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A PRELIMINARY INVENTORY OF THE INSECTS OF MORMON ISLAND REFUGE

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Abstract. The families of insects encountered during one sampling season at Mormon Island Refuge near Grand Island, Hall Co., Nebraska, are listed. When possible, species are listed for Odonata (dragonflies), Lepidoptera (butterflies and moths), Silphidae (carrion beetles), and Scarabaeidae (scarab beetles). The insects observed in the refuge are typical of south-central Nebraska, and rare or endangered species were not collected or recognized. Within the context of insect family level identifications, the implications of mowing, controlled burning, and grazing are alluded to for management of the refuge as it affects insects. Further research needs are not specifically identified as the insect fauna, as currently known, does not seem to warrant this in and of itself; additionally, further research (now that the survey has been accomplished) should be question or problem oriented as opposed to the preliminary general approach.

METHODS

Insects were collected by one to three people every other week during the 1980 sampling season. The sampling dates were 26 April, 11 May, 24 May, 7 June, 21 June, 5 July, 19 July, 2 August, 25 August, 13 September, and 27 September. Collecting was done in all parts of the refuge at one time or another, but certain areas received more intensive collecting due to higher abundance and/or diversity of insects. All habitats (except aquatic and wild animals) were sampled. Figure 1 indicates the primary sampling sites of this study.

Various collecting methods were utilized during the study. During the daylight hours between 9 AM and 6 PM general collecting and foliage gleaning were most successful. Sweep nets (for grasses and shrubs), a beating tray (for woody shrubs and trees), and aerial nets (for flying or conspicuous insects) were used. Insects were also sought out under bark and logs, in piles of organic debris, in flower heads and in cow feces. Dead animals were used as an attractant on two occasions (a dead calf and rhinoceros meat placed as bait). Six baited pitfall traps (three feces, three carrion) were also employed with good success. Flower heads, soil, leaf litter, and rotting straw were, on several occasions, taken back to the laboratory in containers stored in an ice chest, and the samples were placed in a Berlese funnel which uses heat to drive small insects downwards into a collecting container. Minute insects which may otherwise never be seen were easily collected in this fashion.

Light traps were set up at dusk on nearly every sampling date (temperature too low for the first two) to attract nocturnally active insects. Black light lamps (using ultra violet radiation) and mercury vapor lamps were used as light sources; white sheets were used as reflecting backdrops. A small generator and/or car battery was used as a power source. Light trapping proved to be the most productive form of collecting in terms of abundance and diversity.

Specimens collected were properly pinned, mounted (or preserved in fluid), and labeled after each collecting trip. Taxa were identified as per the contractual agreement and are now housed in a storage cabinet provided by the Nature Conservancy (and so labeled) at the University of Nebraska State Museum's Systematics Research Collections facility.

RESULTS

The variety of collecting and trapping methods utilized insured that insects from most ecological niches were sampled. Highly mobile or transient species are, of course, more subject to random encounter and subsequent capture. Nevertheless, I believe that virtually all of the common insects occurring on Mormon Island were collected during the sampling program. Some relatively uncommon species were also undoubtedly taken, but these considerations would be more appropriately made by specialists in the particular group under consideration.

The following list is a capsule summation of the types of insects collected at Mormon Island during the 1980 season. Appendix 1 lists the orders, families, and genera and species (where appropriate) of the taxa collected.

Collembola - Springtails

Springtails are a fairly large group of minute scavenging insects that are found in soil, humus, under bark, in leaf mold, and in fungi. Their principal sources of food are spores, fungal hyphae, bacteria, algae, and decaying plants. Populations may be extremely high on occasion, and the literature estimates 10 individuals to 10 million individuals per cubic meter of soil. Examples of Poduridae and Entomobryidae were collected, and intensive collecting of soil and organic debris might yield an additional family or two. Springtails may be collected throughout the sampling season.

Ephemeroptera - Mayflies

Mayfly adults are soft bodied, terrestrial, and live from a few hours only to a few days during their emergence in the late spring and summer. The adults do not feed. Nymphs occupy a variety of aquatic habitats, and the nymphal stage

ranges from a few months to about a year. Nymphs are primarily grazers and herbivores. Mayfly diversity is highest in clean, flowing water, and the absence or presence of certain mayflies known to occur in an area may be good pollution indicators. The mayflies of Nebraska have been poorly studied, and a great deal of work needs to be done. The adult mayflies taken during this study were taken at light traps in late June and July.

Odonata - Dragonflies

The terrestrial adults of dragonflies and damselflies are well known to everyone. The aquatic nymphs are generalized predators. Dragonflies are fairly abundant at Mormon Island because of the presence of various aquatic habitats. As the Platte stream channels dried up in late June and July, nymphs (and other insects) were readily found in the stock tanks where they develop in a presumably more stable habitat than that of the stream bed or temporary ponds near the stream. The small, artificial pond in the southeast corner of the refuge and the more protected (but drier) north channel appeared to have higher numbers of adult dragonflies. "As large, generalized, long-lived predators, dragonflies depend on relatively stable, productive ecosystems for their existence. Thus dragonflies provide useful ecological indicators of the stability and productivity of aquatic and terrestrial ecosystems. As aquatic insects they are immediately vulnerable to the destruction of freshwater habitats ... Because dragonflies... are widely distributed, readily collected, well known and relatively easily identified, they offer unusually suitable indicators for monitoring faunal changes and for measuring the environmental impact of man's activities" (Corbet, 1979).

Orthoptera - Grasshoppers, crickets, roaches, etc.

This order contains many well known insects. The Acrididae, or short horned

grasshoppers, are quite common throughout the refuge, particularly in late summer where the adults are very abundant in the meadows and roadside vegetation where they feed on various plants. Tetrigidae, or pygmy grasshoppers, are common in this part of Nebraska in early summer; they were not collected in the refuge during the sampling program, but I believe they occur there. Tettigoniidae are the long horned grasshoppers, and they were found primarily in the meadows and wooded areas; adults became abundant in late summer. Gryllidae, or crickets, were quite common throughout the refuge and were most noticeable in late summer after the nymphs reach maturity. Only one immature Mantidae was taken, and they are presumed to be rare at the study site (at least during 1980). Roaches, or Blattidae, were very common, especially in the wooded areas where they hid under bark and in crevices in dead trees. Mole crickets (Gryllotalpidae) were seen on two occasions but were not captured.

Plecoptera - Stoneflies

Common stoneflies (Perlidae) were taken in early July at light traps. The non-feeding adults are terrestrial and the aquatic nymphs are carnivorous.

Psocoptera - Book lice

The book lice are minute to small insects which commonly feed on fungi, algae, and lichens. They were not collected during the sampling program, but I believe they inhabit the refuge (particularly the wooded areas with moister microhabitats). More intense collecting with a Berlese funnel is needed to find these animals.

Mallophaga (Chewing lice) and Anoplura (Sucking lice)

Mallophaga and Anoplura are parasites of wild and domestic birds and mammals. They undoubtedly occur at Mormon Island on the resident wild animals, but the sampling did not entail live capture of host organisms.

Thysanoptera - Thrips

Thrips are minute insects which feed on pollen, fungi, and plants. The ecological significance of thrips is obscure (Lewis, 1973). Thripidae and Phloeothripidae were taken at the refuge, and specialized collecting for these small animals may reveal an additional family or two.

Hemiptera - True bugs

Most families of Nearctic Hemiptera are distributed widely across Nebraska. Several of the families taken at Mormon Island are aquatic as nymphs and adults, and these live in the river, pond, and stock tanks. Most Hemiptera are phytophagous although many others are predators. In general, the diversity of hemipteran species in an area correlates with plant diversity, and their distribution is related to the distribution of their host plants.

The following families of Hemiptera were not taken at the refuge, but I believe they are found there: Belostomatidae (giant water bugs), Gelastocoridae (toad bugs), Gerridae (water striders), Anthocoridae (flower bugs), Tingidae (lace bugs), Neididae (stilt bugs), and Coreidae (leaf footed bugs).

Homoptera - Cicadas, leafhoppers, aphids, etc.

Homoptera are very closely related to Hemiptera. All Homoptera are phytophagous and many species are serious pests of cultivated plants. The Cicadidae were not common at the refuge since they generally require forested habitat. Cicadellidae were extremely abundant and occur on trees, shrubs, and grasses. Delphacidae, Cixiidae, and Coccoidea probably occur on Mormon Island but were not seen during the sampling program. Most homopterans are easily found at the refuge from May through September.

Neuroptera - Lacewings, mantispids, etc.

There were three Neuroptera families seen on Mormon Island, and I suspect that a fourth, the Hemerobiidae (brown lacewings) may also be present. Most Neuroptera are predaceous as adults and larvae. Mantispid larvae feed on the egg sacs of spiders, and the larvae and adults of chrysopids feed primarily on aphids. Myrmeleontidae are common in the refuge, and the considerable areas of fine, loose soil and dry sand there are favorable for the larvae which make conical pits in which to trap small insects.

Coleoptera - Beetles

Beetles are the most diverse and perhaps most successful group of living organisms. Almost one out of every four different animals on this planet is a beetle. Beetles vary greatly in size (minute to very large), habitat (intertidal, arctic, deserts, jungle), and mode of life (predaceous, phytophagous, saprophagous, parasitic). Thirty-nine families of Coleoptera were taken at Mormon Island, and additional collecting might yield five or six additional small families of minute beetles. The Coleoptera are represented by more species in the refuge than any other order of insects. Beetles may be collected there from the first warm days in March into October's first freeze and in nearly every imaginable habitat.

The families Brentidae and Passalidae were not found at the refuge which clearly delineates this type of habitat from the more humid forests in the SE portion of Nebraska.

Mecoptera - Scorpionflies

One species of Bittacus (Bittacidae) occurs on Mormon Island, and, of all the insects collected there, this order is the most surprising. Not only have

they not been collected in this vicinity previously, but Bittacidae and most other Mecoptera are generally found in areas considered to be more moist than the refuge; their occurrence here was unexpected. The specimens (2) were taken at lights in July.

Trichoptera - Caddisflies

The adults of caddisflies are terrestrial while the larvae are aquatic. Most case-building larvae are phytophagous while those few that do not live in cases are generally predaceous. The larvae are an important food source for many aquatic animals. Adult Trichoptera are nocturnal and secretive animals. I suspect, therefore, that one to four additional families may be found at the refuge.

Lepidoptera - Butterflies and moths

The butterfly component of Mormon Island is typical for this kind of habitat in south-central Nebraska. Fifteen species were collected, and an additional species of Papilionidae was seen but not collected. An additional four common species of Nymphalidae were not seen although they should occur there.

The moths are represented by considerably more species. Virtually all of the moths are nocturnal, and the larvae of many species may become agricultural pests. Further collecting would add more moth species to the present collection. Lepidoptera are common in the refuge from spring through fall.

Diptera - Flies

The fly fauna of Mormon Island is fairly diverse, and a number of forms with aquatic larvae are present as would be expected. Many predatory, saprophagous, blood feeding, and flower visiting species are present. Diptera are a taxonomically difficult group of insects to work with, and a specialist is needed for virtually

all identifications. I expect several additional families to be added to the inventory list in the future, and these are listed in the appendix.

Siphonaptera - Fleas

Siphonaptera were not collected during the sampling program because their wild mammal hosts were not live-trapped. However, fleas do occur in the refuge on their mammal hosts.

Hymenoptera - Bees and wasps

Bees and wasps serve important ecological roles, and yet many of the smaller (especially parasitic forms) are relatively unknown. These animals are important pollinators, predators, and parasites. Identification to species for many forms is often extremely difficult due to a lack of specialists and/or taxonomic literature. The ants (Formicidae) were abundant on Mormon Island and occupied a wide variety of habitats where they forage. Honey bees were common at the refuge (artificial hives) where they forage extensively on the wild plum, alfalfa, and other flowering plants. Several small parasitic Hymenoptera and some Apoidea were not seen, but I believe further collecting might find these families.

CONCLUSIONS

I estimate that 40-70% of the insect species on Mormon Island were collected during the 1980 sampling program. Based on only one sampling season, I believe the above percentages indicate good success. My observations indicate that the Mormon Island Refuge has an insect fauna that is very typical of that for south-central Nebraska. No really surprising finds were made (other than Mecoptera), and nothing was collected that has not been seen or collected in neighboring areas. It should be noted, however, that central Nebraska has not

yet been adequately collected, and we have an imprecise idea as to exactly what constitutes the fauna. The Mormon Island project is a substantial and valuable first step in this process.

The feeble isolation of the island (bordered by the Platte river on all sides) is probably an insufficient barrier to keep most insects either out of or restricted to the refuge. This is because the river is not that large and so the distances to be traveled are not that great, and because most of the river dries up in the summer which reduces the water barrier. The exposed, hot, barren sands may form a new barrier, but a weak one not capable of restricting most insect movement. The loss of river water in mid to late summer affects the life strategies of many aquatic insects, and the ponds and stock tanks containing water during this time served as a refuge and were seen to have a diverse assemblage of aquatic insects. The relatively non-intense and varied agricultural activities within the refuge apparently have not adversely affected the diversity and stability of the insect life there as it is now constituted. Agriculture has definitely changed the components of the original tall grass prairie which occurred there.

The number of flowering shrubs, trees, and wild flowers is very beneficial for maintaining insect numbers, particularly in the early spring. The cow dung found in the pastures is also a valuable food resource for many Coleoptera and Diptera which are dependent on fecal food or its associations. The woodlot on the refuge and the small wooded areas along the river provide a small "forest" habitat which enables many tree dependent species to exist on the refuge which otherwise would be absent. The microclimate and microhabitats afforded by stands of trees also enables numerous insects to survive in the refuge.

The alfalfa and corn grown on the refuge were not seen to harbor large

populations of pest organisms in 1980 due primarily to the relative isolation of the fields or to cultural practices such as crop rotation. Part of the alfalfa and corn fields did suffer from a lack of water with subsequent losses.

No endangered species were encountered, and none were anticipated as none have yet been recognized as occurring in Nebraska.

MANAGEMENT IMPLICATIONS

The manner in which the refuge is managed or altered will affect the species composition and/or population levels of the insect fauna as now constituted. Continuation of the status quo at the refuge would probably maintain the current diversity allowing, of course, for natural fluctuations in existing populations due to weather, predation, disease, and parasites.

Effects of mowing. Mowing of the meadows and alfalfa fields for hay will probably have little lasting impact on any of the insects in those fields. Some species will experience mortality because of mowing but not in numbers likely to cause permanent change in numbers. A temporary decrease in population would be expected due to mowing, but recolonization from surrounding fields would occur. A temporary shift to sun-tolerant species may result immediately after mowing, but as the vegetation recovered the changes resulting from this shift would gradually decrease.

Effects of controlled burning. Controlled burning of the meadow areas would have nearly the same affect as mowing. Recovery of populations may take a little longer depending on the recovery time of the plants and on the amount of insect mortality. Many insects would be able to escape the fire (depending on conditions) and recolonize quickly after new plant growth. If native grasses and forbs were burned, the insects associated with those plants would probably move to other food resources during recovery and would not be adversely affected to any great extent.

Controlled burning of the shrubs and trees along the river would have more serious and permanent impact on the insects living there because these plants would be killed. The scattered woods and associated microclimate would be destroyed, and organisms dependent on wooded habitat would then lose the space and conditions necessary for their survival. Elimination of this part of the insects in the ecosystem could change to some degree the populations of other animals that forage on these insects.

Effects of grazing. The presence of cattle on the refuge provides, via their blood and feces, food and habitat for a number of insects. The presence of livestock is, therefore, beneficial for those insects which are blood and feces feeders. Elimination of livestock from the refuge would severely reduce populations of dung feeding insects or perhaps eliminate several species from the island. The resident wild mammals do not provide the necessary quantity or type of feces to support the present populations and diversity of dung feeding insects. Similarly, blood feeding flies would experience a decline in populations.

I foresee no substantial change in insect populations due to grazing if the current pastures are maintained. However, if pastures are expanded into some of the lush wet meadows, then the potential exists for altering the insect composition there if careful grazing is not observed, i.e., too many cattle in a given area. Many insects in the wet meadows would not be able to survive in the conditions of the present pastures because of substantial differences in plant composition and microclimate. For the purposes of cattle nutrition and "pasture viability," the current pastures are probably not considered overgrazed. For the purposes of maintaining a more natural assemblage of grassland insects, however, I believe the north (primary) pasture is overgrazed. The pasture on the western tip of the island is not as overgrazed because there are fewer animals on it.

FUTURE RESEARCH NEEDS

Future research needs in entomology need to be guided by what kind of information the Nature Conservancy desires and how that information is to be used. For example, the identifications in this project were essentially carried to family level only which does not impart a great deal of information about interspecific ecological relationships. A similar survey anywhere in the state of Nebraska might have yielded a similar list of insects at the family level because these families are relatively common and widespread. On the other hand, species level determinations must be made by specialists; some groups are currently without specialists, and specialists in some other groups simply do not have the time for this type of identification and consulting work. Therefore, some compromise approach to identifications (with subsequent ecological extrapolations) must be made. This would entail determinations on well known groups, endangered groups, or good ecological indicator groups where systematists are available to provide identifications. I believe this was partially accomplished in this study by species level identifications for the Odonata, Silphidae, Scarabaeidae, and Lepidoptera. The name of an animal (as opposed to the family in which it is placed) is the key to the literature which then, hopefully, contains some of the information that can be used as building blocks to form a more detailed picture of what is happening in the ecosystem. "Scarabaeidae" indicates scarab beetles occur in the refuge, but scarabs occupy many different ecological niches. Phyllophaga fusca (Froelich), however, indicates a scarab beetle common to the eastern United States which feeds on a wide array of plants ranging from basswood, elm, maple, and walnut to rose, honeysuckle, and field crops, and whose subterranean, grass feeding larvae are also subject to parasitism by tiphiid and scoliid wasps. This is the kind of information

that would enable statements and predictions about interrelationships within the ecosystem. A list of families of animals in a given refuge is a necessary first step in the inventory process, and this list is very helpful in channeling future research. This kind of list cannot provide very many specific answers to specific, ecologically oriented questions.

The survey conducted in this project did not reveal any particularly rare or otherwise noteworthy insect that would warrant further investigation in and of itself.

I believe further research in entomology should be oriented towards answering specific questions or providing data on specific problems that may arise during the management process.

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APPENDIX

Inventory List of Insects Collected at
Mormon Island Refuge in 1980

COLLEMBOLA
- Poduridae
- Entomobryidae
- *Sminthuridae
- *Isotomidae

EPHEMEROPTERA
- Ephemeridae
- Heptageniidae
- Baetidae

ODONATA
- Coenagrionidae
- Gomphidae
  - Ophiogomphus severus Hagen
- Aeshnidae
  - Anax junius (Drury)
- Libellulidae
  - Pantala hymenaea (Say)
  - Sympetrum obtrusum Hagen
  - Libellula luctuosa Burmeister
  - L. forensis Hagen
  - Erythemis simplicicollis (Say)

ORTHOPTERA
- Acrididae
  - Melanoplus sp.
  - undetermined
  - *Tetrigidae
- Tettigoniidae
  - Conocephalus sp.
  - Neoconocephalus sp.
  - Orchelimum sp.
  - undetermined
- Gryllidae
- Mantidae
- Blattidae
- Gryllotalpidae

PLECOPTERA
- Perlidae

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*Presumed to occur at the refuge, but not collected in 1980.

*PSOCOPTERA

*MALLOPHAGA

*ANOPLURA

THYSANOPTERA
- Thripidae
- Phloeothripidae

HEMIPTERA
- Corixidae
- Notonectidae
- Miridae
- Phymatidae
  - Phymatus sp.
- Reduviidae
- Nabidae
- Rhopalidae
- Cydnidae
  - Pangaeus sp.
- Pentatomidae
  - Euschistus sp.
  - Thyanta sp.
  - *Belostomatidae
  - *Gelastocoridae
  - *Gerridae
  - *Anthocoridae
  - *Tingidae
  - *Neididae
  - *Coreidae
- Lygaeidae

HOMOPTERA
- Cicadidae
  - Tibicen sp.
- Membracidae
  - Ceresa sp.
  - undetermined
- Cicadellidae
- Cercopidae
  - Lepyronia sp.
- Fulgoridae
- Dictyopharidae
- Aphididae
  - *Delphacidae
  - *Cixiidae
  - *Coccoidea

NEUROPTERA
- Mantispidae
- Chrysopidae
- Myrmeleontidae
  - *Hemerobiidae

COLEOPTERA
- Cicindelidae
  - *Cicindela* sp.
- Carabidae
  - *Harpalus* sp.
  - *Chlaenius* sp.
  - *Scarites* sp.
  - *Pasimachus* sp.
  - *Euryderus* sp.
  - *Amara* sp.
  - *Stenolophus* sp.
  - undetermined
- Haliplidae
  - *Peltodytes* sp.
- Dytiscidae
- Gyrinidae
  - *Dineutus* sp.
- Histeridae
- Hydrophilidae
  - *Hydrophilus triangularis* Say
  - *Sphaeridius* sp.
  - *Hydrocharis* sp.
  - *Enochrus* sp.
  - *Tropisternus* sp.
- Leiodidae
- Silphidae
  - *Silpha ramosa* Say
  - *S. noveboracensis* Forster
  - *Nicrophorus pustulatus* Herschel
  - *N. orbicollis* Say
  - *N. tomentosus* (Weber)
  - *Necrodes surinamensis* (Fabr.)
- Staphylinidae
  - *Bledius* sp.
  - undetermined
- Cantharidae
  - *Chauliognathus pennsylvanicus* (DeGeer)
  - undetermined
- Lampyridae
  - *Photinus* sp.
- Melyridae
  - *Collops* sp.
- Lycidae
- Dermestidae
  - *Dermestes* sp.
- Cleridae

Elateridae
Buprestidae
  Acmaeodera sp.
  undetermined
Heteroceridae
  Heterocerus sp.
Erotylidae
Languriidae
Cucujidae
Phalacridae
Nitidulidae
Coccinellidae
  Coleomegilla sp.
  Hippodamia sp.
Mycetophagidae
Anthicidae
Oedemeridae
Meloidae
  Epicauta sp.
Mordellidae
Tenebrionidae
  Tenebrio sp.
  Alobates sp.
Melandryiidae
Anobiidae
Bostrichidae
Lyctidae
Scarabaeidae
  Aphodius fimetarius (L.)
  A. walshii Horn
  A. distincta (Muller)
  A. lentus Horn
  A. rubeolus (Beauv.)
  A. granarius (L.)
  Ataenius spretulus Hald.
  Geotrupes opaca Hald.
  G. splendidus (Fabr.)
  Bolbocerosoma bruneri Dawson & McCull.
  Bolboceras filicornis (Say)
  Ochodaeus musculus (Say)
  Copris fricator (Fabr.)
  Canthon nigricornis (Say)
  Onthophagus pennsylvanicus Harold
  O. hecate Panzer
  Polyphylla hammondi LeConte
  Phyllophaga crassissima (Blanchard)
  P. rugosa (Melsh.)
  P. futilis (LeConte)
  P. crenulata (Froel.)
  P. fervida (Fabr.)
  P. fusca (Froel.)
  P. gracilis (Burm.)

Pelidnota punctata (L.)
Anomala flavipennis stigmatella Casey
Strigoderma arboricola (Fabr.)
Cyclocephala pasadenae Casey
Dyscinetus picipes (Burm.)
Ligyrus gibbosus (DeGeer)
L. relictus (Say)
Trox foveacollis (Harold)
Trox suberosus (Fabr.)
Euphoria inda (L.)
Cerambycidae
Tetraopes sp.
Megacyllene sp.
undetermined
Chrysomelidae
Chrysochus sp.
Leptinotarsa sp.
undetermined
Bruchidae
Curculionidae

MECOPTERA
Bittacidae
Bittacus sp.

TRICHOPTERA
Hydropsychidae
Leptoceridae
prob. Brachycentridae

LEPIDOPTERA
Satyridae
Cercyonis pegala (Fabr.)
Pieridae
Pieris rapae (L.)
P. protodice Boisd.
Colias eurytheme Boisd.
C. philodice Godart
Danaidae
Danaus plexippus (L.)
Nymphalidae
Speyeria idalia (Drury)
Phycoides tharos (Drury)
Chlosyne gorgone Hubner
*Nymphalis antiopa (L.)
*Polygonia sp.
*Vanessa cardui (L.)
*V. atalanta (L.)
Papilionidae
Papilio glaucus (L.)
Lycaenidae
† Lycaenia helloides Boisd. Voucher specimen not found (20 January '97); probable only. Purplish Copper Epiden
undetermined

Hesperiidae
- Epargyreus tityrus (Fabr.)
- ~~Limochores~~ taumas (Fabr.) Polites taumas
- Pyrgus ~~tesselata~~ Scudder f. communis

Noctuidae
- Catocala sp.
- Agrotis sp.
- Chorizagrotis sp.
- Pseudoletia unipuncta (Haw.)
- undetermined

Sphingidae
- Pachysphinx modesta Harris
- Sphecodina abbotti Swainson
- Celerio lineata (Fabr.)
- Ampeloeca myron Cramer
- Pholus achemon Drury
- undetermined

Arctiidae
- Apantesis virgo
- A. vittata (Fabr.)
- A. blakei (Grote)
- Diacrisia virginica (Fabr.)
- Euchaetias oregonensis Stretch
- Halisidota tessellatus Abbott & Smith

Lithosiidae
- Hypoprepia fucosa Hubner
- undetermined

Syntomidae
- Scepis fulvicollis Hubner

Lasiocampidae
- Epicanptera americana Harris

Notodontidae
- Pheosia dimidiata Herrich-Schaeffer

Pterophoridae

Pyralidae

Geometridae

DIPTERA

Tipulidae

Culicidae

Chironomidae

Stratiomyidae

Tabanidae

Asilidae

Bombyliidae

Dolichopodidae

Syrphidae

Muscidae

Anthomyidae

Calliphoridae

Sarcophagidae

Tachinidae
Otitidae
Tephretidae
Pyrgotidae
Chloropidae
Lauxaniidae
Therevidae
Sphaeroceridae
Bibionidae
Rhagionidae
*Dixidae
*Simuliidae
*Cecidomyiidae
*Phoridae
*Pipunculidae
*Sepsidae
*Drosophilidae
*Agromyzidae

*SIPHONAPTERA

HYMENOPTERA
Tenthredinidae
Ichneumonidae
Braconidae
Chrysididae
Scoliidae
Mutillidae
Formicidae
Pompilidae
Vespidae
Sphecidae
Apidae
Apis mellifera (L.)
Anthophoridae
Megachilidae
Colletidae
*Cephidae
*Chalcididae
*Cynipidae
*Proctotrupidae
*Andrenidae
*Halictidae

135 families
minimum # species = 210
genera = 121

Fig. 1
Aerial photograph of Mormon Island Refuge.
Symbols indicate primary collecting sites during 1980.