SUPPLEMENTAL ARTHROPOD SAMPLING

AT THE

HALEAKALĀ HIGH ALTITUDE OBSERVATORIES

MAUI, HAWAI`I

Advanced Technology Solar Telescope

Primary and Alternative Sites

March 2007

Prepared for

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II. EXECUTIVE SUMMARY

The Haleakalā volcano on the island of Maui is one of the highest mountains in Hawai`i, reaching an elevation of 3,055-m (10,023-ft) at its summit on Pu`u `Ula`ula. Near the summit is a volcanic cone known as Kolekole with some of the best astronomy viewing in the world. In 1961, an Executive Order of Hawai`i Governor Quinn established the Haleakalā High Altitude Observatories (HO) Site, sometimes referred to as "Science City". The site is managed by the University of Hawai`i.

The summit of Haleakalā is also the home to unique cultural and natural resources. Important cultural places and sites are found here that are spoken of in numerous Hawaiian mele (songs), oli (chants) and legends (NPS 2005). Arthropods occur near the summit of Haleakalā in an aeolian ecosystem that was once considered lifeless.

The National Science Foundation has proposed the development of the Advanced Technology Solar Telescope (ATST) within the 18-acre University of Hawai`i Institute for Astronomy HO site. The ATST represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The proposed ATST project would be the largest and most capable solar telescope in the world. It would be an indispensable tool for exploring and understanding physical processes on the Sun that ultimately affect Earth.

An inventory and assessment of the arthropod fauna at the HO site was conducted in 2003 as part of the Long Range Development Plan (LRDP) (http://www.ifa.hawaii.edu/haleakala/LRDP/) for the Haleakalā High Altitude Observatories.

The 2003 arthropod inventory and assessment was updated in December 2005. The goal was to describe the arthropod fauna at the two proposed ATST sites, and identify Hawaiian native arthropod species or habitats, if any, that could be impacted by construction or operation of the ATST.

Through a desire to have a comprehensive arthropod inventory and in response to comments submitted for the ATST Draft Environmental Impact Statement, supplemental sampling for arthropods at the sites was conducted in March 2007. The goal was to detect additional species that may have been missed during previous samplings. This additional survey, including night sampling, covers a seasonal component not included in the two previous studies.

III. INTRODUCTION

The Haleakalā volcano on the island of Maui is one of the highest mountains in Hawai`i, reaching an elevation of 3,055-m (10,023-ft) at its summit on Pu`u `Ula`ula. Near the summit is a volcanic cone known as Kolekole with some of the best astronomy viewing in the world. In 1961, an Executive Order of Hawai`i Governor Quinn established the Haleakalā High Altitude Observatories (HO) Site, sometimes referred to as "Science City". The site is managed by the University of Hawai`i.

The highest elevations of Haleakalā were once considered largely lifeless with only sparse vegetation, but biologists have discovered a diverse fauna of resident insects and spiders there that are found nowhere else in the world (Medeiros and Loope 1994). These arthropods inhabit unique natural habitats on the bare lava flows and cinder cones. Feeding primarily on windblown organic material, they form an aeolian ecosystem.

The term aeolian has generally been used to describe ecosystems on snow, ice, meltwater, and barren rock, but in Hawai`i it has been used to characterize non-weathered lava substrates, mostly but not exclusively found at high elevations (Howarth 1987, Medeiros and Loope 1994).

On Haleakalā, aeolian and sub-aeolian ecosystems begin at about 2,300-m (7,546-ft) elevation in the cinder-dominated habitat inside the crater, and at around 2,600-m (8,530-ft) on the older western slope of the volcano, and extend up to the summit at 3,055-m (10,023-ft). Climate conditions are extreme, with widely varying diurnal temperatures and little precipitation. Solar radiation can be intense, and the conditions often affect visitors not accustomed to high elevations.

The Haleakalā aeolian ecosystem is extremely xeric, caused by relatively low precipitation, porous lava substrates that retain negligible amounts of moisture, little plant cover, and high solar radiation. The dark, heat-absorbing cinder provides only slight protection from the extreme temperatures. Thermal regulation and moisture conservation are critical adaptations of arthropods that occur in this unusual habitat.

Vegetation covers less than 5% of the open ground, and food is apparently scarce. Wind-assisted diurnal movement and seasonal migrations of

insects from the surrounding lowlands are the primary source of food for the resident scavenger and predator arthropods in this remarkable ecosystem. Aeolian ecosystems are not unique to Haleakalā in Hawai`i. Similar ecosystems also occur on Mauna Kea and Mauna Loa on the Island of Hawai`i (Howarth and Montgomery 1980). Each volcano has its own unique aeolian fauna that exploit the windblown organic material.

The National Science Foundation has proposed the development of the Advanced Technology Solar Telescope (ATST) within the 18-acre University of Hawai`i Institute for Astronomy HO site. The ATST represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The proposed ATST project would be the largest and most capable solar telescope in the world. It would be an indispensable tool for exploring and understanding physical processes on the Sun that ultimately affect Earth.

An inventory and assessment of the arthropod fauna at the HO site was conducted in 2003 as part of the Long Range Development Plan (LRDP) for the Haleakalā High Altitude Observatories. KC Environmental, Inc. managed the environmental and cultural surveys and prepared survey-based recommendations for the IfA committee responsible for long range development planning.

The 2003 arthropod inventory and assessment was updated in December 2005. The goal was to describe the arthropod fauna at the two proposed ATST sites, and identify Hawaiian native arthropod species or habitats, if any, that could be impacted by construction or operation of the ATST.

Comments submitted for the ATST Draft Environmental Impact Statement suggested that important and unique special status species in the summit area may not have been represented in earlier arthropod collections and reports of the proposed sites. Supplemental sampling was proposed in order to satisfy this concern and to obtain a more complete inventory of species at the sites, especially night sampling for nocturnally active species. In additional, this supplemental sampling encompasses a seasonal component not included in the previous two inventories.

Sampling of arthropod habitats was approved in a permit obtained from the Department of Land and Natural Resources (DLNR) issued in February, 2005. Sampling began on March 17, 2007 and was completed on March 20, 2007.

The intended purpose of this study is to gather reliable scientific information about the species of arthropods at the proposed ATST primary and alternative sites within the HO site that are active at night and might not have been detected during the previous two surveys. Additionally, sampling was conducted during daylight hours to capture seasonal variation of the arthropod fauna.

This study completes a comprehensive Arthropod species inventory at the proposed sites and provides valuable information that will be used during development and operation of observatory facilities. This study supports astronomy programs at the Haleakalā High Altitude Observatories Site by promoting the good stewardship of the natural resources located there.

IV. PROJECT DESCRIPTION

The Project consists of five tasks. The tasks were:

Task I) Sample the proposed ATST primary and alternative sites using special techniques for nocturnal species. This includes attracting flying arthropods with UV and other lights deployed at night, and nighttime ground and foliage searching.

Task II) Install five pitfall traps on each of the proposed ATST primary and alternative sites.

Task III) Collect under rocks, on vegetation, in leaf litter, and in special habitats (e.g., for ground dwelling arthropods).

Task IV) Identify and curate of collected specimens.

Task V) Prepare a Final Report of Findings.

V. METHODS

Site Description

The Haleakalā High Altitude Observatories (HO) site is located on Kolekole Hill. The site is at 3,052-m (10,012-ft) above sea level, adjacent to Pu`u `Ula`ula, also known as Red Hill, the highest elevation on Maui, 3,055-m (10,023-ft).

The 7.3-ha (18.1-ac) site was established in 1961, and the first telescope, the Mees Solar observatory was dedicated in 1964. The site now consists of five telescope facilities.

The proposed ATST primary site is approximately 0.24-ha (0.60-ac) of undeveloped land located east of the existing Mees Solar Observatory facility. The proposed alternative site is at Reber Circle, a previously developed site located north of the existing MAGNUM telescope facility.

Annual precipitation at these sites averages 1,349.2-mm (53.14-in), falling primarily as rain and mist during the winter months from November through April. Snow rarely falls at the site.

During the four days of sampling temperatures ranged from 2˚C (36˚F) at night to 12˚C (54˚F) during the day. Wind speed ranged from 14 m/s at night to 1 m/s during the day. The moon was in the New Moon phase when sampling began on March 17 and a waxing crescent first appeared on March 20.

Sampling

Prior to sampling, reports and publications of previous arthropod surveys and studies were examined to determine the best approach to sample the site. Particular attention was given to the Arthropod Inventory and Assessment conducted in 2003 (Pacific Analytics 2003) and the Updated inventory and assessment of the two proposed ATST sites (Pacific Analytics 2005).

The selection of a trapping technique used in a study needs to be carefully considered. If the target species of the trapping system are rare or important for another reason (i.e., endangered, keystone species, etc.) live-trapping should be considered. Entomologists have long believed that they can sample without an impact on the population being sampled. It has been assumed that collecting makes only a small impact on the populations of

interest. While that assumption remains to be tested, responsible entomologists consider appropriate trapping techniques to ensure survival of local populations of interest.

Pitfall Traps

Because sampling was to occur for only four days, ethylene glycol traps were used to sample the arthropod ground fauna. Ethylene glycol pitfall traps are cups placed into the ground so that the lip of the cup is level with the substrate. A small amount of ethylene glycol is placed into the trap to kill and preserve specimens that fall into the traps. Ethylene glycol is used because it has a low evaporation rate and because it prevents specimen decomposition during the sampling period. Additionally, it is easily cleaned from the specimens.

Five pitfall traps were installed an each of the two sites being considered for the proposed ATST. Traps were installed and set on March 17, 2007 and closed on March 20, 2007.

Light Sampling

Night sampling was conducted using lights and a collecting sheet. A sheet was hung on a rope and a UV light was suspended in the middle of the sheet. During windy conditions the sheet was placed on the ground and held down with rocks. The light was turned on after sunset, and allowed to attract night-flying insects for at least two hours. Insects that landed on the sheet were collected with an aspirator or sweep net.

Each of the proposed ATST sites was sampled each night, March 17-20 (four nights).

Light sampling at Reber Circle.

Light sampling on a windy night adjacent to the MEES observatory.

Visual Observations

Approximately eight hours were spent during daylight sampling under rocks,

in leaf litter, and on foliage to locate and collect arthropods at each site.

Approximately 6 hours were spent after sunset sampling foliage and under rocks and visually observing the ground and nearby vertical surfaces for arthropods. The sampling sites were illuminated using a headlamp.

Curation

The contents of the traps were cleaned in 70% ethyl alcohol and placed in vials. The specimens were sorted into the morphospecies for identification. Hard-bodied species, such as beetles, moths, true bugs, flies, and wasps were mounted on pins, either by pinning the specimen or by gluing the specimens to paper points. Pinned specimens were placed into Schmidt boxes. Soft-bodied specimens, such as spiders and caterpillars were stored in vials filled with 70% ethyl alcohol.

Identification

References for general identification of the specimens included Fauna Hawaiiensis (Sharp (ed) 1899-1913) and the 17 volumes of Insects of Hawai'i (Zimmerman 1948a, 1948b, 1948c, 1948d, 1948e, 1957, 1958a, 1958b, 1978, Hardy 1960, 1964, 1965, 1981, Tentorio 1969, Hardy and Delfinado 1980, Christiansen and Bellinger 1992, Liebherr and Zimmerman 2000, and Daly and Magnacca 2003). Other publications that were useful for general identification included The Insects and Other Invertebrates of Hawaiian Sugar Cane Fields (Williams 1931), Common Insects of Hawai'i (Fullaway and Krauss 1945), Hawaiian Insects and Their Kin (Howarth and Mull 1992), and An Introduction to the Study of Insects Sixth Edition (Borror, Triplehorn, and Johnson 1989).

For specific groups specialized keys were necessary. Most of these had to be obtained through library searches. Keys used to identify Heteroptera included those by Usinger (1936, 1942), Ashlock (1966), Beardsley (1966, 1977), and Gagné (1997). Keys used to identify Hymenoptera included Cushman (1944), Watanabe (1958), Townes (1958), Beardsley (1961, 1969, 1976), Yoshimoto and Ishii (1965), and Yoshimoto (1965a, 1965b).

Species identification of those specimens identified to genus or species levels are unconfirmed and subject to change after comparison to specimens in museums.

In many cases changes in family and generic status and species synonymies caused species names to change from those in the keys. Species names used in this report are those listed in Hawaiian Terrestrial Arthropod Checklist Third Edition (Nishida 1997).

VI. RESULTS AND DISCUSSION

Observations

The primary site has had minimal disturbance from previous construction. Vegetation in this area is largely undisturbed.

About eighty percent of the Reber Circle site has been disturbed by previous construction. Native vegetation occurs only at the north and east portions of this site.

Nineteen species of arthropods were detected during the sampling. Twelve of the detected species are thought to be endemic to Hawai`i. Night sampling yielded only one species not detected during the daylight hours, a noctuid moth.

Lycosid spiders, *Lycosa hawaiiensis* Simon, occurred in pitfall traps at both sites being considered for the proposed ATST. They were less abundant than during the two previous arthropod inventories, occurring in only two pitfall traps. Several juvenile spiders were observed during daytime sampling. *Lycosa hawaiiensis* is the predominant predator of the arthropod fauna in from the crater district of Haleakalā (Medeiros and Loope 1994). This spider is also known from the islands of Oahu and Hawai`i.

Juvenile centipedes were observed under rocks. Centipedes are elongate, flattened arthropods with 15 or more pairs of legs, one pair per body segment. They occur in a variety of habitats, where they feed on spiders and insects. There are 24 species of centipedes reported in Hawai'i, only one from Maui, the non-indigenous, *Mecistocephalus spissus* Wood (Nishida 1997). Because of a lack of taxonomic keys for juvenile stages, the centipedes observed during this study were not identified.

Eight species of true bugs and leafhoppers were detected on the vegetation at the sites; seven of the species are endemic to Hawai`i. All eight of these species have been reported from the HO site and surrounding habitats in previous surveys.

The endemic plant bug (family Miridae) *Trigonotylus hawaiiensis* (Kirkaldy) was collected from the native grasses at the Mees site. This species can be very abundant on grasses, and occurs everywhere in suitable habitats from the coast to

10,000 feet (Perkins 1913, Zimmerman 1948), and on all the main Hawaiian Islands except Molokai. This species was present in low abundance.

The endemic plant bug *Engytatus hawaiiensis* (Kirkaldy) was abundant on *na`ena`e* (*Dubautia menziesii* (A. Gray) D. Keck). This insect was first described from specimens collected in the Haleakalā Crater (Zimmerman 1948) and is also known from the islands of Oahu, Molokai and Hawai`i.

The endemic seed bug (family Lygaeidae) *Nysius coenosulus* (Stål) was very abundant on *pukiawe* (*Styphelia tameiameiae* (Cham. & Schlechtend.) F. V.Muell.) and less common on *na`ena`e*. This insect is known from all but one of the major islands, and uses a wide variety of plants as hosts.

An endemic seed bug of the genus *Neseis ochriasis* Usinger was collected in leaf litter under *pukiawe*. This species was not abundant, occurring under only about ten percent of the plants sampled.

Another potentially endemic species of seed bug was found *pukiawe*. Only one specimen of this species was found and may be a vagrant from the surrounding lowlands.

Two species of stink bugs (Pentatomidae) were collected from the Mees site. The largest is the introduced green stink bug, *Nezara viridula* (Linnaeus). One specimen of the endemic *Oechalia similes* Usinger was collected. This species endemic predator is known only from Maui and occurs in low abundance above 4,500 feet (Zimmerman 1948).

One species of leafhopper (family Delphacidae), *Nesosydne osborni* Muir was collected from *pukiawe*. This endemic insect was common on *na`ena`e* and *pukiawe*. It occurs throughout the Haleakalā crater region.

Other arthropods occurred in low abundance including small ground beetles and spiders, Collembola, and flies. The arthropod fauna collected during this study will be discussed according to their taxonomic groups.

Beetles are the most diverse group of arthropods in Hawai'i. There are 1,983 species of beetles reported in Hawai'i (Nishida 1997), 544 on Maui (B.P. Bishop Museum 2002).

Three species of beetles were found during this study, at least one from the genus *Mecyclothorax* is endemic to Hawai'i. Specimens of this species were found in leaf litter under *na`ena`e*, and were not abundant.

A rove beetle (family Staphylinidae) was also detected in low abundance. Species of this group in Hawai`i are adventive and cosmopolitan in distribution. One species of Coccinellidae, *Olla v-nigrum* (Mulsant)

was found on *pukiawe*. This species was purposely introduced in Hawai`i as a biological control agent.

Collembola are small, insect-like arthropods. They are abundant and ubiquitous, exceeding all other insects in numbers of individuals (Christiansen and Bellinger 1992). Most species are detritivors and few are pests. One hundred and sixty-nine species of Collembola are found in Hawai'i, sixty on Maui (Nishida 1997).

Because of their small size (0.25–6-mm), Collembola are seldom observed or reported. In 2003 Collembola were abundant in pitfall traps, occurring in the hundreds in some locations, especially on the outer northwest slopes of Pu`u Kolekole, but uncommon in the southern part of the HO site. During the current study Collembola were observed under rocks and in leaf litter in low abundance.

In previous studies on Haleakalā, more than 115 species of flies were recorded (Beardsley 1980, Medeiros and Loope 1994, Pacific Analytics 2003). Only a few of those species were recorded near Pu`u Kolekole.

During this study, two species of flies were observed. The Blue Bottle Fly, *Calliphora vomitoria* (L.) was seen in low abundance. This non-indigenous fly is widespread throughout the World. It occurs on all the main islands of Hawai`i at higher elevations.

One specimen of *Drosophila melanogaster* Miegen was collected from *pukiawe*. This small fruit fly is an adventive species, not native to Hawai'i.

Bees and wasps are common in Hawai'i. There are 1,270 species that occur in Hawai'i. Of these species, 652 are endemic to Hawai'i that consist largely of small parasitic wasps, mud-daubers, and yellow-faced bees. The yellow-faced bees (family Colletidae) are important pollinators of native plants (Howarth and Mull 1992). Many of the non-indigenous species were purposely released for biological control of agricultural pests.

One species of yellow-faced bee (family Colletidae) was collected during this study, *Hylaeus nivicola* Meade-Waldo. These bees are important pollinators of native plants, and occur in low abundance in higher elevations where vegetation is scarce.

One species of parasitic wasp was collected during this study. Hymenoptera were relatively uncommon at the site, a similar finding as that recorded in 1994 (Medeiros and Loope). In an earlier investigation

(Beardsley 1966), 12 species of Hymenoptera were collected at the site, mostly small parasitic wasps. Most of the species are not likely residents of the site and probably are carried by winds from lower elevations. The status of this group is largely unchanged since 1966.

No ants were found during this study, and none were reported in previous studies.

There are 1,148 species of moths and butterflies found in Hawai'i, a majority (957) of which are endemic. Many of the endemic species are small moths with a wingspan of less than 1 cm (Howarth and Mull 1992).

In higher elevations, larvae of some moths may feed on wind-blown lowland arthropods that become moribund as nighttime temperatures drop. They may also eat the leaves of the few plants that occur in their habitat.

Only one species of moth came to lights during night sampling, *Agrotis baliopa* Meyrick. This moth is known only from the islands of Maui and Hawai'i. Little is known about this species, even its host plant is unknown (Zimmerman 1958). Its type locality is 6,000 feet on Haleakalā.

One caterpillar was found in a pitfall trap. It appears to be a noctuid, or closely related group. The caterpillar was found at the primary site near the Mees observatory.

Night sampling, using attracting lights, and intensive searching for foliage and ground dwelling arthropods yielded only one new species to the arthropod inventory, the noctuid moth mentioned in the previous paragraph. Foliage sampling at night detected only species that were active and common during daylight hours, and ground searching found no active species.

Summary of the Arthropod Fauna

The arthropods species that were collected during this study were typical of what has been found during previous studies. No species were found that are locally unique to the proposed sites. Nor were any species found whose habitat is threatened by normal observatory operations. Species that were detected during this and the previous assessment of the proposed ATST sites were those that occur over the larger Haleakalā, or have wider distributions on Maui and other islands in the Hawaiian chain.

Comments submitted for the ATST Draft Environmental Impact Statement suggested that important and unique special status species in the summit area may not have been represented in

earlier arthropod collections and reports of the proposed sites. The supplemental sampling summarized in this report did not identify any species listed as endangered or threatened, candidate species for listing, or any species of concern.

Night sampling detected only one species not captured in the previous two assessments of the HO facility, an endemic noctuid moth. Overall arthropod diversity was low during this study, likely due to seasonal factors.

The diversity of the arthropod fauna at the Haleakalā High Altitude Observatories Site is somewhat less than what has been reported in adjacent, undisturbed habitat. This could be expected given the fact that about 40% of the site is occupied by buildings, roads, parking areas, and walkways. Also, much of the ground surrounding the buildings is disturbed and compacted from observatory operations. However, the undisturbed habitat on the site that was sampled has an arthropod fauna generally similar to what could be expected from other small habitat patches on the volcano with similar undisturbed habitat.

While development of the site has impacted the availability of some habitat locally, it has only affected a small amount of the available habitat on the volcano overall. The 7.3-ha (18.1-ac) facility occupies less than one percent of similar habitat available on the volcano (MacDonald 1978). The undisturbed portions of the Haleakalā High Altitude Observatories Site are representative of the surrounding habitat on Haleakalā.

The two proposed ATST sites represent an even smaller portion of the habitat overall on Haleakalā. The Reber Circle site was previously developed and has very sparse vegetation to support arthropods. The ground here is largely compacted, and lacks the structure necessary for most ground-dwelling arthropods. Only the surrounding, undisturbed areas contain habitats in which arthropods can survive. The diversity and abundance of arthropods at this site is very low.

The primary proposed ATST site east of the existing Mees Solar Telescope facility is relatively undisturbed. Native vegetation is more abundant here, and the relatively undisturbed nature of the substrate provides microhabitats for arthropods. The diversity and abundance of arthropods here is greater than that of the Reber Circle site, but is low compared to the HO site in general and to the surrounding undisturbed habitats found elsewhere

on Haleakalā. This is likely due to a scarcity of vegetation.

Most of the arthropods collected during this study were largely associated with the vegetation at the site. Development of either of the proposed sites for the ATST will diminish only slightly the presence of the native vegetation in the general area of the HO, and therefore not threaten the persistence of any arthropod species found at the sites. The vegetation cover at these sites is only a small portion of the overall habitat available elsewhere on Haleakalā.

Only a few exclusively ground-dwelling species were found during this study. These include the wolf spider, ground beetles, centipede, and Collembola. These species make their home under rocks and in crevices and do not burrow into the cinder substrate. No obvious threats to these species survival were evident at either of the proposed ATST sites, although development of the primary site will displace some arthropod habitat.

One of the biggest concerns of past evaluations was the presence of ants. None were found during this study, but ants are reported from nearby National Park facilities. With some practical precautions, the site should remain ant free.

Other alien arthropod species also have the potential to impact the native ecosystem. No obviously threatening alien species were found during this study and with similar precautions as those used for ants; none should be introduced by the ATST observatory construction or operation. The harsh environment of this aeolian ecosystem should make it difficult for most alien species to establish populations.

It is unlikely that development of either of the proposed ATST sites will have a serious impact to arthropod species that occur at the sites beyond the limits of the HO facility.

The development of the ATST facility will diminish a small amount of arthropod habitat, including the presence of native plants, and thereby reduce native arthropod species diversity and abundance at the proposed ATST sites, but is not likely to have a direct impact on the persistence of arthropod species on Haleakalā.

The results of the arthropod survey indicate there are no special concerns or legal constraints related to invertebrate resources in the project area. No invertebrate species listed as endangered, threatened, or that are currently proposed for listing under either federal or State of Hawai'i endangered species statutes were

found at the project site (DLNR 1997, Federal Register 1999, 2005).

Table 1. Species List of Arthropods collected during March 2007 sampling.

Order	Family	Genus	Species	Authority	Status
Araneae	Lycosidae	Lycosa	hawaiiensis	Simon	endemic
Coleoptera	Coccinellidae	Olla	v-nigrum	(Mulsant)	purposely
Coleoptera	Staphylinidae		sp.		unknown
Coleoptera	Carabidae	Mecyclothorax			endemic
Diptera	Calliphoridae	Calliphora	vomitoria	Linnaeus	introduced
Diptera	Drosophilidae	Drosophila	melanogaster	Meigen	adventive
Heteroptera	Lygaeidae	Neseis	ochriasis	Usinger	endemic
Heteroptera	Lygaeidae	Nysius	coenosulus	Stål	endemic
Heteroptera	Lygaeidae		sp.		endemic?
Heteroptera	Miridae	Engytatus	hawaiiensis	(Kirkaldy)	endemic
Heteroptera	Miridae	Trigonotylus	hawaiiensis	(Kirkaldy)	endemic
Heteroptera	Pentatomidae	Nezara	viridula	Linnaeus	introduced
Heteroptera	Pentatomidae	Oechalia	similis	Usinger	endemic
Homoptera	Delphacidae	Nesosydne	osburni	Muir	endemic
Hymenoptera	Braconidae		sp.		unknown
Hymenoptera	Colletidae	Hylaeus	nivicola	Meade-Waldo	endemic
Lepidoptera	Noctuidae	Agrotis	baliopa	Meyrick	endemic
Collembola					endemic?
Geophilomorpha?			sp.		juvenile

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