response to volcanic ash, and similar trends were observed for Araneae, Orthoptera, Lepidoptera and Hymenoptera, although these were statistically non-significant (table 2.1).

Table 2.1. Results of linear regression for individual taxa, with regression formulae, p-values and R^2 values indicated. Taxa with a significant, negative response to volcanic ash are shown in bold, and those with a significant, apparently positive response are shown in italics. Response variables that could not be rendered normally distributed using any transformations are indicated by xxx.

Taxon	P-Value	Regression Equation	R^2 Value
All Sites			
Araneae	0.686	$(\ln y)=3.91 + 0.0232(\ln x)$	0.005
Orthoptera	0.193	$y=174 - 8.68(\ln x)$	0.052
Psocoptera	0.171	$(\ln y)=5.35 - 0.171(\ln x)$	0.058
Hemiptera	0.070	$(\ln y)=4.73 - 0.134(\ln x)$	0.099
Coleoptera	0.012	$(\ln y)=4.60 - 0.157(\ln x)$	0.180
Diptera	0.838	$(\ln y)=3.84 - 0.0167(\ln x)$	0.001
Lepidoptera	0.086	$(\ln y)=3.60 - 0.162(\ln x)$	0.089
Formicidae	0.005	$(\ln y)=6.38 - 0.121(\ln x)$	0.218
Other Hymenoptera	0.104	$(\ln y)=3.88 - 0.0981(\ln x)$	0.080
Insect Larvae	0.575	$(\ln y)=2.60 + 0.052(\ln x)$	0.010
High Ash Sites			
Araneae	0.816	$(\ln y)=4.31 - 0.0168(\ln x)$	0.004
Orthoptera	0.238	$y=193 - 11.9(\ln x)$	0.098
Psocoptera	0.062	$(\ln y)=6.74 - 0.311(\ln x)$	0.228
Hemiptera	0.027	$(\ln y)=5.04 - 0.193(\ln x)$	0.304
Coleoptera	0.036	$(\ln y)=4.68 - 0.161(\ln x)$	0.278
Diptera	0.011	$(\ln y)=5.55 - 0.202(\ln x)$	0.383
Lepidoptera	0.003	$(\ln y)=4.84 - 0.293(\ln x)$	0.473
Formicidae	0.007	$(\ln y)=6.37 - 0.121(\ln x)$	0.420
Other Hymenoptera	0.003	$(\ln y)=4.66 - 0.199(\ln x)$	0.490
Insect Larvae	0.074	$(\ln y)=4.56 - 0.151(\ln x)$	0.211
Low Ash Sites			
Araneae	0.610	$(\ln y)=3.58 + 0.065(\ln x)$	0.017
Orthoptera	0.761	$y=177 + 3.6(\ln x)$	0.006
Psocoptera	0.876	$(\ln y)=4.67 - 0.183(\ln x)$	0.002
Hemiptera	xxx	xxx	xxx
Coleoptera	0.221	$(\ln y)=4.67 - 0.183(\ln x)$	0.092
Diptera	0.097	$(\ln y)=1.97 + 0.271(\ln x)$	0.162
Lepidoptera	0.891	$(\ln y)=2.32 + 0.031(\ln x)$	0.001
Formicidae	0.316	$(\ln y)=6.36 - 0.115(\ln x)$	0.063
Other Hymenoptera	0.257	$(\ln y)=2.50 + 0.159(\ln x)$	0.079
Insect Larvae	0.070	$(\ln y)=0.809 + 0.295(\ln x)$	0.190

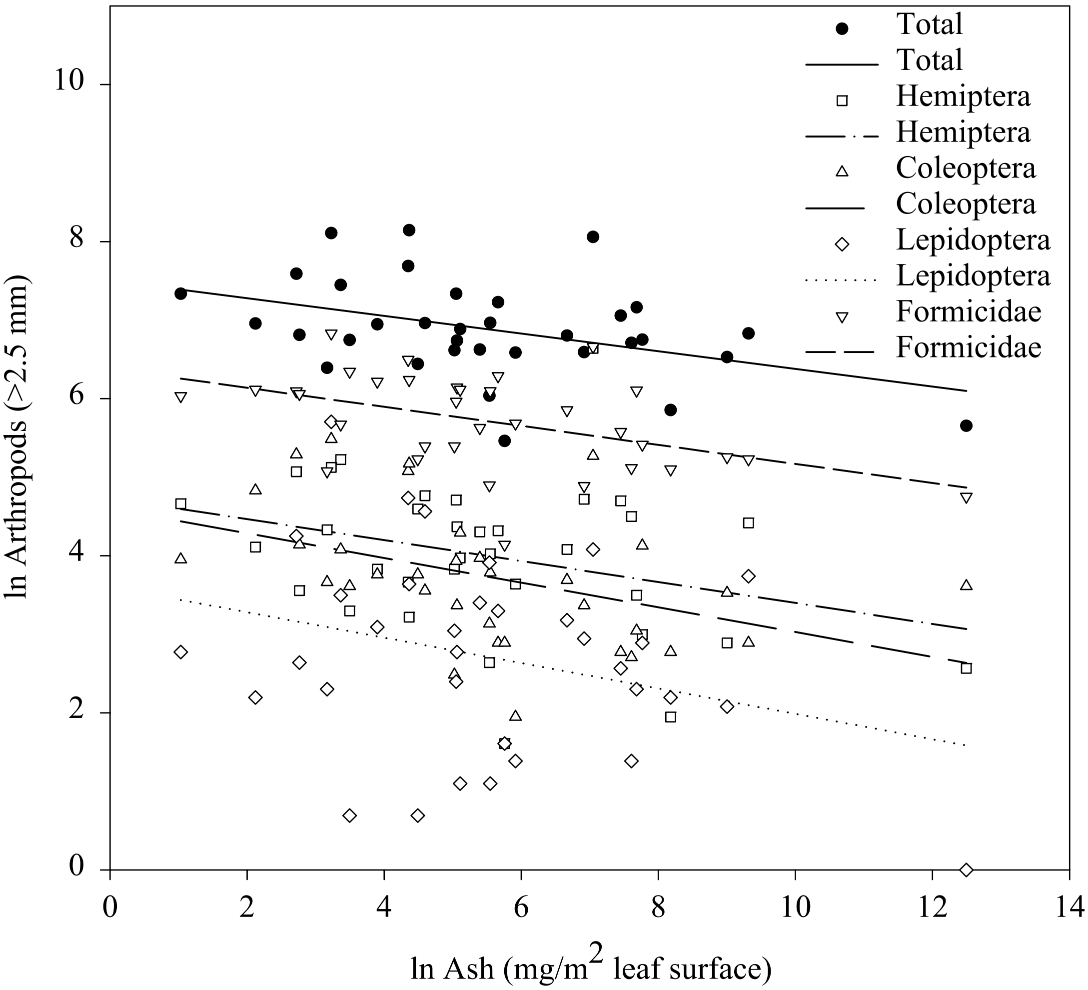

Figure 2.12. Regressions of total arthropods and those taxa with a significant response to volcanic ash, using samples from all four sites.

A contingency table comparing the high versus low ash sites, with the data grouped by taxon, indicates that abundance of each taxon was not independent of whether high or low sites were being sampled (α=0.1, χ^2=121.13, 9 df). This corroborates the findings of the regression analyses, that the effects at the high and low ash sites were not the same for different arthropod groups.

Because ants, which are significantly affected by ash, also make up the largest single portion of the forest canopy fauna, regression analysis of total arthropods (>2.5 mm) was conducted a second time, with ants removed. Regression of total arthropods (>2.5 mm), with ants excluded, versus ash deposition results in a very similar regression line to that found when ants are included ([ln y]=7.04 – 0.103[ln x] versus [ln y]=7.50-0.113[ln x], respectively, figure 2.13). The ants-excluded regression is significant (P=0.047) but explains slightly less variation in the data than the total arthropods regression (R^2=0.118 versus 0.178). The difference between the slopes of the two lines is not statistically significant (α=0.05, t=0.152, 64 df). When the high ash sites were considered separately, excluding ants resulted in a highly significant (P=0.005, [ln y] =44.2 – 2.42[ln x], R^2=0.447, figure 2.14) regression which accounted for more variation in the data than when ants were included. The difference between the slopes of regressions with ants included and ants excluded was not statistically significant (α=0.05, t=0.158, 28 df), so the relationship between insect numbers and ash deposition is not due entirely to the effects of ash on ants. Values for the low ash sites could not be transformed to achieve normality, but ash did not have a significant negative affect on ants or total arthropods at the low ash sites.

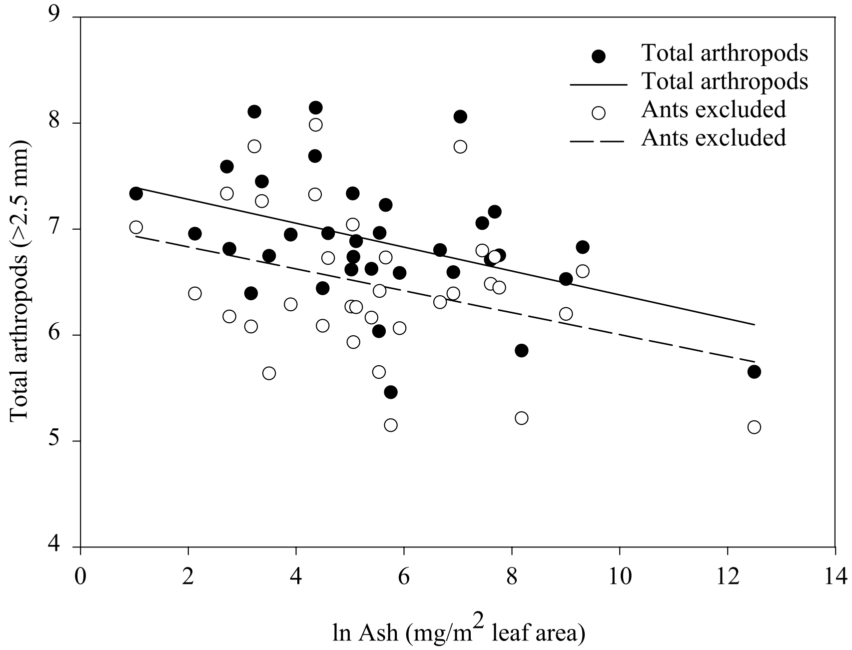

Figure 2.13. Regressions for total arthropods, and for total arthropods with ants excluded, against volcanic ash using values from all four Centre Hills sites.

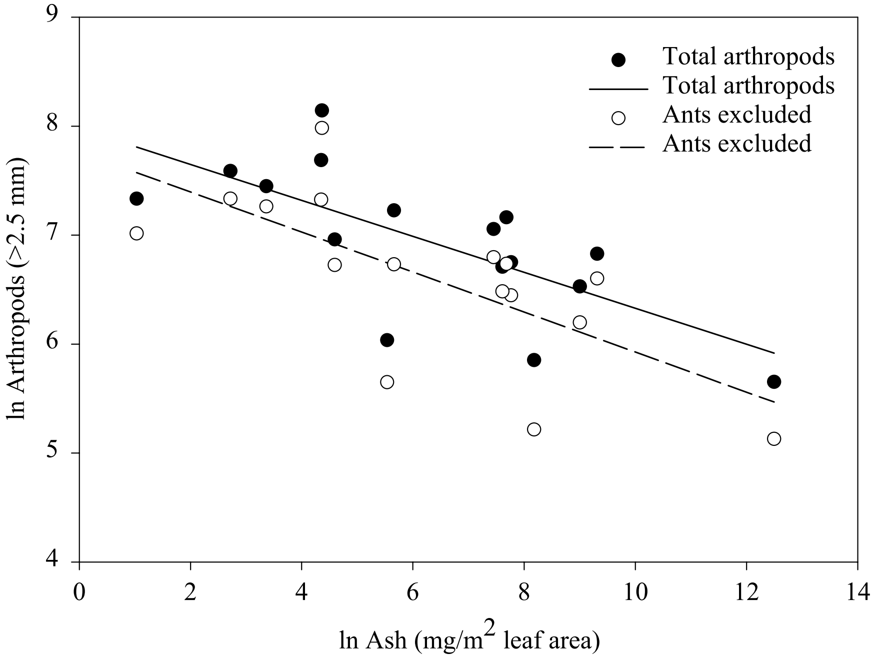

Figure 2.14. Regressions for total arthropods, and for total arthropods excluding ants, against ash using values from only the high ash sites, Hope and Cassava.

Different size categories of arthropods also responded differently to volcanic ash deposition. A series of linear regressions of arthropods in different size categories from all four sites indicated that individuals less than 9.0 mm or greater than 20.0 mm in length were significantly affected by ash, while those between 9.0 and 20.0 were not significantly affected (table 2.2). However, all sizes of insect were significantly affected at the high ash sites, while only individuals greater than 40.0 mm were affected at the low ash sites (table 2.2). The regressions from the high ash sites all explained more variability than were explained by the comparable regressions using all Centre Hills sites, but comparisons of slopes revealed no significant differences (α=0.05, 46 df; 2.5-3.75 mm, t=0.747; 3.75-5.0 mm, t=0.950; 5.0-6.25 mm, t= 0.975; 7.5-9.0 mm, t=0.053; 20.0-40.0 mm, t=0.197; >20.0 mm, t=0.040). The regression of arthropods greater than 20.0 mm at the low ash sites resulted in a slope not significantly different from that of all four sites together (α=0.05, t=0.268, 48 df). Less of the variation in the data was explained by the regression formula for just the low ash sites compared to all four sites together. The findings of the regression analysis were corroborated by a contingency table, which indicates that total numbers of arthropods within each size class were not independent of whether high or low sites were being sampled (α=0.1, χ^2=17.71, 8 df).

Table 2.2. Results of linear regression for different size classes of arthropods, with regression formulae, p-values and R^2 values indicated. Size classes with significant, negative responses to volcanic ash are shown in bold.

Size Class	P-Value	Regression Equation	R^2 Value
All Sites			
2.5-3.75 mm	0.023	$(\ln y)=7.00 - 0.112(\ln x)$	0.152
3.76-5.0 mm	0.038	$(\ln y)= 5.85 - 0.0963(\ln x)$	0.128
5.1-6.25 mm	0.040	$(\text{sqrt } y)=10.0 - 0.393(\ln x)$	0.126
6.26-7.5 mm	0.128	$(\text{sqrt } y)=7.15 - 0.262(\ln x)$	0.071
7.6-9.0 mm	0.010	$(\text{sqrt } y)=8.41 - 0.451(\ln x)$	0.189
9.1-10.0 mm	0.366	$(\ln y)=1.96 - 0.0747(\ln x)$	0.026
10.1-15.0 mm	0.113	$(\text{sqrt } y)=5.24 - 0.278(\ln x)$	0.077
15.1-25.0 mm	0.327	$(\text{sqrt } y)=2.75 - 0.100(\ln x)$	0.030
>25.0 mm	0.000	$(\text{sqrt } y)=4.28 - 0.392(\ln x)$	0.358
High Ash Sites			
2.5-3.75 mm	0.006	$(\ln y)= 7.49 - 0.163(\ln x)$	0.433
3.76-5.0 mm	0.003	$(\ln y)= 6.32 - 0.155(\ln x)$	0.482
5.1-6.25 mm	0.007	$(\text{sqrt } y)=12.3 - 0.663(\ln x)$	0.420
6.26-7.5 mm	0.051	$(\text{sqrt } y)=7.55 - 0.371(\ln x)$	0.245
7.6-9.0 mm	0.010	$(\text{sqrt } y)=8.40 - 0.463(\ln x)$	0.387
9.1-10.0 mm	0.067	$(\ln y)=2.90 - 0.185(\ln x)$	0.220
10.1-15.0 mm	0.013	$(\text{sqrt } y)=8.44 - 0.613(\ln x)$	0.365
15.1-25.0 mm	0.036	$(\text{sqrt } y)=4.09 - 0.246(\ln x)$	0.278
>25.0 mm	0.006	$(\text{sqrt } y)=4.17 - 0.367(\ln x)$	0.432
Low Ash Sites			
2.5-3.75 mm	0.697	$(\ln y)= 6.53 - 0.044(\ln x)$	0.010
3.76-5.0 mm	0.722	$(\ln y)= 5.10 + 0.040(\ln x)$	0.008
5.1-6.25 mm	0.601	$(\text{sqrt } y)=6.75 + 0.209(\ln x)$	0.018
6.26-7.5 mm	0.437	$(\text{sqrt } y)=4.59 + 0.323(\ln x)$	0.038
7.6-9.0 mm	0.450	$(\text{sqrt } y)=8.00 - 0.348(\ln x)$	0.036
9.1-10.0 mm	0.403	$(\ln y)=0.652 + 0.1539(\ln x)$	0.044
10.1-15.0 mm	0.431	$(\text{sqrt } y)=2.06 + 0.185(\ln x)$	0.039
15.1-25.0 mm	0.662	$(\text{sqrt } y)=1.43 + 0.099(\ln x)$	0.012
>25.0 mm	0.037	$(\text{sqrt } y)=4.68 - 0.489(\ln x)$	0.244

While only three samples from St. Kitts were used in analysis (excluding the sample from Phillip's Level, which was rained out), compared with thirty-four from Montserrat, all three St. Kitts arthropod counts fit within the range of those found on Montserrat (figure 2.15). Adding the three St. Kitts arthropod totals (setting ash at zero) to the regression of total arthropods versus ash changes the regression formula very little (P=0.036, [ln y]=7.29-0.0799[ln x], R^2=0.119 versus [ln y]=7.50-0.113[ln x] for Montserrat only), and the slopes of regression formulas including and excluding the three St. Kitts values are not significantly different (α=0.05, t=0.587, 67 df, figure 2.16). However, contingency tables indicate that the composition of the arthropod faunae of Montserrat and St. Kitts by taxon (α=0.1, χ^2=91.25, 9 df) and size class (α=0.1, χ^2=19.61, 7 df) are slightly different for the two islands (figure 2.17), indicating that a comparative analysis of individual taxa or size categories may not be appropriate. A total of 4,419 forest canopy arthropods from three St. Kitts samples were counted, measured and used in analysis.

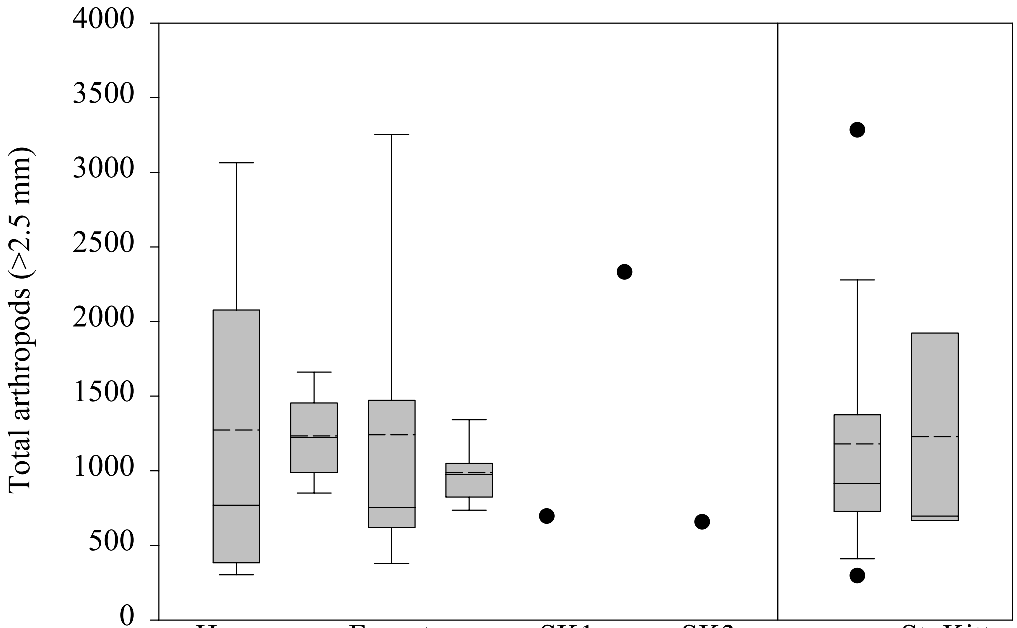

Figure 2.15. Range of total arthropod (>2.5 mm) counts from each fogging site, and for Montserrat and St. Kitts. The box denotes the 25th and 75th percentiles, and the whiskers denote the 5th and 95th percentiles. The solid line within the box indicates the median, and the dashed line indicates the mean.

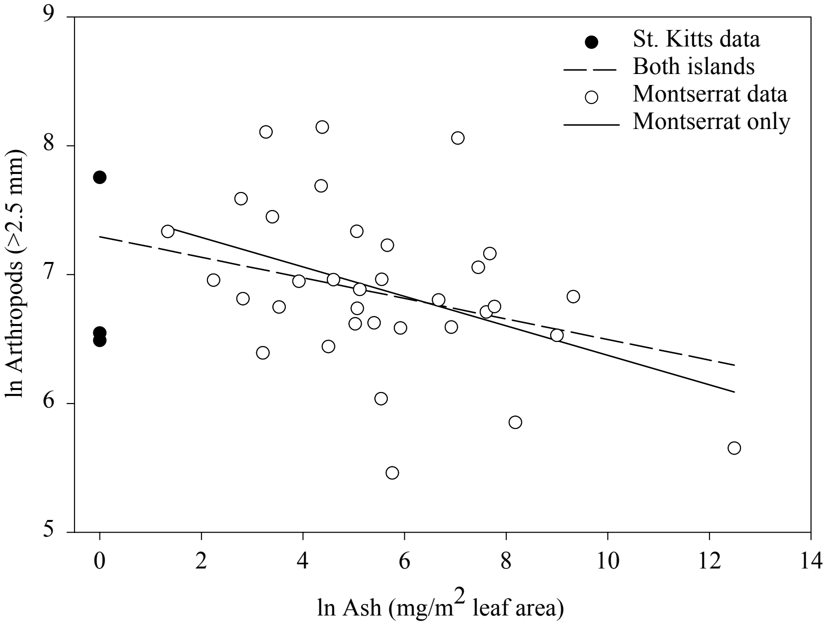

Figure 2.16. Regressions of total arthropods (>2.5 mm) versus volcanic ash, with values from St. Kitts included and excluded.

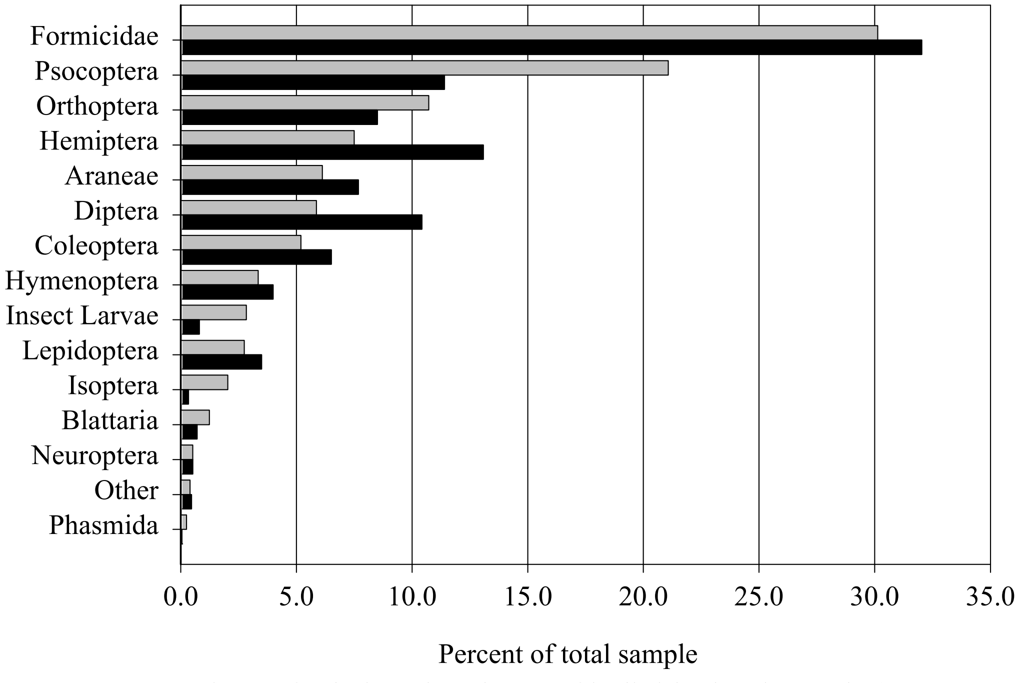

Figure 2.17. Comparison of relative abundance of individual arthropods (>2.5 mm) by taxon, averaged for Montserrat samples, shown in gray, and St. Kitts samples, shown in black. Percent Hymenoptera exclude Formicidae.

Discussion

The effects of volcanic ash residue on leaves had a statistically significant yet limited impact on the forest canopy arthropod fauna of Montserrat. On the scale of the entire Centre Hills, ash explained less than 20% of the variation in total arthropod numbers. However, ash can have a much stronger influence on individual sites, as the level of persistent volcanic ash in an area is heavily dependent upon localized weather and wind conditions. For example, locations downwind of the volcano receive more frequent dustings, and rain can introduce airborne ash particles into an environment, as well as wash them away. The Hope and Cassava sites, which are downwind of the volcano, had a visible layer of volcanic ash between the soil surface and the organic detritus layer of the forest floor. In addition to clinging to leaf surfaces, ash is also captured and held in the crevices of tree bark, dead stumps, tangles of roots and branches, and any other environmental receptacles. Ash was a much stronger predictor of arthropod population trends at Hope (R^2=0.612) and Cassava (R^2=0.510; together, R^2=0.497) than for the Centre Hills as a whole (R^2=0.178). At Fogarty and Underwood, which are farther from the volcano and not immediately downwind, persistent ash is not as readily obvious in the environment. Ash did not have a significant negative impact on forest canopy insects at these sites.

Volcanic ash clearly has different effects on different arthropod groups, but how does this affect overall community composition? While Lepidoptera were significantly affected by ash, they comprised, on average, less than 5% of the individual arthropods found in the fogging samples, and less than 10% of the variation within Lepidoptera populations could be attributed to ash in the environment. Likewise, Hemiptera, which comprised about 8% of the arthropod community, were significantly affected by ash, but very little population variation could be attributed to it. Numbers of Coleoptera and Formicidae demonstrated the same low rate of decline in response to ash as Lepidoptera and Hemiptera, but slightly more population variation—about 20%—could be attributed to ash. Coleoptera only comprised about 5% of individuals within the canopy fauna, but ants comprise over 30% of the fauna and are the dominant member, in numbers of individuals and in total arthropod biomass, of forest canopy communities around the world (Hölldobler and Wilson 1990). A statistically significant reduction of the largest segment of Montserrat's arthropod population (over 30% of total individuals counted) would have a discernible impact on forest communities.

Decline in response to ash present on leaf surfaces is not distributed evenly among all arthropods present; rather, different taxa display different levels of susceptibility. Ash is also a better predictor of numbers of individuals of different taxa at the two high ash sites than at all four sites, although the rates of decline are roughly the same, and three more taxa are significantly affected by ash at the high ash sites. Psocoptera, Diptera and Hymenoptera (excluding Formicidae), which show no significant response when all four sites are analyzed together, experience a significant decline in response to ash at the high ash sites. While the rate of their decline is no more rapid than for any other taxa, volcanic ash accounts for nearly 50% of the population variation within these taxa at the high ash sites.

Understanding why some arthropod taxa are more susceptible to volcanic ash than others may come from comparing the lifestyles of the two groups not significantly affected by ash even at the high ash sites—Araneae and Orthoptera—with those that are strongly influenced by ash. Most canopy arthropod species present on Montserrat are leaf, nectar or pollen feeders or fungus grazers. Leaf grazers were hit particularly hard after the Mount St. Helens eruption. Shanks and Chase (1981) found that coating leaves with ash prevented feeding by *Otiorhynchus ovatus* (L.) and *O. sulcatus* (F.) (Coleoptera: Curculionidae) and catalogued the complete disappearance of heavy infestations of these species after 1-2 cm ash were deposited on blueberry fields. In contrast, spiders and most of the Orthoptera present in the canopy in Montserrat are predaceous. Not being forced to chew on ash-covered food limits the level of exposure to ash, particularly to the mouthparts, digestive system and sensory organs of the head.

Many of the ant species collected in the forest canopy are predacious, but unlike the spiders and Orthoptera, ants showed a significant negative response to ash. The difference between ants and the other predacious canopy species is that ants are not permanent canopy residents, as many ant species that forage in the canopy actually nest on or close to the ground. Ants may be experiencing mortality due to exposure to ash on the way to the canopy, or they may be prevented from accessing the canopy, without experiencing mortality. Akre et al. (1981) observed several *Formica* spp. colonies immediately after the Mount St. Helens eruption and found ants clumped at nest entrances, unable to forage over the soft ash deposits. After rain compacted the ash layer, ants were able to move about on the ash layer without picking up particles, and ant colonies that foraged in the ash layer throughout the summer experienced no ill effects compared to ants in ash-free areas (Akre et al. 1981). Apparent reduction in ant numbers in Montserrat's forest canopy may be due to the effects of ash in the canopy, with species foraging for plant matter or living symbiotically with aphids bearing the brunt of the mortality, but chances are greater that ants are being affected, at least temporarily, by ash on the ground where it is harder to avoid.

The surprising results from the low ash sites, where several taxa appear to respond positively to volcanic ash, highlights the variable nature of ash deposition across an environment. The high and low ash sites differ in the amount of variation in ash deposition they receive, as well as in ashfall totals. While volcanic ash had a statistically obvious impact on insect numbers at high ash sites, the level of variation at the low ash sites may be too low or too high to result in visible population trends. Therefore, if certain taxa have a high threshold for ash, and are experiencing a population peak at the low ash sites during an ash event, their numbers may appear to increase in response to ash while their counterparts at the high ash sites are decreasing in numbers.

Alternatively, the same conditions resulting in deposition of large quantities of ash on the high ash sites may actually result in more favorable conditions for canopy insects in areas receiving less ash. Volcanic ash is known to have fertilizing properties (Cronin et al. 1997), and Matthews et al. (2002) detected a link between major collapses of the volcanic dome on 20 March 2000 and 29 July 2001 and heavy rainfall preceding these events. Due to the positive influence of these factors on forest health, arthropod numbers might be enhanced across Montserrat so that when sampling occurs after large quantities of ash are deposited on the high ash sites, the forest canopy population at the low ash sites appear elevated in response to the smaller amounts of ash they receive. Whether the apparent increase in insect numbers is purely stochastic or is related to some ecological phenomenon has yet to be elucidated, but the increase in Diptera and Hymenoptera is statistically significant, and outweighs the decline occurring at the high ash sites when all four Centre Hills sites are analyzed together.

Comparing the high and low ash sites with results from all four sites combined indicates that arthropod size, as well as taxon, plays a role in susceptibility to volcanic ash. When all sites are considered together, arthropods less than 9.0 mm and greater than 25.0 mm in length are significantly affected by ash, while those between 9.0-25.0 mm are only affected at the high ash sites. When the low ash sites are considered alone, only insects greater than 25.0 mm are significantly affected by ash. Insects around the 10.0-25.0 mm range appear to be less susceptible to the effects of volcanic ash than larger or smaller insects, and require a wider variation in ash measurements for a significant population trend to be detectable. That small insects appear to be readily affected by ash is not surprising; small species have a high surface area/volume ratio, so even limited damage to the cuticle is accompanied by a high risk of desiccation. The significant response of larger insects to volcanic ash at even the low ash sites may be due more to characteristics of the population rather than the vulnerability of the individual. Larger insects, while less abundant, tend to be longer-lived than smaller species, resulting in less stochastic variability in population numbers and possibly making the effects of ash easier to detect.

This study took place in just over a year, and consisted of long periods in which the volcano was quiet, punctuated by large ashfall events associated with small dome collapses and the accompanying pyroclastic flows (September/October and December 2002) and a major dome collapse accompanied by explosive activity (July 2003). In that time span, sample sizes ranged from a high of 3,442 individuals (Hope, 16 July 2002) to a low of 235 individuals (Fogarty, 30 July 2003). We are now nearly ten years into the Soufrière Hills eruption, yet forest canopy insect populations are still comparable to those from St. Kitts, indicating that arthropod totals for Montserrat are not outside the normal range for the region, in spite of volcanic activity. While single generations of canopy insects may be affected during discrete volcanic events, indications are that reductions in insect numbers are short-term phenomena, and that between volcanic events, persistent ash in the environment and occasional light dustings do not have substantial negative effects on insect populations. Tropical forest canopy studies in Borneo and Peru, in which sample plots were refogged ten days after the initial fogging, indicated that recolonization of the canopy was well underway ten days after the complete removal of all arthropods (Stork and Hammond 1997). The second Bornean sample contained 20% of the individuals and species collected in the first fogging event, and the second Peruvian sample contained approximately the same number of individuals as the first (Stork and Hammond 1997). Under ashfall situations in Montserrat, where blocks of canopy are not completely emptied of all individuals, arthropod populations will undoubtedly rebound much faster.

Why aren’t forest canopy insects more seriously affected by volcanic ash? One explanation is that since the effects of ash are mediated by local conditions, recolonization by survivors and from unaffected areas is rapid, and single ash events probably do not affect many generations of insects as the intrinsic rate of increase for many arthropod species tends to be high. Another possibility is that the leaves on which insects may encounter ash residue are themselves refugia during ashfall periods, with insects clinging to the undersides. A third possibility is that ash residues may not coat leaf surfaces for long enough after ashfall periods to present a significant problem for canopy residents. Traces of ash may wash or blow off leaf surfaces, and heavily coated leaves die and are replaced by fresh leaves, so that the forest canopy ecosystem may not retain ash long enough after volcanic events to have a profound effect on canopy insect populations. Finally, while ash samples obtained using the leaf-dipping procedure yielded a snapshot of ash conditions at the times insect sampling occurred, there is no way to know whether that ash had been present on the leaves for a month, or whether it was deposited the day before. A better understanding of the persistence of ash within the canopy, combined with short-term arthropod population dynamics in the weeks following ash deposition, would clarify the short-term response of arthropod populations to volcanic ash.

While the effects of volcanic ash may be only short-term for insects in the canopy, the arthropod fauna on the forest floor encounter ash in the environment over a much longer period of time. Ash may be cleaned out of the canopy, but it piles up on the ground and is not assimilated into the soil very quickly. In some parts of the Centre

Hills, particularly at the Hope fogging site, ash is a semi-permanent feature of the forest floor. Species surviving on the forest floor must therefore be either ash tolerant or strong dispersers, to continually recolonize affected areas. Ants, the only group that inhabit both parts of the forest ecosystem, are an interesting example.

Volcanoes have been an important part of the evolutionary history of Montserrat, and volcanic influence can be seen in the composition of Montserrat's insect fauna. The canopy insect community has a high level of endemism and relatively few widespread species (M. A. Ivie, pers. comm), indicating that forest canopy insects have survived previous volcanic disasters and that recolonization of affected areas has been by on-island survivors with bottle-neck speciation events. While the fauna of the forest floor has not been as systematically sampled as the canopy, preliminary investigation of the litter fauna indicates a much lower proportion of endemic species compared to the region (M. A. Ivie, pers. com.). This indicates that species on the forest floor have been extirpated more often and have had to be recolonized by regionally widespread species. The difference in endemism levels between the forest canopy and floor faunae of Montserrat may simply be due to the higher quantity of refugia and shorter-term exposure to ash in the forest canopy. While studies after the Mount St. Helens eruption investigated the effects of ash on ground-dwelling insects (Akre et al. 1981, Klostermeyer et al. 1981) pollinators (Johansen et al. 1981) and other forest Hymenoptera (Akre et al. 1981), the project on Montserrat is the first to look at the effects of ash on an entire forest canopy community. Should the opportunity arise during some future volcanic episode, simultaneous investigation of the effects of volcanic ash on the forest canopy and forest floor communities in the same area might produce a much clearer picture of how ecosystems respond to-and recover from-volcanic ash deposition.

CHAPTER 3

FEEDING ECOLOGY OF THE MONTSERRAT ORIOLE

Introduction

The Montserrat Oriole (*Icterus oberi* Lawrence) has grown critically endangered since the 1995 onset of volcanic eruption on the West Indian island of Montserrat (16ºN, 62ºW, 102 km^2, figure 3.1), a United Kingdom Overseas Territory, which comprises its entire historic range. In spite of extensive conservation efforts by the governments of Montserrat and the United Kingdom, the Royal Society for the Protection of Birds (RSPB), and other agencies, recent studies indicate a population in steep decline (Hilton 2001, Hilton et al. 2003). Aside from suffering the obvious loss of habitat due to volcanic activity, Montserrat Orioles have experienced a high rate of reproductive failure since the eruption began. Two potential causes are currently under investigation: increased nest predation by rats (*Rattus* spp.) and Pearly-Eyed Thrashers [*Margarops fuscatus* (Vieillot)], which thrive in disturbed habitats, and low quantities of insect food during the breeding season, due to volcanic ash in the environment. This paper will address the latter hypothesis.

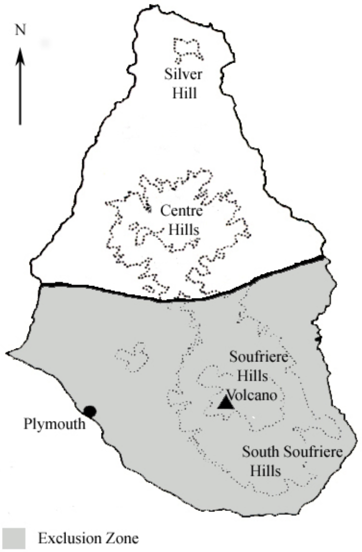

Figure 3.1. Map of Montserrat, with major hill ranges, volcano and exclusion zone, indicating the portion of the island closed to human access, are shown. Exclusion boundary is drawn as of October 2002.

Apart from its description (Lawrence 1880) and a few other scattered reports, the Montserrat Oriole remained largely unstudied for nearly a century after its discovery. Arendt and Arendt (1984) undertook the first comprehensive study of its biology in 1984, looking at population densities, relative abundance, habitat use and reproductive ecology. Their work formed the basis for all subsequent research on the Montserrat Oriole. To date, the most substantive works on Montserrat Oriole biology remain unpublished (Arendt and Arendt 1984, Atkinson et al. 1999), but summaries of oriole habitat use and breeding biology are scattered in the literature (see Arendt 1990, Arendt et al. 1999, Owen 2000). Lovette et al. (1999) used mitochondrial DNA to examine the taxonomic placement of the Montserrat Oriole and two other Lesser Antillean *Icterus* species endemic to single islands—the Martinique Oriole [*I. bonana* (Linnaeus)] and the St. Lucia Oriole (*I. laudabilis* Sclater)—which had previously been treated as part of the

Icterus dominicensis Linnaeus superspecies complex. They found a striking level of mitochondrial divergence, indicating that all three single-island endemics are full species which probably separated 2.3-2.9 million years ago, and are more distinct from each other than their continental counterparts are from each other (Lovette et al. 1999).

Prior to the eruption of the Soufrière Hills Volcano in 1995, almost no baseline data for Montserrat Oriole populations existed, aside from that of Arendt and Arendt (1984). They proposed a conservative estimate of 1,000 to 1,200 individuals on the entire island in 1984, based on the observation of three to eight breeding pairs per km in suitable habitat. Faaborg and Arendt (1985) found orioles to be most heavily concentrated in the hygrophytic forest and elfin woodlands of the South Soufrière Hills (8 breeding pairs/km), where some of the earliest specimens had been collected (Grisdale 1882), and less abundant in the meso- and hygrophytic forests of the Centre Hills (3 pairs/km). After Hurricane Hugo (1989) Arendt (1990) detected orioles at nearly every counting station in the Soufrière Hills, for a total of 106 individuals, and although no population estimates were made at that time, it was apparent that the population was in the hundreds, at least. An emergency oriole census conducted in December 1997, following high levels of volcanic activity, estimated that 4,000 individual orioles inhabited the Centre Hills alone (based on observations of 120 individuals), and that there had likely been 1,000 breeding pairs in 1997 (Arendt et al. 1999). Their findings indicated that the 1984 number was far too low (Arendt et al. 1999), and we therefore have no reliable estimate of how many orioles the island supported before 1995.

The Montserrat Oriole has suffered massive habitat loss as a result of volcanic activity. Most orioles in the Soufrière and South Soufrière Hills were destroyed along with their habitat, and nearly 80% of the world's population is now confined to the Centre Hills, approximately five km from an active volcano (Arendt et al. 1999). The other 20% are even closer, scattered around the foot of the volcano and in a tiny refuge in the South Soufrière Hills (see Bowden et al. 2001). Of greater concern than habitat loss, however, is the regular deposition of wind-borne volcanic ash on Montserrat's remaining forests, and its potential effects on oriole breeding success. While no studies to date have examined the effects of ash on the survival of Montserrat birds aside from the oriole, the impact of volcanic ash on several avian species was recorded after the 18 May 1980 eruption of Mount St. Helens. Heavy ashfall caused seven pairs of the congeneric Northern Orioles (*Icterus galbula* Pleasants) to abandon their nesting territories (Butcher 1981), and Ring-Billed and California Gulls (*Larus delawarensis* Ord and *L. californicus* Lawrence) to temporarily leave their nesting colonies en masse (Hayward et al. 1982). Nestling blackbirds (*Agelaius phoeniceus* Linnaeus and *Xanthocephalus xanthocephalus* Bonaparte) were found dead in their nests following ash deposition at Columbia Basin, and marsh birds (ducks and non-game species) failed to attain pre-ashfall abundance during the remainder of the season (Foster and Myers 1981). While ashfall events on Montserrat are rarely if ever as heavy as those of the Mount St. Helens eruption, they are more frequent and volcanic ash is a more persistent environmental stress.

Although the oriole population of the Centre Hills appeared secure in 1997, routine monitoring was conducted from 1997 to the present, and breeding surveys were conducted in 1998 and 2001, 2002 and 2003 (Arendt et al. 1999, Atkinson et al. 1999, Bowden et al. 2001, Hilton et al. 2003). Results of the monitoring have indicated a substantial decline of the Montserrat Oriole within its remaining habitat from 1997 to the present (Atkinson et al. 1999**,** Bowden et al. 2001, Hilton et al. 2003). Prior to the eruption, Faaborg and Arendt (1985) observed a high rate of reproductive success at five nests studied in 1984, with nine out of ten chicks successfully fledging. Half of the nests observed in 1998 failed to successfully fledge chicks, resulting in a reproductive rate of 0.88 chicks per territorial female, and in 2001 reproductive output declined to 0.52 chicks per territorial female (Atkinson et al. 1999, Hilton 2001). Although the latest breeding numbers are still being analyzed, the most current published estimate places the Montserrat Oriole population at 100-400 breeding pairs, declining at 17-52% per year (Hilton et al. 2003).

The hypothesis that volcanic ash is causing the decline of the insectivorous Montserrat Oriole by reducing insect populations when high prey numbers are needed the most, during chick-rearing, results from some of the wildlife studies following the Mount St. Helens eruption and from feeding observations on Montserrat in 1998. Volcanic ash has a negative impact on insects in laboratory studies and in the field (Edwards and Schwartz 1981, Shanks and Chase 1981). Butcher (1981) concluded that the most severe effect of the Mount St. Helens ashfall on avifauna was the interruption of feeding resulting from insect mortality, and that small insectivorous species and birds with young to feed were the most affected by this interruption. On Montserrat, prior to the current breeding study, Atkinson et al. (1999) observed, during a period of high eruptive activity, a feeding rate half of that recorded in 1984.

Based on the Mount St. Helens observations, a study was designed to test how volcanic ash affects forest canopy insects on Montserrat (Chapter 2), but to adequately interpret how these results relate to the Montserrat Oriole, a better understanding of which portion of the insect population is utilized for nest provisioning was necessary. Some disagreement exists over which groups of insects are most important in the nestlings' diet. Peter Lack recorded insect larvae and pupae, stick insects, and a brown insect, listed as either a cockroach or a cricket, being delivered to a nest he observed in 1973 (unpublished data). Arendt and Arendt (1984) reported that Hymenoptera, Lepidoptera and Coleoptera were the most common prey items at the three nests they observed, but it was later discovered that many of the "Lepidoptera" may actually have been Orthoptera, held with their translucent hind wings visible against the light (M. A. Ivie, Montana State University, pers. comm.). Atkinson et al. (1999) found that the most common prey items at six nests were small spiders (42.5%) and insect larvae (42.5%). However, their observations coincided with an outbreak of dengue fever on Montserrat, and the subsequent application of Malathion® near several rainfall catchment areas for mosquito control (T. Howe, Dept. of Environmental Health, pers. comm.) would have had a distinct impact on the fauna available for orioles to utilize in those areas. Observations in 2000, by the first entomologist to address the question, indicated a preference for large Tettigoniidae (Orthoptera), particularly green katydids (Phaneropterinae) and *Nesonotus* sp. (Pseudophyllinae), and long, sticklike bush crickets

(Orthoptera: Gryllidae) (M. A. Ivie, Montana State University, field notes). Other prey items observed at this time included a white pierid, a geometrid caterpillar, a large white moth, and various immature Orthoptera (M. A. Ivie, field notes). The delivery of a frog to a nest in 2003 (E. B. Massiah, RSPB volunteer, field notes) adds to the indication that foraging adults may not be specialized to a particular taxon.

What is known, however, is that Montserrat Orioles follow the pattern of generalist parents with insectivorous young observed in other icterid species (Bent 1965). The adults are gleaning insectivores, nectar feeders, and have occasionally been observed eating fruit (Arendt and Arendt 1984, M. F. Hulme, RSPB field assistant, pers. comm., Atkinson et al. 1999), and the stomach contents of two adult orioles examined by Danforth (1939) contained weevils, Lepidoptera larvae, cockroach oothecae and miscellaneous insect fragments. The oriole young, as far as is known, are fed exclusively animal matter (Arendt and Arendt 1984, Atkinson et al. 1999, K. A. Marske, pers. obs.). Nestlings are fed via regurgitation for the first four days after hatch, after which one or both parents carry arthropod prey to the nest. Adult orioles were observed to remove the head, legs and wings of the large, predaceous *Nesonotus* before feeding the remainder to the nestlings, but other tettigoniids and bush crickets were delivered whole (M. A. Ivie, field notes).

While the Montserrat Oriole's prey is diverse, certain characteristics about it can be predicted based on the oriole's breeding biology and evolutionary history. First, while adult orioles can eat just about any insect or arachnid encountered, prey items delivered to the nest need to be large enough to offset the energy used in catching the prey, returning to the nest and feeding the chicks. Second, some prey taxa need to be readily available during the Montserrat Oriole's variable nesting season, under a variety of environmental conditions. While the main oriole breeding season runs from April to August (Atkinson et al. 1999, J. R. Madden, pers. comm.), orioles have been observed nesting in November (G. M. Hilton and M. A. Ivie, pers. comm.) and January (K. A. Marske, pers. obs.), making it nearly a year-round activity. Third, the Montserrat Oriole should demonstrate a bias toward food items not affected by volcanic ash, in response to the selection pressures of exclusively inhabiting a small volcanic island for two million years (Lovette et al. 1999). Thus, we should be looking for a relatively large, aseasonal and ash tolerant taxon as the preferred staple of the nestling diet.

The risk of volcanic disasters is high in the inner arc of the Lesser Antilles, as the islands are entirely volcanic in origin. The region has many active and dormant volcanoes and has experienced five major volcanic eruptions in the last century alone (St. Vincent, 1902-1903; Martinique, 1902-1907 and 1929-1932; Guadeloupe, 1976-1977; Montserrat, 1995-present). Since 1692 the longest period between volcanic eruptions in the region has been 47 years (Lovette et al. 1999, MacGregor 1938). Unlike their continental counterparts, who disappeared temporarily after the Mount St. Helens eruption, the insectivorous icterids endemic to individual Lesser Antillean islands have nowhere to go, and have undoubtedly withstood such disasters many times before.

Materials and Methods

Montserrat Oriole Nest Observations

In order to determine the size and identity of prey given to Montserrat Oriole chicks, adults were observed foraging and carrying food to several nests. A total of 211.24 hours were spent observing 16 Montserrat Oriole nests in the Centre Hills in 2002 and 2003. Seven nests were observed in 2002 and eleven nests were observed in 2003. Nests for observation were recommended by Montserrat Forestry Department personnel and by field assistants from the Royal Society for the Protection of Birds, who monitored active oriole territories two to three times a week. The number of days spent observing any particular nest depended upon whether successful observations were obtained. If the adult orioles appeared relatively comfortable with human presence, that nest was watched regularly until the chicks fledged or experienced mortality, but if adults showed discomfort and their behavior was obviously modified as a result, other nests were chosen for observation. Locations of observation nests and the amount of time spent at each nest are indicated in table 3.1.

Table 3.1. Montserrat Oriole nest observation sites, with number of days and hours observed. Sites C3.5 and C4 were at the same location and defended by the same male, but had different females. Site J3 was observed by E. B. Massiah. *=GPS readings unavailable due to landscape relief.

Nest Site	Locality	Coordinates	2002 Days	2002 Hours	2003 Days	2003 Hours
C1.75	Cassava Ghaut	16˚45’39”N, 62˚12’43”W	1	3.85	3	11.95
C3.5	Dry Green Ghaut	16˚45’28”N, 62˚12’50”W	4	16.27		
C4	Dry Green Ghaut	16˚45’28”N, 62˚12’50”W			7	26.85
C6	Cassava Ghaut	16˚45’34”N, 62˚12’50”W			2	8.78
F0.5	Fogarty	16˚46’17”N, 62˚12’30”W			4	17.47

Table 3.1, continued.

F1	Jackie’s Ghaut	16°46’08”N, 62°12’28”W			2	8.12
G1	Gun Hill	16°45’31”N, 62°12’39”W	5	21.64		
G3	Olveston Spring	16°45’32”N, 62°12’42”W	5	18.93		
H3	Hope Ghaut	16°44’56”N, 62°12’48”W			1	3.83
H5	Hope Ghaut	*	3	10.28	2	7.17
H6	Hope Ghaut	*			2	7.49
J1	Jackboy Hill	*			1	4.00
J3	Jackboy Hill	16°44’23”N, 59°39’01”W			4	16.08
JH1	Jubilee Heights	16°45’27”N, 62°12’36”W	4	14.92		
S1	Spring Ghaut	16°43’15”N, 59°40’54”W			1	3.83
U2	Underwood Ghaut	16°46’07”N, 62°11’45”W	3	10.05		
		Totals:	25	95.94	29	115.3

Nest observations began at 08:00 and lasted until 12:00 on most days. Observations were taken from a seated position as close to the nest as adult orioles would allow. I usually began watching approximately nine meters from the nest, moving away if the adults appeared agitated and moving closer if they did not appear to be disturbed by my presence. When possible, I sat behind undergrowth, tree trunks, etc., and in some cases an olive green poncho was used as camouflage. All observations were taken with binoculars or the naked eye. Each time an adult bird brought food to the nest, the following data were recorded: time of visit, which parent visited, whether or not prey was visible, prey size relative to bill-length (approx. 2 cm), prey color, prey identification (to order or more specific), and what portion of the insect was provided if not given whole. Prey size estimates were made in ¼ bill-length increments: <¼ bill, ¼ bill, ½ bill, etc., up to >2 bill. The above details were also recorded when adult orioles were seen with prey but did not deliver it to the nest.

All prey items which could be identified in 2002 and 2003 were compared using the Wilcoxon Signed-Rank test, $\alpha=0.1$, to test for any differences in preferred food items between years. Because the number of nest visits for which prey identifications could be made was different from year to year, percentages of the total insects identified each year were compared instead of raw numbers. Food size estimates for 2002 and 2003 were also analyzed with the Wilcoxon Signed-Rank test, $\alpha=0.1$, again using percentages instead of raw numbers.

During the nest observations described above, there were several nest visits in which the presence or identity of prey items could not be identified. In these situations, knowledge of the habitat and microhabitat in which the adults foraged may be used to predict possible prey taxa. Therefore, whenever possible, qualitative descriptions of foraging habitat and methods of foraging were recorded. The foraging microhabitats of several oriole pairs are described below.

Data from nest observations were also utilized to examine whether nestling feeding rates have increased, decreased, or remained the same since the onset of volcanic eruption. Not all data from 2002 and 2003 were utilized. If adults appeared agitated at human presence and/or refused to take food to the nest during my visits to their territory, their behavior was considered atypical. In order to eliminate the effects my presence may have had on oriole behavior, all sites with an average feeding rate lower than one nest visit per hour were eliminated from analysis.

Videos of oriole nests made in 2001 to 2003 were also used in determining oriole feeding rate; the videos had been set up to record nest predation by rats and Pearly-Eyed Thrashers, but were also scanned for feeding information. Filmed visits to the nests by oriole parents were categorized as definitely no feeding, definite feeding, probable feeding or no idea if feeding occurred. All visits except those categorized as definitely no feeding were used in analysis.

Observational and video data from 2001 to 2003 were combined and compared against Arendt and Arendt's (1984) observations of food delivery at three nests in the Centre Hills and unpublished nest observations made by Peter Lack in 1973 (provided by G. M. Hilton, RSPB). Average number of feeds per hour were calculated for every day between chick hatch and fledging, and pre- and post-1995 feeds per day for days 1-14 were compared using the Wilcoxon Signed-Rank Test, $\alpha=0.1$.

Insect Sampling Protocol

In order to investigate whether the insect food of the Montserrat Orioles is affected by ash, forest canopy arthropods were sampled at four sites every eight weeks from May 2002 to August 2003. The four sites were chosen based on their similarity to Montserrat Oriole habitat, and so that two sites regularly received wind-borne deposits of volcanic ash, while two were protected from all but the largest ashfall events. During each sampling 10m x 10m blocks of canopy were fogged with the insecticide Prentox® Pyronyl™ Crop Spray (EPA Reg. No. 655-489), which was selected for its low toxicity (avian 5-day dietary LC50 >5,620 ppm, Prentiss, Inc. 2003) and environmental persistence. Foliar ash was also sampled, resulting in a measurement of mg ash/m^2 leaf surface for each insect sample. All arthropods >2.5 mm were assigned a size category and identified to order. For a complete description of sampling methods, see Chapter 2.

To test the effects of volcanic ash on forest canopy insects, a series of linear regressions were performed using total insects (>2.5 mm), the ten arthropod taxa which, on average, comprise the majority of each canopy sample (see Chapter 2) and nine size categories as response variables. In all cases foliar ash (mg per m^2 leaf area) was used as the predictor. Several response variables, identified using the Anderson-Darling Normality Test, had to be transformed to satisfy the assumption of normal distribution ($P>0.05$) required in regression. Values for total arthropods and all individual taxa except Orthoptera were log-transformed, and Orthoptera were normally distributed without transformation. All arthropod size categories were transformed by taking the square root, except for arthropods in the 2.5-3.75 mm, 3.75-5.0 mm and 9.0-10.0 mm size classes, for which the natural log transformation was used. Ash measurements were also log-transformed, to reduce the influence of a particularly large ash measurement. For each regression, the transformations used are indicated, and $\alpha=0.1$ was used. All regressions were performed using MINITAB 14.

Because the sites sampled in this study were selected from areas receiving different levels of ash deposition, contingency tables ($\alpha=0.1$) were utilized to determine whether numbers of insects (grouped by orders or size classes) were independent of the site's ash characterization (high or low exposure). In addition, regressions were performed using only values from the high ash sites, and then from the low ash sites, so that the impacts of ash deposition could be ascertained separately for the high and low ash exposure sites.

The fogging data were also used to examine the effects of precipitation on forest canopy insects. To determine whether the oriole prey is affected by drought, rainfall data for 2002 and 2003 were obtained from the Montserrat Forestry Department. Daily rainfall measurements from the Hope Ghaut catchment site, made by the Montserrat Water Authority, were used to calculate rainfall totals for fifteen and thirty days prior to fogging for each sampling date. Because rainfall measurements only came from one source, rather than catchment stations at each fogging site, insect and rainfall totals from all four fogging sites were averaged together for each sampling period, rather than being analyzed separately. Linear regressions were then performed using rainfall totals as predictors and total insects, individual taxa, and individual size classes as response variables ($\alpha=0.1$). Regression of total arthropods was also performed using only the data from Hope Ghaut, the site at which the daily rainfall measurements were taken. In all regressions versus precipitation, response variables were transformed by taking the square root, as necessary. In addition, monthly rainfall totals from January through June, 2002 and 2003, from Hope Ghaut and from rain gauges at Olveston and Brades used by the Montserrat Forestry Department, were compared using the Wilcoxon Signed-Rank Test ($\alpha=0.1$) to determine whether spring rainfall totals were significantly different from year to year. Contingency tables ($\alpha=0.1$) were used to compare total insect numbers from all four sites for May 2002 and May 2003. Differences observed in overall forest condition, insect abundance and oriole foraging behavior between wet and dry periods are also discussed.

Results

Prey Identification

Overall, the distribution of identified prey items among taxa was not significantly different from 2002 (114 identified prey items) to 2003 (169 identified prey items) (α=0.1, n=9, T_+=18) (figure 3.2). Orthoptera were the most important food source both years, comprising 67.5% of identified prey items in 2002 and 45.6% in 2003. Adult Lepidoptera were the only other group which comprised over 10% of observed prey items in 2002, making up 14.04% of the total prey delivered. In 2003, three taxa each comprised over 10% of the total. Insect larvae (mostly Lepidoptera) were 20.12% of the total, adult Lepidoptera were 13.02% of the total, and Coleoptera were 10.06% of the total. Adult Lepidoptera were almost all moths; very few butterflies (Pieridae; one in 2002, two in 2003) were identified. Other food items delivered to the nest in 2002 and 2003 included Araneae, Phasmida, Cicadidae, Pentatomidae and a small frog. Oriole prey identification data are shown in Appendix 2, Table 1.

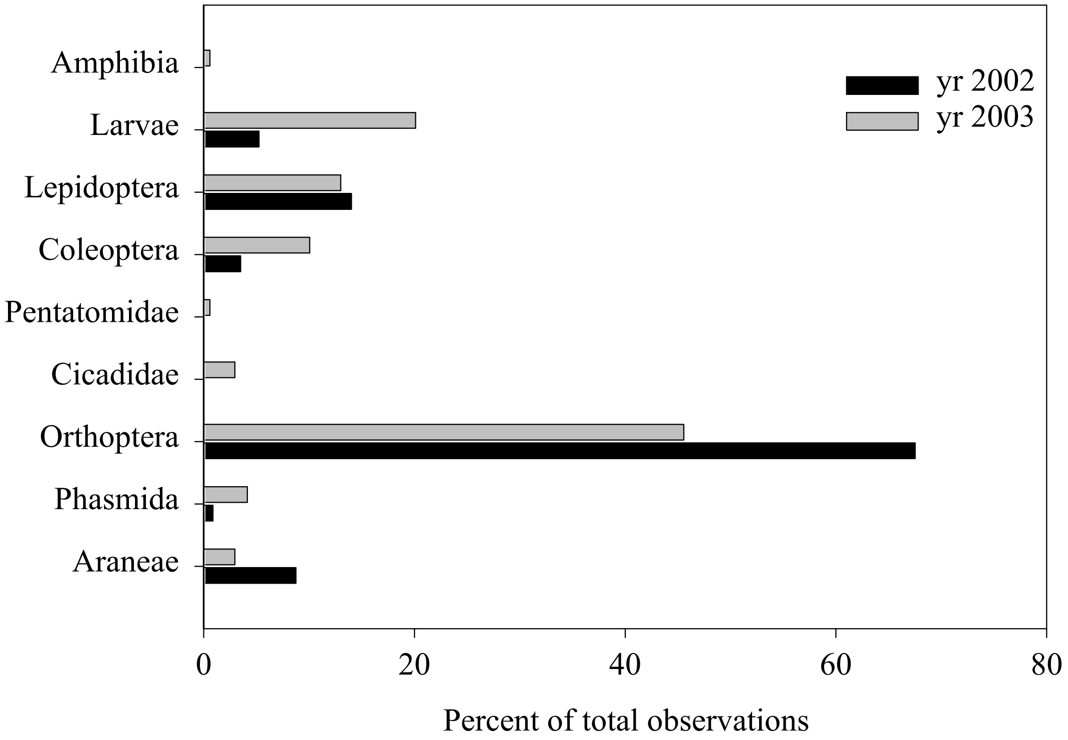

Figure 3.2. Identity of prey delivered to Montserrat Oriole nests in 2002 (n=114) and 2003 (n=169), as a proportion of all observations for that year.

Prey Size

Estimates of prey length from the nest observations were not significantly different between year 2002 (164 observations) and 2003 (292 observations) (α=0.1, n=10, T_+=27) (figure 3.3). One bill-length (approx. 2 cm) prey was the most commonly fed prey size both years (36.59% and 39.04%, respectively). For both years the next most important size categories were ½ bill or less. In 2002 61% of prey items delivered to the nest were ≥1 bill, while in 2003 51% of prey items were ≥1 bill. Twenty-one percent of prey items were >1.5 bill in 2002, while in 2003, only 4% of the observed prey items were >1.5 bill. Oriole prey size data are shown in Appendix 2, Table 2.

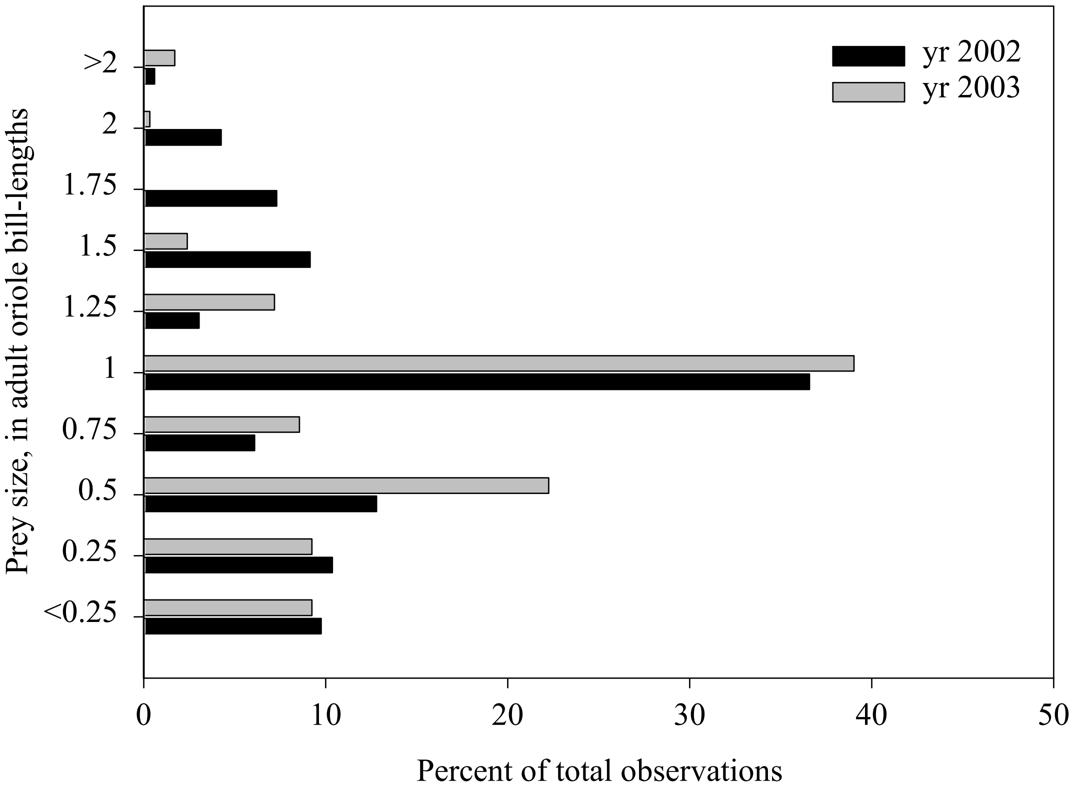

Figure 3.3. Size of prey delivered to Montserrat Oriole nests in 2002 (n=164) and 2003 (n=292), as a proportion of all observations for that year. One bill-length= approximately 2 cm.

Foraging Microhabitats

Observations in 2002 indicated that foraging orioles do not appear to be limited to any forest stratum in particular. Birds at JH1 (Jubilee Heights, observed 2-7 July 2002) were almost always seen very high in the canopy, about 15-20 m high. Both orioles at G3 (Olveston Spring, observed 4-14 June 2002) foraged in the ghaut bottom as well as in taller trees, up to 10 m in the canopy. At C3.5 (Dry Green Ghaut, observed 11-12 June 2002) the female landed on the ground to forage, encouraging a grown fledgling to follow her down and forage there. On another occasion she was observed catching and eating a katydid (Orthoptera: Tettigoniidae) near the ground. In this area the canopy was only 6 m high or less.

In 2002 birds at several sites (G1, G2, C3.5, H5, U2) were observed foraging in *Piper* and *Heliconia* leaves, approximately 3-4 meters above the ground. The male and female at G1 (Gun Hill, observed 29 May to 7 June 2002) were both regularly seen foraging among *Piper* leaves and in *Heliconia* around the territory, among the live stems and leaves as well as in dead, hanging leaves. The female was occasionally seen drinking from the *Heliconia* flowers, and one on occasion, appeared to be searching the flower for prey as well as drinking. At one point a large leaf fell to the ground, and the male went immediately to forage beneath it.

The territory at G3 (Olveston Spring, observed 4-14 June 2002) encompassed a very narrow, steep-sided ghaut (ravine) with *Piper* in the ghaut bottom and *Heliconia* giving way to medium to large deciduous trees on the sides. The male and female both foraged a great deal in the *Piper* on the ghaut bottom, in the *Heliconia* on the sides, and in the larger trees at near the nest and up-ghaut. They did not stray very far down-ghaut from the nest. On 14 June there was evidence of a small landslide from rain in the days preceding, and the female was seen foraging in the downed vegetation.

Foraging patterns in 2003 shifted slightly to emphasize clusters of dead leaves. On many occasions orioles were heard or seen moving along the length of dead *Heliconia* leaves, still hanging from the plants, to look for insects hidden inside the leaf folds. I regularly discovered elaterids (Coleoptera) in dead *Heliconia* leaves while hand collecting, and beating clusters of dead vegetation usually yielded more insects (individuals and species) than beating live plants. Michael A. Ivie had previously observed orioles foraging in dead vegetation and found that bush crickets typically hide in dead leaves during the day, particularly in *Cecropia*, *Heliconia* and banana (M. A. Ivie, field notes).

The male oriole at F1 (Jackie's Ghaut, observed 23 May to 1 June 2003) foraged mostly in *Heliconia* flowers. He frequently went directly from the flowers, which are filled with stagnant water, to the nest, with food items that were often too small to be visible. Those items large enough to be seen were usually long and thin. Possible prey items might include aquatic Diptera or Coleoptera larvae, or other insects that had come to the flowers to drink.

Fogarty was the one area on Montserrat where stick insects (Phasmida) were detected on every collecting occasion, usually on *Ficus* and other trees and bushes with small deciduous leaves, and the female oriole at F0.5 (observed 24-29 June 2003) regularly brought large stick insects to the nest. Phasmids were a much more occasional food item at other sites. The F0.5 female almost always brought larger prey items than the male, but probably had to travel farther to find them, as she was usually out of sight for longer periods of time. This oriole territory was sited in a dry area, characterized by *Ficus* and other small deciduous trees, away from the ghaut bottom and wet-forest vegetation more typically comprising oriole territories.

Seasonal Influence

While a one-year project is not long enough to detect annual seasonal patterns within tropical insect populations, the effects of measurable, short-term seasonal conditions like precipitation can be examined. Regression analyses of total arthropods, individual taxa and size categories (all sites averaged together) by total precipitation 15 and 30 days prior to fogging resulted in no significant P-values for total insects, ten taxa and ten size categories (table 3.2). Average arthropod and precipitation totals for each sampling period are shown in figure 3.4. Repeating the regressions of total arthropods using data only from Hope Ghaut, the site of the Montserrat Water Authority rainfall catchment station, did not indicate that rainfall had a significant effect on total arthropods at that fogging site (P=0.518m, [sqrt y]=40.8-0.603x, R^2=0.073; P=0.368, [sqrt y]=43.3-1.44x, R^2=0.137). Monthly precipitation totals from January through June 2002 and 2003 were compared for three rain gauges (Hope, Olveston, Brades), and only Olveston experienced a significantly lower amount of rainfall in 2003 (α=0.1, T_+=20, n=6). Comparison of total insects from each fogging site for May 2002 and May 2003 indicated that arthropod numbers for each site were not independent of year (α=0.1, χ^2=479.68, 3 df), but the differences were greater from site to site than between years, and annual differences may not be due entirely to precipitation. However, thirty-day rainfall averages for May 2002 and May 2003 were 13.6 cm and 4.4 cm, respectively, and April rainfall levels demonstrated the greatest differences at all three rain gauge sites, leading me to believe that rainfall probably had an impact on the biota of Montserrat that was not measurable using the methods of this study.

Table 3.2. Results of the regressions of individual arthropod taxa and size classes versus total rainfall 15 and 30 days prior to fogging. Transformations, when necessary, are indicated in parentheses following the name of the response variable. Hymenoptera are excluding ants.

	Rain-30 days		Rain-15 days	
Response	P-value	R^2	P-value	R^2
Total arthropods	0.491	0.061	0.845	0.005
Araneae	0.472	0.066	0.667	0.024
Orthoptera	0.994	0.001	0.681	0.022
Psocoptera (sqrt)	0.154	0.237	0.384	0.096
Hemiptera (sqrt)	0.883	0.003	0.481	0.064
Coleoptera	0.839	0.006	0.890	0.003
Diptera	0.643	0.028	0.475	0.065
Lepidoptera (sqrt)	0.564	0.043	0.867	0.004
Formicidae	0.391	0.093	0.860	0.004
Hymenoptera	0.316	0.125	0.794	0.009
Insect larvae	0.436	0.078	0.637	0.029
2.5-3.75 mm (sqrt)	0.257	0.157	0.539	0.094
3.75-5.0 mm (sqrt)	0.706	0.019	0.978	0.000
5.0-6.25 mm (sqrt)	0.855	0.004	0.475	0.066
6.25-7.5 mm (sqrt)	0.494	0.060	0.244	0.165
7.5-9.0 mm (sqrt)	0.573	0.041	0.782	0.010
9.0-10.0 mm (sqrt)	0.627	0.031	0.422	0.082
10.0-15.0 mm (sqrt)	0.864	0.004	0.463	0.069
15.0-20.0 mm (sqrt)	0.470	0.067	0.109	0.289
20.0-40.0 mm (sqrt)	0.576	0.041	0.495	0.060
40.0-80.0 mm (sqrt)	0.625	0.028	0.972	0.002

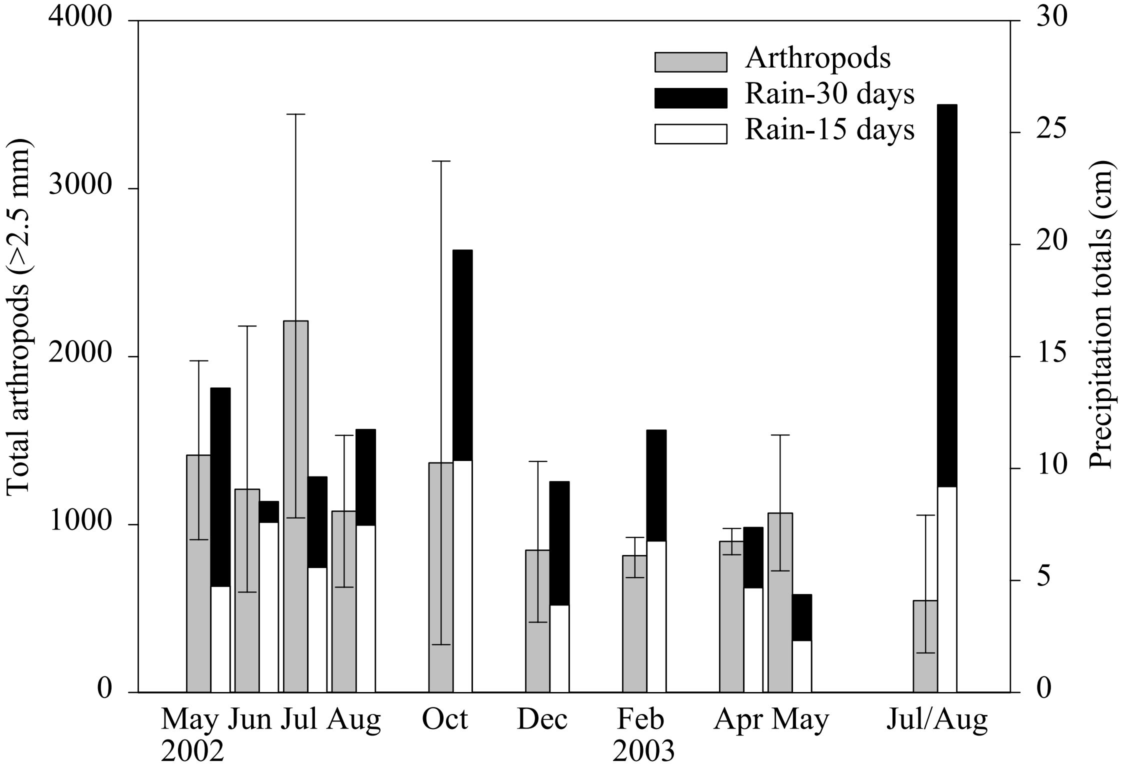

Figure 3.4. Average of total arthropods (>2.5 mm) from all fogging sites for each sampling period, with precipitation totals from the 15 and 30 days preceding fogging. Error bars indicate minimum and maximum arthropod counts for each sampling period.

Effects of Volcanic Ash

While volcanic ash did have an impact on overall arthropod numbers ($P=0.013$, $[\ln y]=7.50-0.113[\ln x]$, $R^2=0.178$; see Chapter 2), taxa important to Montserrat Oriole chicks demonstrated little to no response to volcanic ash. Average arthropod, ash and 30-day precipitation totals for each sampling period are shown in figure 3.5. Orthoptera, the main prey item delivered to nests in 2002 and 2003, did not demonstrate a significant response to volcanic ash ($P=0.193$, $y=174-8.68[\ln x]$, $R^2=0.052$). Total arthropods versus volcanic ash are shown in figure 3.6, and Orthoptera versus volcanic ash are shown in figure 3.7. Orthoptera accounted for, on average, 11.33% of each fogging sample (range: 0.35-28.39%). Lepidoptera had a statistically significant, negative response to volcanic ash ($P=0.086$, $[\ln y]=3.60 - 0.162[\ln x]$, $R^2=0.089$). However, only about 9% of the variation in Lepidoptera populations, which comprised 14.04 and 13.02% of the nestling oriole food supply in 2002 and 2003, respectively, could be attributed to ash. Lepidoptera comprised, on average, 2.49% of each fogging sample (range: 0.26-11.96%). Holometabolous larvae were not significantly affected by ash ($P=0.575$, $[\ln y]=2.6+0.0502[\ln x]$, $R^2=0.010$) and made up an average of 3.61% of each fogging sample (range: 0.03-16.17%). Coleoptera experienced a significant negative response to ash ($P=0.012$, $[\ln y]=4.60-0.157[\ln x]$, $R^2=0.180$). Although 18.0% of the variation in Coleoptera numbers could be attributed to volcanic ash, Coleoptera only comprised 3.51 and 10.06% of the nestling oriole food supply in 2002 and 2003, respectively. Coleoptera comprised, on average, 5.13% of each fogging sample (range: 0.97-12.98%). Together, these four taxa make up approximately 22.56% of each fogging sample (range: 7.75-33.53%).

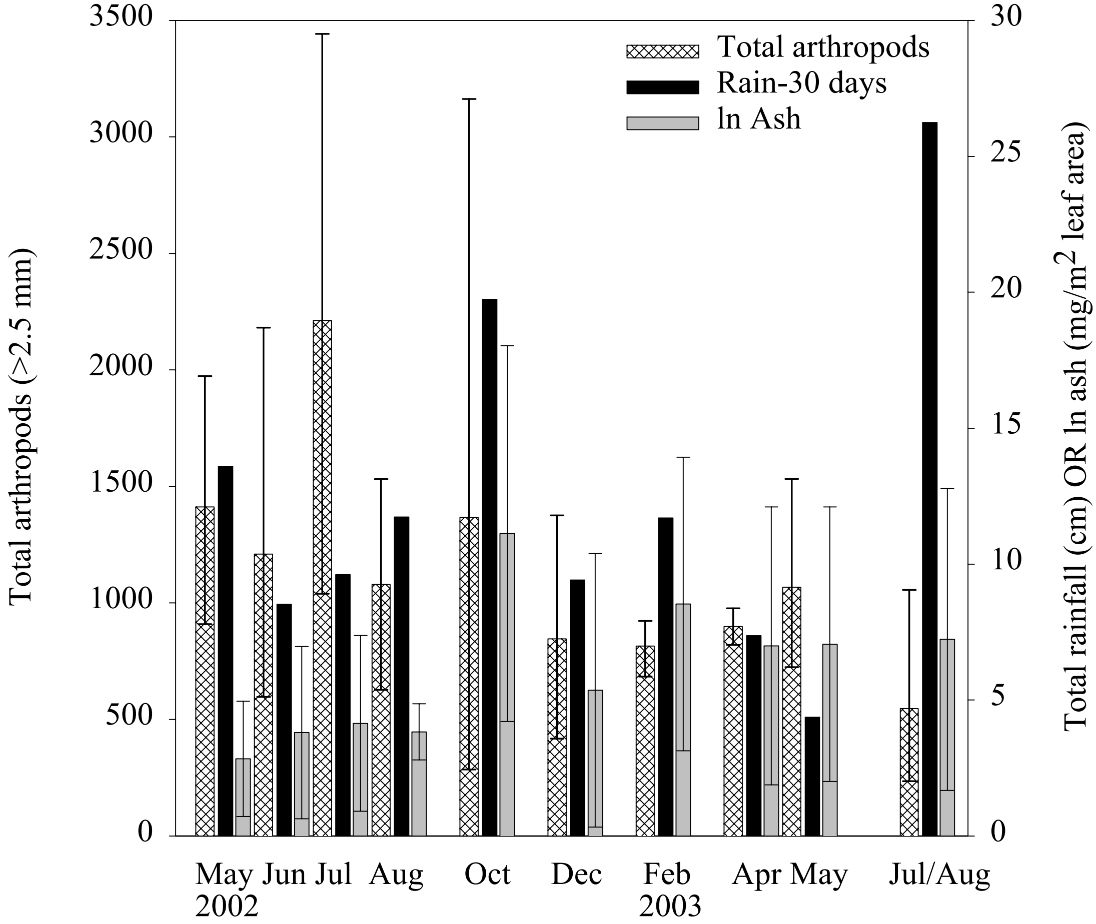

Figure 3.5. Average of total arthropods (>2.5 mm) from all fogging sites for each sampling period, precipitation totals from the 30 days preceding fogging, and average ash measurements (log-transformed). Arthropod counts should be read from the left axis, and rainfall and ash measurements should be read from the right axis. Error bars for total arthropods and ln ash indicate minimum and maximum values for each sampling period.

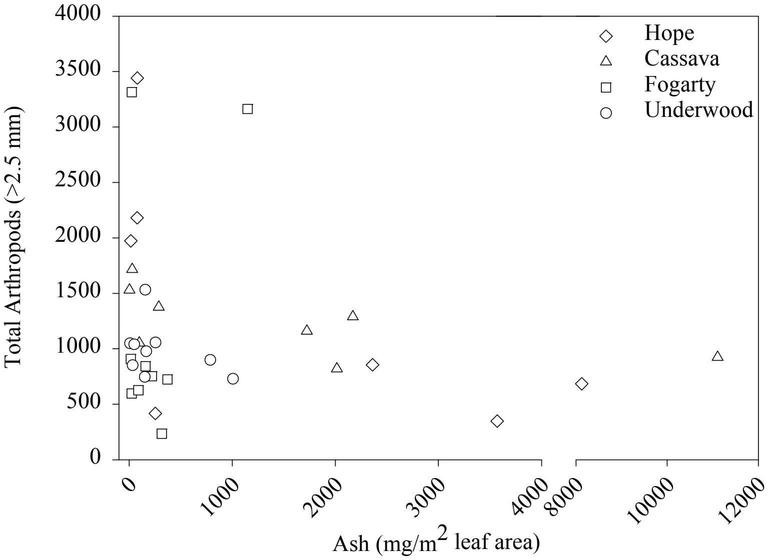

Figure 3.6. Untransformed scatterplot of total arthropods versus ash for all four fogging sites. Coordinates for the Hope Ghaut sample with the highest ash measurement (266,804.98 mg volcanic ash/m^2 leaf area versus 285 arthropods >2.5 mm, 08 October 2002) were excluded so that the spread in ash measurements could be more easily portrayed.

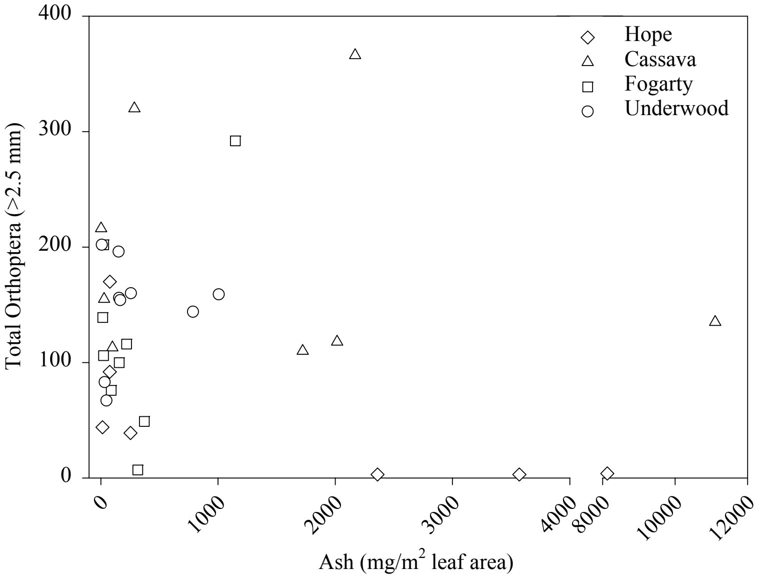

Figure 3.7. Untransformed scatterplot of total Orthoptera versus ash for all four fogging sites. Coordinates for the Hope Ghaut sample with the highest ash measurement (266,804.98 mg volcanic ash/m^2 leaf area versus 2 Orthoptera >2.5 mm, 08 October 2002) were excluded.

Insects approximately 1 bill-length (2 cm), the most important prey size for the nestling orioles, (36.59% of food-length estimates in 2002 and 39.04% in 2003) were not significantly affected by ash, but insects 1.25 bill-lengths (2.5 cm) or longer were significantly affected (see Chapter 2). These insects comprise, on average, only 0.57% of the total insects in a fogging sample. One-half bill items, the second most important food size (12.80% of food-length estimates in 2002 and 22.26% in 2003) were not significantly affected by ash, but insects below ½ bill in length were affected and comprise, on average, 97.3% of the total insects in a fogging sample (see Chapter 2).

All sites were not affected alike. Comparison of the two high ash sites versus. those farther away from the volcano indicated that numbers of insects present within each order or size class were not independent of the site's ash exposure (χ^2=126.24, 10 df; χ^2=17.25, 8 df; α=0.1). Regression of total insects from the high ash sites alone versus foliar ash demonstrated, as would be expected, that ash has a much greater effect on insects at these two sites than in areas protected from ash deposition ($P=0.002$, $[\ln y]=7.98-0.165[\ln x]$, $R^2=0.497$). Regression of total insects from the two low ash sites together could not be performed because the response variable could not be transformed to normal, but when examined individually, arthropods were not significantly affected by ash at either site (Fogarty, $P=0.976$, $[\ln y]=6.83-0.007[\ln x]$, $R^2=0.000$; Underwood, $P=0.487$, $[\ln y]=7.06-0.0394[\ln x]$, $R^2=0.071$). More individual taxa responded significantly to ash at the high ash sites than at the low ash sites, but Orthoptera were not affected by ash at either site. For a complete analysis of arthropods and volcanic ash, see Chapter 2. Data are presented in Appendix 1, Table 1.

Oriole Feeding Rates

Oriole feed rates have decreased since the onset of volcanic eruption (figure 3.8). Feed rates prior to 1995 (four nests) were compared with my nest observations only (nine nests), with the video data only (20 nests), and with the video and nest observations combined (29 nests). In all cases feeding rates were significantly lower than before volcanic activity ($T_+=60$, $n=11$; $T_+=94$, $n=14$; $T_+=96$, $n=14$; all $\alpha=0.1$). Observations from G3, H5, JH1, and U2 for 2002 and from H3, H6, J1 and S1 for 2003 were omitted from feeding rate analyses because the adult orioles at these sites expressed agitation at my presence, and inclusion of these data may have rendered the post-eruption feeding rates artificially low. Oriole nestling feeding rate data from 2001-2003 are shown in Appendix 2, Table 3.

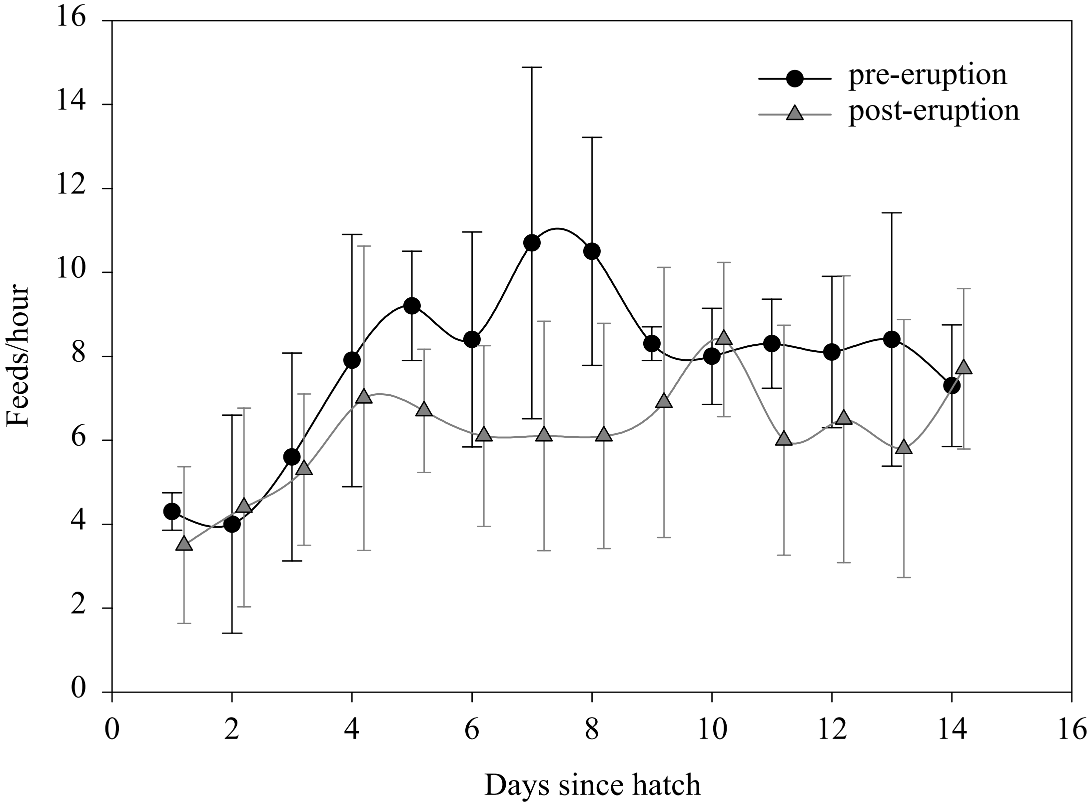

Figure 3.8. Average nestling Montserrat Oriole feeding rates by chick age (in days), before and after the beginning of the volcanic eruption. Error bars indicate standard deviation, and post-eruption points are offset slightly to the right to simplify error bar interpretation. Pre-eruption data are from Arendt and Arendt (1984) and unpublished nest observations by Peter Lack in 1973. Post-eruption data were taken from observations in 2002 and 2003 and nest videos from 2001-2003.

Discussion

An important part of developing any species conservation program is the quantification of subtle details of a species' biology—for example, which insect taxa are most heavily preyed upon by a generalist insectivore—and of the apparently obvious ecological processes surrounding that species. In this case, that volcanic ash would have a negative impact on Montserrat's insects, in turn affecting the predaceous species that feed on them, seemed obvious. Volcanic ash is a semi-permanent environmental feature in parts of the Centre Hills, and the effects of such abrasive particles on insect physiology has long been understood (Wigglesworth 1944). Following the eruption of Mount St. Helens, Edwards and Schwartz (1981) found that physical contact with volcanic ash could cause insect mortality through a variety of mechanisms, and Butler (1981) observed that an insect die-off immediately following heavy ash deposition had a negative impact on localized populations of insectivorous birds.

In the case of the Montserrat Oriole, however, this intuitively obvious explanation for the oriole's decline is turning out not to be supported. While volcanic ash has had a significant negative impact on the insects of Montserrat, it has not had a large impact on those preyed upon by the Montserrat Oriole. Ash accounts for approximately 18% of the variation in total insect populations, but very little of this variation occurs within the main food taxa utilized by the Montserrat Oriole.

Montserrat Orioles use a wide variety of habitats (Arendt and Arendt 1984, Faaborg and Arendt 1985, Atkinson et al. 1999), and can therefore be expected to be generalists in the food species they choose. The most cost-effective prey choices for nest provisioning would be expected to be large, abundant species unaffected by the ash. The observations of nest provisioning support this prediction.

Specimens fed to nestlings tended to be from the largest portion of the size range available in the habitat, with a concentration in the 10-25 mm range. This size class made up only 2.18% of the available canopy arthropods over 2.5 mm, but comprised 67.8% (58.5% in 2002 and 77.1% in 2003) of the observed prey items fed to chicks.

Thus, the Montserrat Oriole is clearly selecting large individuals from the total fauna available.

The most abundant taxon in the heavily utilized 10-25 mm size range was the Orthoptera, which was also the most commonly identified taxon fed to chicks. However, in specific cases where other taxa of this size range were abundant, they were used in relative proportion to their abundance. For example, phasmids were common at F0.5 in 2003, and were heavily utilized there, but were rarely seen elsewhere. While cicadas (Hemiptera: Cicadidae) were identified as prey items on only a few occasions, cicada exuviae were spotted frequently from mid-May to mid-June 2003, indicating an abundant, although temporary, food source for foraging orioles. However, these were swamped in the total data set by the fact that Orthoptera were more generally available over both time and space. Therefore, it is clear that the Montserrat Oriole is choosing the largest and most abundant individuals from the canopy of their territory in a generalized manner, not as a specialist would do.

The Orthoptera fed to nestlings are themselves generalist predators, and are widely distributed in the Centre Hills. In contrast, the distribution and abundance of herbivorous insects are limited by the availability of particular plant species, and ash has been shown to have a profound negative effect on leaf-chewing insects (Edwards and Schwartz 1981, Shanks and Chase 1981). Orthoptera probably receive less exposure to ash than their leaf-chewing counterparts, and are thus better able to withstand ash in the environment. Therefore, the observation that the Orthoptera were not significantly affected by ash, even in the parts of the Centre Hills most heavily affected by ash deposition, would contribute to their choice as prey items.

While a one-year project is not long enough to detect annual seasonal patterns within insect populations, particularly in an environment affected by an abiotic stress factor as intermittent as volcanic ash, on tropical islands without marked seasons insects would be expected to be available year-round. The main environmental factor varying over time is precipitation, which greatly affects the quality of vegetation present and would be expected to influence insect numbers, such that a dryer year might have lower insect abundance. Analysis of rainfall data for Montserrat did not reveal any conclusive effects of precipitation on insect numbers, but field observations indicated that rain may have had more of an impact than was statistically supported. My field work began in May in both 2002 and 2003, and spring of 2003 was very obviously dryer than that time the previous year. Forest vegetation appeared wilted, and the forest floor was covered with dead, dry leaves which crunched underfoot. The *Heliconia* were especially dry and often could not withstand the weight of an oriole nest through the entire nesting period; most nest-leaves were severely wilted and broken by the time chicks fledged. Wind-borne ash deposits at this time, although light, were not washed away by rain, remaining on plant surfaces for longer periods. Successful hand-collecting of insects was very challenging—beating of vegetation yielded mostly ants with the occasional spider, but very little else. The best insect collecting occurred on dead, dried leaves, rather than on live but wilted leaves, and oriole foraging patterns shifted to reflect this.

That precipitation demonstrated so little statistical impact is surprising, since field observations indicated a very obvious difference between the dry year and the wet. We suspect that our sampling regime and statistical analyses were ill-suited to detecting the effects of precipitation, rather than that precipitation had no effect. Because daily rainfall measurements were only available at one fogging site, insect totals from all four sites were combined to avoid pseudoreplication, but regression of the Hope values alone also failed to show significant results. One confounding factor is that the highest 30-day precipitation total coincided with the dome collapse of July 2003, and it is possible that the large quantities of volcanic ash in the environment at key times obliterated any population responses to rain that may have taken place.

Results of the nest observations, combined with the insect study, support our prediction that for an insectivorous bird to evolve exclusively on a single volcanic island, it must utilize a food resource which remains available during volcanic activity. In spite of available food resources, however, oriole feeding rates have declined since the eruption began, for reasons that were not clarified by this study. One possible reason for the reduced feeding rate is that adult orioles are utilizing larger prey species and so need to visit the nest less frequently. However, due to the questionable identifications and qualitative nature of the 1984 data, as well as the small sample size, numerical comparisons of pre- and post-eruption food choices are not possible. Another hypothesis for the feeding rate reduction is that territorial pairs are having smaller broods, thus reducing the need for feeding visits, but again, not enough pre-eruption data exist to draw a meaningful comparison.

A third possible cause for a reduction in feeding rate is that the predation challenge placed on orioles by rats and Pearly-Eyed Thrashers results in adult orioles spending more time defending the nest and less time procuring food for the chicks. While there are no pre-1995 data on oriole nest predation rates for comparison, current nest predation rates are being investigated. Finally, feeding rates may be lower because as the Montserrat Oriole declines, competition for breeding territories diminishes and younger, less experienced pairs are able to hold territories. Male orioles are typically recruited into the breeding population at two years of age (Hilton et al. 2003), but in 2001 and 2002 sub-adult males were successfully defending breeding territories and mating (Hilton et al. 2003, K. A. Marske, pers. obs.). Less experienced males may not be as effective as older ones at simultaneously provisioning the nest and fending off predators. This hypothesis could be studied over the next few years as color-banded oriole nestlings approach recruitment age.

While the causes of the Montserrat Oriole's decline remain unclear, insect scarcity during chick rearing, as a result of volcanic ash in the environment, does not seem to be a factor. Volcanic ash does have a significant negative effect on the canopy arthropod fauna as a whole, but Montserrat Orioles are selecting the portion of the fauna least affected by ash as their main food resources. Recent population studies indicate that Montserrat Oriole chicks are not starving to death on the nest (G. M. Hilton, pers. comm.), and other insect predators on Montserrat, such as the common insectivorous bat *Molossus molossus* (Pallas), appear to be healthy. Gary G. Kwiecinski reported that in 2003 individuals of this species had fur and teeth in good condition with no heavy ectoparasite loads, in stark contrast to their non-insectivorous counterparts (G. G. Kwiecinski, pers. comm.).

Finally, the Montserrat Oriole has survived volcanic eruptions on Montserrat for two million years, and in order to unravel the reasons behind its recent decline, we must consider why this eruption is different from previous, possibly larger ones. Prior to 1995, anthropogenic deforestation was already recognized as a potential problem facing the Montserrat Oriole and other island bird species. Since the evacuation and closure of the southern two-thirds of the island, deforestation and habitat fragmentation have continued as people whose homes and fields have been destroyed have little choice but to carve new homesteads out of the forests of the Centre Hills, where property is still available. In addition to having a highly restricted range, Montserrat Orioles are now pressed up against civilization to an extent as never before, forcing the orioles to live in increasingly disturbed environments.

While the effects of large-scale habitat disruption on oriole population dynamics cannot easily be tested, the impact of encounters with the anthrophilous species that thrive in disturbed habitats can be examined. The role of increased predation by rats and Pearly-Eyed Thrashers in the oriole decline is currently under investigation, and evidence suggests that many nest failures are due to egg and nestling predation. As this is the first eruption on Montserrat to occur in historic times, orioles have never before had to contend with rats, a post-Columbian introduction, while inhabiting a range restricted by volcanic activity. The loss of two-thirds of the island's human population after the eruption began resulted in the abandonment of many agricultural areas, allowing rat populations to increase in forests with more uncollected fruit. While Pearly-Eyed Thrashers are not recent introductions, the species has increased significantly on Montserrat in the last 30-60 years and thrashers are now more abundant in the wet forests of Montserrat than in the wet forests of any other island (Arendt, in press). Faaborg and Arendt (1985) found that populations of some bird species, particularly the bananaquit [*Coereba flaveola* (Linnaeus)] and the Lesser Antillean Bullfinch [*Loxigilla noctis* (Linnaeus)] appeared to be reduced on Montserrat in areas where Pearly-Eyed Thrashers were very abundant. Like rats, Pearly-Eyed Thrashers are able to exploit the increased food and nesting resources accompanying human-mediated habitat disruption (Faaborg and Arendt 1985, Arendt, in press), drawing them closer to the current range of the Montserrat Oriole.

One related factor in the decline of the Montserrat Oriole, which has not been investigated, is the fate of fledgling orioles between leaving the nest and recruitment into the adult population. Recently fledged orioles are extremely difficult to locate (J. R. Madden and M. F. Hulme, pers. comm.), and whether these orioles are remaining near the parent territories, dispersing into the surrounding forest, or succumbing to starvation or predation is not currently known. Understanding the survival rate of fledgling orioles, which are particularly susceptible to predation by rats and thrashers, might help explain the decline of the Montserrat Oriole population as a whole. The risk of natural disasters is high on volcanic islands, and while the Montserrat Oriole has withstood eruptions before, it has been repeatedly predicted that human-mediated habitat fragmentation can render a species with an already limited range extremely vulnerable to natural disasters

(Lovette et al. 1999, Hilton et al. 2003). The critically endangered Montserrat Oriole is in grave danger of becoming the textbook example of that theory.

CHAPTER 4

THE ORTHOPTERA OF MONTSERRAT, INCLUDING PHASMIDS AND BLATTIDS

Introduction

The Orthoptera of Montserrat (including phasmids and blattids), like much of the island's insect fauna, are poorly known. Widely distributed agricultural pests (eg. *Neocurtilla hexadactyla* [Rehn 1905, Woodruff et al. 1998, Stevens and Waldmann 2001] and *Scapteriscus* sp. [Fennah 1947, Ryckewaert 1998, Stevens and Waldmann 2001]) have been repeatedly recorded for the island, but non-pest species are not well represented in the literature. For example, no published records of Montserrat gryllids exist. Most of the Orthoptera reported from Montserrat were collected between 1894-1904 and are among the oldest entomological records for the island.

Charles V. Riley (U.S. National Museum) visited Montserrat in March 1894, probably in response to a scale outbreak affecting the island's lime juice industry (Riley and Howard 1890), and collected the earliest reported specimen of a Montserratian cockroach, a species reported by Rehn and Hebard (1926) on the basis of his specimens. Henry G. Hubbard (U.S. National Museum) also visited Montserrat in February-March 1894 and provided the earliest specimens of several species of Montserrat insects, including the first records for two Blattaria listed in this chapter (Stevens and Waldmann 2001). Although he never described any of them himself, at least four endemic Montserratian insects are named in his honor (Stevens and Waldmann 2001). Harold M.

Lefroy collected on Montserrat in 1901, discovering the first phaneropterine for the island (Rehn 1905), and Henry A. Ballou collected two first records and another early record of Orthoptera on Montserrat in 1904 (Rehn 1905, Rehn and Hebard 1927). Stuart T. Danforth (University of Puerto Rico) collected avian specimens on the island between 1922 and 1937 and performed several stomach dissections (Danforth 1939). His identifications of stomach contents included two Orthoptera records, one of which was a new record for the island (Danforth 1939).

Orthoptera were not collected again on Montserrat until July 1992, when Thomas J. Walker collected several unreported species (pers. comm.). He has kindly allowed me to use these unpublished records here. Michael Stevens and Georg Waldmann collected on the island in 1999, discovering one additional Orthopteran which was reported in their checklist of the fauna of Montserrat (Stevens and Waldmann 2001). Prior to my study, one phasmid, nine Orthoptera and four blattids were reported from Montserrat (Langlois and Lelong 1996, Stevens and Waldmann 2001).

Methods

Orthoptera were collected for this checklist from 2000-2003, using a variety of techniques. Specimens were hand-collected on Montserrat by M. A. Ivie and K. A. Guerrero from 15-30 June 2000, by M. A. Ivie, K. P. Puliafico and me from 2-14 January 2002, by M. A. Ivie and me from 13 May-8 July 2002, by M. A. Ivie, L. L. Ivie and me from 17 May-30 June 2003, and by M. A. Ivie from 02-10 May 2004. Pitfall and flight intercept traps were utilized 13 May to 8 July 2002. Malaise and ultraviolet-light traps were set from January to July 2002 and May to June 2003. Canopy fogging was performed monthly from May 2002 to August 2002 and every eight weeks from October 2002 to August 2003, by personnel from the Montserrat Forestry Department (for details see Chapter 2). Nearly all specimens were collected in the forests of the Centre Hills, as access to the southern half of Montserrat was prohibited due to volcanic activity.

Specimens in moderate to good condition were selected from various samples, and representatives of each type were pinned. All pinned specimens were separated into morphospecies, photographed, and assigned a species number for later identification. Individuals were identified as close to species level as possible, and several specimens were sent away for expert determination. Distribution notes for identified species were gleaned from available literature. Vouchers are deposited in the West Indian Beetle Fauna Collection, Academy of Natural Sciences of Philadelphia and the National Museum of Natural History.

Canopy fogging was also conducted by M. A. Ivie, K. A. Marske and P. Orchard on the neighboring island of St. Kitts during July 2003. While the insects from those samples are largely unsorted and unidentified, a few records of species found on Montserrat are indicated below.

Annotated Checklist to the Orthoptera of Montserrat

Asterisks (*) preceding species references indicate species collected on Montserrat between 2000 and 2004.

Order Phasmida

Phasmatidae

*Phasmid sp.

A species of this family is common on Montserrat. The only Montserrat record for the order is that of Langlois and Lelong (1996), who gave a questionable report of *Clonistria bartholomaea* Stål 1875 (Phibalosomatinae), which is known with certainty only from St. Barthélemy. This species may be wide spread throughout the Caribbean, also appearing on Puerto Rico, St. Kitts, Antigua, St. Lucia, St. Vincent and Grenada (Langlois and Lelong 1996), but is in need of a published revision (Langlois and Lelong 1996, see also Moxey 1972).

Order Orthoptera

Acrididae

Cyrtacanthacridinae

**Schistocerca nitens caribbeana* Dirsh 1974

Stevens and Waldmann (2001) first recorded this species on Montserrat from their 1999 collections. However, it is widely distributed in the Lesser Antilles, including on St. Kitts, Guadeloupe and Antigua (Dirsh 1974). Other subspecies occur in North, Central and South America and throughout the Greater and Lesser Antilles (Woodruff et al. 1998).

**Schistocerca pallens* (Thunberg 1815)

Dirsh (1974) was the first to record this species from Montserrat, but gave no collecting records (Stevens and Waldmann 2001). This species occurs from Mexico to Chile and is widely distributed in the Greater and Lesser Antilles, including Antigua, Aruba, Barbados, Cuba, Curacao, Grenada, Guadeloupe, Hispaniola, Jamaica, Martinique, Nevis, Isla de la Juventud (Is. of Pines), Puerto Rico, Saba, St. Croix, St. Kitts, St. Lucia, St. Thomas, St. Vincent and Trinidad (Dirsh 1974).

*Cyrtacanthacridine sp.

We collected a lone representative of an unidentified species within this subfamily on Montserrat.

Acridinae

*Acridid sp.

We collected a single, immature individual of an unidentified species belonging to this subfamily.

Tettigoniidae

Cophiphorinae

**Acantheremus bonfilsi* Hugel and Morin 2003

This species was plentiful within the forest canopy samples from 2002 and 2003, but it was not previously recorded from the island. It was also taken during canopy fogging on St. Kitts in 2003, and is a new record for that island as well. The type locality of this species is Guadeloupe (Hugel and Morin 2003).

**Neoconocephalus triops* (Linnaeus 1758)

This species was first collected on Montserrat by Ballou in 1904, and was reported by Rehn (1905) as *Conocephalus macropterus* Redtenbacher 1891. Danforth (1939) identified it *as Neoconocephalus triops macropterus* from the stomach contents of the Mangrove Cuckoo (*Coccyzus minor dominicae* Shelley). Stevens and Waldmann (2001) repeated those records. Specimens were also collected in 1992 by T. J. Walker (pers. comm.). This species is reportedly distributed from the U.S. to Peru, and throughout the Greater and Lesser Antilles (Woodruff et al. 1998).

Phaneropterinae

**Anaulacomera laticauda* Brunner v. Wattenwyl 1878 (?)

Anaulacomera laticauda has not been recorded from Montserrrat or St. Kitts, where it was also taken during canopy fogging in 2003. Walker collected an *Anaulacomera* sp. on Montserrat in 1992 (pers. comm), presumably this species. The type was described from Mexico, and has been reported from Trinadad, Cuba and Puerto Rico (Otte and Naskrecki 2004).

**Microcentrum* n. sp.

Danforth (1939) identified a *Microcentrum* sp. from the stomachs of the Mangrove Cuckoo and the Brown Trembler (*Cinclocerthia ruficauda pavida* Ridgway) (Stevens and Waldmann 2001). Walker also collected a

Microcentrum sp. on the island in 1992 (pers. comm.). This species may have been one of several green katydids regularly fed to nestling Montserrat Orioles (*Icterus oberi*) (pers. obs.).

**Phylloptera* (*Diplophyllus*) *punctatus* (Stål 1847)

This species was first collected on Montserrat in 1901 by Lefroy (Rehn 1905, as *Turpilia punctata* Stål 1847). Rehn's record was repeated by Walker (1968, as *T. punctata*) and Stevens and Waldmann (2001). Walker collected a species he identified initially as *Syntechna* sp. but later concluded that it may be *P. punctatus* (pers. comm.). *Phylloptera punctatus* has also been collected on St. Barthélemy, Dominica and Barbados (Otte and Naskrecki 2004).

Pseudophyllinae

**Nesonotus reticulatus* (Fabricius 1793)?

This species, tentatively identified, was very abundant in the Centre Hills in June 2000 (M. A. Ivie, pers. comm.) and was captured regularly in 2002 and 2003, particularly at Underwood. This species is active at night, but is not attracted to lights (M. A. Ivie, field notes). This is the first record of this genus for the island. *Nesonotus reticulatus* is currently recorded only from Guadeloupe (Bonfils 1966). An immature *Nesonotus* was also collected on St. Kitts during canopy fogging in 2003, but no mature, identifiable specimens were found.

Conocephalinae

**Conocephalus (Xiphidion) cinereus* Thunberg 1815

Woodruff et al. (1998) reported *C. saltator* (Saussure 1895) from Montserrat but provided no collection information (Stevens and Waldmann 2001). Their *C. saltator* is apparently a misidentification of *C. cinereus*, as *C. saltator* is a mainland species (Otte and Naskrecki 2004). Walker collected a conocephaline on Montserrat in 1992, which he determined was probably *C. cinereus* (pers. comm.). *Conocephalus cinereus* is known from most of the West Indian islands, and from Florida and Mexico through Central America to French Guyana, Surinam and Peru (Otte and Naskrecki 2004).

Gryllacrididae

*Gryllacridid sp.

We found one individual of a winged gryllacridid that has, thus far, not been further identified.

Gryllidae

No Montserrat records of Gryllidae currently exist in the literature. Representatives of all species collected during this project were sent to D. Otte for expert determination, and several of these species are expected to be new to science (D. Otte, pers. comm).

Oecanthinae

Oecanthus allardi Walker & Gurney 1960

Walker collected this species on Montserrat in 1992 (pers. comm.). The type specimen was from St. Croix, but the species has also been found on Hispaniola (Otte et al. 2004).

Eneopterinae

*Eneopterine spp.

Walker collected five species of Eneopterinae on Montserrat in 1992, and listed three as *Orocharis* spp. and one as *Laurepa* sp. (pers. comm.). We collected six species of Eneopterinae that we could not identify beyond subfamily. Eneopterines were plentiful in the forest canopy samples from 2002 and 2003.

Mogoplistinae

**Cycloptilum* sp.

A species closely resembling *C. spectabile* Strohecker 1939 was abundant in forest canopy samples from 2002 and 2003. Walker also collected specimens of a *Cycloptilum* sp. (pers. comm.).

Gryllinae

Anurogryllus celerinictus T. Walker 1973

T. J. Walker collected this species on Montserrat in 1992 (pers. comm.). The type specimens were from Jamaica, but it has also been collected in the Florida keys (Otte et al. 2004).

Gryllodes supplicans (F. Walker 1869)

Walker reported collecting this species on Montserrat in 1992 (identified as *G. sigillatus*, pers. comm.). This species, which has Sri Lanka as its type locality, is predominately distributed in the eastern hemisphere (Otte et al. 2004), although it may be becoming circumtropical in distribution.

**Gryllus* sp. near *assimilis* (Fabricius 1775)?

Walker collected this species on Montserrat in 1992 (pers. comm.). *Gryllus assimilis assimilis* has previously been recorded only from Jamaica and Hispaniola (Otte et al. 2004). We collected representatives of at least one *Gryllus* species.

Phalangopsinae?

*Phalangopsine spp.

Four species tentatively identified as this subfamily were captured regularly in pitfall traps in 2002, indicating they are abundant on the forest floor. When observed alive, individuals were usually located in dark, moist areas near the ground except for at night, when they were more active.

Gryllotalpidae

Neocurtilla hexadactyla (Perty 1832)

This species was first collected on Montserrat in 1904 by Ballou (Rehn 1905, as *Gryllotalpa hexadactyla* Perty 1832). Woodruff et al. (1998) also reported *N. hexadactyla* for the island, and Stevens and Waldmann (2001) repeated both records. *Neocurtilla hexadactyla* has been recorded from

Florida to Brazil and has been found on Cuba, Antigua, St. Vincent, Grenada, Barbados and Trinadad (Woodruff et al. 1998).

**Scapteriscus didactylus* (Latreille 1804)

This is the first record of this species for Montserrat, based on a single specimen, taken on the ground in Old Towne at night in June 2002. This species occurs from Puerto Rico south along the Antilles into northern South America (Nickle and Castner 1984). In the West Indies it has been collected on Grenada, St. Vincent, St. Lucia, Martinique, Dominica, Puerto Rico, St. Thomas and St. John (Nickle and Castner 1984, Ivie and Nickle 1986).

<u>Order Blattaria</u>

Blattidae

**Pelmatosilpha purpurascens* (Kirby 1903)

This species was first collected on Montserrat in 1894 by C. V. Riley (Rehn and Hebard 1927, Stevens and Waldmann 2001). This species has also been recorded for Antigua, Dominica, Guadeloupe, Iles des Saintes and Marie-Galante (Rehn and Hebard 1927, Bonfils 1969).

**Periplaneta americana* (Linnaeus 1758)

While this species is a globally distributed anthropophilous pest (Bonfils 1969, Stevens and Waldmann 2001), this report may be its first record for Montserrat. Stevens and Waldmann (2001) predicted that *P. americana* would be found on the island but cited no record of its collection. Our specimens were taken in Woodlands in January 1992, at house lights.

Blattellidae

Aglaopteryx absimilis Gurney 1937

Bonfils (1969) first reported this species from Montserrat and included records for Guadeloupe, Marie-Galante, La Désirade, St. Martin, St. Barthélemy, Martinique, Puerto Rico and Barbados.

**Cariblatta punctipennis* Hebard 1916

This is the first record of this species for Montserrat. It also occurs on Barbados, Dominica, Guadeloupe, Marie-Galante, La Désirade, Martinique and St. Kitts (Rehn and Hebard 1927, Bonfils 1969). Our specimens were taken in Spring Ghaut, January 2002, by beating vegetation, and Underwood Ghaut, May 2002, by fogging the forest canopy.

Epilampridae

Phoetalia pallida (Brunner 1865)

This species was first collected on Montserrat in 1894 by Hubbard [Rehn and Hebard 1927, as *Leurolestes pallidus* (Brunner 1865); Stevens and Waldmann 2001]. *Phoetalia pallida* is also known from Cuba, Jamaica, Puerto Rico, Dominica, Guadeloupe and Martinique (Rehn and Hebard 1927, Bonfils 1969). It is widely distributed from Florida, through Central America to Brasil, and in the Greater and Lesser Antilles (Bonfils 1969).

Blaberidae

**Panchlora nivea* (Linnaeus 1758)

Rehn (1905) reported the collection of *P. virescens* (Thunberg 1826) by Ballou on Montserrat in 1904, but stated later (Rehn and Hebard 1927) that it may have been a misidentification of *P. cubensis* Saussure 1862. Rehn and Hebard (1927) recorded an older specimen, collected by Hubbard in 1894, under the name *P. cubensis*. Stevens and Waldmann (2001) repeated both records under *P. nivea*, of which *P. virescens* and *P. cubensis* are now both junior synonyms. *Panchlora nivea* is widespread in Central and South America and the West Indies (Bonfils 1969, Stevens and Waldmann 2001). Most of our specimens were taken in 2002 in Cassava Ghaut, Woodlands, using an ultra-violet light.

**Pycnoscelus surinamensis* (Linnaeus 1758)

This chapter may be the first Montserrat record for this species, which is circumtropical in distribution (Woodruff et al. 1998).

Rejected Records

Scapteriscus vicinus Scudder 1869 (Gryllotalpidae)

This species was listed by Stevens and Waldmann (2001) without an expressed Montserrat record. Although Fennah (1947) described it as a minor pest of root crops on St. Vincent, and Ryckewaert (1998) also records it as a Lesser Antillean pest, the distribution of this species does not actually include the West Indies (Nickle and Castner 1984). Based on the distribution maps in Nickle and Castner (1984), the pests of Fennah (1947) and Ryckewaert (1998) were most likely *S. didactylus* (Latreille), which occurs widely in the Antilles.

Periplaneta australasiae (Fabricius 1775) (Blattaria: Blattidae)

This pest species was listed by Stevens and Waldmann (2001) without an expressed Montserrat record. While *P. australasiae* is widespread throughout the tropics, its presence on Montserrat has not been detected.

Discussion

The final tally of Montserrat Orthoptera stands at one phasmid, 29 Orthoptera (*s.s.*) and seven blattids. Of the 37 total species reported in this chapter, specimens of 31 were collected between 2000 and 2003. Of the Montserrat species identifiable to genus, seven species are represented only by specimens from the 2000-2004 collection, seven have been collected only by Walker, and two were taken both by Walker and from 2000-2004 (table 4.1). In total, 13 Orthoptera (identified to genus) and three Blattaria for Montserrat are reported here for the first time, and these numbers will increase as identifications and descriptions of new species become available. Montserrat is home to at least one new species of phaneropterine (*Microcentrum* n. sp.) and several species of gryllid (D. Otte, pers. comm.).

Table 4.1. Collecting records for the Orthoptera of Montserrat. Collectors' names are given across the top, and authors, where other than the collector, are indicated by numbers within the table. Superscripts: 1=Rehn 1905, 2=Rehn and Hebard 1927, 3=personnal communication.

	Hubbard 1894	Riley 1894	Lefroy 1901	Ballou 1904	Danforth 1939	Bonfils 1969	Dirsh 1974	Walker 1992	Langlois & Lelong 1996	Stevens & Waldmann	Present Study 2000-2003
Phasmida											
Clonistria bartholomaea (?)									X		?
Orthoptera											
Schistocerca nitens caribbeana										X	X
Schistocerca pallens							X				X
Acantheremus bonfilsi											X
Neoconocephalus triops				X^1	X			X^3			X
Anaulacomera laticauda (?)								X^3			X
Microcentrum n. sp.					X			X^3			X
Phylloptera (Diplophyllus) punctatus			X^1					?^{3}			X
Nesonotus reticulatus (?)											X
Conocephalus (Xiphidion) cinereus								X^3			X
Oecanthus allardi								X^3			
Orocharus sp. 1								X^3			
Orocharus sp. 2								X^3			
Orocharus sp. 3								X^3			
Laurepa sp.								X^3			
Cycloptilum sp.								X^3			X
Anurogryllus celerinictus								X^3			
Gryllodes supplicans								X^3			
Gryllus sp. near *assimilis*								X^3			X
Neocurtilla hexadactyla				X^1							
Scapteriscus didactylus											X
Blattaria											
Pelmatosilpha purpurascens		X^2				X					X
Periplaneta americana						X					X
Aglaopteryx absimilis						X					
Cariblatta punctipennis						X					X
Phoetalia pallida	X^2					X					X
Panchlora nivea	X^2			X^1		X					X
Pycnoscelus surinamensis						X					X

The use of different collecting techniques on Montserrat has yielded a much more comprehensive picture of the Orthoptera than could be had using any single technique. The Phaneropterinae, Pseudophyllinae, Eneopterinae, Mogoplistinae, and *Panchlora nivea* were most commonly collected by canopy fogging or in uv-light traps, and appear to be predominantly arboreal species. Montserrat's lone phasmid species was regularly collected by hand and in the canopy fogging samples, indicating it is widely distributed through all forest strata. The rhaphidophorine-like gryllids were captured in pitfall traps. Other species were most commonly collected by hand or malaise trap within two meters of the ground, with occasional representation in fogging or uv-light samples.

When the orthopterofauna from Montserrat were compared with those from other Caribbean islands for which catalogs, checklists or expedition records are available, it appears that the fauna of Montserrat is more diverse than those of even much larger islands (table 4.2). This apparent diversity may be due, in part, to the different collecting techniques used on Montserrat, and the scope of their application. In addition to several lengthy expeditions and the extensive use of a variety of trapping techniques, this study is the first in which insecticidal knockdown methods have been used to collect in the West Indies. Roberts (1973) utilized canopy fogging in the forests of Costa Rica after determining that "rare" species in hand-collected Orthoptera assemblages were, in fact, accidental fallouts from the canopy. His use of canopy fogging is the first record of that method being utilized for insect collecting in the neotropics, and was one of the first conclusive reports of Orthoptera that were completely arboreal in nature (Roberts 1973). While many species from Montserrat were collected using more than one method, the majority of the specimens of several taxa, particularly the Gryllidae and *Nesonotus* sp., came from the canopy samples. None of the gryllids or *Nesonotus* species are recorded in the literature for Montserrat.

Table 4.2. Number of Orthoptera species on West Indian islands for which catalogs, checklists or expedition reports exist.

	Phasmida	Orthoptera	Mantodea	Blattaria	Total	Land Area (km^2)	Species per km^2	References
Catalogs & Checklists								
Puerto Rico	15	40	3	37	95	8,959	0.01	Wolcott 1948
Guadeloupe			2	35		1,706		Bonfils 1969
Barbados	3	16	2	13	34	431	0.08	Bennet & Alam 1985
Grenada & the Grenadines	3	29	2	16	50	344	0.15	Woodruff et al. 1998
St. Croix, VI	3	19	1	16	39	217.6	0.18	Miskimen & Bond 1970
Montserrat	1	29	0	7	37	102	0.36	
Mona Island, PR	2	16	1	10	29	56.5	0.51	Ramos 1964
Little Cayman	1	11	0	6	18	27	0.67	Askew 1980
Caja de Muertos Island, PR	0	7	1	4	12	1.6	7.50	Gaud & Martorell 1974
Collecting Expeditions								
Antigua	2	14	1	4	21	280	0.08	Caudell 1922
Dominica	1	13	0	4	18	754	0.02	Caudell 1915

While comparison of numbers of Orthoptera between Montserrat and its nearest neighbors is not realistic, due to different levels of sampling on the islands, some examination of the similarities between islands seems warranted. Saint Kitts and Guadeloupe, which are similar to Montserrat and to each other in landscape and geological history (Beard 1949), can be predicted to support insect faunae comparable to (St. Kitts) or larger than (Guadeloupe) that of Montserrat. Antigua, which is not volcanic in origin and has suffered a much higher degree of deforestation and habitat alteration

(Beard 1949), would be expected to support a different insect fauna, constituted of more widely distributed species. Nine species reported for Montserrat are also found on Antigua (table 4.3), and three more (*Periplaneta americana, Phoetalia pallida* and *Panchlora nivea*) are almost certainly common to both islands. While records of the Orthoptera of Guadeloupe and St. Kitts are much more scant, the islands share species with Montserrat that are both widely distributed (eg. *Schistocerca nitens caribbeana*) and little-known (eg. *Acantheremus bonfilsi*). Thorough records for the blattids of Guadeloupe do exist, and all Montserrat species are shared with Guadeloupe (Bonfils 1969). More comprehensive sampling of all three neighboring islands, but particularly Guadeloupe and St. Kitts, would yield a much more accurate comparison between the island faunae, as well as revealing the distribution patterns of those species present on Montserrat.

Table 4.3. Comparison of Montserratian Orthoptera with species from the neighboring islands of Guadeloupe, St. Kitts and Antigua. Superscripts: 1=Rehn 1905, 2=Caudell 1922, 3=Rehn and Hebard 1927, 4=Bonfils 1966, 5=Bonfils 1969, 6=Dirsh 1974, 7=Langlois and Lelong 1996, 8=Woodruff et al. 1998, 9=Stevens and Waldmann 2001, 10=Hugel and Morin 2003, 11=record this paper. Distribution: W=widespread, C=circumtropical, G=global. (X)=species level identification tentative.

	Montserrat	Guadeloupe	St. Kitts	Antigua	Distribution
Phasmida					
Clonistria bartholomaea	(X)	(X[7])		(X[7])	
Orthoptera					
Schistocerca nitens caribbeana	X	X[6,8,10]	X[6,8,9]	X[6,8,9]	
Schistocerca pallens	X	X[6,9]		X[2,6,9]	
Acantheremus bonfilsi	X	X[10]	X[11]		
Neoconocephalus triops	X			X[2]	W
Anaulacomera laticauda	(X)		X[11]		
Microcentrum n. sp.	X				
Phylloptera (Diplophyllus) punctatus	X				
Nesonotus reticulatus	(X)	X[4]	(X)		
Conocephalus (Xiphidion) cinereus	X			X[2]	W
Oecanthus allardi	X				
Orocharus spp.	X				
Laurepa sp.	X				
Cycloptilum sp.	X				
Anurogryllus celerinictus	X				
Gryllodes supplicans	X				
Gryllus assimilis	(X)			X[2]	
Neocurtilla hexadactyla	X	X[1,8]		X[2,8,9]	W[9]
Scapteriscus didactylus	X				
Blattaria					
Pelmatosilpha purpurascens	X	X[5]		X[3,5,9]	
Periplaneta americana	X	X[5]			G[9]
Aglaopteryx absimilis	X	X[5]			
Cariblatta punctipennis	X	X[5]	X[5]		
Phoetalia pallida	X	X[5]			W[5]
Panchlora nivea	X	X[5]			W[5]
Pycnoscelus surinamensis	X	X[5]		X[2]	C[5,9]

CHAPTER 5

CONCLUSION

While the causes of the Montserrat Oriole's decline are unclear, insect scarcity during chick rearing, as a result of volcanic ash in the environment, does not seem to be a factor. The effects of volcanic ash deposited on leaves had a statistically significant yet limited impact on the forest canopy arthropod fauna of Montserrat. On the scale of the entire Centre Hills, ash explains approximately 18% of the variation in total arthropod numbers, but decline in response to ash is not distributed evenly among all arthropod taxa present. Different taxa display different levels of susceptibility but very little variation occurs within the main food taxa utilized by the Montserrat Oriole, as numbers of Orthoptera, their most commonly utilized prey items, did not decline in response to volcanic ash in the environment. Comparison of insect numbers at sites with different levels of ash exposure show that, while ash is obviously a more pronounced influence on environments which receive more of it, Orthoptera numbers were not suppressed at any sites. The Orthoptera delivered to nests and present in the canopy insect samples were predaceous tettigoniids and crickets, which receive less exposure to ash than their leaf-chewing counterparts and are thus better able to withstand ash in the environment. Even following years of volcanic activity, Orthoptera diversity on Montserrat appears to be comparable to that from other islands.

We are now nearly ten years into the Soufrière Hills eruption, yet forest canopy insect populations are still comparable in numbers to those from the nearby island of St. Kitts. While single generations of canopy insects may be affected during discrete volcanic events, indications are that reductions in insect numbers in surviving forests are short-term phenomena, and that between volcanic events, persistent ash in the environment and occasional light dustings do not have substantial negative effects on insect populations. Other insect predators on Montserrat appear to be healthy. Individuals of the commonly captured insectivorous bat *Molossus molossus* are generally in excellent health, in stark contrast with their fruit-eating counterparts (G. G. Kwiecinski, pers. comm.). In spite of apparently available food resources, however, Montserrat Oriole feeding rates have declined since the eruption began. Hypotheses for these seemingly anomalous results have been proposed, and it is possible that future fieldwork on Montserrat may clarify some of the questions raised.

Volcanoes have been an important part of the evolutionary history of Montserrat, influencing the development of both the insect fauna and the avifauna of the island. As the island is completely volcanic in origin, all species except for the most recent arrivals must have survived volcanic activity before. The canopy insect community has a relatively high level of endemism (M. A. Ivie, pers. comm), indicating that forest canopy insects have survived previous disasters and that recolonization of affected areas has been by on-island species. Mitochondrial DNA indicates that the Montserrat Oriole has existed as a single-island endemic species for over 2 million years (Lovette et al. 1999), demonstrating that it, too, has survived many previous eruptions. To unravel the reasons behind its decline, we must consider why this eruption is different from previous, possibly larger ones.

Prior to 1995, anthropogenic deforestation was already recognized as a potential problem facing the Montserrat Oriole and other island bird species (Faaborg and Arendt 1985, Arendt 1990). This problem has been exacerbated since the evacuation and closure of the southern two-thirds of the island, as people whose homes and fields have been destroyed have little choice but to carve new homesteads for themselves out of the forests of the Centre Hills. New encroachment into forest habitats has brought people, and anthrophilous species that thrive in disturbed habitats, in closer proximity to the Montserrat Oriole than ever before.

The impacts of increased predation of young orioles by rats and Pearly-Eyed Thrashers is currently under investigation, and this may provide a valuable clue to recent oriole population trends. Rats are a post-Columbian introduction to the island's fauna, and orioles have never before had to contend with rat predation during a volcanic eruption. Pearly-Eyed Thrashers are not recent introductions, but are currently more abundant on the island than ever before (Arendt, in press) and are well adapted to highly disturbed residential areas (Faaborg and Arendt 1985). The combination of a severely restricted and increasingly disturbed habitat, combined with increased predation pressures on nestlings and young fledglings, may be pushing the Montserrat Oriole closer to extinction, but limitation of food resources are probably not contributing to that decline.

LITERATURE CITED

Akre, R. D., L. D. Hansen, H. C. Reed and L. D. Corpus. 1981. Effects of volcanic ash from Mt. St. Helens on ants and yellowjackets. Melanderia 37: 1-19.

Arendt, W. J. 1990. Impact of Hurricane Hugo on the Montserrat Oriole, other forest birds and their habitat. U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry, Rio Piedras, Puerto Rico.

Arendt, W. J. (in press). Adaptations of an Avian Supertramp: Distribution, Ecology and Life History of the Pearly-Eyed Thrasher (*Margarops fuscatus*). Oxford University Press, London.

Arendt, W. J. and A. I. Arendt. 1984. Distribution, population size, status and reproductive ecology of the Montserrat Oriole (*Icterus oberi*). U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry, Rio Piedras, Puerto Rico.

Arendt, W. J., D. W. Gibbons and G. Gray. 1999. Status of the volcanically threatened Montserrat Oriole *Icterus oberi* and other forest birds in Montserrat, West Indies. Bird Conservation International 9: 351-372.

Askew, R. R. 1980. The insect fauna of Little Cayman. Geography and Ecology of Little Cayman 241: 97-114.

Atkinson, P. W., D. W. Gibbons, G. A. L. Gray, W. J. Arendt and K. W. Smith. 1999. The effects of volcanic activity on the breeding ecology of the Montserrat Oriole *Icterus oberi*. Unpublished manuscript.

Ballou, H. H. 1912. Insect Pests of the Lesser Antilles. Pamphlet Series 71. Imperial Department of Agriculture for the West Indies, Bridgetown, Barbados. Ix + 210 pp.

Beard, J. S. 1949. The Natural Vegetation of the Windward and Leeward Islands. Oxford University Press, London. 192 pp.

Bennet, F. D. and M. M. Alam. 1985. An Annotated Checklist of the Insects and Allied Terrestrial Arthropods of Barbados. Caribbean Agricultural Research and Development Institute, St. Augustine, Trinadad. Vi + 81 pp.

Bent, A. C. 1965. Life Histories of North American Blackbirds, Orioles, Tanagers, and Allies. Dover Publications, New York. Viii + 549 pp.

Bonfils, J. 1966. Contribution à l'étude des Orthoptéroïdes des Antilles, II. Bulletin de la Société entomologique de France 71: 77-83.

Bonfils, J. 1969. Catalogue raisonné des insects des Antilles françaises. Dictyoptera: Blattaria et Mantida. Annales de Zoologie Écologie animale 1: 107-120.

Borror, D. J., C. A. Triplehorn and N. F. Johnson. 1989. An Introduction to the Study of Insects. Saunders College Publishing, Fort Worth, TX. Xiv + 875.

Bowden, C. G. R., C. Fenton, G. A. L. Gray, L. Mackley, G. M. Hilton and P. W. Atkinson. 2001. The Montserrat Oriole: in trouble again. Dodo 37: 100.

Brown, J. J. and Y. bin Hussain. 1981. Physiological effects of volcanic ash upon selected insects in the laboratory. Melanderia 37: 30-38.

Butcher, G. S. 1981. Northern Orioles disappear with Mt. St. Helens ashfall. The Murrelet 62: 15-16.

Caudell, A. N. 1915. Orthoptera of the Yale Dominican Expedition of 1913. Proceedings of the United States National Museum 47: 491-495.

Caudell, A. N. 1922. Report on Orthoptera and Dermaptera collected by the Barbados-Antigua Expedition from the University of Iowa in 1918. University of Iowa Studies in Natural History 10: 19-44.

Cole, P. D., E. S. Calder, T. H. Druitt, R. Hoblitt, R. Robertson, R. S. J. Sparks and S. R. Young. 1998. Pyroclastic flows generated by gravitational instability of the 1996-97 lava dome of Soufriere Hills Volcano, Montserrat. Geophysical Research Letters 25: 3425-3428.

Collar, N. J. and P. Andrew. 1988. Birds to Watch: The ICBP World Checklist of Threatened Birds. ICBP Technical Publication No. 8. Smithsonian Institution Press, Washington, D.C. Xvi +303 p.

Cook, R. J., J. C. Barron, R. I. Papendick and G. J. Williams III. 1981. Impact on agriculture of the Mount St. Helens eruptions. Science 211: 16-22.

Cooter, J. 1983. A few insects from Montserrat. Entomologist's Record 95: 185-186.

Cronin, S. J., M. J. Hedley, R. G. Smith and V. E. Neall. 1997. Impact of Ruapehu ash fall on soil and pasture nutrient status 1. October 1995 eruptions. New Zealand Journal of Agricultural Research 40: 383-395.

Daltry, J. C. and G. Gray. 1999. Effects of volcanic activity on the endangered Mountain Chicken frog (*Leptodactylus fallax*). Froglog 32: 1-2.

Danforth, S. T. 1939. Birds of Montserrat. Journal of Agriculture of the University of Puerto Rico 23: 47-66.

Dirsh, V. M. 1974. Genus *Schistocerca* (Acridomorpha, Insecta). Series Entomologia 10. Dr. W. Junk B.V., The Hague. Vi + 238 pp.

Earle, K. W. 1926. Reports on the Geology of St. Kitts—Nevis, B.W.I., and the Geology of Anguilla, B.W.I. The Crown Agents for the Colonies, London. 50 pp.

Edwards, J. S. and L. M. Schwartz. 1981. Mount St. Helens ash: a natural insecticide. Canadian Journal of Zoology 59: 714-715.

Faaborg, J. and W. J. Arendt. 1985. Wildlife assessments in the Caribbean. U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry, Rio Piedras, Puerto Rico.

Fennah, R. G. 1947. The Insect Pests of Food-Crops in the Lesser Antilles. Department of Agriculture for the Windward Islands, St. George’s, Grenada, and Department of Agriculture for the Leeward Islands, St. John’s, Antigua. 207 pp.

Flora and Fauna International. 2004. Sustainable use strategy for ‘Nature Isle’. *http://www.fauna-flora.org/around_the_world/americas/nature_isle.htm.*

Foster, J. H. and W. L. Myers. 1981. Ashfall effects on Columbia Basin wildlife. In: Mt. St. Helens: Effects on Water Resources. Proceedings from the conference, Jantzen Beach, Oregon, 7-8 October 1981. Pp. 151-162.

Fowler, J., L. Cohen and P. Jarvis. 1998. Practical Statistics for Field Biology. John Wiley & Sons, Chichester, UK. Ix + 259 pp.

Gaud, S. M. and L. F. Martorell. 1974. The insects of Caja de Muertos Island, Puerto Rico. Journal of Agriculture of the University of Puerto Rico 58: 244-272.

Genoways, H. H. 1998. Two new subspecies of bats of the genus *Sturnira* from the Lesser Antilles, West Indies. Museum of Texas Tech University Occasional Paper 176: 1-7. *http://www.nsrl.ttu.edu/opapers.htm.*

Gibbons, D. W., K. W. Smith, P. Atkinson, D. Pain, W. J. Arendt, G. Gray, J. Hartley, A. Owen and C. Clubbe. 1998. After the volcano: a future for the Montserrat Oriole? RSPB Conservation Review 12: 97-101.

Grisdale, T. 1882. On the birds of Montserrat. The Ibis 6: 485-493.

Hayward, J. L., D. E. Miller and C. R. Hill. 1982. Mount St. Helens ash: its impact on breeding Ring-Billed and California Gulls. The Auk 99: 623-631.

Hilton, G. M. 2001. Emergency research on the critically threatened Montserrat Oriole—research update, November 2001. Unpublished report for the Montserrat Oriole Project and the Royal Society for the Protection of Birds.

Hilton, G. M., P. W. Atkinson, G. A. L. Gray, W. J. Arendt and D. W. Gibbons. 2003. Rapid decline of the volcanically threatened Montserrat Oriole. Biological Conservation 111: 79-89.

Hölldobler, B. and E. O. Wilson. 1990. The Ants. Harvard University Press, Cambridge, MA. Xii + 732 pp.

Hugel, S. and D. Morin. 2003. Une espèce d'*Acantheremus* de Guadeloupe (Orthoptera, Tettigoniidae, Copiphorinae). Bulletin de la Société entomologique de France 108: 427-432.

IUCN. 2003. 2003 IUCN Red List of Threatened Species. *www.redlist.org*. Downloaded on 27 February 2004.

Irving, N. S. 1978. Report on the Antigua, Montserrat and St. Kitts—Nevis—Anguilla Entomology Programme 1975-1977. Centre for Overseas Pest Research, London. 55 pp.

Ivie, M. A. and D. A. Nickle. 1986. Virgin Island records of the Changa, *Scapteriscus didactylus* (Orthoptera: Gryllotalpidae). Florida Entomologist 69: 760-761.

Johansen, C. A., J. D. Eves, D. F. Mayer, J. C. Bach, M. E. Nedrow and C. W. Kious. Effects of ash from Mt. St. Helens on bees. Melanderia 37: 20-29.

Johnson, T. H. 1988. Biodiversity and Conservation in the Caribbean: Profiles of Selected Islands. ICBP Monograph No. 1. International Council for Bird Preservation, Cambridge, UK. Xvii + 144 p.

Kitching, R. L., J. M. Bergelson, M. D. Lowman, S. McIntyre and G. Carruthers. 1993. The biodiversity of arthropods from Australian rainforest canopies: general introduction, methods, sites and ordinal results. Australian Journal of Ecology 18: 181-191.

Klostermeyer, E. C., L. D. Corpus and C. L. Campbell. 1981. Population changes in arthropods in wheat following volcanic ash fallout. Melanderia 37: 45-49.

Langlois, F. and P. Lelong. 1996. Catalogue bibliographique des Phasmes des Antilles. Le Monde Des Phasmes 35: 20-26.

Lawrence, G. N. 1880. Description of a new species of *Icterus* from the West Indies. Proceedings of the United States National Museum 3: 351.

Lovette, I. J., E. Bermingham and R. E. Ricklefs. 1999. Mitochondrial DNA phylogeography and the conservation of endangered Lesser Antillean *Icterus* orioles. Conservation Biology 13: 1088-1098.

MacGregor, A. G. 1938. The Royal Society expedition to Montserrat, B.W.I. The volcanic history and petrology of Montserrat, with observations on Mt. Pele, in Martinique. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences 229: 1-90.

Matthews, A. J., J. Barclay, S. Carn, G. Thompson, J. Alexander, R. Herd and C. Williams. 2002. Geophysical Research Letters 29: 22-1 to 22-4.

Miskimen, G. W. and R. M. Bond. 1970. The insect fauna of St. Croix, United States Virgin Islands. Scientific Survey of Porto Rico and the Virgin Islands Volume XIII, Part I. New York Academy of Sciences, New York. 114 pp.

Montserrat Volcano Observatory Team. 1997. The ongoing eruption on Montserrat. Science 276: 371-372.

Montserrat Volcano Observatory. 2004a. Chronology of the 1995 to 2004 eruption of Soufrière Hills Volcano. *www.mvo.ms/chronology.htm*. Downloaded 29 April 2004.

Montserrat Volcano Observatory. 2004b. Summary of the 12-15 July 2003 dome collapse and explosive activity at the Soufrière Hills Volcano, Montserrat. *www.mvo.ms/summary_030712.htm*. Downloaded 29 April 2004.

Moxey, C. F. 1972. The stick-insects (Phasmatodea) of the West Indies—their systematics and biology. Ph.D dissertation, Harvard University, Cambridge. 211 pp.

Nickle, D. A. and J. L. Castner. 1984. Introduced species of mole crickets in the United States, Puerto Rico, and the Virgin Islands (Orthoptera: Gryllotalpidae). Annals of the Entomological Society of America 77: 450-465.

Otte, D. and P. Naskrecki. 8 March 2004. Orthoptera Species File Online: Katydids or bush-crickets (Tettigonioidea). *www.tettigonia.com*.

Otte, D., D. C. Eades and P. Naskrecki. 2004. Orthoptera Species File Online (Version 2.2). *http://osf2x.orthoptera.org/osf2.2/*.

Owen, A. 2000. The collection of eight Montserrat Orioles *Icterus oberi* and their establishment at Jersey Zoo. Dodo 36: 51-61.

Pedersen, S. C. 2001. Fruitbats of Montserrat: sub-lethal pathology associated with the ingestion of volcanic ash. Proceedings of the South Dakota Academy of Science 80: 443.

Prentiss, Inc. 2003. Product 655-489. Prentox® Pyronyl^{TM} Crop Spray. Material Safety Data Sheet, U.S. Department of Labor (OSHA 29 CFR 1910.1200).

Ramos, J. A. 1964. The insects of Mona Island (West Indies). Journal of Agriculture of the University of Puerto Rico 30: 1-74.

Rehn, J. A. G. 1905. Notes on a small collection of Orthoptera from the Lesser Antilles, with the description of a new species of *Orphulella*. Entomological News 16: 173-182.

Rehn, J. A. G. and M. Hebard. 1927. The Orthoptera of the West Indies Number 1. Blattidae. Bulletin of the American Museum of Natural History 54: 1-320.

Riley, C. V. and H. C. Howard. 1890. Some new *Icerya*. Insect Life 3: 92-106.

Roberts, H. R. 1973. Arboreal Orthoptera in the rain forests of Costa Rica collected with insecticide: a report on the grasshoppers (Acrididae), including new species. Proceedings of the Academy of Natural Sciences of Philadelphia 125: 49-66.

Robertson, R. E. A., W. P. Aspinall, R. A. Herd, G. E. Norton, R. S. J. Sparks and S. R. Young. 2000. The 1995-1998 eruption of the Soufrière Hills volcano, Montserrat, WI. Philosophical Transactions of the Royal Society of London A 358: 1619-1637.

Robson, W. 1906. Insects from Montserrat. Agricultural News 5: 410.

Ryckewaert, P. 1998. Illustrated guide of insects and mites on vegetable crops in the Lesser Antilles. CIRAD-FLHOR, Martinique. 110 pp.

Schwartz, A. and C. J. Jimenez. 1982. The butterflies of Montserrat, West Indies. Bulletin of the Allyn Museum 66: 1-17.

Shanks, C. H. Jr. and D. L. Chase. 1981. Effect of volcanic ash on adult *Otiorhynchus* (Coleoptera: Curculionidae). Melanderia 37: 63-66.

Stevens, M. and G. Waldmann. 2001. Animal Biodiversity of the Lesser Antillean Island of Montserrat (British West Indies): An Annotated Checklist of Terrestrial and Freshwater Animals. Archiv zoologischer Publikationen Band 6. Martina Galunder-Verlag, Nümbrecht. 140 pp.

Stone, R. 2003. Bracing for the big one on Montserrat. Science 299: 2027-2030.

Stork, N. E., and P. M. Hammond. 1997. Sampling arthropods from tree-crowns by fogging with knockdown insecticides: lessons from studies of oak tree beetle assemblages in Richmond Park (UK). In: Canopy Arthropods (N. E. Stork, J. Adis and R. K. Did ham, editors). Chapman and Hall, London. Pp. 3-26.

Thomas Crosbie Media. 30 July 2001. Caribbean volcano spews ash for hundreds of miles. *http://archives.tcm.ie/breakingnews/2001/07/30/story19604.asp*.

Walker, T. J. 1968. Preliminary checklist of West Indian Tettigoniidae. Unpublished manuscript.

Wigglesworth, V. B. 1944. Action of inert dusts on cuticle. Nature 153: 493-494.

Wille, A. and G. Fuentes. 1975. Efecto de la ceniza Volcán Irazú (Costa Rica) en algunos insectos. Revista de Biologia Tropical 23: 165-175.

Wolcott, G. N. 1948. The insects of Puerto Rico. Journal of Agriculture of the University of Puerto Rico 32: 1-975.

Woodruff, R. E., B. M. Beck, P. E. Skelley, C. Y. L. Schotman and M. C. Thomas. 1998. Checklist and Bibliography of the Insects of Grenada and the Grenadines. Center for Systematic Entomology, Gainesville, FL. 286 pp.

Young, S. R., R. S. Sparks, W. P. Aspinall, L. L. Lynch, A. D. Miller, R. E. A. Robertson and J. B. Shepherd. Overview of the eruption of Soufriere Hills volcano, Montserrat, 18 July 1995 to December 1997. Geophysical Research Letters 25: 3389-3392.

APPENDICES

APPENDIX A

CANOPY FOGGING DATA

Table 1, Appendix 1. Results from canopy fogging samples.

Sample	Island	Site	Date	Ash (mg/m^2 leaf)	Size Class	Taxon	N
1	M	Hope	16-May-02	15.13	<1.25	Acari	1465
1	M	Hope	16-May-02	15.13	1.25-2.5	Acari	4
1	M	Hope	16-May-02	15.13	<1.25	Araneae	263
1	M	Hope	16-May-02	15.13	1.25-2.5	Araneae	198
1	M	Hope	16-May-02	15.13	2.5-3.75	Araneae	44
1	M	Hope	16-May-02	15.13	3.75-5	Araneae	43
1	M	Hope	16-May-02	15.13	5-6.25	Araneae	6
1	M	Hope	16-May-02	15.13	6.25-7.5	Araneae	1
1	M	Hope	16-May-02	15.13	7.5-9	Araneae	2
1	M	Hope	16-May-02	15.13	<1.25	Collembola	109
1	M	Hope	16-May-02	15.13	56--57	Phasmida	2
1	M	Hope	16-May-02	15.13	59--60	Phasmida	1
1	M	Hope	16-May-02	15.13	60--61	Phasmida	4
1	M	Hope	16-May-02	15.13	1.25-2.5	Orthoptera	7
1	M	Hope	16-May-02	15.13	2.5-3.75	Orthoptera	5
1	M	Hope	16-May-02	15.13	3.75-5	Orthoptera	5
1	M	Hope	16-May-02	15.13	5-6.25	Orthoptera	7
1	M	Hope	16-May-02	15.13	6.25-7.5	Orthoptera	2
1	M	Hope	16-May-02	15.13	7.5-9	Orthoptera	9
1	M	Hope	16-May-02	15.13	9--10	Orthoptera	3
1	M	Hope	16-May-02	15.13	10--11	Orthoptera	2
1	M	Hope	16-May-02	15.13	12--13	Orthoptera	2
1	M	Hope	16-May-02	15.13	13--14	Orthoptera	3
1	M	Hope	16-May-02	15.13	14--15	Orthoptera	2
1	M	Hope	16-May-02	15.13	15--16	Orthoptera	2
1	M	Hope	16-May-02	15.13	16--17	Orthoptera	2
1	M	Hope	16-May-02	15.13	6.25-7.5	Blattaria	1
1	M	Hope	16-May-02	15.13	7.5-9	Blattaria	1
1	M	Hope	16-May-02	15.13	1.25-2.5	Isoptera	2
1	M	Hope	16-May-02	15.13	2.5-3.75	Isoptera	50
1	M	Hope	16-May-02	15.13	3.75-5	Isoptera	29
1	M	Hope	16-May-02	15.13	5-6.25	Isoptera	5
1	M	Hope	16-May-02	15.13	6.25-7.5	Isoptera	1
1	M	Hope	16-May-02	15.13	7.5-9	Isoptera	1
1	M	Hope	16-May-02	15.13	<1.25	Psocoptera	4932
1	M	Hope	16-May-02	15.13	1.25-2.5	Psocoptera	513
1	M	Hope	16-May-02	15.13	2.5-3.75	Psocoptera	308
1	M	Hope	16-May-02	15.13	3.75-5	Psocoptera	12
1	M	Hope	16-May-02	15.13	<1.25	Hemiptera	1771
1	M	Hope	16-May-02	15.13	1.25-2.5	Hemiptera	395
1	M	Hope	16-May-02	15.13	2.5-3.75	Hemiptera	144
1	M	Hope	16-May-02	15.13	3.75-5	Hemiptera	9

1	M	Hope	16-May-02	15.13	5-6.25	Hemiptera	3
1	M	Hope	16-May-02	15.13	6.25-7.5	Hemiptera	1
1	M	Hope	16-May-02	15.13	7.5-9	Hemiptera	2
1	M	Hope	16-May-02	15.13	<1.25	Thysanoptera	554
1	M	Hope	16-May-02	15.13	1.25-2.5	Thysanoptera	107
1	M	Hope	16-May-02	15.13	2.5-3.75	Thysanoptera	25
1	M	Hope	16-May-02	15.13	3.75-5	Thysanoptera	1
1	M	Hope	16-May-02	15.13	5-6.25	Thysanoptera	1
1	M	Hope	16-May-02	15.13	1.25-2.5	Neuroptera	69
1	M	Hope	16-May-02	15.13	2.5-3.75	Neuroptera	1
1	M	Hope	16-May-02	15.13	3.75-5	Neuroptera	1
1	M	Hope	16-May-02	15.13	13--14	Neuroptera	4
1	M	Hope	16-May-02	15.13	14--15	Neuroptera	3
1	M	Hope	16-May-02	15.13	17--18	Neuroptera	2
1	M	Hope	16-May-02	15.13	18--19	Neuroptera	1
1	M	Hope	16-May-02	15.13	<1.25	Coleoptera	132
1	M	Hope	16-May-02	15.13	1.25-2.5	Coleoptera	379
1	M	Hope	16-May-02	15.13	2.5-3.75	Coleoptera	102
1	M	Hope	16-May-02	15.13	3.75-5	Coleoptera	18
1	M	Hope	16-May-02	15.13	5-6.25	Coleoptera	8
1	M	Hope	16-May-02	15.13	6.25-7.5	Coleoptera	8
1	M	Hope	16-May-02	15.13	7.5-9	Coleoptera	45
1	M	Hope	16-May-02	15.13	9--10	Coleoptera	14
1	M	Hope	16-May-02	15.13	10--11	Coleoptera	3
1	M	Hope	16-May-02	15.13	<1.25	Diptera	639
1	M	Hope	16-May-02	15.13	1.25-2.5	Diptera	910
1	M	Hope	16-May-02	15.13	2.5-3.75	Diptera	131
1	M	Hope	16-May-02	15.13	3.75-5	Diptera	47
1	M	Hope	16-May-02	15.13	5-6.25	Diptera	13
1	M	Hope	16-May-02	15.13	6.25-7.5	Diptera	2
1	M	Hope	16-May-02	15.13	7.5-9	Diptera	2
1	M	Hope	16-May-02	15.13	9--10	Diptera	2
1	M	Hope	16-May-02	15.13	16--17	Diptera	1
1	M	Hope	16-May-02	15.13	<1.25	Lepidoptera	310
1	M	Hope	16-May-02	15.13	1.25-2.5	Lepidoptera	39
1	M	Hope	16-May-02	15.13	2.5-3.75	Lepidoptera	27
1	M	Hope	16-May-02	15.13	3.75-5	Lepidoptera	31
1	M	Hope	16-May-02	15.13	5-6.25	Lepidoptera	11
1	M	Hope	16-May-02	15.13	7.5-9	Lepidoptera	1
1	M	Hope	16-May-02	15.13	<1.25	Formicidae	88
1	M	Hope	16-May-02	15.13	1.25-2.5	Formicidae	1549
1	M	Hope	16-May-02	15.13	2.5-3.75	Formicidae	231
1	M	Hope	16-May-02	15.13	3.75-5	Formicidae	186
1	M	Hope	16-May-02	15.13	5-6.25	Formicidae	25
1	M	Hope	16-May-02	15.13	6.25-7.5	Formicidae	1
1	M	Hope	16-May-02	15.13	9--10	Formicidae	1
1	M	Hope	16-May-02	15.13	<1.25	Hymenoptera	1672

1	M	Hope	16-May-02	15.13	1.25-2.5	Hymenoptera	429
1	M	Hope	16-May-02	15.13	2.5-3.75	Hymenoptera	143
1	M	Hope	16-May-02	15.13	3.75-5	Hymenoptera	27
1	M	Hope	16-May-02	15.13	5-6.25	Hymenoptera	31
1	M	Hope	16-May-02	15.13	6.25-7.5	Hymenoptera	6
1	M	Hope	16-May-02	15.13	7.5-9	Hymenoptera	4
1	M	Hope	16-May-02	15.13	12--13	Hymenoptera	1
1	M	Hope	16-May-02	15.13	<1.25	insect larvae	111
1	M	Hope	16-May-02	15.13	1.25-2.5	insect larvae	295
1	M	Hope	16-May-02	15.13	2.5-3.75	insect larvae	87
1	M	Hope	16-May-02	15.13	3.75-5	insect larvae	8
1	M	Hope	16-May-02	15.13	5-6.25	insect larvae	2
1	M	Hope	16-May-02	15.13	6.25-7.5	insect larvae	1
1	M	Hope	16-May-02	15.13	7.5-9	insect larvae	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Araneae	20
2	M	Cassava	21-May-02	28.92	3.75-5	Araneae	10
2	M	Cassava	21-May-02	28.92	7.5-9	Araneae	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Orthoptera	49
2	M	Cassava	21-May-02	28.92	3.75-5	Orthoptera	25
2	M	Cassava	21-May-02	28.92	5-6.25	Orthoptera	11
2	M	Cassava	21-May-02	28.92	6.25-7.5	Orthoptera	17
2	M	Cassava	21-May-02	28.92	7.5-9	Orthoptera	25
2	M	Cassava	21-May-02	28.92	9--10	Orthoptera	1
2	M	Cassava	21-May-02	28.92	10--11	Orthoptera	2
2	M	Cassava	21-May-02	28.92	11--12	Orthoptera	8
2	M	Cassava	21-May-02	28.92	12--13	Orthoptera	1
2	M	Cassava	21-May-02	28.92	13--14	Orthoptera	2
2	M	Cassava	21-May-02	28.92	14--15	Orthoptera	2
2	M	Cassava	21-May-02	28.92	15--16	Orthoptera	1
2	M	Cassava	21-May-02	28.92	16--17	Orthoptera	2
2	M	Cassava	21-May-02	28.92	17--18	Orthoptera	3
2	M	Cassava	21-May-02	28.92	19-20	Orthoptera	1
2	M	Cassava	21-May-02	28.92	21-22	Orthoptera	1
2	M	Cassava	21-May-02	28.92	32-33	Orthoptera	1
2	M	Cassava	21-May-02	28.92	33-34	Orthoptera	1
2	M	Cassava	21-May-02	28.92	34-35	Orthoptera	1
2	M	Cassava	21-May-02	28.92	39-40	Orthoptera	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Blattaria	1
2	M	Cassava	21-May-02	28.92	5-6.25	Blattaria	1
2	M	Cassava	21-May-02	28.92	6.25-7.5	Blattaria	2
2	M	Cassava	21-May-02	28.92	7.5-9	Blattaria	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Isoptera	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Psocoptera	579
2	M	Cassava	21-May-02	28.92	3.75-5	Psocoptera	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Hemiptera	130
2	M	Cassava	21-May-02	28.92	3.75-5	Hemiptera	41

2	M	Cassava	21-May-02	28.92	5-6.25	Hemiptera	9
2	M	Cassava	21-May-02	28.92	6.25-7.5	Hemiptera	2
2	M	Cassava	21-May-02	28.92	7.5-9	Hemiptera	4
2	M	Cassava	21-May-02	28.92	2.5-3.75	Thysanoptera	1
2	M	Cassava	21-May-02	28.92	13--14	Neuroptera	2
2	M	Cassava	21-May-02	28.92	15--16	Neuroptera	1
2	M	Cassava	21-May-02	28.92	16--17	Neuroptera	1
2	M	Cassava	21-May-02	28.92	<1.25	Coleoptera	107
2	M	Cassava	21-May-02	28.92	1.25-2.5	Coleoptera	181
2	M	Cassava	21-May-02	28.92	2.5-3.75	Coleoptera	38
2	M	Cassava	21-May-02	28.92	3.75-5	Coleoptera	16
2	M	Cassava	21-May-02	28.92	5-6.25	Coleoptera	1
2	M	Cassava	21-May-02	28.92	6.25-7.5	Coleoptera	3
2	M	Cassava	21-May-02	28.92	7.5-9	Coleoptera	1
2	M	Cassava	21-May-02	28.92	2.5-3.75	Diptera	170
2	M	Cassava	21-May-02	28.92	3.75-5	Diptera	58
2	M	Cassava	21-May-02	28.92	5-6.25	Diptera	12
2	M	Cassava	21-May-02	28.92	6.25-7.5	Diptera	11
2	M	Cassava	21-May-02	28.92	7.5-9	Diptera	3
2	M	Cassava	21-May-02	28.92	2.5-3.75	Lepidoptera	8
2	M	Cassava	21-May-02	28.92	3.75-5	Lepidoptera	20
2	M	Cassava	21-May-02	28.92	5-6.25	Lepidoptera	2
2	M	Cassava	21-May-02	28.92	6.25-7.5	Lepidoptera	1
2	M	Cassava	21-May-02	28.92	7.5-9	Lepidoptera	2
2	M	Cassava	21-May-02	28.92	2.5-3.75	Formicidae	182
2	M	Cassava	21-May-02	28.92	3.75-5	Formicidae	101
2	M	Cassava	21-May-02	28.92	5-6.25	Formicidae	8
2	M	Cassava	21-May-02	28.92	2.5-3.75	Hymenoptera	28
2	M	Cassava	21-May-02	28.92	3.75-5	Hymenoptera	14
2	M	Cassava	21-May-02	28.92	5-6.25	Hymenoptera	6
2	M	Cassava	21-May-02	28.92	6.25-7.5	Hymenoptera	2
2	M	Cassava	21-May-02	28.92	7.5-9	Hymenoptera	3
2	M	Cassava	21-May-02	28.92	2.5-3.75	insect larvae	18
2	M	Cassava	21-May-02	28.92	3.75-5	insect larvae	17
2	M	Cassava	21-May-02	28.92	5-6.25	insect larvae	13
2	M	Cassava	21-May-02	28.92	6.25-7.5	insect larvae	10
2	M	Cassava	21-May-02	28.92	7.5-9	insect larvae	3
2	M	Cassava	21-May-02	28.92	14--15	insect larvae	1
2	M	Cassava	21-May-02	28.92	15--16	insect larvae	1
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Araneae	24
3	M	Fogarty	22-May-02	15.83	3.75-5	Araneae	11
3	M	Fogarty	22-May-02	15.83	5-6.25	Araneae	2
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Polyxenida	1
3	M	Fogarty	22-May-02	15.83	13--14	Phasmida	1
3	M	Fogarty	22-May-02	15.83	14--15	Phasmida	2
3	M	Fogarty	22-May-02	15.83	31-32	Phasmida	1

3	M	Fogarty	22-May-02	15.83	35-36	Phasmida	1
3	M	Fogarty	22-May-02	15.83	36-37	Phasmida	1
3	M	Fogarty	22-May-02	15.83	37-38	Phasmida	1
3	M	Fogarty	22-May-02	15.83	40-41	Phasmida	1
3	M	Fogarty	22-May-02	15.83	44-45	Phasmida	2
3	M	Fogarty	22-May-02	15.83	47-48	Phasmida	1
3	M	Fogarty	22-May-02	15.83	48-49	Phasmida	1
3	M	Fogarty	22-May-02	15.83	53-54	Phasmida	1
3	M	Fogarty	22-May-02	15.83	54-55	Phasmida	1
3	M	Fogarty	22-May-02	15.83	55-56	Phasmida	2
3	M	Fogarty	22-May-02	15.83	57-58	Phasmida	1
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Orthoptera	54
3	M	Fogarty	22-May-02	15.83	3.75-5	Orthoptera	29
3	M	Fogarty	22-May-02	15.83	5-6.25	Orthoptera	19
3	M	Fogarty	22-May-02	15.83	6.25-7.5	Orthoptera	11
3	M	Fogarty	22-May-02	15.83	7.5-9	Orthoptera	19
3	M	Fogarty	22-May-02	15.83	9--10	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	11--12	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	12--13	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	14--15	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	15-16	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	19-20	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	20-21	Orthoptera	1
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Blattaria	2
3	M	Fogarty	22-May-02	15.83	5-6.25	Blattaria	7
3	M	Fogarty	22-May-02	15.83	6.25-7.5	Blattaria	6
3	M	Fogarty	22-May-02	15.83	7.5-9	Blattaria	5
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Psocoptera	93
3	M	Fogarty	22-May-02	15.83	3.75-5	Psocoptera	1
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Hemiptera	23
3	M	Fogarty	22-May-02	15.83	3.75-5	Hemiptera	8
3	M	Fogarty	22-May-02	15.83	5-6.25	Hemiptera	1
3	M	Fogarty	22-May-02	15.83	6.25-7.5	Hemiptera	1
3	M	Fogarty	22-May-02	15.83	7.5-9	Hemiptera	2
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Thysanoptera	4
3	M	Fogarty	22-May-02	15.83	<1.25	Coleoptera	126
3	M	Fogarty	22-May-02	15.83	1.25-2.5	Coleoptera	199
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Coleoptera	23
3	M	Fogarty	22-May-02	15.83	3.75-5	Coleoptera	18
3	M	Fogarty	22-May-02	15.83	5-6.25	Coleoptera	9
3	M	Fogarty	22-May-02	15.83	6.25-7.5	Coleoptera	6
3	M	Fogarty	22-May-02	15.83	7.5-9	Coleoptera	7
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Diptera	5
3	M	Fogarty	22-May-02	15.83	3.75-5	Diptera	6
3	M	Fogarty	22-May-02	15.83	7.5-9	Diptera	1
3	M	Fogarty	22-May-02	15.83	3.75-5	Trichoptera	1
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Lepidoptera	6

3	M	Fogarty	22-May-02	15.83	3.75-5	Lepidoptera	7
3	M	Fogarty	22-May-02	15.83	5-6.25	Lepidoptera	1
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Formicidae	215
3	M	Fogarty	22-May-02	15.83	3.75-5	Formicidae	186
3	M	Fogarty	22-May-02	15.83	5-6.25	Formicidae	28
3	M	Fogarty	22-May-02	15.83	2.5-3.75	Hymenoptera	33
3	M	Fogarty	22-May-02	15.83	3.75-5	Hymenoptera	3
3	M	Fogarty	22-May-02	15.83	2.5-3.75	insect larvae	5
3	M	Fogarty	22-May-02	15.83	3.75-5	insect larvae	1
3	M	Fogarty	22-May-02	15.83	5-6.25	insect larvae	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Araneae	62
4	M	Underwood	23-May-02	8.35	3.75-5	Araneae	20
4	M	Underwood	23-May-02	8.35	5-6.25	Araneae	8
4	M	Underwood	23-May-02	8.35	7.5-9	Araneae	2
4	M	Underwood	23-May-02	8.35	2.5-3.75	Polyxenida	6
4	M	Underwood	23-May-02	8.35	5-6.25	Microcoryphia	1
4	M	Underwood	23-May-02	8.35	7.5-9	Microcoryphia	2
4	M	Underwood	23-May-02	8.35	26-27	Phasmida	1
4	M	Underwood	23-May-02	8.35	30-31	Phasmida	1
4	M	Underwood	23-May-02	8.35	38-39	Phasmida	1
4	M	Underwood	23-May-02	8.35	39-40	Phasmida	1
4	M	Underwood	23-May-02	8.35	46-47	Phasmida	1
4	M	Underwood	23-May-02	8.35	54-55	Phasmida	1
4	M	Underwood	23-May-02	8.35	59-60	Phasmida	1
4	M	Underwood	23-May-02	8.35	61-62	Phasmida	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Orthoptera	47
4	M	Underwood	23-May-02	8.35	3.75-5	Orthoptera	36
4	M	Underwood	23-May-02	8.35	5-6.25	Orthoptera	39
4	M	Underwood	23-May-02	8.35	6.25-7.5	Orthoptera	41
4	M	Underwood	23-May-02	8.35	7.5-9	Orthoptera	30
4	M	Underwood	23-May-02	8.35	9--10	Orthoptera	1
4	M	Underwood	23-May-02	8.35	10--11	Orthoptera	1
4	M	Underwood	23-May-02	8.35	13--14	Orthoptera	2
4	M	Underwood	23-May-02	8.35	15--16	Orthoptera	2
4	M	Underwood	23-May-02	8.35	24-25	Orthoptera	1
4	M	Underwood	23-May-02	8.35	43-44	Orthoptera	1
4	M	Underwood	23-May-02	8.35	46-47	Orthoptera	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Blattaria	1
4	M	Underwood	23-May-02	8.35	5-6.25	Blattaria	1
4	M	Underwood	23-May-02	8.35	7.5-9	Blattaria	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Isoptera	20
4	M	Underwood	23-May-02	8.35	3.75-5	Isoptera	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Psocoptera	11
4	M	Underwood	23-May-02	8.35	2.5-3.75	Hemiptera	39
4	M	Underwood	23-May-02	8.35	3.75-5	Hemiptera	11
4	M	Underwood	23-May-02	8.35	5-6.25	Hemiptera	3

4	M	Underwood	23-May-02	8.35	6.25-7.5	Hemiptera	3
4	M	Underwood	23-May-02	8.35	7.5-9	Hemiptera	5
4	M	Underwood	23-May-02	8.35	2.5-3.75	Thysanoptera	6
4	M	Underwood	23-May-02	8.35	3.75-5	Thysanoptera	1
4	M	Underwood	23-May-02	8.35	<1.25	Coleoptera	33
4	M	Underwood	23-May-02	8.35	1.25-2.5	Coleoptera	69
4	M	Underwood	23-May-02	8.35	2.5-3.75	Coleoptera	10
4	M	Underwood	23-May-02	8.35	3.75-5	Coleoptera	20
4	M	Underwood	23-May-02	8.35	5-6.25	Coleoptera	9
4	M	Underwood	23-May-02	8.35	6.25-7.5	Coleoptera	18
4	M	Underwood	23-May-02	8.35	7.5-9	Coleoptera	68
4	M	Underwood	23-May-02	8.35	2.5-3.75	Diptera	18
4	M	Underwood	23-May-02	8.35	5-6.25	Diptera	2
4	M	Underwood	23-May-02	8.35	6.25-7.5	Diptera	1
4	M	Underwood	23-May-02	8.35	7.5-9	Diptera	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Lepidoptera	3
4	M	Underwood	23-May-02	8.35	3.75-5	Lepidoptera	4
4	M	Underwood	23-May-02	8.35	5-6.25	Lepidoptera	1
4	M	Underwood	23-May-02	8.35	7.5-9	Lepidoptera	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	Formicidae	364
4	M	Underwood	23-May-02	8.35	3.75-5	Formicidae	73
4	M	Underwood	23-May-02	8.35	5-6.25	Formicidae	11
4	M	Underwood	23-May-02	8.35	6.25-7.5	Formicidae	5
4	M	Underwood	23-May-02	8.35	2.5-3.75	Hymenoptera	15
4	M	Underwood	23-May-02	8.35	3.75-5	Hymenoptera	4
4	M	Underwood	23-May-02	8.35	5-6.25	Hymenoptera	1
4	M	Underwood	23-May-02	8.35	7.5-9	Hymenoptera	1
4	M	Underwood	23-May-02	8.35	2.5-3.75	insect larvae	2
4	M	Underwood	23-May-02	8.35	3.75-5	insect larvae	1
4	M	Underwood	23-May-02	8.35	6.25-7.5	insect larvae	1
4	M	Underwood	23-May-02	8.35	7.5-9	insect larvae	1
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Araneae	59
5	M	Hope	19-Jun-02	77.43	3.75-5	Araneae	25
5	M	Hope	19-Jun-02	77.43	5-6.25	Araneae	12
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Araneae	2
5	M	Hope	19-Jun-02	77.43	7.5-9	Araneae	1
5	M	Hope	19-Jun-02	77.43	16-17	Phasmida	1
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Orthoptera	7
5	M	Hope	19-Jun-02	77.43	3.75-5	Orthoptera	17
5	M	Hope	19-Jun-02	77.43	5-6.25	Orthoptera	25
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Orthoptera	14
5	M	Hope	19-Jun-02	77.43	7.5-9	Orthoptera	9
5	M	Hope	19-Jun-02	77.43	9--10	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	10--11	Orthoptera	6
5	M	Hope	19-Jun-02	77.43	11--12	Orthoptera	3
5	M	Hope	19-Jun-02	77.43	12--13	Orthoptera	2

5	M	Hope	19-Jun-02	77.43	13--14	Orthoptera	2
5	M	Hope	19-Jun-02	77.43	14--15	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	15-16	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	16-17	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	19-20	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	20-21	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	29-30	Orthoptera	1
5	M	Hope	19-Jun-02	77.43	5-6.25	Blattaria	3
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Blattaria	2
5	M	Hope	19-Jun-02	77.43	14--15	Blattaria	2
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Isoptera	1
5	M	Hope	19-Jun-02	77.43	5-6.25	Isoptera	1
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Isoptera	1
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Psocoptera	787
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Hemiptera	22
5	M	Hope	19-Jun-02	77.43	3.75-5	Hemiptera	11
5	M	Hope	19-Jun-02	77.43	5-6.25	Hemiptera	3
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Hemiptera	1
5	M	Hope	19-Jun-02	77.43	7.5-9	Hemiptera	1
5	M	Hope	19-Jun-02	77.43	10--11	Hemiptera	1
5	M	Hope	19-Jun-02	77.43	14--15	Neuroptera	2
5	M	Hope	19-Jun-02	77.43	16-17	Neuroptera	1
5	M	Hope	19-Jun-02	77.43	<1.25	Coleoptera	85
5	M	Hope	19-Jun-02	77.43	1.25-2.5	Coleoptera	303
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Coleoptera	83
5	M	Hope	19-Jun-02	77.43	3.75-5	Coleoptera	10
5	M	Hope	19-Jun-02	77.43	5-6.25	Coleoptera	3
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Coleoptera	16
5	M	Hope	19-Jun-02	77.43	7.5-9	Coleoptera	35
5	M	Hope	19-Jun-02	77.43	9--10	Coleoptera	13
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Diptera	48
5	M	Hope	19-Jun-02	77.43	3.75-5	Diptera	35
5	M	Hope	19-Jun-02	77.43	5-6.25	Diptera	11
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Diptera	9
5	M	Hope	19-Jun-02	77.43	7.5-9	Diptera	5
5	M	Hope	19-Jun-02	77.43	9--10	Diptera	1
5	M	Hope	19-Jun-02	77.43	10--11	Diptera	3
5	M	Hope	19-Jun-02	77.43	12--13	Diptera	1
5	M	Hope	19-Jun-02	77.43	15-16	Diptera	1
5	M	Hope	19-Jun-02	77.43	3.75-5	Trichoptera	1
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Lepidoptera	32
5	M	Hope	19-Jun-02	77.43	3.75-5	Lepidoptera	70
5	M	Hope	19-Jun-02	77.43	5-6.25	Lepidoptera	8
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Lepidoptera	1
5	M	Hope	19-Jun-02	77.43	7.5-9	Lepidoptera	2
5	M	Hope	19-Jun-02	77.43	12--13	Lepidoptera	1
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Formicidae	355

5	M	Hope	19-Jun-02	77.43	3.75-5	Formicidae	254
5	M	Hope	19-Jun-02	77.43	5-6.25	Formicidae	51
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Formicidae	3
5	M	Hope	19-Jun-02	77.43	2.5-3.75	Hymenoptera	54
5	M	Hope	19-Jun-02	77.43	3.75-5	Hymenoptera	18
5	M	Hope	19-Jun-02	77.43	5-6.25	Hymenoptera	1
5	M	Hope	19-Jun-02	77.43	6.25-7.5	Hymenoptera	4
5	M	Hope	19-Jun-02	77.43	7.5-9	Hymenoptera	5
5	M	Hope	19-Jun-02	77.43	2.5-3.75	insect larvae	13
5	M	Hope	19-Jun-02	77.43	3.75-5	insect larvae	2
5	M	Hope	19-Jun-02	77.43	5-6.25	insect larvae	1

6	M	Fogarty	21-Jun-02	23.7	<1.25	Acari	281
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Acari	3
6	M	Fogarty	21-Jun-02	23.7	<1.25	Araneae	43
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Araneae	38
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Araneae	13
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Araneae	6
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Araneae	2
6	M	Fogarty	21-Jun-02	23.7	<1.25	Polyxenida	1
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Polyxenida	3
6	M	Fogarty	21-Jun-02	23.7	>1.25	Collembola	29
6	M	Fogarty	21-Jun-02	23.7	21-22	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	24-25	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	26-27	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	30-31	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	31-32	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	38-39	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	47-48	Phasmida	2
6	M	Fogarty	21-Jun-02	23.7	55-56	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	58-59	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	60-61	Phasmida	1
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Orthoptera	22
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Orthoptera	35
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Orthoptera	11
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Orthoptera	11
6	M	Fogarty	21-Jun-02	23.7	6.25-7.5	Orthoptera	6
6	M	Fogarty	21-Jun-02	23.7	7.5-9	Orthoptera	13
6	M	Fogarty	21-Jun-02	23.7	9--10	Orthoptera	2
6	M	Fogarty	21-Jun-02	23.7	10--11	Orthoptera	2
6	M	Fogarty	21-Jun-02	23.7	11--12	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	12--13	Orthoptera	4
6	M	Fogarty	21-Jun-02	23.7	13--14	Orthoptera	2
6	M	Fogarty	21-Jun-02	23.7	14--15	Orthoptera	2
6	M	Fogarty	21-Jun-02	23.7	15--16	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	16--17	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	18-19	Orthoptera	2

6	M	Fogarty	21-Jun-02	23.7	20-21	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	23-24	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	30-31	Orthoptera	3
6	M	Fogarty	21-Jun-02	23.7	31-32	Orthoptera	2
6	M	Fogarty	21-Jun-02	23.7	32-33	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	34-35	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	35-36	Orthoptera	3
6	M	Fogarty	21-Jun-02	23.7	41-42	Orthoptera	1
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Blattaria	4
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Blattaria	5
6	M	Fogarty	21-Jun-02	23.7	6.25-7.5	Blattaria	2
6	M	Fogarty	21-Jun-02	23.7	7.5-9	Blattaria	4
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Isoptera	4
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Isoptera	34
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Isoptera	10
6	M	Fogarty	21-Jun-02	23.7	<1.25	Psocoptera	108
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Psocoptera	131
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Psocoptera	85
6	M	Fogarty	21-Jun-02	23.7	<1.25	Hemiptera	8
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Hemiptera	65
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Hemiptera	49
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Hemiptera	19
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Hemiptera	3
6	M	Fogarty	21-Jun-02	23.7	6.25-7.5	Hemiptera	3
6	M	Fogarty	21-Jun-02	23.7	7.5-9	Hemiptera	1
6	M	Fogarty	21-Jun-02	23.7	22-23	Hemiptera	1
6	M	Fogarty	21-Jun-02	23.7	<1.25	Thysanoptera	25
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Thysanoptera	23
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Thysanoptera	1
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Neuroptera	2
6	M	Fogarty	21-Jun-02	23.7	<1.25	Coleoptera	42
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Coleoptera	87
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Coleoptera	17
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Coleoptera	9
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Coleoptera	3
6	M	Fogarty	21-Jun-02	23.7	6.25-7.5	Coleoptera	2
6	M	Fogarty	21-Jun-02	23.7	7.5-9	Coleoptera	6
6	M	Fogarty	21-Jun-02	23.7	9--10	Coleoptera	2
6	M	Fogarty	21-Jun-02	23.7	<1.25	Diptera	16
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Diptera	23
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Diptera	3
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Diptera	3
6	M	Fogarty	21-Jun-02	23.7	<1.25	Lepidoptera	1
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Lepidoptera	1
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Lepidoptera	8
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Lepidoptera	2
6	M	Fogarty	21-Jun-02	23.7	<1.25	Formicidae	131

6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Formicidae	493
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Formicidae	110
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Formicidae	42
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Formicidae	5
6	M	Fogarty	21-Jun-02	23.7	6.25-7.5	Formicidae	3
6	M	Fogarty	21-Jun-02	23.7	<1.25	Hymenoptera	67
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	Hymenoptera	80
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	Hymenoptera	10
6	M	Fogarty	21-Jun-02	23.7	3.75-5	Hymenoptera	5
6	M	Fogarty	21-Jun-02	23.7	5-6.25	Hymenoptera	3
6	M	Fogarty	21-Jun-02	23.7	<1.25	insect larvae	8
6	M	Fogarty	21-Jun-02	23.7	1.25-2.5	insect larvae	18
6	M	Fogarty	21-Jun-02	23.7	2.5-3.75	insect larvae	4
6	M	Fogarty	21-Jun-02	23.7	3.75-5	insect larvae	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Araneae	23
7	M	Underwood	24-Jun-02	33.03	3.75-5	Araneae	7
7	M	Underwood	24-Jun-02	33.03	5-6.25	Araneae	3
7	M	Underwood	24-Jun-02	33.03	6.25-7.5	Araneae	1
7	M	Underwood	24-Jun-02	33.03	7.5-9	Araneae	1
7	M	Underwood	24-Jun-02	33.03	12--13	Julida	1
7	M	Underwood	24-Jun-02	33.03	13--14	Julida	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Polyxenida	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Orthoptera	35
7	M	Underwood	24-Jun-02	33.03	3.75-5	Orthoptera	23
7	M	Underwood	24-Jun-02	33.03	5-6.25	Orthoptera	3
7	M	Underwood	24-Jun-02	33.03	6.25-7.5	Orthoptera	8
7	M	Underwood	24-Jun-02	33.03	7.5-9	Orthoptera	9
7	M	Underwood	24-Jun-02	33.03	14--15	Orthoptera	1
7	M	Underwood	24-Jun-02	33.03	30-31	Orthoptera	2
7	M	Underwood	24-Jun-02	33.03	32-33	Orthoptera	1
7	M	Underwood	24-Jun-02	33.03	35-36	Orthoptera	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Blattaria	2
7	M	Underwood	24-Jun-02	33.03	3.75-5	Blattaria	2
7	M	Underwood	24-Jun-02	33.03	5-6.25	Blattaria	2
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Isoptera	2
7	M	Underwood	24-Jun-02	33.03	3.75-5	Isoptera	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Dermaptera	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Psocoptera	59
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Hemiptera	15
7	M	Underwood	24-Jun-02	33.03	3.75-5	Hemiptera	6
7	M	Underwood	24-Jun-02	33.03	5-6.25	Hemiptera	1
7	M	Underwood	24-Jun-02	33.03	6.25-7.5	Hemiptera	1
7	M	Underwood	24-Jun-02	33.03	7.5-9	Hemiptera	2
7	M	Underwood	24-Jun-02	33.03	9--10	Hemiptera	2
7	M	Underwood	24-Jun-02	33.03	<1.25	Coleoptera	7
7	M	Underwood	24-Jun-02	33.03	1.25-2.5	Coleoptera	33

7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Coleoptera	11
7	M	Underwood	24-Jun-02	33.03	3.75-5	Coleoptera	3
7	M	Underwood	24-Jun-02	33.03	5-6.25	Coleoptera	3
7	M	Underwood	24-Jun-02	33.03	7.5-9	Coleoptera	16
7	M	Underwood	24-Jun-02	33.03	9--10	Coleoptera	4
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Diptera	13
7	M	Underwood	24-Jun-02	33.03	3.75-5	Diptera	1
7	M	Underwood	24-Jun-02	33.03	5-6.25	Diptera	2
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Trichoptera	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Lepidoptera	1
7	M	Underwood	24-Jun-02	33.03	3.75-5	Lepidoptera	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Formicidae	480
7	M	Underwood	24-Jun-02	33.03	3.75-5	Formicidae	66
7	M	Underwood	24-Jun-02	33.03	5-6.25	Formicidae	17
7	M	Underwood	24-Jun-02	33.03	6.25-7.5	Formicidae	7
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	Hymenoptera	3
7	M	Underwood	24-Jun-02	33.03	3.75-5	Hymenoptera	1
7	M	Underwood	24-Jun-02	33.03	2.5-3.75	insect larvae	2
7	M	Underwood	24-Jun-02	33.03	5-6.25	insect larvae	1
7	M	Underwood	24-Jun-02	33.03	13--14	insect larvae	1

8	M	Hope	16-Jul-02	78.59	2.5-3.75	Araneae	69
8	M	Hope	16-Jul-02	78.59	3.75-5	Araneae	53
8	M	Hope	16-Jul-02	78.59	5-6.25	Araneae	18
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Araneae	3
8	M	Hope	16-Jul-02	78.59	7.5-9	Araneae	3
8	M	Hope	16-Jul-02	78.59	9--10	Araneae	1
8	M	Hope	16-Jul-02	78.59	10--11	Araneae	1
8	M	Hope	16-Jul-02	78.59	13--14	Phasmida	1
8	M	Hope	16-Jul-02	78.59	15-16	Phasmida	1
8	M	Hope	16-Jul-02	78.59	16-17	Phasmida	1
8	M	Hope	16-Jul-02	78.59	17-18	Phasmida	2
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Orthoptera	35
8	M	Hope	16-Jul-02	78.59	3.75-5	Orthoptera	42
8	M	Hope	16-Jul-02	78.59	5-6.25	Orthoptera	41
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Orthoptera	15
8	M	Hope	16-Jul-02	78.59	7.5-9	Orthoptera	8
8	M	Hope	16-Jul-02	78.59	9--10	Orthoptera	7
8	M	Hope	16-Jul-02	78.59	10--11	Orthoptera	4
8	M	Hope	16-Jul-02	78.59	11--12	Orthoptera	1
8	M	Hope	16-Jul-02	78.59	12--13	Orthoptera	5
8	M	Hope	16-Jul-02	78.59	15-16	Orthoptera	2
8	M	Hope	16-Jul-02	78.59	17-18	Orthoptera	3
8	M	Hope	16-Jul-02	78.59	20-21	Orthoptera	1
8	M	Hope	16-Jul-02	78.59	21-22	Orthoptera	1
8	M	Hope	16-Jul-02	78.59	39-40	Orthoptera	1
8	M	Hope	16-Jul-02	78.59	40-41	Orthoptera	1

8	M	Hope	16-Jul-02	78.59	43-44	Orthoptera	2
8	M	Hope	16-Jul-02	78.59	56-57	Orthoptera	1
8	M	Hope	16-Jul-02	78.59	5-6.25	Blattaria	4
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Blattaria	1
8	M	Hope	16-Jul-02	78.59	7.5-9	Blattaria	1
8	M	Hope	16-Jul-02	78.59	12--13	Blattaria	1
8	M	Hope	16-Jul-02	78.59	13--14	Blattaria	1
8	M	Hope	16-Jul-02	78.59	23-24	Blattaria	1
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Isoptera	1
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Psocoptera	2154
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Hemiptera	9
8	M	Hope	16-Jul-02	78.59	3.75-5	Hemiptera	12
8	M	Hope	16-Jul-02	78.59	5-6.25	Hemiptera	1
8	M	Hope	16-Jul-02	78.59	9--10	Hemiptera	1
8	M	Hope	16-Jul-02	78.59	11--12	Hemiptera	2
8	M	Hope	16-Jul-02	78.59	12--13	Neuroptera	2
8	M	Hope	16-Jul-02	78.59	14--15	Neuroptera	1
8	M	Hope	16-Jul-02	78.59	16-17	Neuroptera	1
8	M	Hope	16-Jul-02	78.59	17-18	Neuroptera	1
8	M	Hope	16-Jul-02	78.59	<1.25	Coleoptera	66
8	M	Hope	16-Jul-02	78.59	1.25-2.5	Coleoptera	251
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Coleoptera	80
8	M	Hope	16-Jul-02	78.59	3.75-5	Coleoptera	17
8	M	Hope	16-Jul-02	78.59	5-6.25	Coleoptera	3
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Coleoptera	15
8	M	Hope	16-Jul-02	78.59	7.5-9	Coleoptera	49
8	M	Hope	16-Jul-02	78.59	9--10	Coleoptera	11
8	M	Hope	16-Jul-02	78.59	10--11	Coleoptera	1
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Diptera	68
8	M	Hope	16-Jul-02	78.59	3.75-5	Diptera	16
8	M	Hope	16-Jul-02	78.59	5-6.25	Diptera	5
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Diptera	2
8	M	Hope	16-Jul-02	78.59	7.5-9	Diptera	8
8	M	Hope	16-Jul-02	78.59	9--10	Diptera	6
8	M	Hope	16-Jul-02	78.59	10--11	Diptera	12
8	M	Hope	16-Jul-02	78.59	11--12	Diptera	3
8	M	Hope	16-Jul-02	78.59	14--15	Diptera	1
8	M	Hope	16-Jul-02	78.59	18-19	Diptera	1
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Lepidoptera	12
8	M	Hope	16-Jul-02	78.59	3.75-5	Lepidoptera	24
8	M	Hope	16-Jul-02	78.59	5-6.25	Lepidoptera	1
8	M	Hope	16-Jul-02	78.59	7.5-9	Lepidoptera	1
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Formicidae	235
8	M	Hope	16-Jul-02	78.59	3.75-5	Formicidae	224
8	M	Hope	16-Jul-02	78.59	5-6.25	Formicidae	33
8	M	Hope	16-Jul-02	78.59	7.5-9	Formicidae	8
8	M	Hope	16-Jul-02	78.59	9--10	Formicidae	9

8	M	Hope	16-Jul-02	78.59	10--11	Formicidae	3
8	M	Hope	16-Jul-02	78.59	2.5-3.75	Hymenoptera	34
8	M	Hope	16-Jul-02	78.59	3.75-5	Hymenoptera	12
8	M	Hope	16-Jul-02	78.59	5-6.25	Hymenoptera	9
8	M	Hope	16-Jul-02	78.59	6.25-7.5	Hymenoptera	6
8	M	Hope	16-Jul-02	78.59	7.5-9	Hymenoptera	2
8	M	Hope	16-Jul-02	78.59	10--11	Hymenoptera	1
8	M	Hope	16-Jul-02	78.59	19-20	Hymenoptera	1
8	M	Hope	16-Jul-02	78.59	2.5-3.75	insect larvae	6
8	M	Hope	16-Jul-02	78.59	3.75-5	insect larvae	4
8	M	Hope	16-Jul-02	78.59	5-6.25	insect larvae	2
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Araneae	11
9	M	Cassava	18-Jul-02	98.86	3.75-5	Araneae	19
9	M	Cassava	18-Jul-02	98.86	5-6.25	Araneae	4
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Orthoptera	21
9	M	Cassava	18-Jul-02	98.86	3.75-5	Orthoptera	15
9	M	Cassava	18-Jul-02	98.86	5-6.25	Orthoptera	11
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Orthoptera	13
9	M	Cassava	18-Jul-02	98.86	7.5-9	Orthoptera	21
9	M	Cassava	18-Jul-02	98.86	9--10	Orthoptera	6
9	M	Cassava	18-Jul-02	98.86	10--11	Orthoptera	4
9	M	Cassava	18-Jul-02	98.86	11--12	Orthoptera	4
9	M	Cassava	18-Jul-02	98.86	12--13	Orthoptera	3
9	M	Cassava	18-Jul-02	98.86	13--14	Orthoptera	3
9	M	Cassava	18-Jul-02	98.86	16-17	Orthoptera	1
9	M	Cassava	18-Jul-02	98.86	17-18	Orthoptera	3
9	M	Cassava	18-Jul-02	98.86	18-19	Orthoptera	1
9	M	Cassava	18-Jul-02	98.86	29-30	Orthoptera	3
9	M	Cassava	18-Jul-02	98.86	30-31	Orthoptera	2
9	M	Cassava	18-Jul-02	98.86	34-35	Orthoptera	1
9	M	Cassava	18-Jul-02	98.86	38-39	Orthoptera	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Blattaria	1
9	M	Cassava	18-Jul-02	98.86	3.75-5	Blattaria	1
9	M	Cassava	18-Jul-02	98.86	5-6.25	Blattaria	2
9	M	Cassava	18-Jul-02	98.86	10--11	Blattaria	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Dermaptera	2
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Psocoptera	127
9	M	Cassava	18-Jul-02	98.86	3.75-5	Psocoptera	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Hemiptera	76
9	M	Cassava	18-Jul-02	98.86	3.75-5	Hemiptera	16
9	M	Cassava	18-Jul-02	98.86	5-6.25	Hemiptera	13
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Hemiptera	3
9	M	Cassava	18-Jul-02	98.86	7.5-9	Hemiptera	4
9	M	Cassava	18-Jul-02	98.86	9--10	Hemiptera	5
9	M	Cassava	18-Jul-02	98.86	7.5-9	Neuroptera	1
9	M	Cassava	18-Jul-02	98.86	11--12	Neuroptera	1

9	M	Cassava	18-Jul-02	98.86	12--13	Neuroptera	5
9	M	Cassava	18-Jul-02	98.86	13--14	Neuroptera	21
9	M	Cassava	18-Jul-02	98.86	14--15	Neuroptera	14
9	M	Cassava	18-Jul-02	98.86	15-16	Neuroptera	1
9	M	Cassava	18-Jul-02	98.86	16-17	Neuroptera	1
9	M	Cassava	18-Jul-02	98.86	<1.25	Coleoptera	25
9	M	Cassava	18-Jul-02	98.86	1.25-2.5	Coleoptera	126
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Coleoptera	17
9	M	Cassava	18-Jul-02	98.86	3.75-5	Coleoptera	6
9	M	Cassava	18-Jul-02	98.86	5-6.25	Coleoptera	4
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Coleoptera	2
9	M	Cassava	18-Jul-02	98.86	7.5-9	Coleoptera	6
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Diptera	76
9	M	Cassava	18-Jul-02	98.86	3.75-5	Diptera	26
9	M	Cassava	18-Jul-02	98.86	5-6.25	Diptera	11
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Diptera	7
9	M	Cassava	18-Jul-02	98.86	7.5-9	Diptera	7
9	M	Cassava	18-Jul-02	98.86	9--10	Diptera	3
9	M	Cassava	18-Jul-02	98.86	10--11	Diptera	2
9	M	Cassava	18-Jul-02	98.86	11--12	Diptera	1
9	M	Cassava	18-Jul-02	98.86	12--13	Diptera	1
9	M	Cassava	18-Jul-02	98.86	15-16	Diptera	1
9	M	Cassava	18-Jul-02	98.86	16-17	Diptera	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Trichoptera	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Lepidoptera	30
9	M	Cassava	18-Jul-02	98.86	3.75-5	Lepidoptera	45
9	M	Cassava	18-Jul-02	98.86	5-6.25	Lepidoptera	9
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Lepidoptera	3
9	M	Cassava	18-Jul-02	98.86	7.5-9	Lepidoptera	5
9	M	Cassava	18-Jul-02	98.86	9--10	Lepidoptera	3
9	M	Cassava	18-Jul-02	98.86	10--11	Lepidoptera	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Formicidae	125
9	M	Cassava	18-Jul-02	98.86	3.75-5	Formicidae	77
9	M	Cassava	18-Jul-02	98.86	5-6.25	Formicidae	12
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Formicidae	1
9	M	Cassava	18-Jul-02	98.86	7.5-9	Formicidae	1
9	M	Cassava	18-Jul-02	98.86	9--10	Formicidae	1
9	M	Cassava	18-Jul-02	98.86	10--11	Formicidae	2
9	M	Cassava	18-Jul-02	98.86	11--12	Formicidae	1
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	Hymenoptera	18
9	M	Cassava	18-Jul-02	98.86	3.75-5	Hymenoptera	9
9	M	Cassava	18-Jul-02	98.86	5-6.25	Hymenoptera	5
9	M	Cassava	18-Jul-02	98.86	6.25-7.5	Hymenoptera	2
9	M	Cassava	18-Jul-02	98.86	7.5-9	Hymenoptera	5
9	M	Cassava	18-Jul-02	98.86	2.5-3.75	insect larvae	20
9	M	Cassava	18-Jul-02	98.86	3.75-5	insect larvae	47
9	M	Cassava	18-Jul-02	98.86	5-6.25	insect larvae	10

9	M	Cassava	18-Jul-02	98.86	6.25-7.5	insect larvae	2
9	M	Cassava	18-Jul-02	98.86	7.5-9	insect larvae	1
9	M	Cassava	18-Jul-02	98.86	12--13	insect larvae	1
9	M	Cassava	18-Jul-02	98.86	16-17	insect larvae	1
9	M	Cassava	18-Jul-02	98.86	28-29	insect larvae	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Araneae	46
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Araneae	19
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Araneae	2
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Araneae	2
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Araneae	2
10	M	Fogarty	19-Jul-02	25.24	14--15	Phasmida	1
10	M	Fogarty	19-Jul-02	25.24	48-49	Phasmida	4
10	M	Fogarty	19-Jul-02	25.24	54-55	Phasmida	4
10	M	Fogarty	19-Jul-02	25.24	56-57	Phasmida	3
10	M	Fogarty	19-Jul-02	25.24	58-59	Phasmida	1
10	M	Fogarty	19-Jul-02	25.24	60-61	Phasmida	1
10	M	Fogarty	19-Jul-02	25.24	66-67	Phasmida	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Orthoptera	55
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Orthoptera	34
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Orthoptera	21
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Orthoptera	20
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Orthoptera	41
10	M	Fogarty	19-Jul-02	25.24	9--10	Orthoptera	7
10	M	Fogarty	19-Jul-02	25.24	10--11	Orthoptera	3
10	M	Fogarty	19-Jul-02	25.24	11--12	Orthoptera	2
10	M	Fogarty	19-Jul-02	25.24	12--13	Orthoptera	3
10	M	Fogarty	19-Jul-02	25.24	15-16	Orthoptera	4
10	M	Fogarty	19-Jul-02	25.24	16-17	Orthoptera	1
10	M	Fogarty	19-Jul-02	25.24	17-18	Orthoptera	2
10	M	Fogarty	19-Jul-02	25.24	18-19	Orthoptera	1
10	M	Fogarty	19-Jul-02	25.24	19-20	Orthoptera	2
10	M	Fogarty	19-Jul-02	25.24	21-22	Orthoptera	2
10	M	Fogarty	19-Jul-02	25.24	30-31	Orthoptera	2
10	M	Fogarty	19-Jul-02	25.24	33-34	Orthoptera	1
10	M	Fogarty	19-Jul-02	25.24	43-44	Orthoptera	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Blattaria	9
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Blattaria	8
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Blattaria	11
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Blattaria	10
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Blattaria	8
10	M	Fogarty	19-Jul-02	25.24	10--11	Blattaria	1
10	M	Fogarty	19-Jul-02	25.24	11--12	Blattaria	1
10	M	Fogarty	19-Jul-02	25.24	14--15	Blattaria	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Isoptera	33
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Isoptera	4
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Isoptera	1

10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Psocoptera	1082
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Hemiptera	111
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Hemiptera	36
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Hemiptera	2
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Hemiptera	12
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Hemiptera	7
10	M	Fogarty	19-Jul-02	25.24	14--15	Neuroptera	1
10	M	Fogarty	19-Jul-02	25.24	16-17	Neuroptera	1
10	M	Fogarty	19-Jul-02	25.24	<1.25	Coleoptera	95
10	M	Fogarty	19-Jul-02	25.24	1.25-2.5	Coleoptera	500
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Coleoptera	105
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Coleoptera	51
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Coleoptera	15
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Coleoptera	18
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Coleoptera	46
10	M	Fogarty	19-Jul-02	25.24	9--10	Coleoptera	3
10	M	Fogarty	19-Jul-02	25.24	12--13	Coleoptera	2
10	M	Fogarty	19-Jul-02	25.24	14--15	Coleoptera	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Diptera	66
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Diptera	25
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Diptera	3
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Diptera	2
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Diptera	14
10	M	Fogarty	19-Jul-02	25.24	9--10	Diptera	2
10	M	Fogarty	19-Jul-02	25.24	10--11	Diptera	7
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Lepidoptera	280
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Lepidoptera	12
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Lepidoptera	5
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Lepidoptera	2
10	M	Fogarty	19-Jul-02	25.24	9--10	Lepidoptera	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Formicidae	419
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Formicidae	471
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Formicidae	34
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Formicidae	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	Hymenoptera	56
10	M	Fogarty	19-Jul-02	25.24	3.75-5	Hymenoptera	23
10	M	Fogarty	19-Jul-02	25.24	5-6.25	Hymenoptera	6
10	M	Fogarty	19-Jul-02	25.24	6.25-7.5	Hymenoptera	2
10	M	Fogarty	19-Jul-02	25.24	7.5-9	Hymenoptera	3
10	M	Fogarty	19-Jul-02	25.24	10--11	Hymenoptera	1
10	M	Fogarty	19-Jul-02	25.24	11--12	Hymenoptera	1
10	M	Fogarty	19-Jul-02	25.24	2.5-3.75	insect larvae	1
10	M	Fogarty	19-Jul-02	25.24	3.75-5	insect larvae	8
10	M	Fogarty	19-Jul-02	25.24	7.5-9	insect larvae	1
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Araneae	34
11	M	Underwood	22-Jul-02	49.35	3.75-5	Araneae	6

11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Polyxenida	1
11	M	Underwood	22-Jul-02	49.35	39-40	Phasmida	1
11	M	Underwood	22-Jul-02	49.35	56-57	Phasmida	1
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Orthoptera	18
11	M	Underwood	22-Jul-02	49.35	3.75-5	Orthoptera	5
11	M	Underwood	22-Jul-02	49.35	5-6.25	Orthoptera	9
11	M	Underwood	22-Jul-02	49.35	6.25-7.5	Orthoptera	17
11	M	Underwood	22-Jul-02	49.35	7.5-9	Orthoptera	16
11	M	Underwood	22-Jul-02	49.35	30-31	Orthoptera	1
11	M	Underwood	22-Jul-02	49.35	32-33	Orthoptera	1
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Blattaria	2
11	M	Underwood	22-Jul-02	49.35	5-6.25	Blattaria	2
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Isoptera	155
11	M	Underwood	22-Jul-02	49.35	3.75-5	Isoptera	13
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Dermaptera	3
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Psocoptera	107
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Hemiptera	37
11	M	Underwood	22-Jul-02	49.35	3.75-5	Hemiptera	4
11	M	Underwood	22-Jul-02	49.35	5-6.25	Hemiptera	1
11	M	Underwood	22-Jul-02	49.35	6.25-7.5	Hemiptera	1
11	M	Underwood	22-Jul-02	49.35	7.5-9	Hemiptera	2
11	M	Underwood	22-Jul-02	49.35	12--13	Hemiptera	1
11	M	Underwood	22-Jul-02	49.35	<1.25	Coleoptera	27
11	M	Underwood	22-Jul-02	49.35	1.25-2.5	Coleoptera	88
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Coleoptera	16
11	M	Underwood	22-Jul-02	49.35	3.75-5	Coleoptera	16
11	M	Underwood	22-Jul-02	49.35	5-6.25	Coleoptera	1
11	M	Underwood	22-Jul-02	49.35	7.5-9	Coleoptera	9
11	M	Underwood	22-Jul-02	49.35	14--15	Coleoptera	1
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Diptera	8
11	M	Underwood	22-Jul-02	49.35	3.75-5	Diptera	1
11	M	Underwood	22-Jul-02	49.35	5-6.25	Diptera	1
11	M	Underwood	22-Jul-02	49.35	6.25-7.5	Diptera	1
11	M	Underwood	22-Jul-02	49.35	7.5-9	Diptera	1
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Lepidoptera	18
11	M	Underwood	22-Jul-02	49.35	3.75-5	Lepidoptera	4
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Formicidae	418
11	M	Underwood	22-Jul-02	49.35	3.75-5	Formicidae	70
11	M	Underwood	22-Jul-02	49.35	5-6.25	Formicidae	9
11	M	Underwood	22-Jul-02	49.35	6.25-7.5	Formicidae	5
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	Hymenoptera	12
11	M	Underwood	22-Jul-02	49.35	3.75-5	Hymenoptera	2
11	M	Underwood	22-Jul-02	49.35	7.5-9	Hymenoptera	1
11	M	Underwood	22-Jul-02	49.35	2.5-3.75	insect larvae	1
11	M	Underwood	22-Jul-02	49.35	5-6.25	insect larvae	1
11	M	Underwood	22-Jul-02	49.35	7.5-9	insect larvae	1
11	M	Underwood	22-Jul-02	49.35	10--11	insect larvae	2

11	M	Underwood	22-Jul-02	49.35	12--13	insect larvae	1
11	M	Underwood	22-Jul-02	49.35	13--14	insect larvae	1
11	M	Underwood	22-Jul-02	49.35	14--15	insect larvae	1
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Araneae	20
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Araneae	19
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Araneae	4
12	M	Fogarty	16-Aug-02	89.28	6.25-7.5	Araneae	1
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Araneae	1
12	M	Fogarty	16-Aug-02	89.28	19-20	Phasmida	2
12	M	Fogarty	16-Aug-02	89.28	24-25	Phasmida	1
12	M	Fogarty	16-Aug-02	89.28	37-38	Phasmida	1
12	M	Fogarty	16-Aug-02	89.28	40-41	Phasmida	1
12	M	Fogarty	16-Aug-02	89.28	51-52	Phasmida	1
12	M	Fogarty	16-Aug-02	89.28	54-55	Phasmida	2
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Orthoptera	12
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Orthoptera	9
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Orthoptera	11
12	M	Fogarty	16-Aug-02	89.28	6.25-7.5	Orthoptera	11
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Orthoptera	10
12	M	Fogarty	16-Aug-02	89.28	9--10	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	10--11	Orthoptera	5
12	M	Fogarty	16-Aug-02	89.28	12--13	Orthoptera	4
12	M	Fogarty	16-Aug-02	89.28	15-16	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	16-17	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	17-18	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	19-20	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	20-21	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	21-22	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	24-25	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	28-29	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	32-33	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	36-37	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	37-38	Orthoptera	1
12	M	Fogarty	16-Aug-02	89.28	45-46	Orthoptera	2
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Blattaria	2
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Blattaria	1
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Blattaria	5
12	M	Fogarty	16-Aug-02	89.28	6.25-7.5	Blattaria	7
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Blattaria	1
12	M	Fogarty	16-Aug-02	89.28	10--11	Blattaria	1
12	M	Fogarty	16-Aug-02	89.28	11--12	Blattaria	1
12	M	Fogarty	16-Aug-02	89.28	12--13	Blattaria	1
12	M	Fogarty	16-Aug-02	89.28	13--14	Blattaria	1
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Isoptera	60
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Isoptera	19
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Isoptera	1

12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Psocoptera	32
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Hemiptera	52
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Hemiptera	30
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Hemiptera	9
12	M	Fogarty	16-Aug-02	89.28	6.25-7.5	Hemiptera	2
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Hemiptera	6
12	M	Fogarty	16-Aug-02	89.28	<1.25	Coleoptera	7
12	M	Fogarty	16-Aug-02	89.28	1.25-2.5	Coleoptera	68
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Coleoptera	19
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Coleoptera	11
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Coleoptera	1
12	M	Fogarty	16-Aug-02	89.28	6.25-7.5	Coleoptera	4
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Coleoptera	6
12	M	Fogarty	16-Aug-02	89.28	9--10	Coleoptera	1
12	M	Fogarty	16-Aug-02	89.28	10--11	Coleoptera	1
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Diptera	10
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Diptera	5
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Diptera	2
12	M	Fogarty	16-Aug-02	89.28	10--11	Diptera	1
12	M	Fogarty	16-Aug-02	89.28	11--12	Diptera	1
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Lepidoptera	1
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Lepidoptera	1
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Formicidae	54
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Formicidae	91
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Formicidae	31
12	M	Fogarty	16-Aug-02	89.28	6.25-7.5	Formicidae	9
12	M	Fogarty	16-Aug-02	89.28	7.5-9	Formicidae	1
12	M	Fogarty	16-Aug-02	89.28	9--10	Formicidae	1
12	M	Fogarty	16-Aug-02	89.28	2.5-3.75	Hymenoptera	7
12	M	Fogarty	16-Aug-02	89.28	3.75-5	Hymenoptera	5
12	M	Fogarty	16-Aug-02	89.28	5-6.25	Hymenoptera	2
12	M	Fogarty	16-Aug-02	89.28	3.75-5	insect larvae	1
12	M	Fogarty	16-Aug-02	89.28	5-6.25	insect larvae	1
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Araneae	41
13	M	Cassava	19-Aug-02	2.81	3.75-5	Araneae	37
13	M	Cassava	19-Aug-02	2.81	5-6.25	Araneae	8
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	Araneae	1
13	M	Cassava	19-Aug-02	2.81	7.5-9	Araneae	1
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Polyxenida	1
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Orthoptera	74
13	M	Cassava	19-Aug-02	2.81	3.75-5	Orthoptera	35
13	M	Cassava	19-Aug-02	2.81	5-6.25	Orthoptera	14
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	Orthoptera	6
13	M	Cassava	19-Aug-02	2.81	7.5-9	Orthoptera	12
13	M	Cassava	19-Aug-02	2.81	9--10	Orthoptera	7
13	M	Cassava	19-Aug-02	2.81	10--11	Orthoptera	4

13	M	Cassava	19-Aug-02	2.81	11--12	Orthoptera	3
13	M	Cassava	19-Aug-02	2.81	12--13	Orthoptera	3
13	M	Cassava	19-Aug-02	2.81	13--14	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	14--15	Orthoptera	3
13	M	Cassava	19-Aug-02	2.81	15-16	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	16-17	Orthoptera	5
13	M	Cassava	19-Aug-02	2.81	17-18	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	18-19	Orthoptera	3
13	M	Cassava	19-Aug-02	2.81	19-20	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	20-21	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	21-22	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	23-24	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	24-25	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	27-28	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	28-29	Orthoptera	4
13	M	Cassava	19-Aug-02	2.81	29-30	Orthoptera	9
13	M	Cassava	19-Aug-02	2.81	30-31	Orthoptera	5
13	M	Cassava	19-Aug-02	2.81	31-32	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	32-33	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	33-34	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	34-35	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	35-36	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	37-38	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	49-50	Orthoptera	2
13	M	Cassava	19-Aug-02	2.81	50-51	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	52-53	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	59-60	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	60-61	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	62-63	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	63-64	Orthoptera	1
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Blattaria	3
13	M	Cassava	19-Aug-02	2.81	3.75-5	Blattaria	2
13	M	Cassava	19-Aug-02	2.81	5-6.25	Blattaria	3
13	M	Cassava	19-Aug-02	2.81	10--11	Blattaria	2
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Isoptera	17
13	M	Cassava	19-Aug-02	2.81	3.75-5	Isoptera	3
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Dermaptera	2
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Psocoptera	111
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Hemiptera	76
13	M	Cassava	19-Aug-02	2.81	3.75-5	Hemiptera	17
13	M	Cassava	19-Aug-02	2.81	5-6.25	Hemiptera	6
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	Hemiptera	3
13	M	Cassava	19-Aug-02	2.81	7.5-9	Hemiptera	4
13	M	Cassava	19-Aug-02	2.81	11--12	Neuroptera	3
13	M	Cassava	19-Aug-02	2.81	12--13	Neuroptera	13
13	M	Cassava	19-Aug-02	2.81	13--14	Neuroptera	45
13	M	Cassava	19-Aug-02	2.81	14--15	Neuroptera	31

13	M	Cassava	19-Aug-02	2.81	15-16	Neuroptera	5
13	M	Cassava	19-Aug-02	2.81	16-17	Neuroptera	1
13	M	Cassava	19-Aug-02	2.81	<1.25	Coleoptera	56
13	M	Cassava	19-Aug-02	2.81	1.25-2.5	Coleoptera	123
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Coleoptera	27
13	M	Cassava	19-Aug-02	2.81	3.75-5	Coleoptera	8
13	M	Cassava	19-Aug-02	2.81	5-6.25	Coleoptera	2
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	Coleoptera	12
13	M	Cassava	19-Aug-02	2.81	7.5-9	Coleoptera	3
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Diptera	102
13	M	Cassava	19-Aug-02	2.81	3.75-5	Diptera	53
13	M	Cassava	19-Aug-02	2.81	5-6.25	Diptera	9
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	Diptera	13
13	M	Cassava	19-Aug-02	2.81	7.5-9	Diptera	6
13	M	Cassava	19-Aug-02	2.81	9--10	Diptera	3
13	M	Cassava	19-Aug-02	2.81	10--11	Diptera	2
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Lepidoptera	7
13	M	Cassava	19-Aug-02	2.81	3.75-5	Lepidoptera	6
13	M	Cassava	19-Aug-02	2.81	7.5-9	Lepidoptera	1
13	M	Cassava	19-Aug-02	2.81	13--14	Lepidoptera	1
13	M	Cassava	19-Aug-02	2.81	25-26	Lepidoptera	1
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Formicidae	199
13	M	Cassava	19-Aug-02	2.81	3.75-5	Formicidae	100
13	M	Cassava	19-Aug-02	2.81	5-6.25	Formicidae	105
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	Formicidae	10
13	M	Cassava	19-Aug-02	2.81	7.5-9	Formicidae	1
13	M	Cassava	19-Aug-02	2.81	10--11	Formicidae	2
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	Hymenoptera	15
13	M	Cassava	19-Aug-02	2.81	3.75-5	Hymenoptera	6
13	M	Cassava	19-Aug-02	2.81	7.5-9	Hymenoptera	2
13	M	Cassava	19-Aug-02	2.81	10--11	Hymenoptera	1
13	M	Cassava	19-Aug-02	2.81	2.5-3.75	insect larvae	86
13	M	Cassava	19-Aug-02	2.81	3.75-5	insect larvae	62
13	M	Cassava	19-Aug-02	2.81	5-6.25	insect larvae	25
13	M	Cassava	19-Aug-02	2.81	6.25-7.5	insect larvae	8
13	M	Cassava	19-Aug-02	2.81	14--15	insect larvae	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Araneae	32
14	M	Hope	8-Oct-02	266804.98	3.75-5	Araneae	10
14	M	Hope	8-Oct-02	266804.98	5-6.25	Araneae	3
14	M	Hope	8-Oct-02	266804.98	6.25-7.5	Araneae	2
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Polyxenida	2
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Orthoptera	2
14	M	Hope	8-Oct-02	266804.98	7.5-9	Blattaria	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Psocoptera	6
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Hemiptera	3
14	M	Hope	8-Oct-02	266804.98	3.75-5	Hemiptera	7

14	M	Hope	8-Oct-02	266804.98	7.5-9	Hemiptera	2
14	M	Hope	8-Oct-02	266804.98	9--10	Hemiptera	1
14	M	Hope	8-Oct-02	266804.98	16-17	Neuroptera	1
14	M	Hope	8-Oct-02	266804.98	<1.25	Coleoptera	12
14	M	Hope	8-Oct-02	266804.98	1.25-2.5	Coleoptera	38
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Coleoptera	23
14	M	Hope	8-Oct-02	266804.98	3.75-5	Coleoptera	7
14	M	Hope	8-Oct-02	266804.98	6.25-7.5	Coleoptera	2
14	M	Hope	8-Oct-02	266804.98	7.5-9	Coleoptera	4
14	M	Hope	8-Oct-02	266804.98	11--12	Coleoptera	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Diptera	26
14	M	Hope	8-Oct-02	266804.98	3.75-5	Diptera	6
14	M	Hope	8-Oct-02	266804.98	5-6.25	Diptera	4
14	M	Hope	8-Oct-02	266804.98	6.25-7.5	Diptera	2
14	M	Hope	8-Oct-02	266804.98	7.5-9	Diptera	1
14	M	Hope	8-Oct-02	266804.98	17-18	Diptera	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Lepidoptera	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Formicidae	45
14	M	Hope	8-Oct-02	266804.98	3.75-5	Formicidae	48
14	M	Hope	8-Oct-02	266804.98	5-6.25	Formicidae	21
14	M	Hope	8-Oct-02	266804.98	6.25-7.5	Formicidae	1
14	M	Hope	8-Oct-02	266804.98	7.5-9	Formicidae	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	Hymenoptera	5
14	M	Hope	8-Oct-02	266804.98	3.75-5	Hymenoptera	3
14	M	Hope	8-Oct-02	266804.98	7.5-9	Hymenoptera	1
14	M	Hope	8-Oct-02	266804.98	2.5-3.75	insect larvae	7
14	M	Hope	8-Oct-02	266804.98	3.75-5	insect larvae	2
14	M	Hope	8-Oct-02	266804.98	5-6.25	insect larvae	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Araneae	88
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Araneae	44
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Araneae	17
15	M	Cassava	9-Oct-02	2169.52	11--12	Scolopendromorpha	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Orthoptera	112
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Orthoptera	50
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Orthoptera	61
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Orthoptera	41
15	M	Cassava	9-Oct-02	2169.52	7.5-9	Orthoptera	31
15	M	Cassava	9-Oct-02	2169.52	9--10	Orthoptera	10
15	M	Cassava	9-Oct-02	2169.52	10--11	Orthoptera	11
15	M	Cassava	9-Oct-02	2169.52	11--12	Orthoptera	5
15	M	Cassava	9-Oct-02	2169.52	12--13	Orthoptera	2
15	M	Cassava	9-Oct-02	2169.52	13--14	Orthoptera	1
15	M	Cassava	9-Oct-02	2169.52	14-15	Orthoptera	6
15	M	Cassava	9-Oct-02	2169.52	15-16	Orthoptera	6
15	M	Cassava	9-Oct-02	2169.52	16-17	Orthoptera	4
15	M	Cassava	9-Oct-02	2169.52	17-18	Orthoptera	3

15	M	Cassava	9-Oct-02	2169.52	18-19	Orthoptera	4
15	M	Cassava	9-Oct-02	2169.52	19-20	Orthoptera	3
15	M	Cassava	9-Oct-02	2169.52	20-21	Orthoptera	1
15	M	Cassava	9-Oct-02	2169.52	27-28	Orthoptera	2
15	M	Cassava	9-Oct-02	2169.52	28-29	Orthoptera	2
15	M	Cassava	9-Oct-02	2169.52	29-30	Orthoptera	1
15	M	Cassava	9-Oct-02	2169.52	30-31	Orthoptera	5
15	M	Cassava	9-Oct-02	2169.52	31-32	Orthoptera	2
15	M	Cassava	9-Oct-02	2169.52	32-33	Orthoptera	1
15	M	Cassava	9-Oct-02	2169.52	38-39	Orthoptera	1
15	M	Cassava	9-Oct-02	2169.52	57-58	Orthoptera	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Blattaria	6
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Blattaria	1
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Blattaria	3
15	M	Cassava	9-Oct-02	2169.52	7.5-9	Blattaria	1
15	M	Cassava	9-Oct-02	2169.52	9--10	Blattaria	2
15	M	Cassava	9-Oct-02	2169.52	10--11	Blattaria	1
15	M	Cassava	9-Oct-02	2169.52	24-25	Blattaria	2
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Dermaptera	7
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Dermaptera	1
15	M	Cassava	9-Oct-02	2169.52	14-15	Dermaptera	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Psocoptera	55
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Hemiptera	19
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Hemiptera	4
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Hemiptera	1
15	M	Cassava	9-Oct-02	2169.52	7.5-9	Hemiptera	7
15	M	Cassava	9-Oct-02	2169.52	11--12	Hemiptera	2
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Neuroptera	1
15	M	Cassava	9-Oct-02	2169.52	12--13	Neuroptera	1
15	M	Cassava	9-Oct-02	2169.52	13--14	Neuroptera	1
15	M	Cassava	9-Oct-02	2169.52	<1.25	Coleoptera	63
15	M	Cassava	9-Oct-02	2169.52	1.25-2.5	Coleoptera	107
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Coleoptera	14
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Coleoptera	2
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Coleoptera	3
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Coleoptera	1
15	M	Cassava	9-Oct-02	2169.52	9--10	Coleoptera	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Diptera	74
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Diptera	13
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Diptera	7
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Diptera	7
15	M	Cassava	9-Oct-02	2169.52	7.5-8.75	Diptera	1
15	M	Cassava	9-Oct-02	2169.52	11--12	Diptera	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Lepidoptera	4
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Lepidoptera	4
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Lepidoptera	1
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Lepidoptera	1

15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Formicidae	208
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Formicidae	196
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	Formicidae	41
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	Formicidae	3
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	Hymenoptera	8
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	Hymenoptera	5
15	M	Cassava	9-Oct-02	2169.52	9--10	Hymenoptera	1
15	M	Cassava	9-Oct-02	2169.52	2.5-3.75	insect larvae	17
15	M	Cassava	9-Oct-02	2169.52	3.75-5.0	insect larvae	25
15	M	Cassava	9-Oct-02	2169.52	5.0-6.25	insect larvae	10
15	M	Cassava	9-Oct-02	2169.52	6.25-7.5	insect larvae	7
15	M	Cassava	9-Oct-02	2169.52	10--11	insect larvae	1
15	M	Cassava	9-Oct-02	2169.52	20-21	insect larvae	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Araneae	84
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Araneae	43
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Araneae	9
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Araneae	4
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Araneae	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Polyxenida	3
16	M	Fogarty	10-Oct-02	1148.59	31-32	Phasmida	1
16	M	Fogarty	10-Oct-02	1148.59	40-41	Phasmida	1
16	M	Fogarty	10-Oct-02	1148.59	55-56	Phasmida	1
16	M	Fogarty	10-Oct-02	1148.59	56-57	Phasmida	1
16	M	Fogarty	10-Oct-02	1148.59	70-71	Phasmida	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Orthoptera	89
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Orthoptera	59
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Orthoptera	27
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Orthoptera	21
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Orthoptera	32
16	M	Fogarty	10-Oct-02	1148.59	9--10	Orthoptera	11
16	M	Fogarty	10-Oct-02	1148.59	10--11	Orthoptera	9
16	M	Fogarty	10-Oct-02	1148.59	11--12	Orthoptera	6
16	M	Fogarty	10-Oct-02	1148.59	12--13	Orthoptera	6
16	M	Fogarty	10-Oct-02	1148.59	14-15	Orthoptera	2
16	M	Fogarty	10-Oct-02	1148.59	15-16	Orthoptera	2
16	M	Fogarty	10-Oct-02	1148.59	16-17	Orthoptera	7
16	M	Fogarty	10-Oct-02	1148.59	17-18	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	18-19	Orthoptera	3
16	M	Fogarty	10-Oct-02	1148.59	19-20	Orthoptera	4
16	M	Fogarty	10-Oct-02	1148.59	21-22	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	24-25	Orthoptera	2
16	M	Fogarty	10-Oct-02	1148.59	26-27	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	27-28	Orthoptera	2
16	M	Fogarty	10-Oct-02	1148.59	31-32	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	32-33	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	33-34	Orthoptera	1

16	M	Fogarty	10-Oct-02	1148.59	34-35	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	35-36	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	39-40	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	45-46	Orthoptera	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Blattaria	19
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Blattaria	14
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Blattaria	10
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Blattaria	18
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Blattaria	17
16	M	Fogarty	10-Oct-02	1148.59	9--10	Blattaria	10
16	M	Fogarty	10-Oct-02	1148.59	10--11	Blattaria	7
16	M	Fogarty	10-Oct-02	1148.59	15-16	Blattaria	1
16	M	Fogarty	10-Oct-02	1148.59	17-18	Blattaria	1
16	M	Fogarty	10-Oct-02	1148.59	21-22	Blattaria	1
16	M	Fogarty	10-Oct-02	1148.59	23-24	Blattaria	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Isoptera	12
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Isoptera	5
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Dermaptera	4
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Psocoptera	471
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Hemiptera	399
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Hemiptera	280
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Hemiptera	21
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Hemiptera	29
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Hemiptera	31
16	M	Fogarty	10-Oct-02	1148.59	9--10	Hemiptera	5
16	M	Fogarty	10-Oct-02	1148.59	10--11	Hemiptera	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Thysanoptera	2
16	M	Fogarty	10-Oct-02	1148.59	<1.25	Coleoptera	110
16	M	Fogarty	10-Oct-02	1148.59	1.25-2.5	Coleoptera	268
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Coleoptera	58
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Coleoptera	27
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Coleoptera	15
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Coleoptera	62
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Coleoptera	22
16	M	Fogarty	10-Oct-02	1148.59	9--10	Coleoptera	5
16	M	Fogarty	10-Oct-02	1148.59	10--11	Coleoptera	1
16	M	Fogarty	10-Oct-02	1148.59	12--13	Coleoptera	1
16	M	Fogarty	10-Oct-02	1148.59	13--14	Coleoptera	1
16	M	Fogarty	10-Oct-02	1148.59	15-16	Coleoptera	1
16	M	Fogarty	10-Oct-02	1148.59	16-17	Coleoptera	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Diptera	126
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Diptera	20
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Diptera	11
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Diptera	9
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Diptera	2
16	M	Fogarty	10-Oct-02	1148.59	9--10	Diptera	1
16	M	Fogarty	10-Oct-02	1148.59	15-16	Diptera	1

16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Lepidoptera	39
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Lepidoptera	18
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Lepidoptera	1
16	M	Fogarty	10-Oct-02	1148.59	11--12	Lepidoptera	1
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Formicidae	338
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Formicidae	383
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Formicidae	52
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Formicidae	7
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Formicidae	1
16	M	Fogarty	10-Oct-02	1148.59	9--10	Formicidae	2
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	Hymenoptera	123
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	Hymenoptera	14
16	M	Fogarty	10-Oct-02	1148.59	5-6.25	Hymenoptera	4
16	M	Fogarty	10-Oct-02	1148.59	6.25-7.5	Hymenoptera	2
16	M	Fogarty	10-Oct-02	1148.59	7.5-9	Hymenoptera	2
16	M	Fogarty	10-Oct-02	1148.59	2.5-3.75	insect larvae	4
16	M	Fogarty	10-Oct-02	1148.59	3.75-5	insect larvae	7
16	M	Fogarty	10-Oct-02	1148.59	26-27	insect larvae	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Araneae	39
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Araneae	24
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Araneae	5
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Araneae	1
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Araneae	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Pseudoscorpiones	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Polyxenida	6
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Microcoryphia	1
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Microcoryphia	3
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Microcoryphia	3
17	M	Underwood	11-Oct-02	1006.9	31-32	Phasmida	1
17	M	Underwood	11-Oct-02	1006.9	37-38	Phasmida	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Orthoptera	28
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Orthoptera	42
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Orthoptera	24
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Orthoptera	36
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Orthoptera	19
17	M	Underwood	11-Oct-02	1006.9	9--10	Orthoptera	2
17	M	Underwood	11-Oct-02	1006.9	10--11	Orthoptera	1
17	M	Underwood	11-Oct-02	1006.9	13--14	Orthoptera	1
17	M	Underwood	11-Oct-02	1006.9	14-15	Orthoptera	1
17	M	Underwood	11-Oct-02	1006.9	15-16	Orthoptera	1
17	M	Underwood	11-Oct-02	1006.9	16-17	Orthoptera	1
17	M	Underwood	11-Oct-02	1006.9	33-34	Orthoptera	2
17	M	Underwood	11-Oct-02	1006.9	55-56	Orthoptera	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Blattaria	2
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Blattaria	5
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Blattaria	3

17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Blattaria	1
17	M	Underwood	11-Oct-02	1006.9	10--11	Blattaria	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Isoptera	23
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Isoptera	3
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Dermaptera	1
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Dermaptera	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Psocoptera	54
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Hemiptera	92
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Hemiptera	13
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Hemiptera	2
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Hemiptera	3
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Hemiptera	1
17	M	Underwood	11-Oct-02	1006.9	18-19	Hemiptera	1
17	M	Underwood	11-Oct-02	1006.9	<1.25	Coleoptera	21
17	M	Underwood	11-Oct-02	1006.9	1.25-2.5	Coleoptera	64
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Coleoptera	15
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Coleoptera	1
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Coleoptera	2
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Coleoptera	3
17	M	Underwood	11-Oct-02	1006.9	9--10	Coleoptera	8
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Diptera	38
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Diptera	6
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Diptera	6
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Diptera	2
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Diptera	1
17	M	Underwood	11-Oct-02	1006.9	11--12	Diptera	1
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Trichoptera	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Lepidoptera	8
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Lepidoptera	7
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Lepidoptera	2
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Lepidoptera	1
17	M	Underwood	11-Oct-02	1006.9	13--14	Lepidoptera	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Formicidae	54
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Formicidae	37
17	M	Underwood	11-Oct-02	1006.9	5-6.25	Formicidae	23
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Formicidae	11
17	M	Underwood	11-Oct-02	1006.9	7.5-9	Formicidae	5
17	M	Underwood	11-Oct-02	1006.9	10--11	Formicidae	3
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	Hymenoptera	14
17	M	Underwood	11-Oct-02	1006.9	3.75-5	Hymenoptera	1
17	M	Underwood	11-Oct-02	1006.9	6.25-7.5	Hymenoptera	2
17	M	Underwood	11-Oct-02	1006.9	12--13	Hymenoptera	1
17	M	Underwood	11-Oct-02	1006.9	2.5-3.75	insect larvae	7
17	M	Underwood	11-Oct-02	1006.9	3.75-5	insect larvae	9
17	M	Underwood	11-Oct-02	1006.9	5-6.25	insect larvae	4
17	M	Underwood	11-Oct-02	1006.9	7.5-9	insect larvae	1
17	M	Underwood	11-Oct-02	1006.9	13--14	insect larvae	1

17	M	Underwood	11-Oct-02	1006.9	14-15	insect larvae	1
17	M	Underwood	11-Oct-02	1006.9	19-20	insect larvae	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Araneae	5
18	M	Hope	4-Dec-02	253.61	3.75-5	Araneae	5
18	M	Hope	4-Dec-02	253.61	5-6.25	Araneae	1
18	M	Hope	4-Dec-02	253.61	7.5-9	Araneae	1
18	M	Hope	4-Dec-02	253.61	10--11	Geophilomorpha	1
18	M	Hope	4-Dec-02	253.61	14--15	Phasmida	1
18	M	Hope	4-Dec-02	253.61	15-16	Phasmida	1
18	M	Hope	4-Dec-02	253.61	24-25	Phasmida	1
18	M	Hope	4-Dec-02	253.61	55-56	Phasmida	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Orthoptera	16
18	M	Hope	4-Dec-02	253.61	3.75-5	Orthoptera	8
18	M	Hope	4-Dec-02	253.61	5-6.25	Orthoptera	5
18	M	Hope	4-Dec-02	253.61	6.25-7.5	Orthoptera	2
18	M	Hope	4-Dec-02	253.61	7.5-9	Orthoptera	2
18	M	Hope	4-Dec-02	253.61	9--10	Orthoptera	1
18	M	Hope	4-Dec-02	253.61	10--11	Orthoptera	3
18	M	Hope	4-Dec-02	253.61	12--13	Orthoptera	1
18	M	Hope	4-Dec-02	253.61	13--14	Orthoptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Blattaria	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Isoptera	3
18	M	Hope	4-Dec-02	253.61	10--11	Isoptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Psocoptera	28
18	M	Hope	4-Dec-02	253.61	3.75-5	Psocoptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Hemiptera	11
18	M	Hope	4-Dec-02	253.61	7.5-9	Hemiptera	2
18	M	Hope	4-Dec-02	253.61	13--14	Hemiptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Thysanoptera	1
18	M	Hope	4-Dec-02	253.61	<1.25	Coleoptera	60
18	M	Hope	4-Dec-02	253.61	1.25-2.5	Coleoptera	100
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Coleoptera	18
18	M	Hope	4-Dec-02	253.61	5-6.25	Coleoptera	3
18	M	Hope	4-Dec-02	253.61	6.25-7.5	Coleoptera	1
18	M	Hope	4-Dec-02	253.61	7.5-9	Coleoptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Diptera	37
18	M	Hope	4-Dec-02	253.61	3.75-5	Diptera	5
18	M	Hope	4-Dec-02	253.61	5-6.25	Diptera	4
18	M	Hope	4-Dec-02	253.61	6.25-7.5	Diptera	1
18	M	Hope	4-Dec-02	253.61	7.5-9	Diptera	5
18	M	Hope	4-Dec-02	253.61	11--12	Diptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Lepidoptera	41
18	M	Hope	4-Dec-02	253.61	3.75-5	Lepidoptera	8
18	M	Hope	4-Dec-02	253.61	7.5-9	Lepidoptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Formicidae	60
18	M	Hope	4-Dec-02	253.61	3.75-5	Formicidae	64

18	M	Hope	4-Dec-02	253.61	5-6.25	Formicidae	9
18	M	Hope	4-Dec-02	253.61	6.25-7.5	Formicidae	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	Hymenoptera	29
18	M	Hope	4-Dec-02	253.61	3.75-5	Hymenoptera	7
18	M	Hope	4-Dec-02	253.61	5-6.25	Hymenoptera	1
18	M	Hope	4-Dec-02	253.61	2.5-3.75	insect larvae	12
18	M	Hope	4-Dec-02	253.61	3.75-5	insect larvae	2
18	M	Hope	4-Dec-02	253.61	5-6.25	insect larvae	2
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Araneae	98
19	M	Cassava	5-Dec-02	287.53	3.75-5	Araneae	49
19	M	Cassava	5-Dec-02	287.53	5-6.25	Araneae	9
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	Araneae	1
19	M	Cassava	5-Dec-02	287.53	7.5-9	Araneae	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Orthoptera	63
19	M	Cassava	5-Dec-02	287.53	3.75-5	Orthoptera	73
19	M	Cassava	5-Dec-02	287.53	5-6.25	Orthoptera	60
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	Orthoptera	53
19	M	Cassava	5-Dec-02	287.53	7.5-9	Orthoptera	30
19	M	Cassava	5-Dec-02	287.53	9--10	Orthoptera	5
19	M	Cassava	5-Dec-02	287.53	10--11	Orthoptera	4
19	M	Cassava	5-Dec-02	287.53	11--12	Orthoptera	4
19	M	Cassava	5-Dec-02	287.53	12--13	Orthoptera	11
19	M	Cassava	5-Dec-02	287.53	13--14	Orthoptera	3
19	M	Cassava	5-Dec-02	287.53	14--15	Orthoptera	3
19	M	Cassava	5-Dec-02	287.53	16--17	Orthoptera	1
19	M	Cassava	5-Dec-02	287.53	17--18	Orthoptera	1
19	M	Cassava	5-Dec-02	287.53	20-21	Orthoptera	1
19	M	Cassava	5-Dec-02	287.53	28-29	Orthoptera	1
19	M	Cassava	5-Dec-02	287.53	29-30	Orthoptera	2
19	M	Cassava	5-Dec-02	287.53	31-32	Orthoptera	1
19	M	Cassava	5-Dec-02	287.53	33-34	Orthoptera	3
19	M	Cassava	5-Dec-02	287.53	39-40	Orthoptera	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Blattaria	12
19	M	Cassava	5-Dec-02	287.53	3.75-5	Blattaria	4
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	Blattaria	2
19	M	Cassava	5-Dec-02	287.53	7.5-9	Blattaria	6
19	M	Cassava	5-Dec-02	287.53	10--11	Blattaria	1
19	M	Cassava	5-Dec-02	287.53	11--12	Blattaria	2
19	M	Cassava	5-Dec-02	287.53	14--15	Blattaria	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Dermaptera	4
19	M	Cassava	5-Dec-02	287.53	3.75-5	Dermaptera	1
19	M	Cassava	5-Dec-02	287.53	7.5-9	Dermaptera	1
19	M	Cassava	5-Dec-02	287.53	13--14	Dermaptera	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Psocoptera	70
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Hemiptera	60
19	M	Cassava	5-Dec-02	287.53	3.75-5	Hemiptera	4

19	M	Cassava	5-Dec-02	287.53	5-6.25	Hemiptera	3
19	M	Cassava	5-Dec-02	287.53	7.5-9	Hemiptera	6
19	M	Cassava	5-Dec-02	287.53	11--12	Hemiptera	2
19	M	Cassava	5-Dec-02	287.53	<1.25	Coleoptera	14
19	M	Cassava	5-Dec-02	287.53	1.25-2.5	Coleoptera	59
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Coleoptera	9
19	M	Cassava	5-Dec-02	287.53	3.75-5	Coleoptera	3
19	M	Cassava	5-Dec-02	287.53	5-6.25	Coleoptera	2
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	Coleoptera	2
19	M	Cassava	5-Dec-02	287.53	7.5-9	Coleoptera	2
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Diptera	61
19	M	Cassava	5-Dec-02	287.53	3.75-5	Diptera	24
19	M	Cassava	5-Dec-02	287.53	5-6.25	Diptera	3
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	Diptera	4
19	M	Cassava	5-Dec-02	287.53	7.5-9	Diptera	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Lepidoptera	5
19	M	Cassava	5-Dec-02	287.53	3.75-5	Lepidoptera	17
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	Lepidoptera	1
19	M	Cassava	5-Dec-02	287.53	11--12	Lepidoptera	1
19	M	Cassava	5-Dec-02	287.53	13--14	Lepidoptera	1
19	M	Cassava	5-Dec-02	287.53	14--15	Lepidoptera	1
19	M	Cassava	5-Dec-02	287.53	17--18	Lepidoptera	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Formicidae	320
19	M	Cassava	5-Dec-02	287.53	3.75-5	Formicidae	202
19	M	Cassava	5-Dec-02	287.53	5-6.25	Formicidae	14
19	M	Cassava	5-Dec-02	287.53	7.5-9	Formicidae	2
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	Hymenoptera	18
19	M	Cassava	5-Dec-02	287.53	3.75-5	Hymenoptera	3
19	M	Cassava	5-Dec-02	287.53	7.5-9	Hymenoptera	1
19	M	Cassava	5-Dec-02	287.53	2.5-3.75	insect larvae	11
19	M	Cassava	5-Dec-02	287.53	3.75-5	insect larvae	3
19	M	Cassava	5-Dec-02	287.53	5-6.25	insect larvae	2
19	M	Cassava	5-Dec-02	287.53	6.25-7.5	insect larvae	1
19	M	Cassava	5-Dec-02	287.53	7.5-9	insect larvae	2
19	M	Cassava	5-Dec-02	287.53	10--11	insect larvae	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Araneae	13
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Araneae	5
20	M	Fogarty	6-Dec-02	157.97	5-6.25	Araneae	1
20	M	Fogarty	6-Dec-02	157.97	7.5-9	Geophilomorpha	1
20	M	Fogarty	6-Dec-02	157.97	27-28	Geophilomorpha	1
20	M	Fogarty	6-Dec-02	157.97	53-54	Phasmida	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Orthoptera	43
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Orthoptera	11
20	M	Fogarty	6-Dec-02	157.97	5-6.25	Orthoptera	5
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Orthoptera	11
20	M	Fogarty	6-Dec-02	157.97	7.5-9	Orthoptera	9

20	M	Fogarty	6-Dec-02	157.97	9--10	Orthoptera	3
20	M	Fogarty	6-Dec-02	157.97	10--11	Orthoptera	2
20	M	Fogarty	6-Dec-02	157.97	11--12	Orthoptera	3
20	M	Fogarty	6-Dec-02	157.97	12--13	Orthoptera	3
20	M	Fogarty	6-Dec-02	157.97	13--14	Orthoptera	1
20	M	Fogarty	6-Dec-02	157.97	14--15	Orthoptera	2
20	M	Fogarty	6-Dec-02	157.97	18-19	Orthoptera	1
20	M	Fogarty	6-Dec-02	157.97	19-20	Orthoptera	1
20	M	Fogarty	6-Dec-02	157.97	29-30	Orthoptera	2
20	M	Fogarty	6-Dec-02	157.97	32-33	Orthoptera	1
20	M	Fogarty	6-Dec-02	157.97	33-34	Orthoptera	2
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Blattaria	3
20	M	Fogarty	6-Dec-02	157.97	5-6.25	Blattaria	1
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Blattaria	1
20	M	Fogarty	6-Dec-02	157.97	7.5-9	Blattaria	2
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Isoptera	26
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Isoptera	9
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Dermaptera	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Psocoptera	34
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Hemiptera	56
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Hemiptera	19
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Hemiptera	2
20	M	Fogarty	6-Dec-02	157.97	7.5-9	Hemiptera	2
20	M	Fogarty	6-Dec-02	157.97	<1.25	Coleoptera	28
20	M	Fogarty	6-Dec-02	157.97	1.25-2.5	Coleoptera	118
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Coleoptera	16
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Coleoptera	12
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Coleoptera	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Diptera	14
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Diptera	3
20	M	Fogarty	6-Dec-02	157.97	5-6.25	Diptera	2
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Diptera	1
20	M	Fogarty	6-Dec-02	157.97	11--12	Diptera	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Lepidoptera	11
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Lepidoptera	4
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Lepidoptera	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Formicidae	303
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Formicidae	149
20	M	Fogarty	6-Dec-02	157.97	5-6.25	Formicidae	13
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	Formicidae	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	Hymenoptera	13
20	M	Fogarty	6-Dec-02	157.97	3.75-5	Hymenoptera	6
20	M	Fogarty	6-Dec-02	157.97	10--11	Hymenoptera	1
20	M	Fogarty	6-Dec-02	157.97	2.5-3.75	insect larvae	5
20	M	Fogarty	6-Dec-02	157.97	3.75-5	insect larvae	3
20	M	Fogarty	6-Dec-02	157.97	5-6.25	insect larvae	1
20	M	Fogarty	6-Dec-02	157.97	6.25-7.5	insect larvae	2

20	M	Fogarty	6-Dec-02	157.97	7.5-9	insect larvae	2
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Araneae	75
21	M	Underwood	10-Dec-02	152.27	3.75-5	Araneae	22
21	M	Underwood	10-Dec-02	152.27	5-6.25	Araneae	10
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Araneae	1
21	M	Underwood	10-Dec-02	152.27	7.5-9	Araneae	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Isopoda	2
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Polyxenida	3
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Microcoryphia	1
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Microcoryphia	1
21	M	Underwood	10-Dec-02	152.27	58-59	Phasmida	1
21	M	Underwood	10-Dec-02	152.27	59-60	Phasmida	1
21	M	Underwood	10-Dec-02	152.27	61-62	Phasmida	1
21	M	Underwood	10-Dec-02	152.27	65-66	Phasmida	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Orthoptera	67
21	M	Underwood	10-Dec-02	152.27	3.75-5	Orthoptera	32
21	M	Underwood	10-Dec-02	152.27	5-6.25	Orthoptera	26
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Orthoptera	51
21	M	Underwood	10-Dec-02	152.27	7.5-9	Orthoptera	15
21	M	Underwood	10-Dec-02	152.27	9--10	Orthoptera	1
21	M	Underwood	10-Dec-02	152.27	11--12	Orthoptera	1
21	M	Underwood	10-Dec-02	152.27	14--15	Orthoptera	1
21	M	Underwood	10-Dec-02	152.27	16--17	Orthoptera	1
21	M	Underwood	10-Dec-02	152.27	17--18	Orthoptera	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Blattaria	14
21	M	Underwood	10-Dec-02	152.27	3.75-5	Blattaria	10
21	M	Underwood	10-Dec-02	152.27	5-6.25	Blattaria	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Isoptera	38
21	M	Underwood	10-Dec-02	152.27	3.75-5	Isoptera	3
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Dermaptera	3
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Psocoptera	30
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Hemiptera	37
21	M	Underwood	10-Dec-02	152.27	3.75-5	Hemiptera	5
21	M	Underwood	10-Dec-02	152.27	5-6.25	Hemiptera	2
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Hemiptera	1
21	M	Underwood	10-Dec-02	152.27	7.5-9	Hemiptera	1
21	M	Underwood	10-Dec-02	152.27	<1.25	Coleoptera	19
21	M	Underwood	10-Dec-02	152.27	1.25-2.5	Coleoptera	84
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Coleoptera	10
21	M	Underwood	10-Dec-02	152.27	3.75-5	Coleoptera	1
21	M	Underwood	10-Dec-02	152.27	7.5-9	Coleoptera	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Diptera	11
21	M	Underwood	10-Dec-02	152.27	3.75-5	Diptera	4
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Diptera	1
21	M	Underwood	10-Dec-02	152.27	3.75-5	Trichoptera	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Lepidoptera	11

21	M	Underwood	10-Dec-02	152.27	3.75-5	Lepidoptera	10
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Formicidae	122
21	M	Underwood	10-Dec-02	152.27	3.75-5	Formicidae	45
21	M	Underwood	10-Dec-02	152.27	5-6.25	Formicidae	44
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Formicidae	9
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	Hymenoptera	7
21	M	Underwood	10-Dec-02	152.27	5-6.25	Hymenoptera	1
21	M	Underwood	10-Dec-02	152.27	6.25-7.5	Hymenoptera	2
21	M	Underwood	10-Dec-02	152.27	7.5-9	Hymenoptera	1
21	M	Underwood	10-Dec-02	152.27	2.5-3.75	insect larvae	2
21	M	Underwood	10-Dec-02	152.27	3.75-5	insect larvae	2
21	M	Underwood	10-Dec-02	152.27	7.5-9	insect larvae	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Araneae	71
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Araneae	32
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Araneae	5
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Araneae	3
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Orthoptera	35
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Orthoptera	18
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Orthoptera	6
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Orthoptera	14
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Orthoptera	12
22	M	Cassava	4-Feb-03	11107.03	9--10	Orthoptera	10
22	M	Cassava	4-Feb-03	11107.03	10--11	Orthoptera	9
22	M	Cassava	4-Feb-03	11107.03	11--12	Orthoptera	3
22	M	Cassava	4-Feb-03	11107.03	12--13	Orthoptera	4
22	M	Cassava	4-Feb-03	11107.03	13--14	Orthoptera	4
22	M	Cassava	4-Feb-03	11107.03	14--15	Orthoptera	8
22	M	Cassava	4-Feb-03	11107.03	15-16	Orthoptera	2
22	M	Cassava	4-Feb-03	11107.03	16-17	Orthoptera	2
22	M	Cassava	4-Feb-03	11107.03	17-18	Orthoptera	2
22	M	Cassava	4-Feb-03	11107.03	18-19	Orthoptera	1
22	M	Cassava	4-Feb-03	11107.03	19-20	Orthoptera	3
22	M	Cassava	4-Feb-03	11107.03	31-32	Orthoptera	1
22	M	Cassava	4-Feb-03	11107.03	36-37	Orthoptera	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Blattaria	3
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Blattaria	5
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Blattaria	2
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Blattaria	1
22	M	Cassava	4-Feb-03	11107.03	23-24	Blattaria	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Dermaptera	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Psocoptera	102
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Hemiptera	54
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Hemiptera	16
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Hemiptera	4
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Hemiptera	1
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Hemiptera	7

22	M	Cassava	4-Feb-03	11107.03	11--12	Hemiptera	1
22	M	Cassava	4-Feb-03	11107.03	12--13	Neuroptera	3
22	M	Cassava	4-Feb-03	11107.03	13--14	Neuroptera	5
22	M	Cassava	4-Feb-03	11107.03	14--15	Neuroptera	5
22	M	Cassava	4-Feb-03	11107.03	<1.25	Coleoptera	28
22	M	Cassava	4-Feb-03	11107.03	1.25-2.5	Coleoptera	44
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Coleoptera	9
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Coleoptera	2
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Coleoptera	1
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Coleoptera	4
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Coleoptera	1
22	M	Cassava	4-Feb-03	11107.03	14--15	Coleoptera	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Diptera	102
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Diptera	25
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Diptera	12
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Diptera	5
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Diptera	4
22	M	Cassava	4-Feb-03	11107.03	13--14	Diptera	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Lepidoptera	17
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Lepidoptera	9
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Lepidoptera	2
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Lepidoptera	4
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Lepidoptera	1
22	M	Cassava	4-Feb-03	11107.03	9--10	Lepidoptera	1
22	M	Cassava	4-Feb-03	11107.03	10--11	Lepidoptera	3
22	M	Cassava	4-Feb-03	11107.03	11--12	Lepidoptera	2
22	M	Cassava	4-Feb-03	11107.03	12--13	Lepidoptera	1
22	M	Cassava	4-Feb-03	11107.03	13--14	Lepidoptera	2
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Formicidae	129
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Formicidae	42
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Formicidae	13
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Formicidae	2
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Formicidae	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	Hymenoptera	15
22	M	Cassava	4-Feb-03	11107.03	3.75-5	Hymenoptera	1
22	M	Cassava	4-Feb-03	11107.03	5-6.25	Hymenoptera	2
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	Hymenoptera	1
22	M	Cassava	4-Feb-03	11107.03	7.5-9	Hymenoptera	1
22	M	Cassava	4-Feb-03	11107.03	25-26	Hymenoptera	1
22	M	Cassava	4-Feb-03	11107.03	2.5-3.75	insect larvae	11
22	M	Cassava	4-Feb-03	11107.03	3.75-5	insect larvae	4
22	M	Cassava	4-Feb-03	11107.03	5-6.25	insect larvae	12
22	M	Cassava	4-Feb-03	11107.03	6.25-7.5	insect larvae	18
22	M	Cassava	4-Feb-03	11107.03	7.5-9	insect larvae	4
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Araneae	39
23	M	Hope	5-Feb-03	8128.86	3.75-5	Araneae	6

23	M	Hope	5-Feb-03	8128.86	5-6.25	Araneae	1
23	M	Hope	5-Feb-03	8128.86	6.25-7.5	Araneae	1
23	M	Hope	5-Feb-03	8128.86	3.75-5	Orthoptera	3
23	M	Hope	5-Feb-03	8128.86	5-6.25	Orthoptera	1
23	M	Hope	5-Feb-03	8128.86	3.75-5	Blattaria	2
23	M	Hope	5-Feb-03	8128.86	5-6.25	Blattaria	1
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Isoptera	25
23	M	Hope	5-Feb-03	8128.86	3.75-5	Isoptera	2
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Psocoptera	316
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Hemiptera	15
23	M	Hope	5-Feb-03	8128.86	3.75-5	Hemiptera	3
23	M	Hope	5-Feb-03	8128.86	<1.25	Coleoptera	16
23	M	Hope	5-Feb-03	8128.86	1.25-2.5	Coleoptera	137
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Coleoptera	28
23	M	Hope	5-Feb-03	8128.86	3.75-5	Coleoptera	3
23	M	Hope	5-Feb-03	8128.86	6.25-7.5	Coleoptera	2
23	M	Hope	5-Feb-03	8128.86	7.5-9	Coleoptera	1
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Diptera	13
23	M	Hope	5-Feb-03	8128.86	3.75-5	Diptera	4
23	M	Hope	5-Feb-03	8128.86	6.25-7.5	Diptera	1
23	M	Hope	5-Feb-03	8128.86	7.5-9	Diptera	1
23	M	Hope	5-Feb-03	8128.86	9--10	Diptera	1
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Lepidoptera	2
23	M	Hope	5-Feb-03	8128.86	3.75-5	Lepidoptera	3
23	M	Hope	5-Feb-03	8128.86	5-6.25	Lepidoptera	2
23	M	Hope	5-Feb-03	8128.86	9--10	Lepidoptera	1
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Formicidae	105
23	M	Hope	5-Feb-03	8128.86	3.75-5	Formicidae	81
23	M	Hope	5-Feb-03	8128.86	5-6.25	Formicidae	6
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	Hymenoptera	6
23	M	Hope	5-Feb-03	8128.86	3.75-5	Hymenoptera	1
23	M	Hope	5-Feb-03	8128.86	7.5-9	Hymenoptera	1
23	M	Hope	5-Feb-03	8128.86	2.5-3.75	insect larvae	5
23	M	Hope	5-Feb-03	8128.86	3.75-5	insect larvae	1
23	M	Hope	5-Feb-03	8128.86	6.25-7.5	insect larvae	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Araneae	19
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Araneae	6
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Araneae	2
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Araneae	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Orthoptera	61
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Orthoptera	14
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Orthoptera	15
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Orthoptera	8
24	M	Fogarty	20-Feb-03	220.49	7.5-9	Orthoptera	12
24	M	Fogarty	20-Feb-03	220.49	9--10	Orthoptera	1
24	M	Fogarty	20-Feb-03	220.49	10--11	Orthoptera	1

24	M	Fogarty	20-Feb-03	220.49	11--12	Orthoptera	1
24	M	Fogarty	20-Feb-03	220.49	14--15	Orthoptera	1
24	M	Fogarty	20-Feb-03	220.49	15-16	Orthoptera	1
24	M	Fogarty	20-Feb-03	220.49	16-17	Orthoptera	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Blattaria	3
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Blattaria	7
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Blattaria	5
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Blattaria	4
24	M	Fogarty	20-Feb-03	220.49	7.5-9	Blattaria	1
24	M	Fogarty	20-Feb-03	220.49	9--10	Blattaria	2
24	M	Fogarty	20-Feb-03	220.49	11--12	Blattaria	1
24	M	Fogarty	20-Feb-03	220.49	24-25	Blattaria	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Isoptera	19
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Isoptera	2
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Psocoptera	12
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Hemiptera	51
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Hemiptera	21
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Hemiptera	1
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Hemiptera	1
24	M	Fogarty	20-Feb-03	220.49	13--14	Neuroptera	1
24	M	Fogarty	20-Feb-03	220.49	<1.25	Coleoptera	33
24	M	Fogarty	20-Feb-03	220.49	1.25-2.5	Coleoptera	524
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Coleoptera	29
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Coleoptera	7
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Coleoptera	7
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Coleoptera	5
24	M	Fogarty	20-Feb-03	220.49	7.5-9	Coleoptera	4
24	M	Fogarty	20-Feb-03	220.49	10--11	Coleoptera	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Diptera	33
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Diptera	13
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Diptera	3
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Diptera	2
24	M	Fogarty	20-Feb-03	220.49	7.5-9	Diptera	2
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Lepidoptera	13
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Lepidoptera	13
24	M	Fogarty	20-Feb-03	220.49	7.5-9	Lepidoptera	3
24	M	Fogarty	20-Feb-03	220.49	10--11	Lepidoptera	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Formicidae	145
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Formicidae	103
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Formicidae	26
24	M	Fogarty	20-Feb-03	220.49	6.25-7.5	Formicidae	3
24	M	Fogarty	20-Feb-03	220.49	10--11	Formicidae	1
24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	Hymenoptera	33
24	M	Fogarty	20-Feb-03	220.49	3.75-5	Hymenoptera	6
24	M	Fogarty	20-Feb-03	220.49	5-6.25	Hymenoptera	2
24	M	Fogarty	20-Feb-03	220.49	7.5-9	Hymenoptera	2
24	M	Fogarty	20-Feb-03	220.49	9--10	Hymenoptera	1

24	M	Fogarty	20-Feb-03	220.49	2.5-3.75	insect larvae	18
24	M	Fogarty	20-Feb-03	220.49	5-6.25	insect larvae	1
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Araneae	54
25	M	Underwood	21-Feb-03	768.9	3.75-5	Araneae	18
25	M	Underwood	21-Feb-03	768.9	5-6.25	Araneae	7
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Araneae	1
25	M	Underwood	21-Feb-03	768.9	7.5-9	Araneae	4
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Polyxenida	5
25	M	Underwood	21-Feb-03	768.9	3.75-5	Microcoryphia	2
25	M	Underwood	21-Feb-03	768.9	16-17	Phasmida	1
25	M	Underwood	21-Feb-03	768.9	17-18	Phasmida	1
25	M	Underwood	21-Feb-03	768.9	31-32	Phasmida	1
25	M	Underwood	21-Feb-03	768.9	54-55	Phasmida	1
25	M	Underwood	21-Feb-03	768.9	58-59	Phasmida	1
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Orthoptera	68
25	M	Underwood	21-Feb-03	768.9	3.75-5	Orthoptera	25
25	M	Underwood	21-Feb-03	768.9	5-6.25	Orthoptera	10
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Orthoptera	18
25	M	Underwood	21-Feb-03	768.9	7.5-9	Orthoptera	15
25	M	Underwood	21-Feb-03	768.9	9--10	Orthoptera	1
25	M	Underwood	21-Feb-03	768.9	10--11	Orthoptera	1
25	M	Underwood	21-Feb-03	768.9	12--13	Orthoptera	2
25	M	Underwood	21-Feb-03	768.9	15-16	Orthoptera	2
25	M	Underwood	21-Feb-03	768.9	21-22	Orthoptera	1
25	M	Underwood	21-Feb-03	768.9	33-34	Orthoptera	1
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Blattaria	2
25	M	Underwood	21-Feb-03	768.9	3.75-5	Blattaria	1
25	M	Underwood	21-Feb-03	768.9	5-6.25	Blattaria	2
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Blattaria	1
25	M	Underwood	21-Feb-03	768.9	10--11	Blattaria	1
25	M	Underwood	21-Feb-03	768.9	11--12	Blattaria	1
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Isoptera	51
25	M	Underwood	21-Feb-03	768.9	3.75-5	Isoptera	9
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Psocoptera	26
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Hemiptera	47
25	M	Underwood	21-Feb-03	768.9	3.75-5	Hemiptera	9
25	M	Underwood	21-Feb-03	768.9	5-6.25	Hemiptera	2
25	M	Underwood	21-Feb-03	768.9	7.5-9	Hemiptera	1
25	M	Underwood	21-Feb-03	768.9	<1.25	Coleoptera	18
25	M	Underwood	21-Feb-03	768.9	1.25-2.5	Coleoptera	125
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Coleoptera	11
25	M	Underwood	21-Feb-03	768.9	3.75-5	Coleoptera	8
25	M	Underwood	21-Feb-03	768.9	5-6.25	Coleoptera	3
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Coleoptera	1
25	M	Underwood	21-Feb-03	768.9	7.5-9	Coleoptera	16
25	M	Underwood	21-Feb-03	768.9	9--10	Coleoptera	1

25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Diptera	38
25	M	Underwood	21-Feb-03	768.9	3.75-5	Diptera	9
25	M	Underwood	21-Feb-03	768.9	5-6.25	Diptera	1
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Diptera	3
25	M	Underwood	21-Feb-03	768.9	7.5-9	Diptera	1
25	M	Underwood	21-Feb-03	768.9	10--11	Diptera	1
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Lepidoptera	7
25	M	Underwood	21-Feb-03	768.9	3.75-5	Lepidoptera	13
25	M	Underwood	21-Feb-03	768.9	5-6.25	Lepidoptera	1
25	M	Underwood	21-Feb-03	768.9	10--11	Lepidoptera	1
25	M	Underwood	21-Feb-03	768.9	11--12	Lepidoptera	1
25	M	Underwood	21-Feb-03	768.9	14--15	Lepidoptera	1
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Formicidae	269
25	M	Underwood	21-Feb-03	768.9	3.75-5	Formicidae	66
25	M	Underwood	21-Feb-03	768.9	5-6.25	Formicidae	7
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Formicidae	4
25	M	Underwood	21-Feb-03	768.9	7.5-9	Formicidae	1
25	M	Underwood	21-Feb-03	768.9	11--12	Formicidae	2
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	Hymenoptera	15
25	M	Underwood	21-Feb-03	768.9	3.75-5	Hymenoptera	4
25	M	Underwood	21-Feb-03	768.9	5-6.25	Hymenoptera	1
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	Hymenoptera	1
25	M	Underwood	21-Feb-03	768.9	7.5-9	Hymenoptera	2
25	M	Underwood	21-Feb-03	768.9	2.5-3.75	insect larvae	8
25	M	Underwood	21-Feb-03	768.9	3.75-5	insect larvae	1
25	M	Underwood	21-Feb-03	768.9	6.25-7.5	insect larvae	4
25	M	Underwood	21-Feb-03	768.9	7.5-9	insect larvae	4
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Araneae	47
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Araneae	27
26	M	Cassava	1-Apr-03	2015.2	5-6.25	Araneae	2
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Polyxenida	1
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Orthoptera	16
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Orthoptera	35
26	M	Cassava	1-Apr-03	2015.2	5-6.25	Orthoptera	29
26	M	Cassava	1-Apr-03	2015.2	6.25-7.5	Orthoptera	12
26	M	Cassava	1-Apr-03	2015.2	7.5-9	Orthoptera	16
26	M	Cassava	1-Apr-03	2015.2	9--10	Orthoptera	3
26	M	Cassava	1-Apr-03	2015.2	10--11	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	11--12	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	12--13	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	13--14	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	16-17	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	23-24	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	29-30	Orthoptera	1
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Blattaria	5
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Blattaria	1

26	M	Cassava	1-Apr-03	2015.2	5-6.25	Blattaria	2
26	M	Cassava	1-Apr-03	2015.2	7.5-9	Blattaria	5
26	M	Cassava	1-Apr-03	2015.2	10--11	Blattaria	3
26	M	Cassava	1-Apr-03	2015.2	14--15	Blattaria	2
26	M	Cassava	1-Apr-03	2015.2	24-25	Blattaria	1
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Isoptera	1
26	M	Cassava	1-Apr-03	2015.2	5-6.25	Isoptera	1
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Psocoptera	138
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Hemiptera	61
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Hemiptera	24
26	M	Cassava	1-Apr-03	2015.2	5-6.25	Hemiptera	1
26	M	Cassava	1-Apr-03	2015.2	7.5-9	Hemiptera	4
26	M	Cassava	1-Apr-03	2015.2	11--12	Neuroptera	1
26	M	Cassava	1-Apr-03	2015.2	12--13	Neuroptera	1
26	M	Cassava	1-Apr-03	2015.2	13--14	Neuroptera	12
26	M	Cassava	1-Apr-03	2015.2	14--15	Neuroptera	2
26	M	Cassava	1-Apr-03	2015.2	15-16	Neuroptera	1
26	M	Cassava	1-Apr-03	2015.2	<1.25	Coleoptera	28
26	M	Cassava	1-Apr-03	2015.2	1.25-2.5	Coleoptera	41
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Coleoptera	10
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Coleoptera	4
26	M	Cassava	1-Apr-03	2015.2	14--15	Coleoptera	1
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Diptera	64
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Diptera	9
26	M	Cassava	1-Apr-03	2015.2	5-6.25	Diptera	1
26	M	Cassava	1-Apr-03	2015.2	6.25-7.5	Diptera	2
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Lepidoptera	2
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Lepidoptera	2
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Formicidae	102
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Formicidae	52
26	M	Cassava	1-Apr-03	2015.2	5-6.25	Formicidae	11
26	M	Cassava	1-Apr-03	2015.2	10--11	Formicidae	2
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	Hymenoptera	17
26	M	Cassava	1-Apr-03	2015.2	3.75-5	Hymenoptera	1
26	M	Cassava	1-Apr-03	2015.2	6.25-7.5	Hymenoptera	1
26	M	Cassava	1-Apr-03	2015.2	7.5-9	Hymenoptera	1
26	M	Cassava	1-Apr-03	2015.2	13--14	Hymenoptera	1
26	M	Cassava	1-Apr-03	2015.2	2.5-3.75	insect larvae	35
26	M	Cassava	1-Apr-03	2015.2	3.75-5	insect larvae	29
26	M	Cassava	1-Apr-03	2015.2	5-6.25	insect larvae	8
26	M	Cassava	1-Apr-03	2015.2	6.25-7.5	insect larvae	2
26	M	Cassava	1-Apr-03	2015.2	14--15	insect larvae	1
26	M	Cassava	1-Apr-03	2015.2	36-37	insect larvae	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Araneae	52
27	M	Underwood	8-Apr-03	165.69	3.75-5	Araneae	22
27	M	Underwood	8-Apr-03	165.69	5-6.25	Araneae	10

27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Araneae	4
27	M	Underwood	8-Apr-03	165.69	7.5-9	Julida	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Microcoryphia	1
27	M	Underwood	8-Apr-03	165.69	53-54	Phasmida	1
27	M	Underwood	8-Apr-03	165.69	58-59	Phasmida	1
27	M	Underwood	8-Apr-03	165.69	67-68	Phasmida	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Orthoptera	21
27	M	Underwood	8-Apr-03	165.69	3.75-5	Orthoptera	24
27	M	Underwood	8-Apr-03	165.69	5-6.25	Orthoptera	20
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Orthoptera	16
27	M	Underwood	8-Apr-03	165.69	7.5-9	Orthoptera	44
27	M	Underwood	8-Apr-03	165.69	9--10	Orthoptera	14
27	M	Underwood	8-Apr-03	165.69	10--11	Orthoptera	3
27	M	Underwood	8-Apr-03	165.69	11--12	Orthoptera	1
27	M	Underwood	8-Apr-03	165.69	13--14	Orthoptera	2
27	M	Underwood	8-Apr-03	165.69	16-17	Orthoptera	1
27	M	Underwood	8-Apr-03	165.69	20-21	Orthoptera	1
27	M	Underwood	8-Apr-03	165.69	21-22	Orthoptera	2
27	M	Underwood	8-Apr-03	165.69	28-29	Orthoptera	3
27	M	Underwood	8-Apr-03	165.69	34-35	Orthoptera	2
27	M	Underwood	8-Apr-03	165.69	3.75-5	Blattaria	4
27	M	Underwood	8-Apr-03	165.69	5-6.25	Blattaria	5
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Blattaria	5
27	M	Underwood	8-Apr-03	165.69	10--11	Blattaria	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Isoptera	6
27	M	Underwood	8-Apr-03	165.69	3.75-5	Isoptera	6
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Psocoptera	19
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Hemiptera	25
27	M	Underwood	8-Apr-03	165.69	3.75-5	Hemiptera	15
27	M	Underwood	8-Apr-03	165.69	5-6.25	Hemiptera	9
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Hemiptera	1
27	M	Underwood	8-Apr-03	165.69	7.5-9	Hemiptera	2
27	M	Underwood	8-Apr-03	165.69	9--10	Hemiptera	1
27	M	Underwood	8-Apr-03	165.69	14--15	Neuroptera	2
27	M	Underwood	8-Apr-03	165.69	<1.25	Coleoptera	11
27	M	Underwood	8-Apr-03	165.69	1.25-2.5	Coleoptera	157
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Coleoptera	19
27	M	Underwood	8-Apr-03	165.69	3.75-5	Coleoptera	3
27	M	Underwood	8-Apr-03	165.69	7.5-9	Coleoptera	43
27	M	Underwood	8-Apr-03	165.69	9--10	Coleoptera	7
27	M	Underwood	8-Apr-03	165.69	10--11	Coleoptera	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Diptera	53
27	M	Underwood	8-Apr-03	165.69	3.75-5	Diptera	4
27	M	Underwood	8-Apr-03	165.69	5-6.25	Diptera	4
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Diptera	2
27	M	Underwood	8-Apr-03	165.69	7.5-9	Diptera	2
27	M	Underwood	8-Apr-03	165.69	9--10	Diptera	1

27	M	Underwood	8-Apr-03	165.69	10--11	Diptera	1
27	M	Underwood	8-Apr-03	165.69	11--12	Diptera	1
27	M	Underwood	8-Apr-03	165.69	5-6.25	Trichoptera	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Lepidoptera	1
27	M	Underwood	8-Apr-03	165.69	3.75-5	Lepidoptera	1
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Lepidoptera	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Formicidae	278
27	M	Underwood	8-Apr-03	165.69	3.75-5	Formicidae	137
27	M	Underwood	8-Apr-03	165.69	5-6.25	Formicidae	31
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Formicidae	4
27	M	Underwood	8-Apr-03	165.69	7.5-9	Formicidae	1
27	M	Underwood	8-Apr-03	165.69	9--10	Formicidae	1
27	M	Underwood	8-Apr-03	165.69	10--11	Formicidae	1
27	M	Underwood	8-Apr-03	165.69	2.5-3.75	Hymenoptera	13
27	M	Underwood	8-Apr-03	165.69	3.75-5	Hymenoptera	7
27	M	Underwood	8-Apr-03	165.69	6.25-7.5	Hymenoptera	3
27	M	Underwood	8-Apr-03	165.69	7.5-9	Hymenoptera	5
27	M	Underwood	8-Apr-03	165.69	5-6.25	insect larvae	1
27	M	Underwood	8-Apr-03	165.69	7.5-9	insect larvae	2
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Araneae	147
28	M	Cassava	21-May-03	1722.89	3.75-5	Araneae	29
28	M	Cassava	21-May-03	1722.89	5-6.25	Araneae	16
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Araneae	1
28	M	Cassava	21-May-03	1722.89	7.5-9	Araneae	2
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Orthoptera	29
28	M	Cassava	21-May-03	1722.89	3.75-5	Orthoptera	31
28	M	Cassava	21-May-03	1722.89	5-6.25	Orthoptera	16
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Orthoptera	15
28	M	Cassava	21-May-03	1722.89	7.5-9	Orthoptera	6
28	M	Cassava	21-May-03	1722.89	9--10	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	10--11	Orthoptera	2
28	M	Cassava	21-May-03	1722.89	11--12	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	12--13	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	13--14	Orthoptera	2
28	M	Cassava	21-May-03	1722.89	17-18	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	18-19	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	19-20	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	31-32	Orthoptera	2
28	M	Cassava	21-May-03	1722.89	32-33	Orthoptera	1
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Blattaria	5
28	M	Cassava	21-May-03	1722.89	3.75-5	Blattaria	6
28	M	Cassava	21-May-03	1722.89	5-6.25	Blattaria	5
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Blattaria	2
28	M	Cassava	21-May-03	1722.89	7.5-9	Blattaria	7
28	M	Cassava	21-May-03	1722.89	10--11	Blattaria	1
28	M	Cassava	21-May-03	1722.89	16-17	Blattaria	1

28	M	Cassava	21-May-03	1722.89	2.5-3.75	Isoptera	1
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Psocoptera	295
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Hemiptera	44
28	M	Cassava	21-May-03	1722.89	3.75-5	Hemiptera	41
28	M	Cassava	21-May-03	1722.89	5-6.25	Hemiptera	21
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Hemiptera	2
28	M	Cassava	21-May-03	1722.89	7.5-9	Hemiptera	2
28	M	Cassava	21-May-03	1722.89	13--14	Neuroptera	3
28	M	Cassava	21-May-03	1722.89	<1.25	Coleoptera	18
28	M	Cassava	21-May-03	1722.89	1.25-2.5	Coleoptera	66
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Coleoptera	9
28	M	Cassava	21-May-03	1722.89	3.75-5	Coleoptera	3
28	M	Cassava	21-May-03	1722.89	5-6.25	Coleoptera	1
28	M	Cassava	21-May-03	1722.89	7.5-9	Coleoptera	1
28	M	Cassava	21-May-03	1722.89	9--10	Coleoptera	2
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Diptera	12
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Diptera	1
28	M	Cassava	21-May-03	1722.89	7.5-9	Diptera	2
28	M	Cassava	21-May-03	1722.89	3.75-5	Trichoptera	1
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Lepidoptera	6
28	M	Cassava	21-May-03	1722.89	3.75-5	Lepidoptera	5
28	M	Cassava	21-May-03	1722.89	5-6.25	Lepidoptera	2
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Formicidae	113
28	M	Cassava	21-May-03	1722.89	3.75-5	Formicidae	133
28	M	Cassava	21-May-03	1722.89	5-6.25	Formicidae	14
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Formicidae	1
28	M	Cassava	21-May-03	1722.89	7.5-9	Formicidae	3
28	M	Cassava	21-May-03	1722.89	2.5-3.75	Hymenoptera	15
28	M	Cassava	21-May-03	1722.89	3.75-5	Hymenoptera	2
28	M	Cassava	21-May-03	1722.89	5-6.25	Hymenoptera	1
28	M	Cassava	21-May-03	1722.89	6.25-7.5	Hymenoptera	1
28	M	Cassava	21-May-03	1722.89	7.5-9	Hymenoptera	1
28	M	Cassava	21-May-03	1722.89	10--11	Hymenoptera	1
28	M	Cassava	21-May-03	1722.89	2.5-3.75	insect larvae	45
28	M	Cassava	21-May-03	1722.89	3.75-5	insect larvae	39
28	M	Cassava	21-May-03	1722.89	5-6.25	insect larvae	4
29	M	Hope	22-May-03	2360.92	2.5-3.75	Araneae	24
29	M	Hope	22-May-03	2360.92	3.75-5	Araneae	4
29	M	Hope	22-May-03	2360.92	5-6.25	Araneae	4
29	M	Hope	22-May-03	2360.92	6.25-7.5	Araneae	1
29	M	Hope	22-May-03	2360.92	2.5-3.75	Orthoptera	2
29	M	Hope	22-May-03	2360.92	5-6.25	Orthoptera	1
29	M	Hope	22-May-03	2360.92	7.5-9	Blattaria	1
29	M	Hope	22-May-03	2360.92	2.5-3.75	Isoptera	2
29	M	Hope	22-May-03	2360.92	2.5-3.75	Psocoptera	409
29	M	Hope	22-May-03	2360.92	2.5-3.75	Hemiptera	10

29	M	Hope	22-May-03	2360.92	3.75-5	Hemiptera	9
29	M	Hope	22-May-03	2360.92	5-6.25	Hemiptera	1
29	M	Hope	22-May-03	2360.92	<1.25	Coleoptera	81
29	M	Hope	22-May-03	2360.92	1.25-2.5	Coleoptera	134
29	M	Hope	22-May-03	2360.92	2.5-3.75	Coleoptera	40
29	M	Hope	22-May-03	2360.92	3.75-5	Coleoptera	11
29	M	Hope	22-May-03	2360.92	5-6.25	Coleoptera	3
29	M	Hope	22-May-03	2360.92	6.25-7.5	Coleoptera	5
29	M	Hope	22-May-03	2360.92	7.5-9	Coleoptera	3
29	M	Hope	22-May-03	2360.92	2.5-3.75	Diptera	8
29	M	Hope	22-May-03	2360.92	3.75-5	Diptera	1
29	M	Hope	22-May-03	2360.92	7.5-9	Diptera	2
29	M	Hope	22-May-03	2360.92	2.5-3.75	Lepidoptera	9
29	M	Hope	22-May-03	2360.92	3.75-5	Lepidoptera	6
29	M	Hope	22-May-03	2360.92	5-6.25	Lepidoptera	2
29	M	Hope	22-May-03	2360.92	6.25-7.5	Lepidoptera	1
29	M	Hope	22-May-03	2360.92	2.5-3.75	Formicidae	164
29	M	Hope	22-May-03	2360.92	3.75-5	Formicidae	57
29	M	Hope	22-May-03	2360.92	5-6.25	Formicidae	3
29	M	Hope	22-May-03	2360.92	7.5-9	Formicidae	1
29	M	Hope	22-May-03	2360.92	2.5-3.75	Hymenoptera	18
29	M	Hope	22-May-03	2360.92	3.75-5	Hymenoptera	7
29	M	Hope	22-May-03	2360.92	5-6.25	Hymenoptera	2
29	M	Hope	22-May-03	2360.92	6.25-7.5	Hymenoptera	2
29	M	Hope	22-May-03	2360.92	7.5-9	Hymenoptera	4
29	M	Hope	22-May-03	2360.92	2.5-3.75	insect larvae	20
29	M	Hope	22-May-03	2360.92	3.75-5	insect larvae	15
29	M	Hope	22-May-03	2360.92	5-6.25	insect larvae	2
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Araneae	9
30	M	Fogarty	27-May-03	371.22	3.75-5	Araneae	1
30	M	Fogarty	27-May-03	371.22	5-6.25	Araneae	1
30	M	Fogarty	27-May-03	371.22	6.25-7.5	Araneae	1
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Orthoptera	21
30	M	Fogarty	27-May-03	371.22	3.75-5	Orthoptera	7
30	M	Fogarty	27-May-03	371.22	5-6.25	Orthoptera	9
30	M	Fogarty	27-May-03	371.22	6.25-7.5	Orthoptera	8
30	M	Fogarty	27-May-03	371.22	7.5-9	Orthoptera	3
30	M	Fogarty	27-May-03	371.22	15--16	Orthoptera	1
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Blattaria	9
30	M	Fogarty	27-May-03	371.22	3.75-5	Blattaria	1
30	M	Fogarty	27-May-03	371.22	5-6.25	Blattaria	2
30	M	Fogarty	27-May-03	371.22	6.25-7.5	Blattaria	1
30	M	Fogarty	27-May-03	371.22	7.5-9	Blattaria	2
30	M	Fogarty	27-May-03	371.22	12--13	Blattaria	1
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Isoptera	2
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Psocoptera	270

30	M	Fogarty	27-May-03	371.22	2.5-3.75	Hemiptera	27
30	M	Fogarty	27-May-03	371.22	3.75-5	Hemiptera	9
30	M	Fogarty	27-May-03	371.22	5-6.25	Hemiptera	1
30	M	Fogarty	27-May-03	371.22	7.5-9	Hemiptera	1
30	M	Fogarty	27-May-03	371.22	<1.25	Coleoptera	32
30	M	Fogarty	27-May-03	371.22	1.25-2.5	Coleoptera	160
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Coleoptera	1
30	M	Fogarty	27-May-03	371.22	3.75-5	Coleoptera	2
30	M	Fogarty	27-May-03	371.22	5-6.25	Coleoptera	2
30	M	Fogarty	27-May-03	371.22	7.5-9	Coleoptera	2
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Diptera	2
30	M	Fogarty	27-May-03	371.22	3.75-5	Diptera	2
30	M	Fogarty	27-May-03	371.22	5-6.25	Diptera	1
30	M	Fogarty	27-May-03	371.22	7.5-9	Diptera	1
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Lepidoptera	3
30	M	Fogarty	27-May-03	371.22	3.75-5	Lepidoptera	1
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Formicidae	170
30	M	Fogarty	27-May-03	371.22	3.75-5	Formicidae	105
30	M	Fogarty	27-May-03	371.22	5-6.25	Formicidae	19
30	M	Fogarty	27-May-03	371.22	2.5-3.75	Hymenoptera	17
30	M	Fogarty	27-May-03	371.22	3.75-5	Hymenoptera	4
30	M	Fogarty	27-May-03	371.22	5-6.25	Hymenoptera	1
30	M	Fogarty	27-May-03	371.22	6.25-7.5	Hymenoptera	1
30	M	Fogarty	27-May-03	371.22	2.5-3.75	insect larvae	2
30	M	Fogarty	27-May-03	371.22	3.75-5	insect larvae	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Araneae	68
31	M	Underwood	29-May-03	156.01	3.75-5	Araneae	26
31	M	Underwood	29-May-03	156.01	5-6.25	Araneae	9
31	M	Underwood	29-May-03	156.01	6.25-7.5	Araneae	2
31	M	Underwood	29-May-03	156.01	14--15	Spirostreptida	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Polyxenida	2
31	M	Underwood	29-May-03	156.01	21-22	Phasmida	1
31	M	Underwood	29-May-03	156.01	37-38	Phasmida	1
31	M	Underwood	29-May-03	156.01	39-40	Phasmida	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Orthoptera	48
31	M	Underwood	29-May-03	156.01	3.75-5	Orthoptera	17
31	M	Underwood	29-May-03	156.01	5-6.25	Orthoptera	22
31	M	Underwood	29-May-03	156.01	6.25-7.5	Orthoptera	34
31	M	Underwood	29-May-03	156.01	7.5-9	Orthoptera	27
31	M	Underwood	29-May-03	156.01	9--10	Orthoptera	1
31	M	Underwood	29-May-03	156.01	11--12	Orthoptera	1
31	M	Underwood	29-May-03	156.01	12--13	Orthoptera	1
31	M	Underwood	29-May-03	156.01	19-20	Orthoptera	1
31	M	Underwood	29-May-03	156.01	21-22	Orthoptera	1
31	M	Underwood	29-May-03	156.01	30-31	Orthoptera	1
31	M	Underwood	29-May-03	156.01	33-34	Orthoptera	1

31	M	Underwood	29-May-03	156.01	59-60	Orthoptera	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Blattaria	1
31	M	Underwood	29-May-03	156.01	3.75-5	Blattaria	1
31	M	Underwood	29-May-03	156.01	5-6.25	Blattaria	2
31	M	Underwood	29-May-03	156.01	6.25-7.5	Blattaria	5
31	M	Underwood	29-May-03	156.01	7.5-9	Blattaria	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Isoptera	68
31	M	Underwood	29-May-03	156.01	3.75-5	Isoptera	18
31	M	Underwood	29-May-03	156.01	2.5-3.75	Psocoptera	545
31	M	Underwood	29-May-03	156.01	2.5-3.75	Hemiptera	55
31	M	Underwood	29-May-03	156.01	3.75-5	Hemiptera	28
31	M	Underwood	29-May-03	156.01	5-6.25	Hemiptera	18
31	M	Underwood	29-May-03	156.01	6.25-7.5	Hemiptera	9
31	M	Underwood	29-May-03	156.01	7.5-9	Hemiptera	1
31	M	Underwood	29-May-03	156.01	<1.25	Coleoptera	57
31	M	Underwood	29-May-03	156.01	1.25-2.5	Coleoptera	269
31	M	Underwood	29-May-03	156.01	2.5-3.75	Coleoptera	19
31	M	Underwood	29-May-03	156.01	3.75-5	Coleoptera	8
31	M	Underwood	29-May-03	156.01	6.25-7.5	Coleoptera	2
31	M	Underwood	29-May-03	156.01	7.5-9	Coleoptera	22
31	M	Underwood	29-May-03	156.01	2.5-3.75	Diptera	9
31	M	Underwood	29-May-03	156.01	3.75-5	Diptera	2
31	M	Underwood	29-May-03	156.01	6.25-7.5	Diptera	1
31	M	Underwood	29-May-03	156.01	7.5-9	Diptera	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Lepidoptera	6
31	M	Underwood	29-May-03	156.01	3.75-5	Lepidoptera	4
31	M	Underwood	29-May-03	156.01	6.25-7.5	Lepidoptera	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	Formicidae	174
31	M	Underwood	29-May-03	156.01	3.75-5	Formicidae	182
31	M	Underwood	29-May-03	156.01	5-6.25	Formicidae	29
31	M	Underwood	29-May-03	156.01	6.25-7.5	Formicidae	4
31	M	Underwood	29-May-03	156.01	2.5-3.75	Hymenoptera	31
31	M	Underwood	29-May-03	156.01	3.75-5	Hymenoptera	5
31	M	Underwood	29-May-03	156.01	5-6.25	Hymenoptera	1
31	M	Underwood	29-May-03	156.01	2.5-3.75	insect larvae	6
31	M	Underwood	29-May-03	156.01	3.75-5	insect larvae	5
31	M	Underwood	29-May-03	156.01	7.5-9	insect larvae	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Araneae	10
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Araneae	5
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Araneae	2
32	M	Fogarty	30-Jul-03	315.9	6.25-7.5	Araneae	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Orthoptera	3
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Orthoptera	1
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Orthoptera	3
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Blattaria	1
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Blattaria	1

32	M	Fogarty	30-Jul-03	315.9	5-6.25	Blattaria	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Isoptera	4
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Psocoptera	9
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Hemiptera	2
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Hemiptera	2
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Hemiptera	1
32	M	Fogarty	30-Jul-03	315.9	<1.25	Coleoptera	25
32	M	Fogarty	30-Jul-03	315.9	1.25-2.5	Coleoptera	36
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Coleoptera	6
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Coleoptera	10
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Coleoptera	1
32	M	Fogarty	30-Jul-03	315.9	7.5-9	Coleoptera	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Diptera	16
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Diptera	1
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Lepidoptera	3
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Lepidoptera	1
32	M	Fogarty	30-Jul-03	315.9	7.5-9	Lepidoptera	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Formicidae	37
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Formicidae	25
32	M	Fogarty	30-Jul-03	315.9	10--11	Formicidae	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	Hymenoptera	34
32	M	Fogarty	30-Jul-03	315.9	3.75-5	Hymenoptera	5
32	M	Fogarty	30-Jul-03	315.9	5-6.25	Hymenoptera	8
32	M	Fogarty	30-Jul-03	315.9	7.5-9	Hymenoptera	1
32	M	Fogarty	30-Jul-03	315.9	2.5-3.75	insect larvae	13
32	M	Fogarty	30-Jul-03	315.9	3.75-5	insect larvae	17
32	M	Fogarty	30-Jul-03	315.9	5-6.25	insect larvae	2
32	M	Fogarty	30-Jul-03	315.9	6.25-7.5	insect larvae	5
32	M	Fogarty	30-Jul-03	315.9	7.5-9	insect larvae	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Araneae	21
33	M	Hope	1-Aug-03	3569.92	3.75-5	Araneae	10
33	M	Hope	1-Aug-03	3569.92	5-6.25	Araneae	4
33	M	Hope	1-Aug-03	3569.92	6.25-7.5	Araneae	1
33	M	Hope	1-Aug-03	3569.92	7.5-9	Araneae	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Orthoptera	2
33	M	Hope	1-Aug-03	3569.92	7.5-9	Orthoptera	1
33	M	Hope	1-Aug-03	3569.92	5-6.25	Blattaria	1
33	M	Hope	1-Aug-03	3569.92	3.75-5	Isoptera	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Psocoptera	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Hemiptera	4
33	M	Hope	1-Aug-03	3569.92	5-6.25	Hemiptera	2
33	M	Hope	1-Aug-03	3569.92	6.25-7.5	Hemiptera	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Thysanoptera	1
33	M	Hope	1-Aug-03	3569.92	<1.25	Coleoptera	14
33	M	Hope	1-Aug-03	3569.92	1.25-2.5	Coleoptera	44
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Coleoptera	9

33	M	Hope	1-Aug-03	3569.92	3.75-5	Coleoptera	3
33	M	Hope	1-Aug-03	3569.92	5-6.25	Coleoptera	1
33	M	Hope	1-Aug-03	3569.92	6.25-7.5	Coleoptera	1
33	M	Hope	1-Aug-03	3569.92	7.5-9	Coleoptera	1
33	M	Hope	1-Aug-03	3569.92	10--11	Coleoptera	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Diptera	23
33	M	Hope	1-Aug-03	3569.92	3.75-5	Diptera	6
33	M	Hope	1-Aug-03	3569.92	5-6.25	Diptera	1
33	M	Hope	1-Aug-03	3569.92	7.5-9	Diptera	2
33	M	Hope	1-Aug-03	3569.92	11--12	Diptera	1
33	M	Hope	1-Aug-03	3569.92	18-19	Diptera	2
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Lepidoptera	2
33	M	Hope	1-Aug-03	3569.92	3.75-5	Lepidoptera	7
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Formicidae	139
33	M	Hope	1-Aug-03	3569.92	3.75-5	Formicidae	20
33	M	Hope	1-Aug-03	3569.92	5-6.25	Formicidae	5
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	Hymenoptera	19
33	M	Hope	1-Aug-03	3569.92	3.75-5	Hymenoptera	7
33	M	Hope	1-Aug-03	3569.92	5-6.25	Hymenoptera	5
33	M	Hope	1-Aug-03	3569.92	6.25-7.5	Hymenoptera	1
33	M	Hope	1-Aug-03	3569.92	7.5-9	Hymenoptera	1
33	M	Hope	1-Aug-03	3569.92	2.5-3.75	insect larvae	19
33	M	Hope	1-Aug-03	3569.92	3.75-5	insect larvae	12
33	M	Hope	1-Aug-03	3569.92	5-6.25	insect larvae	3
33	M	Hope	1-Aug-03	3569.92	6.25-7.5	insect larvae	2
33	M	Hope	1-Aug-03	3569.92	11--12	insect larvae	2
33	M	Hope	1-Aug-03	3569.92	12--13	insect larvae	1
33	M	Hope	1-Aug-03	3569.92	21-22	insect larvae	1
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Araneae	41
34	M	Underwood	7-Aug-03	256.45	3.75-5	Araneae	26
34	M	Underwood	7-Aug-03	256.45	5-6.25	Araneae	12
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Araneae	3
34	M	Underwood	7-Aug-03	256.45	7.5-9	Araneae	1
34	M	Underwood	7-Aug-03	256.45	5-6.25	Opiliones	1
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Polyxenida	7
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Spirostreptida	1
34	M	Underwood	7-Aug-03	256.45	3.75-5	Isopoda	1
34	M	Underwood	7-Aug-03	256.45	5-6.25	Microcoryphia	1
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Microcoryphia	2
34	M	Underwood	7-Aug-03	256.45	7.5-9	Microcoryphia	1
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Orthoptera	32
34	M	Underwood	7-Aug-03	256.45	3.75-5	Orthoptera	34
34	M	Underwood	7-Aug-03	256.45	5-6.25	Orthoptera	41
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Orthoptera	28
34	M	Underwood	7-Aug-03	256.45	7.5-9	Orthoptera	19
34	M	Underwood	7-Aug-03	256.45	9--10	Orthoptera	2

34	M	Underwood	7-Aug-03	256.45	10--11	Orthoptera	3
34	M	Underwood	7-Aug-03	256.45	14-15	Orthoptera	1
34	M	Underwood	7-Aug-03	256.45	3.75-5	Blattaria	6
34	M	Underwood	7-Aug-03	256.45	5-6.25	Blattaria	4
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Blattaria	2
34	M	Underwood	7-Aug-03	256.45	7.5-9	Blattaria	2
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Isoptera	11
34	M	Underwood	7-Aug-03	256.45	3.75-5	Isoptera	1
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Psocoptera	11
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Hemiptera	28
34	M	Underwood	7-Aug-03	256.45	3.75-5	Hemiptera	16
34	M	Underwood	7-Aug-03	256.45	5-6.25	Hemiptera	7
34	M	Underwood	7-Aug-03	256.45	7.5-9	Hemiptera	4
34	M	Underwood	7-Aug-03	256.45	25-26	Hemiptera	1
34	M	Underwood	7-Aug-03	256.45	<1.25	Coleoptera	24
34	M	Underwood	7-Aug-03	256.45	1.25-2.5	Coleoptera	82
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Coleoptera	22
34	M	Underwood	7-Aug-03	256.45	3.75-5	Coleoptera	14
34	M	Underwood	7-Aug-03	256.45	5-6.25	Coleoptera	1
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Coleoptera	2
34	M	Underwood	7-Aug-03	256.45	7.5-9	Coleoptera	5
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Diptera	34
34	M	Underwood	7-Aug-03	256.45	3.75-5	Diptera	17
34	M	Underwood	7-Aug-03	256.45	5-6.25	Diptera	7
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Diptera	5
34	M	Underwood	7-Aug-03	256.45	7.5-9	Diptera	3
34	M	Underwood	7-Aug-03	256.45	12--13	Diptera	1
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Trichoptera	1
34	M	Underwood	7-Aug-03	256.45	3.75-5	Trichoptera	1
34	M	Underwood	7-Aug-03	256.45	5-6.25	Trichoptera	1
34	M	Underwood	7-Aug-03	256.45	3.75-5	Lepidoptera	3
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Formicidae	213
34	M	Underwood	7-Aug-03	256.45	3.75-5	Formicidae	187
34	M	Underwood	7-Aug-03	256.45	5-6.25	Formicidae	39
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Formicidae	4
34	M	Underwood	7-Aug-03	256.45	7.5-9	Formicidae	2
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	Hymenoptera	26
34	M	Underwood	7-Aug-03	256.45	3.75-5	Hymenoptera	16
34	M	Underwood	7-Aug-03	256.45	5-6.25	Hymenoptera	5
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	Hymenoptera	2
34	M	Underwood	7-Aug-03	256.45	7.5-9	Hymenoptera	3
34	M	Underwood	7-Aug-03	256.45	2.5-3.75	insect larvae	24
34	M	Underwood	7-Aug-03	256.45	3.75-5	insect larvae	22
34	M	Underwood	7-Aug-03	256.45	5-6.25	insect larvae	11
34	M	Underwood	7-Aug-03	256.45	6.25-7.5	insect larvae	11
34	M	Underwood	7-Aug-03	256.45	7.5-9	insect larvae	6
34	M	Underwood	7-Aug-03	256.45	9--10	insect larvae	1

34	M	Underwood	7-Aug-03	256.45	10--11	insect larvae	1
34	M	Underwood	7-Aug-03	256.45	11--12	insect larvae	3
34	M	Underwood	7-Aug-03	256.45	13--14	insect larvae	4
34	M	Underwood	7-Aug-03	256.45	14-15	insect larvae	4
34	M	Underwood	7-Aug-03	256.45	15-16	insect larvae	3
34	M	Underwood	7-Aug-03	256.45	16-17	insect larvae	1
34	M	Underwood	7-Aug-03	256.45	19-20	insect larvae	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Araneae	43
35	SK	Wingfield	3-Jul-03	0	3.75-5	Araneae	26
35	SK	Wingfield	3-Jul-03	0	5-6.25	Araneae	6
35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Araneae	3
35	SK	Wingfield	3-Jul-03	0	7.5-9	Araneae	1
35	SK	Wingfield	3-Jul-03	0	19-20	Scolopendromorpha	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Orthoptera	10
35	SK	Wingfield	3-Jul-03	0	3.75-5	Orthoptera	7
35	SK	Wingfield	3-Jul-03	0	5-6.25	Orthoptera	7
35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Orthoptera	11
35	SK	Wingfield	3-Jul-03	0	7.5-9	Orthoptera	10
35	SK	Wingfield	3-Jul-03	0	9--10	Orthoptera	2
35	SK	Wingfield	3-Jul-03	0	12--13	Orthoptera	1
35	SK	Wingfield	3-Jul-03	0	13--14	Orthoptera	2
35	SK	Wingfield	3-Jul-03	0	14--15	Orthoptera	1
35	SK	Wingfield	3-Jul-03	0	18-19	Orthoptera	1
35	SK	Wingfield	3-Jul-03	0	19-20	Orthoptera	1
35	SK	Wingfield	3-Jul-03	0	31-32	Orthoptera	1
35	SK	Wingfield	3-Jul-03	0	38-39	Orthoptera	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Blattaria	6
35	SK	Wingfield	3-Jul-03	0	3.75-5	Blattaria	4
35	SK	Wingfield	3-Jul-03	0	5-6.25	Blattaria	3
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Isoptera	9
35	SK	Wingfield	3-Jul-03	0	3.75-5	Isoptera	3
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Dermaptera	5
35	SK	Wingfield	3-Jul-03	0	3.75-5	Dermaptera	2
35	SK	Wingfield	3-Jul-03	0	11--12	Dermaptera	1
35	SK	Wingfield	3-Jul-03	0	13--14	Dermaptera	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Psocoptera	101
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Hemiptera	45
35	SK	Wingfield	3-Jul-03	0	3.75-5	Hemiptera	3
35	SK	Wingfield	3-Jul-03	0	5-6.25	Hemiptera	2
35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Hemiptera	3
35	SK	Wingfield	3-Jul-03	0	13--14	Neuroptera	1
35	SK	Wingfield	3-Jul-03	0	<1.25	Coleoptera	5
35	SK	Wingfield	3-Jul-03	0	1.25-2.5	Coleoptera	32
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Coleoptera	5
35	SK	Wingfield	3-Jul-03	0	3.75-5	Coleoptera	5
35	SK	Wingfield	3-Jul-03	0	5-6.25	Coleoptera	4

35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Coleoptera	1
35	SK	Wingfield	3-Jul-03	0	11--12	Coleoptera	2
35	SK	Wingfield	3-Jul-03	0	13--14	Coleoptera	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Diptera	14
35	SK	Wingfield	3-Jul-03	0	3.75-5	Diptera	12
35	SK	Wingfield	3-Jul-03	0	5-6.25	Diptera	1
35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Diptera	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Lepidoptera	6
35	SK	Wingfield	3-Jul-03	0	3.75-5	Lepidoptera	33
35	SK	Wingfield	3-Jul-03	0	5-6.25	Lepidoptera	2
35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Lepidoptera	1
35	SK	Wingfield	3-Jul-03	0	7.5-9	Lepidoptera	12
35	SK	Wingfield	3-Jul-03	0	9--10	Lepidoptera	2
35	SK	Wingfield	3-Jul-03	0	26-27	Lepidoptera	1
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Formicidae	98
35	SK	Wingfield	3-Jul-03	0	3.75-5	Formicidae	124
35	SK	Wingfield	3-Jul-03	0	5-6.25	Formicidae	17
35	SK	Wingfield	3-Jul-03	0	6.25-7.5	Formicidae	13
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	Hymenoptera	8
35	SK	Wingfield	3-Jul-03	0	3.75-5	Hymenoptera	5
35	SK	Wingfield	3-Jul-03	0	2.5-3.75	insect larvae	3
35	SK	Wingfield	3-Jul-03	0	3.75-5	insect larvae	1
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Araneae	77
36	SK	PM Trail	4-Jul-02	0	3.75-5	Araneae	66
36	SK	PM Trail	4-Jul-02	0	5-6.25	Araneae	21
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Araneae	8
36	SK	PM Trail	4-Jul-02	0	7.5-9	Araneae	7
36	SK	PM Trail	4-Jul-02	0	7.5-9	Cambalida	1
36	SK	PM Trail	4-Jul-02	0	15--16	Scolopendromorpha	1
36	SK	PM Trail	4-Jul-02	0	37-38	Scolopendromorpha	1
36	SK	PM Trail	4-Jul-02	0	11--12	Phasmida	2
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Orthoptera	64
36	SK	PM Trail	4-Jul-02	0	3.75-5	Orthoptera	42
36	SK	PM Trail	4-Jul-02	0	5-6.25	Orthoptera	13
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Orthoptera	21
36	SK	PM Trail	4-Jul-02	0	7.5-9	Orthoptera	25
36	SK	PM Trail	4-Jul-02	0	9--10	Orthoptera	15
36	SK	PM Trail	4-Jul-02	0	10--11	Orthoptera	8
36	SK	PM Trail	4-Jul-02	0	11--12	Orthoptera	3
36	SK	PM Trail	4-Jul-02	0	12--13	Orthoptera	4
36	SK	PM Trail	4-Jul-02	0	13--14	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	15--16	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	16--17	Orthoptera	2
36	SK	PM Trail	4-Jul-02	0	19-20	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	22-23	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	28-29	Orthoptera	1

36	SK	PM Trail	4-Jul-02	0	29-30	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	31-32	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	34-35	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	37-38	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	39-40	Orthoptera	1
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Blattaria	3
36	SK	PM Trail	4-Jul-02	0	3.75-5	Blattaria	4
36	SK	PM Trail	4-Jul-02	0	5-6.25	Blattaria	2
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Blattaria	2
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Psocoptera	200
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Hemiptera	279
36	SK	PM Trail	4-Jul-02	0	3.75-5	Hemiptera	98
36	SK	PM Trail	4-Jul-02	0	5-6.25	Hemiptera	3
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Hemiptera	2
36	SK	PM Trail	4-Jul-02	0	9--10	Hemiptera	1
36	SK	PM Trail	4-Jul-02	0	10--11	Hemiptera	1
36	SK	PM Trail	4-Jul-02	0	12--13	Neuroptera	1
36	SK	PM Trail	4-Jul-02	0	13--14	Neuroptera	3
36	SK	PM Trail	4-Jul-02	0	14--15	Neuroptera	4
36	SK	PM Trail	4-Jul-02	0	15--16	Neuroptera	5
36	SK	PM Trail	4-Jul-02	0	16--17	Neuroptera	3
36	SK	PM Trail	4-Jul-02	0	17--18	Neuroptera	1
36	SK	PM Trail	4-Jul-02	0	<1.25	Coleoptera	64
36	SK	PM Trail	4-Jul-02	0	1.25-2.5	Coleoptera	497
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Coleoptera	80
36	SK	PM Trail	4-Jul-02	0	3.75-5	Coleoptera	98
36	SK	PM Trail	4-Jul-02	0	5-6.25	Coleoptera	22
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Coleoptera	2
36	SK	PM Trail	4-Jul-02	0	7.5-9	Coleoptera	1
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Diptera	159
36	SK	PM Trail	4-Jul-02	0	3.75-5	Diptera	145
36	SK	PM Trail	4-Jul-02	0	5-6.25	Diptera	6
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Diptera	1
36	SK	PM Trail	4-Jul-02	0	7.5-9	Diptera	4
36	SK	PM Trail	4-Jul-02	0	10--11	Diptera	2
36	SK	PM Trail	4-Jul-02	0	13--14	Diptera	1
36	SK	PM Trail	4-Jul-02	0	15--16	Diptera	1
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Lepidoptera	23
36	SK	PM Trail	4-Jul-02	0	3.75-5	Lepidoptera	27
36	SK	PM Trail	4-Jul-02	0	5-6.25	Lepidoptera	2
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Lepidoptera	1
36	SK	PM Trail	4-Jul-02	0	7.5-9	Lepidoptera	4
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Formicidae	502
36	SK	PM Trail	4-Jul-02	0	3.75-5	Formicidae	125
36	SK	PM Trail	4-Jul-02	0	5-6.25	Formicidae	12
36	SK	PM Trail	4-Jul-02	0	7.5-9	Formicidae	1
36	SK	PM Trail	4-Jul-02	0	9--10	Formicidae	1

36	SK	PM Trail	4-Jul-02	0	2.5-3.75	Hymenoptera	69
36	SK	PM Trail	4-Jul-02	0	3.75-5	Hymenoptera	9
36	SK	PM Trail	4-Jul-02	0	5-6.25	Hymenoptera	1
36	SK	PM Trail	4-Jul-02	0	6.25-7.5	Hymenoptera	3
36	SK	PM Trail	4-Jul-02	0	7.5-9	Hymenoptera	2
36	SK	PM Trail	4-Jul-02	0	10--11	Hymenoptera	1
36	SK	PM Trail	4-Jul-02	0	2.5-3.75	insect larvae	10
36	SK	PM Trail	4-Jul-02	0	3.75-5	insect larvae	5
36	SK	PM Trail	4-Jul-02	0	5-6.25	insect larvae	3
36	SK	PM Trail	4-Jul-02	0	7.5-9	insect larvae	2
36	SK	PM Trail	4-Jul-02	0	10--11	insect larvae	1
36	SK	PM Trail	4-Jul-02	0	12--13	insect larvae	1
36	SK	PM Trail	4-Jul-02	0	15--16	insect larvae	1
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Araneae	16
37	SK	Bayford's	5-Jul-02	0	3.75-5	Araneae	5
37	SK	Bayford's	5-Jul-02	0	5-6.25	Araneae	2
37	SK	Bayford's	5-Jul-02	0	6.25-7.5	Araneae	2
37	SK	Bayford's	5-Jul-02	0	3.75-5	Cambalida	1
37	SK	Bayford's	5-Jul-02	0	12--13	Cambalida	1
37	SK	Bayford's	5-Jul-02	0	62-63	Scolopendromorpha	1
37	SK	Bayford's	5-Jul-02	0	75-76	Scolopendromorpha	1
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Orthoptera	15
37	SK	Bayford's	5-Jul-02	0	3.75-5	Orthoptera	10
37	SK	Bayford's	5-Jul-02	0	5-6.25	Orthoptera	3
37	SK	Bayford's	5-Jul-02	0	6.25-7.5	Orthoptera	12
37	SK	Bayford's	5-Jul-02	0	7.5-9	Orthoptera	6
37	SK	Bayford's	5-Jul-02	0	9--10	Orthoptera	1
37	SK	Bayford's	5-Jul-02	0	21-22	Orthoptera	1
37	SK	Bayford's	5-Jul-02	0	22-23	Orthoptera	1
37	SK	Bayford's	5-Jul-02	0	23-24	Orthoptera	1
37	SK	Bayford's	5-Jul-02	0	35-36	Orthoptera	1
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Blattaria	1
37	SK	Bayford's	5-Jul-02	0	5-6.25	Blattaria	1
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Psocoptera	119
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Hemiptera	36
37	SK	Bayford's	5-Jul-02	0	3.75-5	Hemiptera	8
37	SK	Bayford's	5-Jul-02	0	9--10	Hemiptera	1
37	SK	Bayford's	5-Jul-02	0	13--14	Neuroptera	1
37	SK	Bayford's	5-Jul-02	0	<1.25	Coleoptera	27
37	SK	Bayford's	5-Jul-02	0	1.25-2.5	Coleoptera	110
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Coleoptera	8
37	SK	Bayford's	5-Jul-02	0	3.75-5	Coleoptera	5
37	SK	Bayford's	5-Jul-02	0	6.25-7.5	Coleoptera	3
37	SK	Bayford's	5-Jul-02	0	7.5-9	Coleoptera	1
37	SK	Bayford's	5-Jul-02	0	9--10	Coleoptera	2
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Diptera	29

37	SK	Bayford's	5-Jul-02	0	3.75-5	Diptera	8
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Lepidoptera	6
37	SK	Bayford's	5-Jul-02	0	3.75-5	Lepidoptera	9
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Formicidae	171
37	SK	Bayford's	5-Jul-02	0	3.75-5	Formicidae	101
37	SK	Bayford's	5-Jul-02	0	5-6.25	Formicidae	9
37	SK	Bayford's	5-Jul-02	0	6.25-7.5	Formicidae	5
37	SK	Bayford's	5-Jul-02	0	7.5-9	Formicidae	1
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	Hymenoptera	45
37	SK	Bayford's	5-Jul-02	0	3.75-5	Hymenoptera	4
37	SK	Bayford's	5-Jul-02	0	2.5-3.75	insect larvae	2
37	SK	Bayford's	5-Jul-02	0	6.25-7.5	insect larvae	1

APPENDIX B

MONTSERRAT ORIOLE FEEDING DATA

Table 1, Appendix 2. Montserrat Oriole prey identifications, by site and date.

Site	Date	Araneae	Phasmida	Orthoptera	Cicadidae	Hemiptera	Coleoptera	Lepidoptera	Insect Larvae	Amphibia
C1.75	27-May-02									
G1	29-May-02			3				1		
G1	30-May-02	4		1				5		
G1	02-Jun-02	2		7			2	2	1	
G1	03-Jun-02	3		5				1		
G1	07-Jun-02		1	5			1	2		
G3	04-Jun-02									
G3	06-Jun-02									
G3	08-Jun-02			4				2		
G3	10-Jun-02			3						
G3	14-Jun-02			2						
H5	15-Jun-02			1					1	
H5	17-Jun-02			1				1		
H5	18-Jun-02			3			1			
JH1	02-Jul-02									
JH1	03-Jul-02									
JH1	06-Jul-02			1				1		
JH1	07-Jul-02			1						
U2	26-Jun-02			3						
U2	27-Jun-02			1						
U2	30-Jun-02			1						
C3.5	07-Jun-02	1		7				1	3	
C3.5	08-Jun-02			8					1	
C3.5	11-Jun-02			6						
C3.5	12-Jun-02			14						
C1.75	20-May-03									
C1.75	30-May-03			2						
C1.75	02-Jun-03			2				1		
C4	07-Jun-03	1		1				1		
C4	08-Jun-03			1						
C4	09-Jun-03			8				2		
C4	11-Jun-03			8	1			2	1	
C4	13-Jun-03			9						
C4	14-Jun-03			9					1	
C4	16-Jun-03	1		2						
C6	19-May-03			2	1			3		
C6	26-May-03			3				2		
F0.5	24-Jun-03		1	4					1	
F0.5	25-Jun-03		2	4					2	

F0.5	27-Jun-03		1	1	1				3	
F0.5	29-Jun-30	1		1				2	1	
F1	23-May-03		2		1			2	2	
F1	01-Jun-03						1			
H3	24-May-03				1			1		
H5	21-Jun-03							1		
H5	26-Jun-03							1		
H6	17-Jun-03								3	
H6	19-Jun-03			1					1	
J1	12-Jun-03	1		3					1	
J3	11-Aug-03	1		2			2		4	
J3	12-Aug-03			1			4		4	
J3	13-Aug-03			5		1	6	1	9	1
J3	14-Aug-03		1	8			4	1	1	
S1	28-May-03							2		

Table 2, Appendix 2. Montserrat Oriole prey size estimates, by site and date.

Site	Date	<1/4	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	>2
C1.75	27-May-02		2	1		2					
G1	29-May-02		2	1	1	4		1			
G1	30-May-02	3	1	4		4					
G1	02-Jun-02	4	3	3	1	4		3			
G1	03-Jun-02	1	3		1	7					
G1	07-Jun-02	2	1	7	2	5	2			1	
G3	04-Jun-02										
G3	06-Jun-02			1		1					
G3	08-Jun-02					3					
G3	10-Jun-02		2		1	3				2	
G3	14-Jun-02					4					
H5	15-Jun-02	3						1			
H5	17-Jun-02	1				1		1	1		
H5	18-Jun-02			1		3		1			
JH1	02-Jul-02										
JH1	03-Jul-02										
JH1	06-Jul-02					2					
JH1	07-Jul-02					1					
U2	26-Jun-02					4			1		
U2	27-Jun-02					1					
U2	30-Jun-02	1						1			
C3.5	07-Jun-02		3	2	3	3		2			
C3.5	08-Jun-02			1	1	1	2		10		
C3.5	11-Jun-02					2		2		1	
C3.5	12-Jun-02	1				5	1	3		3	
C1.75	20-May-03	1		1							
C1.75	30-May-03					3					

C1.75	02-Jun-03					4				
C4	07-Jun-03	1		1		1	1			
C4	08-Jun-03						1			
C4	09-Jun-03			4	1	7		2		
C4	11-Jun-03			2		10	1	1		
C4	13-Jun-03		2	2	1	4	4			
C4	14-Jun-03			4	3	6	1			
C4	16-Jun-03			2				1		
C6	19-May-03	1		2		11				
C6	26-May-03			2		5				1
F0.5	24-Jun-03	1	1	4		5	1			1
F0.5	25-Jun-03	5		4		4	2			2
F0.5	27-Jun-03	2		1		1	1	1	1	
F0.5	29-Jun-30	2	1	6						
F1	23-May-03	1	1	5		6				
F1	01-Jun-03	2		1	1	1				
H3	24-May-03					1				
H5	21-Jun-03			1		1				
H5	26-Jun-03									
H6	17-Jun-03			1		2		1		
H6	19-Jun-03			2	1					
J1	12-Jun-03			3	1	2				
J3	11-Aug-03	5	3	6	4	3				
J3	12-Aug-03	6	13	1	3	1	5			
J3	13-Aug-03		4	7	7	15	2	1		
J3	14-Aug-03		2	3	3	18	2			1
S1	28-May-03					3				

Table 3, Appendix 2. Post-eruption Montserrat Oriole nestling feeding rates, from nest observations (obs) and nest cameras (vid). Rates are feeds per hour. Nest sites and years are given along the x-axis, and days since chick hatch are given along the y-axis.

	C1.75	C1.75	C3.5	C4	C6	F0.5	F1	G1	H5	C1.75	C1.75	C3.5	C4	C6
	2002	2003	2002	2003	2003	2003	2003	2002	2003	2002	2003	2002	2003	2003
Day	obs	obs	obs	obs	obs	obs	obs	obs	obs	vid	vid	vid	vid	vid
1											6.51		5.49	
2	2.08	2.70		4.64				0.76		5.62	9.67		5.37	
3			3.29	3.91				1.78			6.18			
4			5.50	7.75				3.95			10.88	4.45		5.25
5											7.59	8.88		6.92
6				8.93		4.48					3.83			3.14
7			0.75		4.91	10.72		3.98			4.54			4.50
8			3.50						1.14					4.27
9				10.95		3.81	6.54				2.96			4.63
10				11.74		10.60					7.30			7.19
11								3.92			5.60			9.18
12				2.37							5.76	7.27		4.88
13		3.50							2.19			10.34		9.31
14														
15					0.24		12.00							
16		4.33												

Table 3, Appendix 2 (cont'd).

	C7	F2	G1	G1	G2	G3	G3	H1	H3	H5	U1	U1	U2	U2	U3
	2002	2002	2001	2002	2001	2002	2003	2001	2001	2001	2001	2002	2001	2002	2001
Day	vid	vid	vid	vid	vid	vid	vid	vid	vid	vid	vid	vid	vid	vid	vid
1					4.75			2.67	1.22	4.38	3.40		2.00		1.40
2				2.58		4.82			8.27	4.33	3.73	1.88	5.42		3.71
3				4.46		5.85			8.07	5.71	6.14	6.30	7.08	6.71	3.27
4				4.07		6.76			7.50	5.64	8.00		8.64	17.14	2.91
5		6.29	7.20	5.51		5.68			7.55	5.91	6.67		8.38		3.36
6		7.62		5.01		5.97			9.08	5.64			9.50	5.05	5.00
7			8.75	5.43				4.70	9.73	6.57			9.08	7.22	4.30
8			9.13	6.70				7.83	9.00	5.14			8.89	5.49	
9			12.50	3.37				6.08	9.73	4.45			9.71		7.70
10	9.59		9.67	6.87				6.58		5.93			8.90		8.55
11				4.90		5.71		6.88	0.50	5.50			9.89		8.30
12			15.67	9.67		4.39	5.83	7.50		4.50			4.75		5.80
13			1.67					7.22		6.85			4.14		7.00
14								9.00		6.86			5.50		9.63
15								6.44		5.93					7.33
16			1.00		1.67					4.78					4.75