

**Cooperative National Park  
Resources Studies Unit**

**ARIZONA**

TECHNICAL REPORT NO. 21

GRASSHOPPERS AND BUTTERFLIES  
OF THE QUITOBAQUITO MANAGEMENT AREA,  
ORGAN PIPE CACTUS NATIONAL MONUMENT, ARIZONA

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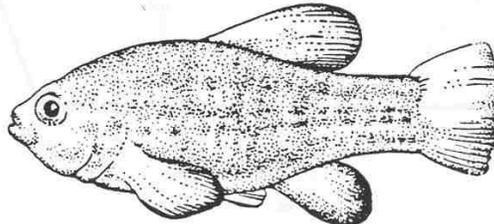
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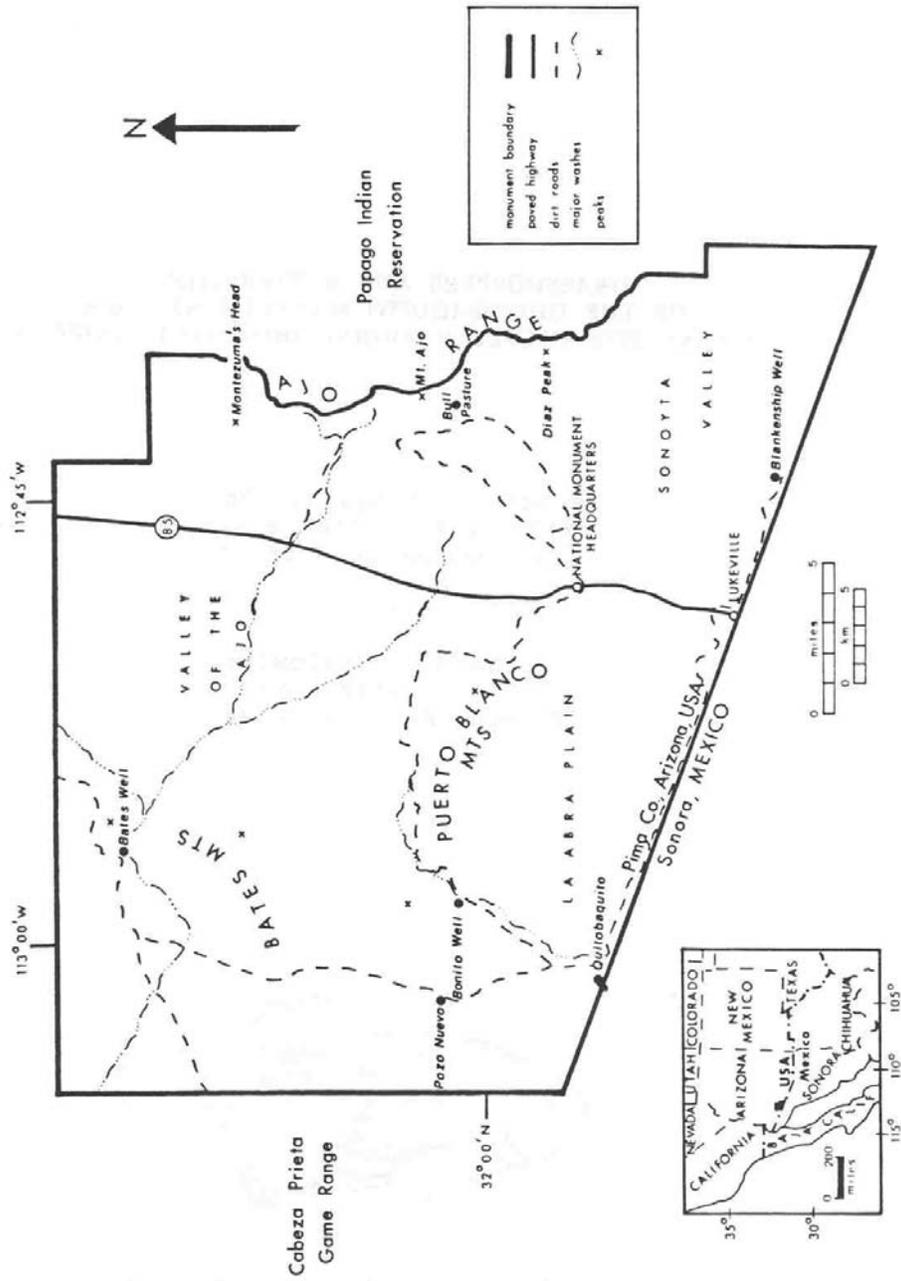
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# ORGAN PIPE CACTUS NATIONAL MONUMENT



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## ABSTRACT

Grasshoppers (Orthoptera: Acrididae and Tettigoniidae) and butterflies (Lepidoptera: Hesperidae, Papilionidae, Pieridae, Lycaenidae, Libytheidae, and Nymphalidae) were collected and observed at the Quitobaquito Management Area in Organ Pipe Cactus National Monument, Arizona. Nine field trips were taken to the area. The area extends from Williams Spring to Aguajita Wash and includes the oasis and the Quitobaquito Hills. Seventeen species of Orthoptera and 52 species of Lepidoptera were found. Species accounts, including food plants, microhabitat selection, relative abundance and constancy, and information on the role in the ecosystem and relationship to human activity, where appropriate, are given for each species.

The area is recovering from intensive human use for many years, including small-scale agriculture and grazing by cattle. It includes a high degree of diversity of plants and microhabitats, and the diversity of grasshoppers and butterflies reflects this history and diversity. The area supports a diverse resident community of grasshoppers and butterflies and is also an important stop-over area for transient butterflies. No apparent threats to the insect community were discovered. The insect community itself creates little or no problem for management consideration, with the possible exception of grasshopper feeding causing slight retardation of recovery from overgrazing.

## INTRODUCTION

The number of species of organisms in an area is often regarded as an indication of the biological health of that area (MacArthur 1965; Odum 1969; Panza 1972; Roberts 1974; Tomoff 1971, 1974; Whittaker 1977; Yensen 1973). However, it is difficult if not impossible to locate and identify all species of all classes of organisms in a natural area of any size. Because of the complexity of interactions among a large number of species, studies at the community level may be unmanageable. Ecologists have often chosen to focus their attention on particular groups of organisms, generally those that are easiest to study such as plants or birds, as indicators of environmental quality. Restriction of studies to a particular taxonomic groups allows examination of community organization in response to ecological forces structuring the communities.

Insects are the most abundant and diverse organisms present in most environments. Because of their short life cycles and sensitivity to perturbations, insects may be useful as indicators of environmental quality. In most terrestrial environments, insects are the dominant herbivores. They may greatly influence the plant community as well as reflect the quality of plant resources available to them. Few studies have been published on organization of insect communities in general--these would be far too difficult to pursue. However, several good studies have been published on the organization of communities of specific groups of insects (Joern, 1979; Joern and Pruess 1986; Van-Wright 1978; Mulkern et al. 1969; Cantrall 1943). Fewer studies exist on the value of insects as indicators of environmental quality or on the effects of environmental manipulation by man on the communities of insects present in an area (Parmenter and MacMahon 1987; Ditsworth et al. 1982; Price 1984). No studies of this sort are available from lower Sonoran desert oases.

As far as we know, no previous studies combine both grasshoppers and butterflies and examine the relationships of these two diverse groups to their environment. For purposes of this study, the loose group "grasshoppers" includes the families Acrididae (true grasshoppers) and Tettigoniidae (Katydid) but does not include other Orthoptera. The term "butterflies" includes the families Hesperidae (Skippers), Papilionidae, Pieridae, Lycaenidae, Libytheidae, and Nymphalidae.

We had several reasons for examining these two groups. Butterflies and grasshoppers represent diverse approaches to life by phytophagous (plant-eating) insects covering a variety of niches. Their ecological roles and relationships are better understood than those of most other insect groups. They are generally common, easily observable, and easier to identify than most other groups of insects. And finally, they are conspicuous and colorful enough to be of interest to the general public.

We had several reasons for examining these two groups. The ecological roles and relationships of butterflies and grasshoppers are better understood than most groups; they can be better correlated to the existing environment. Our first objective was to establish correlations at Quitobaquito. The second objective was to secure a well-rounded picture of the present biota and its ecology in an area which is to be preserved for future biological studies. The Quitobaquito Management Area has been so recently freed from the influences of cultivation and grazing that it will unquestionably be modified by succession and possibly by disclimax, with resulting changes in the fauna. Any study of the present biota may, therefore, aid future investigators in estimating the amounts of such changes. This paper presents a survey of the present grasshopper and butterfly fauna which may be useful as a basis for future studies.

Since they are economically important, grasshopper ecology on overgrazed rangelands is well known (Ball et al. 1942, Otte 1981). This may have relevance at Quitobaquito because the range has recently been retired from severe grazing pressure.

Certain species of grasshoppers which are not abundant on ranges with good stands of grass become very abundant when the stand is destroyed by overgrazing or drought (Ball et al. 1942). Increased numbers of grasshoppers and their feeding tends to prevent revegetation of the range and to preserve the overgrazed condition. Grasshopper eggs usually hatch at about the time that plants are germinating, when the young plants are most easily killed. Some grasshopper species destroy many immature seed heads even when they are not abundant enough to cause noticeable damage to the rest of the plant. This may prevent natural reseeding of the range. Still other species increase in numbers on depleted ranges because of the increase in numbers of specific food plants. Some species such as the Green Streak, *Hesperotettix viridis*, should be considered beneficial because they feed on range weeds which compete with the pre-grazing plant species.

Relationships between butterflies and their habitats are less well understood. Butterflies as a group are not generally considered to be of major economic importance. Many species of butterflies are highly vagile (flying from one environment to another). Fluctuations in butterfly populations may be great from one year to the next, and several species may have mass migrations which further complicate investigations. Definitive data explaining these phenomena are rarely available (Tilden and Smith 1986). Seasons of great abundance of a species may be followed by seasons of scarcity. Predators, parasites, and diseases influence the numbers of butterflies each year. Climatic factors, especially severe weather during critical phases of the life cycle, may significantly affect butterfly numbers (Tilden and Smith 1986).

In recent years, human activities have had a profound effect on several species of butterflies. Most butterflies are somewhat restricted in the number of species of food plants that they consume as larvae (Vane-Wright 1978). Some may be dependent upon rare plants or habitats. As human activities modify rare habitats, some plant species are driven to or near extinction. Butterflies that depend upon these resources are severely impacted. Insecticide and herbicide use also impact butterfly populations.

None of the butterfly species collected during this study is a candidate for federally protected status, and none are so rare that they should be considered for such protection.

## **DESCRIPTION OF THE AREA**

Quitobaquito Springs is an oasis at 332 meters elevation near the extreme southwestern corner of Organ Pipe Cactus National Monument, Pima County, Arizona. The springs and pond area are 100 to 300 m north of the international boundary between the United States and Mexico. Extensive agricultural operations are found just south of the border. Quitobaquito Springs forms an oasis larger in extent than any other such situation in the central portion of the Sonoran Desert. The oasis provides open water surrounded by a zone of lush vegetation which in contrast to the surrounding arid habitats, serves as a strong attraction for wildlife. This attraction applies not only to water dependent resident local species, but to a larger and diverse group of migratory birds that use the area for stopover feeding and resting purposes. The oasis also attracts a number of rare vagrant birds (Johnson et al. 1983).

The presence of abundant surface water at Quitobaquito Springs has also been an attraction for man and his domestic animals. Human settlements involved small agricultural operations, which included planting of exotic species and grazing. Vegetation around Quitobaquito Springs has changed greatly within historic times (Johnson et al. 1983). The area has been described and discussed by Bryan (1925), Brown et al. (1983), and Nabhan et

al. (1982). Johnson et al. (1983) discussed the use of the area by birds. Brown and Warren (1986) described the woody riparian vegetation. Bowers (1980) included Quitobaquito Springs in her papers on the flora of Organ Pipe Cactus National Monument. Plant nomenclature in this report follows that of Bowers. Adams (1971) compiled an unpublished flora of Quitobaquito.

In an approximately 400 x 400 m area of flat to slightly rolling terrain north of the international boundary are found the two perennial springs that flow through a series of ditches and weirs into a man-made pond of approximately 60 x 70 m. Emergent vegetation in the pond includes a dense stand of (*Typha domingensis*) and (*Scirpus olneyi*). A densely vegetated area of (*Prosopis velutina*) and other trees forms a north-to-south oblong around the pond. Shrubby riparian vegetation includes: *Prosopis velutina*, *Lycium* spp., *Zizyphus obtusifolia*, *Baccharis salicifolia*, *Panicum granatum*, *Isocoma acradenia*, *Suaeda torreyana*, *Prosopis pubescens*, *Sarcostemma cynanchoides*, *Atriplex polycarpa*, *Populus fremontii*, *Salix goodingii*, *Ficus carica*, *Atamisquea emarginata*, *Larrea tridentata*, *Tamarix chinensis*, *Stephanomeria* sp., and *Condalia alobosa* (Brown and Warren 1986). Several species of grasses and forbs grow in clearings and as an understory.

Between the pond and springs is an area of dense mesophytes and hydrophytes including *Distichlis spicata*, *Agrostis semiverticillata*, *Cynodon dactylon*, *Hordeum arizonicum*, *Polypogon monsgeliensis*, *Sporobolus* spp., *Cyperus* spp., *Eleocharis caribaea*, *Scirpus olneyi*, *Juncus* spp., *Anemopsis californica*, *Atriplex* spp., *Nitrophila occidentalis*, *Suaeda torreyana*, *Melilotus indicus*, *Tamarix chinensis*, *Centaurium calycosum*, *Eustoma exaltatum*, *Heliotropum curassavicum*, *Solanum nodiflorum*, *Veronica peregrina*, *Aster intricatus*, *Baccharis salicifolia*, *Carthamnus tinctorius*, *Eclipta alba*, *Machaeranthera arizonica*, *Pluchea purpurascens*, *Tessaria sericea*, and other species.

Located to the east of the pond is an improved gravel parking lot. To the west of the pond is a disturbed open area of largely bare ground with scattered small shrubs, subshrubs, and annuals, and a wash with dense xeroriparian shrubs and trees. Beyond that is an extensive area of relatively flat ground dominated by *Larrea*. Immediately north of the oasis and extending to the northwest are the Quitobaquito Hills, with characteristic desert hillside vegetation including *Aristida adscensionis*, *Hilaria rigida*, *Atriplex polycarpa*, *Cercidium microphyllum*, *Bursera microphylla*, *Argythamnia lanceolata*, *Jatropha* spp., *Hibiscus denudatus*, *Cereus giganteus*, *Cereus thurberi*, *Ferocactus acanthodes*, *Hyptis emoryi*, *Ambrosia dumosa*, *Porophyllum gracile*, and other species.

The area considered in this study includes the Quitobaquito oasis, but extends beyond it to the north, east and west to encompass an area from Williams Springs to Aguajita Wash and part of the Quitobaquito Hills. This area is called the "Quitobaquito Management Area."

## METHODS

This study was begun as part of a general survey of the insects of the area, which has been reported on elsewhere (Kingsley et al. 1987). The original study was expanded to include two more field trips and an intensification of focus on grasshoppers and butterflies. Nine field trips were taken to the area between April 23, 1983 and December 31, 1984. On each trip, insects observed were collected by standard methods such as aerial and sweep netting and hand capture. Butterfly specimens were killed by pinching, and grasshopper specimens were killed by ethyl acetate fumes in killing jars. Efforts were made to sample each of the habitats present in the area. Plants that were in bloom were examined carefully and watched for nectar feeding butterflies. The tops of some of the hills were visited to watch for butterflies that tend to congregate on hilltops for mating.

Specimens were identified through the use of the appropriate keys (Ball et al. 1942; Otte 1981, 1984; Scott 1986) and comparison with specimens in the collection of the University of Arizona Department of Entomology. Specimens were deposited in the collection at organ Pipe Cactus National Monument and duplicates were deposited with the collection of the University of Arizona.

The frequency of occurrence and abundance of species in each type of habitat are two of the most important factors which must be considered in determining the normal habitat of the species and the species role in the environment (Cantrall 1943). Determination of the abundance of species has been one of the most difficult problems encountered in this study. At present, there are no means whereby reliable quantitative samples may be obtained. If the differences in behavior, activities, and habitat preferences of the various forms of grasshoppers and butterflies are considered, it is obvious that quantitative methods of collecting have not been successfully developed, and probably never will be.

In this investigation, a general impression of the abundance of each species was formed based on the number taken or observed in relation to the length of the collecting period. The impression was then recorded as abundant, common, occasional, or rare. Butterflies, because of their often migratory habits, were additionally recorded according to the relative regularity of sightings as rare, irregular and regular. A species was defined as rare if it was found on only one or two trips, irregular if it was found on less than half of the trips, and regular if it was found on more than half of the trips.

In this report, nomenclature for grasshoppers follows Otte (1981 and 1984), and nomenclature for butterflies follows Scott (1986). Names are presented with the scientific name first, this includes the genus, species and subspecies, if appropriate. Following the scientific name is the name of the author of the species--that is the scientist who gave the species its name. If the author name is in parentheses, this means that the author originally put the species in a different genus and subsequent taxonomic workers have assigned the species to its current genus. The common name, for those forms that have common names, is in boldface type, following the author name. Common names for grasshoppers are not given by Otte (1981 and 1984), so in this paper they are taken from either Helfer (1982) or Ball et al. (1942). Some species have no common names given in any of these sources.

## DISCUSSION AND RESULTS

Species diversity is the primary indicator of ecological health of an area. The diversity and size of herbivorous insect populations often indicates the diversity and size of the plant population (Price 1983). Patchiness of the habitat may be reflected in the composition of the insect fauna. Small patches of rare plants may or may not be sufficient to support insects that are highly host-specific. For example, no Sandhill Skippers (Polites sabuleti (Boisduval)) have colonized the salt grass (Distichlis) at Quitobaquito. But a small breeding population of Giant Whites (Ascia howarthi) has colonized the scattered Atamisquea emarginata population in the monument, and a population of Cattail Grasshoppers (Leptysmia hebardii) has become established in the small patch of cattails at the pond.

Grasshoppers as a group tend to differ from butterflies as a group in that grasshoppers generally feed on a wider variety of plants than butterflies. diversity of the plant communities may be important to butterflies by providing a range of food plants from which specialists may select. In insect groups that are strong food specialists, a broad food resource spectrum might result in high species diversity. with the generally less specialized grasshoppers, however, the role of diversity of hiding places and escape space may be of equal or greater importance. this is especially true in those species which rely on camouflage as a defense measure, as many of ours do. Plant communities that are taxonomically diverse have a high diversity of escape spaces and hiding places, and these may be most important in explaining grasshopper diversity (Otte and Joern 1977). The oasis at Quitobaquito provides an area with high plant diversity, compared to the surrounding desert, and this diversity may explain the diversity of insects found there.

Beyond plant diversity, other environmental factors may be important in shaping insect habitats and providing a diversity of resources for insects. Joern (1982) reviewed factors important in microhabitat selection in grasshoppers. These include: vegetation structure, number of plant species, microclimate, soil characteristics, availability of food plants, availability of suitable oviposition sites, and substrate characteristics which render an individual cryptic. He also reported that microhabitat selection in grasshoppers may be influenced by interaction among the species involved either through competition or selective predation.

Joern (1982) demonstrated that grasshopper species select microhabitat sites which differ in the degree of vegetation density. Many species are found primarily in open areas. Other species are associated with fairly dense vegetation over. Some species are very broad in their use of microhabitats with varying structure while other species generally are found in microhabitats with only a small variation in vegetation structure. The diversity of microhabitats in the Quitobaquito Management Area may explain, at least in part, the grasshopper diversity.

Some species of butterflies are dependent on hilltops for mate location, and larval host plants often tend to grow on the north faces of those hills. The Quitobaquito Hills are valuable for maintaining regular populations of Pima Orange-tip (Anthocharis pima) and, perhaps, Columella Hairstreak (Strymon columella) and Great Purple Hairstreak (Atlides halesus).

Some species are dependant on arroyos of some size, not only for daily and seasonal movements but for mate location and specialized food plants. Various types of patrolling and perching behaviors in canyons, complete with territoriality and pugnaciousness among butterflies were seen in the Aguajita Wash. The Arroyo Grasshopper (Heliastus benjamini) was found only along the two major washes and near the springs and pond.

The lush riparian vegetation at Quitobaquito provides afternoon shade which is important to butterflies and some grasshoppers during the hottest months of the year. this is necessary to preserve body temperature within comfortable levels and to minimize water loss. Also, some species of butterflies are late afternoon perchers in sunlit clearing within woodland, a habitat supplied by the oasis. The surface water at the various springs in the area is an important for many butterfly species and may be of value to a few grasshopper species.

Community compositions vary in time and space. Rare species and colonizing events may be missed, especially in a study such as this that involves only a few field trips. Many butterfly species, such as the Gulf Fritillary (Argraulis vanillae) and the Nyctelius Skipper (Nyctelius nyctelius) range widely as adults into areas in which they do not breed, and may be present only briefly. Life histories of various grasshopper and butterfly species are staggered throughout the growing season. Some species such as the Pallid-winged Grasshopper (Trimerotropis pallidipennis) and the Obscure Grasshopper (Opeia obscura) are multivoltine (at least bivoltine) and have more than one generation during the season. Other species (in addition to the species with single colonist events) are present for only short periods. Insect diversity is low in the spring, increases until late August or September and then gradually decreases. The summer rainy season brings new plant growth and flowering of some species, thereby increasing available plant resources for insects for a short time.

Quitobaquito Management Area represents approximately 250 hectares of lower Sonoran Zone desert and riparian areas. A similar faunistic study done at the Appleton-Whittel Research Ranch at Elgin, Arizona in Santa Cruz County (Bailowitz, unpublished) involved more trips, considerably more area, but yielded only about twice the number of species.

Comparison of Quitobaquito Management Area (QMA)  
And Appleton-Whittel Research Ranch Butterfly Faunas

Area	No. Trips	No. Butterfly Species	Approximate Area (ha.)	Species/ha
QMA	9	52	250	.208
AWRR	50	103	3100	.033

This does not suggest that the diversity of butterflies is significantly great at Quitobaquito Management Area than other areas, but that it is quite high. Certainly for low, mostly flat Sonoran Desert locales, the total of 52 species of butterflies is high in light of the fact that fewer than 70 species have been recorded for all of Yuma County (Bailowitz,

TABLE 1. Grasshoppers of Organ Pipe Cactus National Monument.

Scientific Name:	Common Name:	Abundance:	Page:
<b>FAMILY ACRIDIDAE:</b>			
<b>Gomphocerinae:</b>			
<u>Opeia obscura</u>	Obscure grasshopper	A	10
<u>Horesidotes cinereus</u>	Ash-gray range g.h.	C	10
<u>Cibolacris parviceps</u>	Cream grasshopper	C	10
<u>Ligurotettix coquilletti</u>	Desert clicker g.h.	A	10
<b>Oedipodinae:</b>			
<u>Lactista aztecus</u>	None	A	10
<u>Heliastus benjamini</u>	Arroyo grasshopper	C	11
<u>Trimerotropis pallidipennis</u>	Pallid-winged g.h.	A	11
<u>Anconia integra</u>	Alkali grasshopper	C	11
<b>Crytanthacridinae:</b>			
<u>Schistocerca vaga</u>	Gray bird locust	UC	11
<u>Melanoplus sp.</u>	N/A	C	11
<u>Aeoloplides tenuipennis</u>	Narrow-winged bush g.h.	C	12
<u>Hesperotettix viridis viridis</u>	Green streak	C	12
<u>Leptysma hebardii</u>	Cattail grasshopper	UC	12
<b>FAMILY TETTIGONIIDAE:</b>			
<u>Insara elegans</u>	Mesquite katydid	C	12
<u>Insara covilleae</u>	Creosote-bush katydid	C	12
<u>Scudderia mexicana</u>	Mexican katydid	UC	12
<u>Neoconocephalus triops</u>	Cone-nosed katydid	UC	12

Key: C = Common UC = Uncommon A = Abundant R= Rare N/A = Not Applicable

unpublished data). but in more mountainous terrain, such as the Ajo Mountains, greater diversity is expected.

## SPECIES ACCOUNTS

The following species accounts are divided into two sections: first grasshoppers and then butterflies. Each section contains first a table of all of the collected species of the group, followed by a more detailed listing of each species. The butterfly section contains a color plate of selected collected species.

### GRASSHOPPERS

#### **FAMILY. ACRIDIDAE**

Subfamily: Gomphocerinae

##### Opeia obscura (Thomas) **Obscura grasshopper.**

A very common grasshopper in the study area, this species is sometimes destructive in alfalfa, grains, and Bermuda grass in cultivated areas. It is also common in thicker stands of grass in the Lower Sonoran Zone and in sparse, short grasses of the Upper Sonoran and lower Transition Zones (Ball et al. 1942). An important range grasshopper in the northern short-grass prairies and great plains. Feeds on a wide variety of grasses, especially in the genera Bouteloua, Sporobolus, Distichlis, Aristida, and Muhlenbergia. Found in all Arizona except highest elevations; north to Montana (Otte 1981). Adults are present from April to October.

##### Horesidotes cinereus Scudder **Ash-gray range grasshopper.**

Common, occurring on grass under shrubs on rocky hillsides, though feeding to some extent on plants other than grasses, such as Calliandra and Haploppannus. Lower Sonoran Zone desert up to lower edge of oak belt, southern Arizona to southern California; north to Bradshaw Mountains in Yavapai County (Ball et al. 1942). Adults are present from June to October.

##### Cibolacris parviceps (Walker) **Cream grasshopper.**

A widely distributed very common grasshopper which rarely becomes abundant enough to attract much attention. Occurs on thin exposed soil and overgrazed range in the Upper and Lower Sonoran Zones. Arizona to California, Utah, Colorado, New Mexico, and Mexico (Otte 1981). Feeds on Larrea at night and rests on the ground in the daytime (Otte and Joern 1975). Seems to prefer stony ground to sandy areas. Eats annual herbs when they are available. Adults are found from late March to November in Arizona. Development depends on the time of spring and summer rainfall (Otte 1981).

##### Ligurotettix coauillettii kunzei **Caudell Desert clicker grasshopper.**

Abundant, found on such plants as creosote bush, Lycium, mesquite, Atriplex, and Franseria, and Ironwood. Secretive and hard to find, through the sound of its stridulation is one of the most familiar daytime noises on the desert. Usually found on Larrea, nymphs feed on spring and summer annuals. Southern Arizona

north to near Kingman (Ball et al. 1984). This is the only grasshopper species known to defend territories (Otte and Joern 1975), at least when population density is low. A host plant rarely contains more than one male, and males fight for possession of the plant. Resides on gray Larrea stems during the daytime and feeds on the foliage at night. Adults are present from June to October.

### **Subfamily: Oedipodinae**

#### Lactista aztecus (Saussure).

One of the commonest grasshoppers of the Lower Sonoran Zone, yet this species has no common name. It is usually found on the desert but also found in dry, bare areas in the desert grasslands, where it is common enough to be considered destructive (Ball et al. 1942). Found from Arizona to Texas and Mexico (Otte 1984). Prefers open ground with sparse vegetation. Depends upon camouflage for protection, remaining motionless until nearly touched, then flashing its yellow wings as it flies. Adults from March to November.

#### Heliastus benjamini Caudell **Arroyo grasshopper**.

A fairly common grasshopper in washes and arroyos on gravelly ground with sparse vegetation and near water. Found primarily in the Upper Sonoran Zone but extending into the Lower Sonoran Zone (Ball et al. 1942). Food consists in part of algae growing around pools of water, and in part of weeds. Occasionally found in grassland or irrigated land near the arroyos. Arizona, New Mexico, west Texas and northern Mexico (Otte 1984). Adults July to November.

#### Trimerotropis pallidipennis (Burmeister) **Pallid-winged grasshopper**.

Abundant in the study area, and especially conspicuous when it sits in open areas such as the parking lot and trails and flies up in front of people. One of the most abundant grasshoppers in the lower and Upper Sonoran Zones; up to about 8,500 feet elevation on rocky ridges. Breeds in areas of thin soil and sparse vegetation. Migrations occur especially in June and July at which time much damage may be done in cultivated areas. Many crops are injured. Migratory flights occur at night. Large numbers may come to lights. Widespread in the western United States south to Argentina (Ball et al. 1942). Lives on open ground and feeds on the annual grass Bouteloua aristidoides and other grasses and herbs. Produces at least two generations a year. May overwinter as adults (Otte 1984).

#### Anconia integra Scudder **Alkali grasshopper**.

Fairly common in alkali areas in the Lower Sonoran Zone (Ball et al. 1942), this grasshopper is common in the patch of vegetation between the pond and spring at Quitobaquito. It feeds on alkali plants such as Suaeda, Atriplex canescens, A. polycarpa, and Sarcobatus vemiculatus. Western Arizona east to Phoenix, Eloy, and Tucson. Arizona to California, Nevada and Utah (Otte 1984). One of the few oedipodine species that does not live on the ground, but remains for most of its life in the plants that it eats and flies from plant to plant. Adults from March to July.

Subfamily: Crytanthacridinae

Schistocerca vaga (Scudder) **Gray bird locust.**

This is a large, conspicuous, gray locust common on irrigated land, and in yards (Ball et al. 1942) but uncommon in the study area during the period covered by this investigation. May be a minor pest in citrus, alfalfa, cotton. Lives to a considerable extent on mesquite, but feeds on a wide variety of plants, especially low weeds and herbs, of which ragweed (Franseria tenuifolia and pigweed (Amaranthus palmeri) are especially important. May also develop on such widely different plants as Jatropha, Hilaria rigida, oaks and Larrea. A member of the Lower Sonoran desert fauna. California to Texas, Mexico, and Nicaragua. (Ball et al. 1942).

Melanoplus sp.

This is a very large genus of grasshoppers, and the species are practically indistinguishable by any but the most expert students. It is a widespread and common. Several species are possibly found at Quitobaquito, but no attempt was made to distinguish them. Most are at least moderately omnivorous.

Aeoloplides tenuipennis (Scudder) **Narrow-winged bush grasshopper.**

Common in the study area close to the springs, this species is found on plants in alkaline regions in the Lower Sonoran Zone (Ball et al. 1942). Most common on Atriplex canescens, but also found on Atriplex polycarpa and other species as well as on Suaeda and Sarcobatus vermiculatus.

Hesperotettix viridis viridis (Thomas) **Green Streak.**

In our study area this common species may generally be found on snakeweed (Gutierrezia sarothrae) and seep willow (Baccharis salicifolia). According to some ranchers it is quite important in checking the growth of noxious range weeds (Ball et al. 1942). Widely distributed from Canada to Mexico and from Atlantic to Pacific (Helfer 1972).

Leptysmia hebardei Rehn and Eades **Cattail Grasshopper.**

This uncommon species feeds exclusively on cattails (Typha domingensis) and was found only in the cattail patch at the pond. It is very slender, cryptically colored, and flies quickly when approached or hides behind stems, so it is difficult to catch or observe and may be more common than we suspect. Its distribution includes California, Nevada and Arizona (Helfer 1972).

**FAMILY: TETTIGONIIDAE**

Insara elegans Scudder **Mesquite katydid.**

Lives on mesquite, catclaw (Acacia greggii), and other spiny shrubs and trees and is common in the study area. It also lives on willow, desert willow, arrowweed, and low composites. Arizona to Mexico, New Mexico, and southwestern Texas (Ball et al. 1942).

Insara covilleae Rehn and Hebard **Creosote-bush katydid.**

This common species is found only in Larrea. Occurs over most of the creosote bush desert from Altar, Sonora, Mexico, north to Boulder Dam (Ball et al. 1942).

Scudderia mexicana (Saussure) **Mexican katydid.**

This species was uncommon in this area during the period of investigation, but may be more common at other times. It feeds on trees, bushes, and low vegetation and is more common in damp situations along stream beds and edges of cultivated areas. Arizona to California, Texas and Guatemala (Ball et al. 1942).

Neoconocephalus triops (Linnaeus) **Cone-nosed katydid.**

Only collected once during this study, this species is probably more common than our data suggest, but it is cryptic and nocturnal. It is usually most common in dense, low vegetation, and especially common on Johnson grass (Sorghum halengense) and other rank grasses (Ball et al. 1942). It is widespread throughout the southern U.S. (Hebard 1972).

## **BUTTERFLIES**

### **FAMILY: HESPERIIDAE**

Lerodea eufala (W.H. Edwards) **Eufala Skipper.**

Taken two of nine trips, it is probably most closely associated with Cynodon dactylon and usually found in riparian areas. Uncommon. Widespread from California to the East coast of the United States, mostly in grassy flats, uncultivated fields, marshes, and along roadsides (Tilden and Smith 1986).

Lerodea arabus (W.H. Edwards) **Arabus Skipper.**

Taken two of the nine trips, it is a species more confined to the Sonoran Desert than the previous one. It favors patches of sunlight and grassy flats in riparian areas, often near Cynodon dactylon. Uncommon.

Nyctelius nyctelius (Latreille) **Nyctelius Skipper.**

Stray, only taken once. There are only four known records of this species from Arizona. It is regularly found from South America north to Sinaloa (Tilden and Smith 1986).

Copaeodes aurantiacus (Hewitson) **Orange Skipperling.**

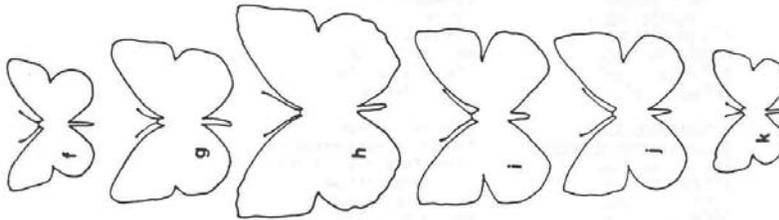
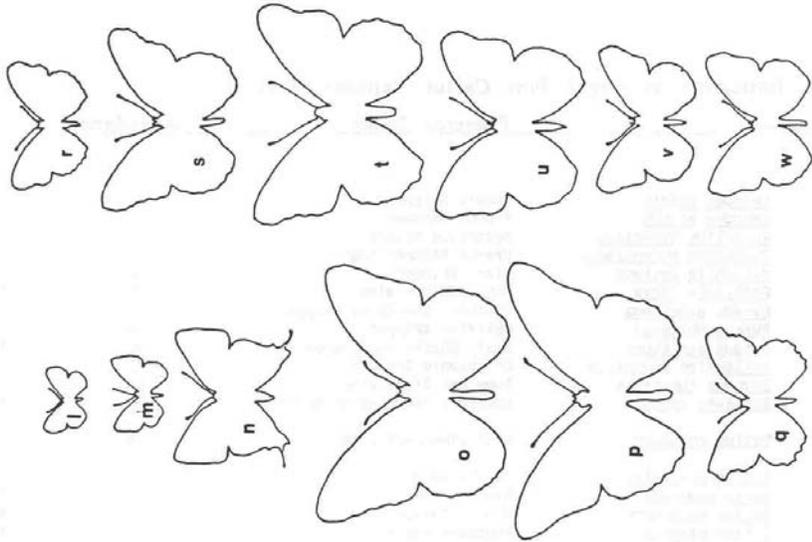
Taken on two of the nine trips, but should occur regularly in the washes. Widespread from California to the east coast. Larvae feed on Cynodon dactylon. Typical habitats include grassy streamsides, washes, and fields (Tilden and Smith 1986).

TABLE 2. Butterflies of Organ Pipe Cactus National Monument.

Scientific Name:	Common Name:	Abundance:	Page:
<b>FAMILY:</b>			
<b>HESPERIIDAE</b>	<u>Lerodea eufala</u>	Eufala Skipper	UC 15*
	<u>Lerodea arabus</u>	Arabus Skipper	UC 15
	<u>Nyctelius nyctelius</u>	Nyctelius Skipper	R 15
	<u>Copaeodes aurantiacus</u>	Orange Skipperling	C 15
	<u>Hyalephila phyleus</u>	Fiery Skipper	C 15*
	<u>Pholisora libya</u>	Mohave Sooty-wing	C 15*
	<u>Pyrgus albescens</u>	Southern Checkered Skipper	C 15
	<u>Pyrgus philetas</u>	Philetas Skipper	UC 15
	<u>Pyrgus scriptura</u>	Small Checkered Skipper	R 15
	<u>Heliopetes domicella</u>	Erichson's Skipper	C 16*
	<u>Erynnis funeralis</u>	Funereal Disky-wing	UC 16
	<u>Systasea zampa</u>	Edward's Powdered Skipper	R 16
<b>PAPILIONIDAE</b>	<u>Battus philenor</u>	Pipe-vine Swallowtail	UC 16*
<b>PIERIDAE</b>	<u>Pieris protodice</u>	Checkered White	C 16*
	<u>Ascia howarthi</u>	Giant White	UC 16*
	<u>Colias eurhythme</u>	Orange Sulfur	C 16*
	<u>Colias cesonia</u>	Southern Dogface	C 16*
	<u>Phoebis sennae</u>	Cloudless Sulfur	C 17
	<u>Kricogonia lyside</u>	Lyside	UC 17
	<u>Eurema nicippe</u>	Sleepy Orange	C 17
	<u>Eurema mexicana</u>	Mexican Sulfur	UC 17
	<u>Anthocharis pima</u>	Pima Orange-tip	R 17*
	<u>Nathalis iole</u>	Dainty Sulfur	C 17*
<b>LYCAENIDAE</b>	<u>Ministrymon leda</u>	Leda Hairstreak	C 17
	<u>Chlorostymon simaethis</u>	Simaethis Hairstreak	UC 17
	<u>Atlides halesus</u>	Great Purple Hairstreak	C 18*
	<u>Strymon melinus</u>	Common Hairstreak	C 18
	<u>Strymon columella</u>	Columella Hairstreak	C 18
	<u>Leptotes marina</u>	Marine Blue	R 18
	<u>Hemiargus isola</u>	Reakirt's Blue	UC 18
	<u>Hemiargus ceraunus</u>	Ceraunus Blue	UC 18
	<u>Brphidium exilis</u>	Pygmy Blue	C 18*
	<u>Calephelis nemesis</u>	Fatal Metalmark	C 18*
	<u>Adopdemia moro</u>	Mormon Metalmark	R 18
	<u>Adopdemia palmerii</u>	Palmer's Metalmark	R 19
<b>LIBYTHEIDAE</b>	<u>Libytheana bachmanii</u>	Snout Butterfly	UC 19*
<b>NYMPHALIDAE</b>	<u>Asterocampa leilia</u>	Express Leilia	C 19
	<u>Marpesia petreus</u>	Ruddy Dagger-wing	UC 19
	<u>Nymphalis antiopa</u>	Mourning Cloak	A 19
	<u>Vanessa atalanta</u>	Red Admiral	C 19
	<u>Vanessa cardui</u>	Painted Lady	C 19*
	<u>Vanessa annabella</u>	West Coast Painted Lady	R 20
	<u>Vanessa virginiensis</u>	American Painted Lady	C 20
	<u>Precis coenitis</u>	Buckeye/Peacock	C 20
	<u>Precis nigrosuffusa</u>	Dark Peacock	UC 20*
	<u>Anthanassa texana</u>	Texas Crescent	C 20*
	<u>Chlosyne californica</u>	California Patch	R 20*
	<u>Chlosyne lacinia</u>	Border Patch	C 20*
	<u>Euptoieta claudia</u>	Variegated Fritillary	C 20*
<b>HELICONIIDAE</b>	<u>Agraulis vanillae</u>	Gulf Fritillary	C 21*
<b>DANAIDAE</b>	<u>Danaus gilippus</u>	Queen	C 21*
	<u>Danaus plexippus</u>	Monarch	C 21

KEY: C=Common UC=Uncommon A=Abundant R=Rare \*=pictured on color plate (pg. 14)

KEY FOR COLOR PLATE  
(Columns reading left to right)



COLUMN ONE

- a. *Lerodes eufala* Eufala Skipper
- b. *Mylephila phyleus* Fiery Skipper
- c. *Battus philenor* Pipe-vine Swallowtail
- d. *Pholisora libya* Moheve Sooty-wing
- e. *Heliopetes domicella* Erichson's Skipper

COLUMN TWO

- f. *Anthocharis pima* Pima Orange-ti
- g. *Colias eurytheme* Orange Sulfur
- h. *Colias cesonia* Southern Dogface
- i. *Ascia howarthi* Giant White
- j. *Pieris protodice* Checker White
- k. *Nathalis iole* Dainty sulfur

COLUMN THREE

- l. *Brephidium exilis* Pymy Blue
- m. *Calpehelia nemesis* Fatal Metalmark
- n. *Atlixes halesus* Great Purple Hairstreak
- o. *Danaus gilippus* Queen
- p. *Agraulis vanillae* Gulf Fritillary
- q. *Libythea bechmanii* Snout Butterfly

COLUMN FOUR

- r. *Anthanassa texana* Texas Crescent
- s. *Euptoieta claudia* Variegated Fritillary
- t. *Venessa cardui* Painted Lady
- u. *Precis nigrosuffusa* Dark Peacock
- v. *Chlosyne licinia* Border Patch
- w. *Chlosyne californica* California Patch



Hylephila phyleus (Drury) **Fiery Skipper.**

Taken on only one trip of the nine, but in small numbers. Associated with Cynodon dactylon and widespread across the U.S. It should be found regularly at nectar-bearing flowers. Most often found in moist grassland, marshes, uncultivated fields, lawns, yards, and gardens (Tilden and Smith 1986).

Pholisora libya (Scudder) **Mohave Sooty-wing.**

Taken on six of the nine trips, it requires large stands of Atriplex sp. As host plants. Occurs spottily north to Oregon and North Dakota. Common. Generally found in Atriplex stands, alkali flats, and desert streamsides (Tilden and Smith 1986).

Pyrgus albescens Plotz Southern **Checkered Skipper.**

Taken on six of the nine trips, it is common in a wide variety of habitats. It utilizes a variety of plants of the family Malvaceae and is widespread across the U.S.

Pyrgus philetas W.H. Edwards **Philetas Skipper.**

Found only once, but in small numbers. It favors hot canyons and is confined to the Sonoran and Chihuahuan Deserts. Uncommon. Host plant unknown.

Pyrgus scriptura (Boisduval) **Small Checkered Skipper.**

Found only once, hilltopping in the Quitobaquito Hills. Larvae feed on Sida or Sphaeralcea spp. Rare. Occurs from California to Texas.

Heliopetes domicella (Erichson) **Erichson's Skipper.**

Taken on two of the nine trips. its hosts are probably plants in the family Malvaceae. It occurs from the Colorado River to the mouth of the Rio Grande and southward (Tilden and Smith 1986). Rare. Found only at Aguajita Spring in our area.

Erynnis funeralis (Scudder and Burgess) **Funereal Dusky-Wing.**

Uncommon, but found on four of the nine trips, usually at flowers in washes. Widespread in the western U.S., utilizing a variety of tree and herb legumes.

Systasea zampa (W.H. Edwards) **Edwards' Powdered Skipper.**

Found only once, in Aguajita Wash. Host plants are Malvaceous, perhaps Hibiscus spp. Rare. Southern California to southern Texas.

## **FAMILY. PAPILIONIDAE**

Battus philenor (Linnaeus) **Pipe-vine Swallowtail.**

Uncommon but resident, taken on six out of nine trips, mostly in Aguajita Wash. Its host plant is Aristolochia watsoni. Occurs from California to the east coast of the U.S. and south to Costa Rica (Tilden and Smith 1986).

## **FAMILY: PIERIDAE**

Pieris protodice Boisduval and Leconte **Checkered White.**

Very common in most habitats in the study area. Host plants are various crucifers and probably also Wislizenia refracta. Throughout the U.S. and Central America. its distribution is very general, and its habitats include fields, roadsides, cultivated lands, yards, and vacant lots (Tilden and Smith 1986).

Ascia howarthi (Dixey) **Giant White.**

Regularly found, but uncommon, mostly in Aguajita Wash, but also seen at Quitobaquito. this is the only breeding colony of this Mexican species in the U.S. Host plant is Atamisquea emarginata, the only U.S. locality of which is the study area.

Colias eurytheme Boisduval **Orange Sulfur.**

Found on half of the trips, this species may be a fly-in from the agricultural areas across the border where it feeds on alfalfa. Found throughout the U.S. and into Mexico. Also called the Alfalfa Butterfly because it is often a pest in alfalfa (Tilden and Smith 1986). Uncommon in the study area.

Colias cesonia (Stoll) **Southern Dogface.**

Common and regular, this butterfly utilizes various legumes such as Dalea spp. Occurs in a variety of habitats including fields, meadows, roadsides, washes, thorn forests, and pastures. Ranges throughout the U.S. and south to Central America (Tilden and Smith 1986).

Phoebis sennae (Linnaeus) **Cloudless Sulfur.**

A common influx species from Mexico during the summer rains. May occasionally utilize Cassia covesii as a host plant. Ranges from California to the southeastern U.S. and south through Mexico, Central and South America to Patagonia (Tilden and Smith 1986).

Kricogonia lyside (Godart) **Lyside.**

Found only once, in small numbers. This is a sporadic influx species from Mexico, probably absent from the area in most years.

Eurema nicippe (Cramer) **Sleepy Orange.**

Common and regular in deserts and washes. Its host plant is Cassia covesii. Ranges from southern California to the east coast and south to Brazil. Extremely varied habitats including fields, meadows, fence rows, desert scrub, washes, gardens, parks, yards, and vacant lots (Tilden and Smith 1986).

Eurema mexicana (Boisduval) **Mexican Sulfur.**

Uncommon but regular, occurring in the flats and washes. Host plants include a variety of legumes. The species is widespread across the southern U.S. and throughout Mexico.

Anthocharis pima (W.H. Edwards) **Pima Orange-tip.**

Although found only once, it should occur regularly on hilltops in early springs. Host plants are various crucifers, e.g. Thelypodium sp. Rare. California to El Paso on desert hills.

Nathalis iole Boisduval **Dainty Sulfur.**

Regular and common on flats and in washes. Larvae feed on a variety of herbaceous composites, but food plant is unknown in the area. Ranges from California to the east coast and south to South America. Habitats include meadows, grassland, roadsides, and open places in brushland, to treeline in summer in mountainous areas (Tilden and Smith 1986).

**FAMILY: LYCAENIDAE**

Ministrymon leda (W.H. Edwards) **Leda Hairstreak.**

Regular and common, larvae feed on floral spikes of mesquite. Rests in shade during the heat of the day. California to Texas and south into Mexico.

Chlorostrymon simaethis (Drury) **Simaethis Hairstreak.**

Stray, found only once. Its major host plant, balloon-vine (Cardiospermum halicacabum) is not found in Arizona. Typically Mexican, this species is common at Hermosillo.

Atlides halesus (Cramer) **Great Purple Hairstreak.**

Found regularly but uncommonly at flowers and on hilltops. Ranges from California to the east coast of the U.S. and south into Mexico in a variety of situations including woodland, parks, yards, fence rows, roadsides, and city shade trees (Tilden and Smith 1986). Its food plants are mistletoes, including Phoradendron californicum which grows in mesquites and palo verdes.

Strymon melinus Hubner **Common Hairstreak.**

Common and regular, mostly feeding at flowers. It ranges throughout the U.S. and south to Venezuela, and uses a wide variety of host plants (Tilden and Smith 1986).

Strymon columella (Fabricius) **Columella Hairstreak.**

Uncommon but regular at flowers and on hilltops. Ranges from southern California to southern Florida to Central America and West Indies. Larva host plant is Hibiscus denudatus.

Leptotes marina (Reakirt) **Marine Blue.**

Irregular and numbers highly variable from rare to uncommon. Widespread in the southern U.S. and south to Central America. Larvae feed on various legumes. Found in many habitats including thorn scrub, desert, yards, parks, roadsides, and fence rows. Follows cultivated legumes into urban areas (Tilden and Smith 1986).

Hemiargus isola (Reakirt) **Reakirt's Blue**.

Uncommon but regular in a variety of habitats. Larvae feed on a variety of legumes including mesquite. It ranges across much of the U.S. south to Costa Rica.

Hemiargus ceraunus (Fabricius) **Ceraunus Blue**.

Uncommon but regular. Habits and habitats much like the preceding species, but the range is more restricted and it does not range as far north.

Brephidium exilis (Boisduval) **Pygmy Blue**.

Common and found on all trips. Occurs throughout the area in association with plants of the family Chenopodiaceae such as Atriplex, Suaeda, and Salsola. Western U.S. south to Venezuela.

Calephelis nemesis (W.H. Edwards) **Fatal Metalmark**.

Common and regular, and most common at the oasis and at Aguajita Spring. Larvae feed on shrub composites, probably Baccharis salicifolia. Ranges from California to Texas and into Mexico.

Apodemia Mormo (C. & R. Felder) **Mormon Metalmark**.

Rare and irregular, found hilltopping in the Quitobaquito Hills. Larvae feed on Erioeonum wrightii. Ranges throughout most of the western U.S. and into Mexico.

Apodemia Palmerii (W.H. Edwards) **Palmer's Metalmark**.

Rare and irregular, usually in riparian areas. Larvae eat tender leaves of Prosopis spp. Ranges throughout the desert southwest.

**FAMILY: LIBYTHEIDAE**

Libytheana bachmanii (Kirtland) **Snout Butterfly**.

Uncommon, widespread and fairly regular. Although the host plant, Celtis pallida, has not been recorded at Quitobaquito, it is present in the Monument and this butterfly probably breeds near Quitobaquito. This species sometimes migrates in enormous numbers.

**FAMILY: NYMPHALIDAE**

Asterocampa leilia (W.H. Edwards) **Empress Leilia**.

Found only once during the study, near Burrow Spring. This butterfly should breed on Celtis pallida, which is widely distributed in the monument, although it has not been reported from Quitobaquito. Males are territorial in arroyos. Found from Arizona to southern Texas and northern Mexico. It often sits on rocks or bare ground. Typical habitats include streamsides, washes, canyons and thorn forest (Tilden and Smith 1986).

Marpesia petreus (Cramer) **Ruddy Dagger-wing.**

A stray, taken only once in the area. Breeds on Ficus sp. in Central Sonora and might conceivably use the introduced fig trees at Quitobaquito. Ranges from southern Texas to southern Florida, occasionally reaching Arizona, but is typically a tropical American butterfly.

Nymphalis antiopa (Linnaeus) **Mourning Cloak.**

Taken only once during the study, at Aguajita Spring. Utilizes Salix and Populus as food plants, among other plants. Should breed in the area. Almost cosmopolitan in distribution and found in a variety of habitats (Tilden and Smith 1986).

Vanessa atalanta (Linnaeus) **Red Admiral.**

Taken on only two trips, in or near riparian areas. utilizes various plants in the family Urteicaceae, the only one of which that is found in the monument is Parietaria hesperia, which is widespread (Bowers 1980). this species often wanders far from where it grew up, and is found in a wide variety of habitats as an adult that will not support larvae. It was rare in this study area. found throughout the U.S. and Mexico, also in Europe and Asia (Tilden and Smith 1986).

Vanessa cardui (Linnaeus) **Painted Lady.**

Common and regular, worldwide in distribution and generally common. Eats many food plants from several families, but is most often associated with thistles and other Compositae.

Vanessa annabella (Field) **West Coast Lady.**

Irregular and rare, but found in a variety of habitats. Mostly utilizes plants in the family Malvaceae. Prone to mass movements, it is found throughout most of the western U.S.

Vanessa virginiensis (Drury) **American Painted Lady.**

Found only once in this study. This species feeds on many composites and is prone to mass movements. Found throughout North and Central America in a variety of habitats (Tilden and Smith 1986).

Precis coenia (Hubner) **Buckeye or Peacock Butterfly.**

Taken twice, the abundance of this butterfly varies greatly from year to year. Ranges throughout the southern two-thirds of the U.S., feeding mostly on plants in the families Scrophulariaceae and Platanaceae. this species was rare during the time of this study, but may be more abundant in other years.

Precis nigrosuffusa (Barnes and McDunnough) **Dark Peacock.**

Taken on four out of nine trips but always uncommon, this species varies greatly in abundance from one year to the next. It ranges throughout the southwest, utilizing the same food plants as P. coenia.

Anthanassa texana (W.H. Edwards) **Texas Crescent.**

Taken twice at Aguajita Spring. Ranges from Arizona to Georgia and south to Guatemala. The larval food plants are in the family Acanthaceae, seven species of which are recorded from the monument but not specifically from Quitobaquito, where the butterfly is rare.

Chlosyne californica (W.G. Wright) **California Patch.**

Found only once as males hilltopping. The host plant is Viguiera deltoidea which is widespread in the monument. This rare species is confined to the southwestern U.S. and northern Mexico.

Chlosyne lacinia (Geyer) **Border Patch.**

Found only once, this species should occasionally be common. The host plants are mostly herbaceous plants in the composite family. The species ranges through much of the southwestern U.S. and south to Argentina in a variety of habitats.

Euptoieta claudia (Cramer) **Variegated Fritillary.**

Found only once in this study, the species is widely distributed in the U.S. and Mexico in a variety of situations. Feeds on a variety of plants of various families.

**FAMILY: HELICONIIDAE**

Agraulis vanillae (Linnaeus) **Gulf Fritillary.**

Taken only once in this study, the species is highly vagile. The host plant, Passiflora spp. is not known from the monument, but is probably cultivated as an ornamental at Sonoyta. Ranges from California to Virginia and south to Argentina (Tilden and Smith 1986).

**FAMILY: DANAIIDAE**

Danaus gilippus (Cramer) **Queen.**

Common and regular in the area. This species utilizes various plants in the milkweed family and is widely distributed in the southern U.S. and south to South America in a variety of habitats.

Danaus plexippus (Linnaeus) **Monarch.**

Found only once in this study, this species is a strong migrant and should come through the area in the fall and occasionally in spring. Found throughout the hemisphere, from Canada to South America. Larvae feed on milkweeds, but it is unlikely that this species breeds in the monument.

Past management of Quitobaquito may have affected the ecosystem enough to alter species abundance or diversity. Grazing probably affected the grass growth, especially that growth close to the wetlands. Grass-feeding species, e.g. Hesperine skippers, and some species of grasshoppers, may have been affected. As mentioned previously, the grasshoppers present in the area may have an effect on slowing the recovery of the land from overgrazing.

Present day management with the deepened pond and minimal marshy areas does not favor extensive grass growth which might feed skippers and grasshoppers.

Aguajita Spring is worthy of special attention by butterfly observers. It is in the largest wash in the area, with the most dense riparian vegetation providing the most cover. It drains the largest area, and it has a rocky, shaded, damp area rather than an overgrown or sandy or sunny exposed area. And most importantly, it is close to Sonoyta Creek, serving as a catch-all for wandering species of butterflies from that area.

General conclusions that might be drawing from this work are: The high plant diversity supported by the oasis in turn supports a highly diverse butterfly and grasshopper fauna; furthermore, the diversity of microhabitats affords a complex of resources for insect species that is in excess of those provided by the surrounding desert, and the insect fauna has responded by colonizing many of these microhabitats. There is, at present, no indication of insecticide use in the agricultural area in Mexico adversely affecting the insect community of the study area. There is some indication that few species may, in fact, come to the study area from the agricultural area, thereby increasing the insect diversity. Past human activity in the may have had some effect on the insect community, but the insects are responding to the existing resources, and will continue to respond as the resources change through time. Insect species in the area may have some effect in slowing recovery of the land from overgrazing, but it is unlikely that this effect is profound enough to warrant insect population management.

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