



Seven Mile Spring, Courthouse Wash, Arches National Park

***BIOLOGICAL AND HYDROLOGICAL SURVEYS OF SPRINGS
ALONG THE COLORADO RIVER, UTAH AND ARIZONA***

138/
164/
608/
113/ } 161456

**SURVEYS OF SPRINGS IN THE COLORADO RIVER DRAINAGE IN
ARCHES NATIONAL PARK, CANYONLANDS NATIONAL PARK,
GLEN CANYON NATIONAL RECREATION AREA, AND
GRAND CANYON NATIONAL PARK**

PART II-Appendices

Final Report

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Report to the

National Park Service
Water Resources Division-WASO
PO Box 25287
Denver, CO 80225

Account No. 1445-7431-NWZ (1997)
Account No. 1445-8250-NWZ (1998)

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A7. Lists of aquatic invertebrates by habitats

PURDUE UNIVERSITY



DEPARTMENT OF ENTOMOLOGY

July 21, 1999

Dr. John Spence
Glen Canyon Recreational Area
P. O. Box 1507
Page, AR 86040-1507

Dear John:

Enclosed are the items pertaining to our "seeps and springs" report for 1998. They include: 1) a tally of all taxa collected by Jerry Monks and myself, 2) a tally of taxa collected by Jerry at all areas, 3) a tally of taxa collected by me in the Grand Canyon, and 4) a summary of various main points pertaining to the insect component of the project, in outline form.

In sum, we collected representatives of 7 insect orders and 41 insect families, with most specimens being larvae. Among all the taxa collected, 107 were identified to genus and 9 to species. If you recall, I mentioned that generic identifications likely would be possible for many groups, but not all, and species identifications would be possible only for certain adult flies and larval mayflies (which are well known as larvae).

John, just as a reminder, larvae of most insects, including aquatic taxa, are at best known as genera and certain groups only known to subfamily and at times family level. There are a number of reasons, first of all just the vast number of species, with many groups not studied well or at all. In general, very few larvae have been reared and associated with their adults (typically the stage upon which taxonomy is based). As an example of the difficulty of arriving at even generic level identifications of flies, we just recently developed the ability to differentiate larvae of two genera of my flies (Hemerodromiinae), but the research took a few years of field collecting, rearing attempts, and finally PCR and reliable rDNA markers. First, we had to demonstrate the potential of the molecular markers for adults and then we could apply them to larvae.

One point of explanation about the recording of taxa stemming from the samples sent by Jerry Monks. Colin copied exactly the collecting data in each sample, but the data from Canyonlands & Arches appeared in a format that differed from that used in the other areas, as you will see on the tally list for Jerry's collections. I trust you will be able to correlate Jerry's collection data with the sites in Canyonlands & Arches.

Included with the above are Colin's cover letter pertaining to his invoice and the invoice, for your action. He will send Jerry's specimens to you under separate cover today. Since Brad Sinclair is working on the adult empidids that I collected, my specimens will be sent to you eventually. Please call if you need any clarification.

Sincerely,

A handwritten signature in cursive script, appearing to read "John".

John F. MacDonald
Associate Professor

Seeps and Springs Summary: May 1998

Based on the Grand Canyon Collecting Trip
(the only one in which MacDonald was involved)

Outline of Main Points

I. Overview

A. What was done

1. Typically limited to 30-40 minutes collecting at each site
 - a. Jerry Monks: focused on taking substrate samples (in the madicolous, in pools, in "streams" that existed)
 - b. John MacDonald: focused on aspirating adult insects (almost totally focused on the madicolous)
2. Identifications
 - a. Jerry Monk's samples identified by Colin Brammer
 - b. MacDonald's samples identified by him, Colin, and Brad Sinclair
3. Results and lists of taxa collected (3 separate ones included):
 - a. total tally of all taxa from all areas arranged by classification of specimens (i. e., Order, then Family within an Order, then genera within a Family, etc.)
 - b. tally of taxa collected by Jerry Monks arranged by area, site, and subsample (e. g., Grand Canyon, Buckfarm, site 98-01, sample 1)
 - c. tally of taxa collected by MacDonald arranged by site (Grand Canyon only) (e. g., Buckfarm-site 98-01)

B. Comments pertaining to the approach

1. Collecting time at each site was severely limited, with a focus on the madicolous
2. substrates and "muck" sampled well by Jerry Monks (potentially repeatable)
3. MacDonald's efforts to aspirate adult insects was "hit and miss" (tough to repeat), but collecting in deep, shaded, wet canyons was relatively successful (see below)
4. other collecting equated to us "capturing anything that we saw" (not repeatable)

C. Comments pertaining to limitations and generalizations stemming from the approach

1. collections represent a "snapshot" of what might be taken at the time at each site; it is not possible to suggest anything about abundance of taxa collected, only occurrence; it is not possible to suggest anything about what wasn't collected; some generalizations may, with caution, be attempted relative to category of seep and spring (see below)

2. variables influencing insect collections at each site:

- a. time of year: many species spend long periods in a diapausing life cycle stage, including some species that may spend months in an egg stage
- b. time of day: many species exhibit pronounced circadian activity cycles, often independent of amount of sunlight, but influenced by heat and dryness
- c. some sites sampled in the A.M., other sites sampled in the P.M., and so direct comparisons of even seemingly identical sites is tenuous
- d. amount of sunlight: bright sun existed in some sites, deep shade in others, and sunlight at a site would vary depending on time of day sampled, etc.
- e. possible clumped distributions of larvae in substrates: "snapshot" sampling perhaps missed or encountered insects by chance alone
- f. recent history of "flashing", or drying up, could influence subsequent insect presence and abundance, with restoration of habitat & insect fauna "taking time"
- g. technique used and "skill" of collector can make a difference in collections; (future sampling protocol needs to consider "repeatability" by various collectors)

II. Comments about results

A. Generalization: the various madicolous sites tended to sort into one of three categories:

1. deep, shaded, wetter canyons such as site 98-03 (Saddle), site 98-07 (Elves Chasm), and site 98-15 (Fern Glen)
2. exposed, sunlit, drier sites such as site 98-08 (Mile 125.5 spring) and site 98-13 (Ledges)
3. broad, shallow, more exposed, canyons such as site 98-16 (Mohawk Canyon), site 98-14 (Slimey Tick), and 98-17 (Cove Canyon)

B. Trends: examples which seem to hold, taking into consideration the "snapshot" approach

1. deep, shaded, wetter sites: adult Empididae and adult Trichoptera present
2. exposed, sunlit, drier sites: adult Empididae lacking, but larval Stratiomyidae present and abundant (even in the hottest, "muckiest" madicolous)
3. broad, drier, canyons appear to reflect the insect taxa associated with category # 2, although wetter, shaded madicolous had a few adult Empidid flies and adult caddisflies
4. taxa that appeared to be present at all sites include: *Microvelia* adults, *Argia* larvae, stratiomyid larvae, and, depending on the site, various chironomid larvae

C. Comments pertaining to specific taxa that were "relatively commonly" encountered

1. Ephemeroptera: larvae of *Callibaetis* found in several "flowing" madicolous sites (note: adult *Callibaetis* are great dispersers, especially for mayflies)
2. Odonata: larvae of *Argia* in nearly all "flowing" madicolous sites

3. Hemiptera: *Microvelia* adults at nearly every site in all areas
4. Coleoptera: various species of Dytiscidae and Hydrophilidae at most exposed sites
5. Lepidoptera: larvae of a Pyralid moth, *Petrophila*, at several sites
6. Trichoptera: larvae of Hydroptilidae at nearly all sites in flowing madicolous sites
7. Diptera:
 - a. larvae of Stratiomyidae at nearly all sites, including exposed madicolous
 - b. adults of *Clinocera* (Empididae) at all shaded, wet madicolous sites
 - c. larvae of *Pericoma*, or *Telmatoscopus*?, (Psychodidae) at most sites
 - d. larvae of at least 24 genera of Chironomidae collected, but each site supported only one to a few taxa
 - e. larvae of at least 11 genera of Tipulidae collected, but only certain sites appeared to support more than 1 or 2 taxa

D. Comments pertaining to taxa of some interest

1. Hemiptera, Ochteridae, *Ochterus* sp.: this is an eastern species, found east into Texas (collected at sites 98-02, 98-06, 98-07) (reported from Grand Canyon in 1976)
2. Diptera, Empididae, *Asymphyloptera* sp.: a Neotropical taxon, with one species recorded from Arizona (new sp. ? collected at sites 98-03, 98-07, 98-15)
3. Diptera, Empididae, *Clinocera*: 5 species collected, including 3 undescribed spp., nearly all in deep, shaded, wetter canyons (e. g., Bert's, Elves, Fern, etc.)
4. one new species of *Wiedemannia* (Empididae) collected at the base of Vasey's Paradise
5. Empididae species will be described by Brad Sinclair, the world authority, his new species will be correlated with numbered *Clinocera* on the seeps and springs tallies

III. Suggestions for future work

A. Candidates to evaluate for possible indicator taxa; these appear to be taxa that should be collected and thus constitute "red flags" if they aren't present in certain sites:

1. *Microvelia*: they were present, usually in abundance, at nearly every site
2. *Argia* larvae: while present in nearly every flowing madicolous, they most likely exist in low densities and ample collecting effort needs to be made
3. Hydroptilidae larvae: usually abundant, but limited to "cleaner" rock surfaces
4. Stratiomyidae larvae (*Calopharyphus*, *Euparyphus*, *Stratiomys*): of special value in hot, sunlit, exposed sites that tended to support relatively few madicolous insects
5. *Clinocera* adults (Diptera, Empididae): of special value in deep, shaded, wet canyons, but they take special effort to recognize and collect by mouth aspirator

B. Thorough faunistic studies of the madicolous habitat that might facilitate making comparisons

between sites in an area like Grand Canyon, and between similar madicolous habitats in different areas such as the Grand Canyon versus Glen Canyon, or Arches, etc. This would require:

1. carefully selecting at least 1 or 2 of each of the two main madicolous sites (i. e., deep & shaded & wet vs. exposed & sunlit & drier) in proximity to facilitate repeated sampling
2. develop a year-long sampling protocol, at least quarterly, much better monthly
3. repeated collecting at various times of the diurnal period and under varying light intensities at each site for each sampling period over the entire year
4. focus on substrate sampling, including in the "muck" on rock surfaces (but, species identifications will not be possible)
5. focus on collecting adult empidid flies and adult caddisflies) on water films on steep, flowing madicolous (but, tough to see and aspirate, initially) (species i. d.s are possible)
6. sweeping emergent and overhanging foliage in the madicolous habitat (but, this would collect not only adults of madicolous taxa, but also terrestrial taxa "enjoying" the protection of foliage, higher humidity, increased prey, etc.) (tough to make repeatable)

C. Other habitats associated with seeps and springs that ought to be studied (but, again, year-long diversified, thorough sampling will be needed):

1. pools at the base of seeps and springs, including collecting in water, on the water surface, from foliage using insect nets, etc.)
2. in-flow and out-flow "streams" associated with the pools, using kicknets in riffles (most potential to be repeatable) and handpicking specimens from rocks, emerged wood, etc. (but, tough to make repeatable)

Appendix A: Keys to major Habitat and collection microhabitat

Habitat Key

<u>Abbreviation</u>	<u>Habitat Description</u>
S	Seep w/ laminar flow over vertical or nearly vertical surface. Flow usually unquantifiable.
SP	Spring w/ quantifiable flow and small stream outlet(s).
P1	Pool isolated from any spring/seep source except during high flows.
P2	Pool which is part of a spring/seep complex under most flows.
ST	Stream or rivulet usually associated with high volume springs.

Microhabitat Key

<u>Abbreviation</u>	<u>Microhabitat Description</u>
M	Madicolous habitat
LS	Laminar seepage over bare rock, detritus or algae
SS	Sediment sample from low velocity habitat
C	Chara sample from low velocity habitat
LP	Leaf pack: sample consisting of allochthonous materials
SW	Sweep of pool with aquarium net - can include rock surfaces

LIST of TAXA

GRAND CANYON/ARCHES/CANYONLANDS/GLEN CANYON

COLLECTIONS 1998
(Monks and MacDonald combined)

EPHEMEROPTERA

Baetidae

Baetis magnus
Baetis sp.
Callibaetis pictus
Callibaetis sp.

Leptophlebiidae

Thraulodes sp.

ODONATA

Anisoptera

Aeshnidae

Aeshna sp.
Anax sp.
Boyeria sp.

Libellulidae

Paltothermis sp.

Zygoptera

Coenagrionidae

Argia sp.

Lestidae

Archilestes sp.
Lestes sp.

HEMIPTERA

Gelastocoridae

Gelastocoris sp.

Gerridae

Aquarius sp.
Limnoporus sp.

Hebridae

Hebrus sp.

Notonectidae

Buenoa sp.
Notonecta sp.

Ochteridae

Ochterus sp.

Veliidae

Microvelia sp.

TRICHOPTERA

Hydroptilidae

Hydroptila sp.
Ochrotrichia sp.

Philopotamidae

Chimarra sp.
Wormaldia sp.

Psychomyiidae

Tinodes sp.

Rhyacophilidae

Rhyacophila sp.

Sericostomatidae

Gumaga sp.

LEPIDOPTERA

Noctuidae

Archana sp.

Pyralidae

Petrophila sp.

COLEOPTERA

Carabidae

Omophron sp.

Dryopidae

Helichus confluentus

Dytiscidae

Ilybius sp.
Oreodytes sp. - larva
Derovatellus sp. - adults
Neoscutopterus sp. or *Rhantus* sp.
Carrhydrus sp.
Agabus sp.
Derovatellus sp. or *Uvarus* sp.
Hydrovatus sp.
Hydaticus sp. - larva
Laccophilus sp. - larva
Hydroporus sp. - larva
Uvarus sp. A - adults
Uvarus sp. B - adults
Rhantus sp.
Acilius sp. - larva

Elmidae

Microcylloepus sp. - larva

Gyrinidae

Gyrinus sp.

Heteroceridae

Hydraenidae

Hydraena sp.
Ochthebius sp.

Hydrophilidae

Enochrus sp.
Paracymus sp.
Tropisternus sp. - larva
Berosus sp. A
Berosus sp. B
Hydrobiomorpha sp. - larva

Sphaeridiinae

Lampyridae - larva

Staphylinidae

Psephidonus sp.

DIPTERA

Ceratopogonidae

Atrichopogon sp.
Bezzia sp.
Dasyhelea sp.

Chironomidae

Procladius sp.
Monopelopia sp.
Rheotanytarsus sp.
Polypedilum sp.
Phaenopsectra sp.
Krenopelopia sp.
Natarsia sp.
Paralauterborniella sp.
Trissopelopia sp.
Pentaneura sp.
Micropsectra sp. or *Lauterbornia* sp.
Lauterborniella sp. or *Xenochironomus* sp.
Labrundinia sp.
Microtendipes sp.
Macropelopia sp.
Xenochironomus sp.
Micropsectra sp. or *Lauterborniella* sp.
Chironomus sp.
Apsectrotanupus sp.
Tanytarsus sp.
Ablabesmyia sp.

Orthocladiinae

Cardiocladius sp.
Cricotopus sp. or *Orthocladius* sp.
Psectrocladius sp.

Culicidae

Culiseta sp.
Culex sp.
Anopheles sp.

Dolichopodidae

Rhaphium sp.

Empididae

Asymphyloptera sp.
Clinocera binotata
Clinocera lecta
Clinocera sp. # 22
Clinocera sp. # 26
Clinocera sp. # 41
Neoplasta paramegorchis

Ephydriidae

Scatella sp.

Muscidae

Limnophora sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Simuliidae

Simulium sp.

Stratiomyidae

Caloparyphus sp.
Euparyphus sp.
Stratiomys sp.

Tabanidae

Tabanus sp.

Tipulidae

Erioptera sp.
Hexatoma sp.
Tipula sp.
Pedicia sp.
Gonomyia sp.
Cryptolabis sp.
Helius sp.
Rhabdomastix sp.
Limonia sp. or *Dicranota* sp.
Dicranota sp.
Limonia sp. A
Limonia sp. B

NOTE: taxa either are aquatic or semi-aquatic, or associated directly with madicolous habitats

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DEPARTMENT OF ENTOMOLOGY

12 February 1998

Dr. John Spence
Glen Canyon NRA
P.O. Box 1507
Page AZ 86040

Dear Dr. Spence,

To start I would like to thank you for letting me have this opportunity to identify the insects from a seldom sampled habitat. Identifying these samples is not only helpful in broadening my knowledge of insect taxa, but it is something I enjoy greatly.

The samples are very interesting in the diversity of taxa that you and Dr. MacDonald collected. Although I did not count the number of families, etc. that Jerry Monks identified, I believe the number of taxa present in the seep and spring areas exceeds his doubling estimate. ("Seeps and Springs Taxa List 1997-98", SWCA Inc. Environmental Consultants). The numbers of taxa will increase further when I identify the Chironomidae to lower taxonomic levels.

The following pages contain a glimpse of what I have identified thus far, reporting only on sites I (B), III and IV, along with a summary of the number of families and genera contained in all samples. Sample IV is interesting in the number of different Diptera taxa found, as well as the diversity of taxa in general. For your information, very few species' identifications will be possible, and virtually none for larvae since very few larvae have been described and only certain groups can be keyed to species (e.g. mayflies).

If you have any questions about the samples or my identifications of the insects, please feel free to contact me.

Sincerely,

A handwritten signature in cursive script, appearing to read "Colin A. Brammer".

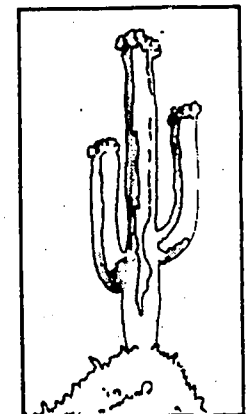
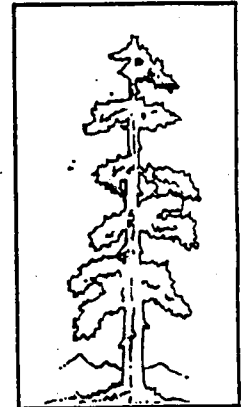
Colin A. Brammer

e-mail: colin_brammer@entm.purdue.edu
Ph#: 765 494-2370

Seeps and Springs Taxa List 1997-98

Prepared for Dr. John Spence

by Jerry Monks
SWCA, Inc. Environmental Consultants.



Taxa Present in Glen Canyon Seeps and Springs

Site I

Sample A

O. Odonata (Order)

S.O. Zygoptera

F. Coenagrionidae (Family)

G. *Argia* sp.

O. Trichoptera

F. Hydroptilidae

G. *Ochrotrichia arizonica* ?

F. Psychomyiidae

G. *Tinodes* sp.

O. Diptera

F. Tipulidae

G. *Tipula* sp.

G. *Pedicia* or *Dicranota* sp.

F. Chironomidae

~~S.F. Chironominae~~

Tribe Tanytarsini

G. *Micropsectra* sp. or *Lauterbornia* sp.

S.F. Tanypodinae

Tribe Macropelopiini

F. Ceratopogonidae

G. *Dasyhelea* sp.

Sample B

O. Odonata

~~S.O. Zygoptera~~

F. Coenagrionidae

G. *Argia* sp.

O. Hemiptera

F. Veliidae

G. *Microvelia* sp.

O. Trichoptera

F. Hydroptilidae

G. *Hydroptila* sp.

G. *Ochrotrichia* sp.

O. Coleoptera

F. Hydrophilidae

G. *Paracymus* sp.

O. Diptera

F. Tipulidae

- G. *Dicranota* sp.
- G. *Hexatoma* sp.

F. Chironomidae

~~S.F. Chironominae~~

Tribe Tanytarsini

- G. *Micropsectra* sp. or *Lauterbornia* sp.

~~S.F. Tanypodinae~~

Tribe Macropelopiini

- G. *Procladius* sp. ?

F. Ceratopogonidae

- G. *Dasyhelea* sp.

F. Stratiomyidae

- G. *Caloparyphus* sp.

F. Sciomyzidae

- G. *Antichaeta* sp. or *Tetanocera* sp.

Sample C

O. Odonata

~~S.O. Zygoptera~~

F. Coenagrionidae

- G. *Argia* sp.

O. Trichoptera

F. Hydroptilidae

- G. *Ochrotrichia* sp.

O. Coleoptera

F. Lampyridae

O. Diptera

F. Tipulidae

- G. *Dicranota* sp.

F. Chironomidae

~~S.F. Chironominae~~

Tribe Chironomini

F. Ceratopogonidae

- G. *Bezzia* sp.
- G. *Dasyhelea* sp.

F. Stratiomyidae

- G. *Stratiomys* sp.

Sample D

O. Odonata

~~S.O. Zygoptera~~

F. Coenagrionidae

G. *Argia* sp.

O. Hemiptera

F. Hebridae

G. *Hebrus* sp.

O. Coleoptera

F. Hydrophilidae

G. *Paracymus* sp.

F. one specimen keys to Elmidae, but is a terrestrial Carabidae

O. Diptera

F. Tipulidae

G. *Dicranota* sp.

F. Ceratopogonidae

G. *Bezzia* sp.

G. *Dasyhelea* sp.

F. Stratiomyidae

G. *Stratiomys* sp.

F. Tabanidae

G. *Hybomitra* sp. ?

F. Dolichopodidae

G. *Rhaphium* sp. ?

Site II - Samples received do not represent list received concomitantly

QCA 0297

Sample A

O. Ephemeroptera

F. Baetidae

G. *Callibaetis* sp.

O. Odonata

~~S.O. Anisoptera~~

F. Aeshnidae

G. *Anax* sp.

~~S.O. Zygoptera~~

F. Coenagrionidae

G. *Argia* sp.

G. *Coenagrion* or *Enallagma* sp.

O. Hemiptera

F. Belostomatidae

G. *Lethocerus* sp.

F. Veliidae
G. *Microvelia* sp.

O. Trichoptera
F. Psychomyiidae
G. *Tinodes* sp.

O. Lepidoptera
F. Pyralidae
G. *Petrophila* sp.

Sample B
O. Coleoptera
F. Gyrinidae
G. *Gyrinus* sp.

F. Hydrophilidae
G. *Paracymus* sp.

O. Diptera
F. Ceratopogonidae
G. *Dasyhelea* sp.

Sample C
O. Coleoptera
F. Dytiscidae
G. *Agabus* sp. Adult
G. *Acilius* sp. Larva

F. Hydrophilidae
G. *Tropisternus* sp. ? - very immature larva

O. Diptera
F. Stratiomyidae
G. *Euparyphus* sp.

Site III

6LCA03-97

O. Ephemeroptera
F. Baetidae
G. *Baetis* sp.

O. Odonata
~~S.O. Zygoptera~~
F. Coenagrionidae
G. *Argia* sp.

O. Trichoptera
F. Hydroptilidae
G. *Hydroptila* sp.
G. *Ochrotrichia* sp.

F. Hydropsychidae
G. *Ceratopsyche* sp.

F. Psychomyiidae
G. *Tinodes* sp.

O. Coleoptera
F. Hydrophilidae
G. *Paracymus* sp.

F. Elmidae
G. *Zaitzevia parvula* adults notes
G. *Heterelmis* sp. larvae notes

O. Diptera
F. Tipulidae
G. *Dicranota* sp.
G. *Prionocera* sp.

F. Psychodidae
G. *Maruina* sp.

F. Tabanidae
G. *Tabanus* sp.

F. Dolichopodidae
G. *Rhaphium* sp. ?

C. Arachnida
O. Araneae
F. Lycosidae
G. *Pardosa* sp.

Site IV

O. Ephemeroptera
F. Baetidae

GCCA 04-97

O. Odonata
S.O. Zygoptera
F. Coenagrionidae
G. *Argia* sp.

O. Trichoptera
F. Hydroptilidae
G. *Hydroptila* sp.

F. Hydropsychidae
G. *Ceratopsyche* sp.

F. Psychomyiidae
G. *Tinodes* sp.

O. Coleoptera
F. Hydrophilidae
G. *Paracymus* sp.

F. Elmidae

G. *Neocyloepus* sp. Adults

G. *Heterelmis* sp. Larvae

+ O. Lepidoptera

F. Pyralidae

G. *Petrophila* sp.

O. Diptera

F. Tipulidae

G. *Dicranota* sp.

G. *Limonia* sp.

F. Chironomidae

S.F. Chironominae

Tribe Chironomini

G. *Saetheria* sp. ?

F. Ceratopogonidae

G. *Bezzia* sp.

F. Stratiomyidae

G. *Caloparyphus* sp.

G. *Euparyphus* sp.

F. Psychodidae

G. *Pericoma* sp.

G. *Maruina* sp. - pupa

F. Tabanidae

G. *Tabanus* sp.

F. Dolichopodidae

G. *Rhaphium* sp. ?

Site V

GCCA 05 97

O. Ephemeroptera

F. Baetidae

G. *Callibaetis* sp.

O. Odonata

S.O. Anisoptera

F. Libellulidae

G. *Sympetrum* sp.

S.O. Zygoptera

F. Coenagrionidae

G. *Argia* sp.

G. *Coenagrion* or *Enallagma* sp.

O. Hemiptera

F. Gerridae

G. *Aquarius* sp.

F. Notonectidae
G. *Notonecta* sp.

F. Veliidae
G. *Microvelia* sp.

F. Hebridae
G. *Hebrus* sp.

O. Coleoptera
F. Gyrinidae
G. *Gyrinus* sp.

F. Dytiscidae
G. *Liodes* sp. (small specimen)
G. *Thermonectus* sp. - adult (larger specimen)
G. *Acilius* sp. - larvae

F. Hydrophilidae
G. *Paracymus* sp. - adults
G. *Tropisternus* sp. ? - larvae

O. Diptera
F. Tipulidae
G. *Dicranota* sp.
G. *Limonia* sp.

F. Ceratopogonidae
G. *Dasyhelea* sp.

F. Chironomidae
S.F. Orthocladiinae

S.F. Chironominae
Tribe Chironomini
G. *Chironomus* sp.

S.F. Tanypodinae
Tribe Pentaneurini
G. *Ablabesmyia* sp.
G. *Krenopelopia* sp.

F. Culicidae
G. *Culex* sp.

F. Tabanidae
G. *Tabanus* sp.

F. Dolichopodidae
G. *Rhaphium* sp. ?

F. Sciomyzidae
G. *Tetanocera* sp.

C. Arachnida

O. Araneae

F. Nesticidae - no keys to genera

F. Tetragnathidae

G. *Tetragnatha* sp.

F. Lycosidae

G. *Pardosa* sp.

Site VI

Pool Habitats

O. Ephemeroptera

F. Baetidae

G. *Callibaetis* sp.

O. Odonata

S.O. Anisoptera

F. Aeshnidae

G. *Anax* sp.

S.O. Zygoptera

F. Coenagrionidae

G. *Coenagrion* or *Enallagma* sp.

F. Lestidae

G. *Archilestes* sp.

O. Hemiptera

F. Corixidae

G. *Neocorixia* sp.

F. Belostomatidae

G. *Lethocerus* sp.

F. Naucoridae

G. *Ambrysus* sp.

O. Coleoptera

F. Dytiscidae

G. *Liodessus* sp. - adult (smaller specimens)

G. *Thermonectus* sp. - adult (larger specimens)

G. *Acilius* sp. - larva

F. Hydrophilidae

S.F. Sphaeridiinae - no keys to genera

GCCA 06-97

O. Diptera

F. Chironomidae

S.F. Chironominae

Tribe Chironomini

G. Phaenopsectra sp.

Tribe Tanytarsini

G. Rheotanytarsus sp.

S.F. Tanypodinae

Tribe Macropelopiini

G. Apsectrotanypus sp.

Tribe Pentaneurini

G. Ablabesmyia sp.

F. Stratiomyidae

G. Caloparyphus sp.

C. Arachnida

O. Acari

Seep Wall Habitat

O. Odonata

S.O. Zygoptera

F. Coenagrionidae

G. Argia sp.

O. Trichoptera

F. Psychomyiidae

G. Tinodes sp.

O. Coleoptera

F. Hydroscaphidae

G. Hydroscapha sp.

O. Diptera

F. Chironomidae

S.F. Chironominae

Tribe Pseudochironomini

G. Pseudochironomus sp.

F. Ceratopogonidae

G. Bezzia sp.

G. Dasyhelea sp.

F. Stratiomyidae

G. Caloparyphus sp.

F. Tabanidae

G. Tabanus sp.

C. Arachnida
O. Acari

Site VII

GCCA 07-97

O. Ephemeroptera
F. Baetidae

O. Odonata
~~S.O. Zygoptera~~
F. Coenagrionidae
G. *Argia* sp.

O. Trichoptera
F. Hydroptilidae
G. *Hydroptila* sp. ?

F. Hydropsychidae
G. *Ceratopsyche* sp.

O. Lepidoptera
F. Pyralidae
G. *Petrophila* sp.

O. Coleoptera
F. Hydroscaphidae
G. *Hydroscapha* sp. - larvae and adults

F. Hydrophilidae
G. *Paracymus* sp.

F. Elmidae
G. *Neocylloepus boeseli* ? - adults
G. *Heterelmis* sp. - larvae

O. Diptera
F. Tipulidae
G. *Limonia* sp.

F. Simuliidae
G. *Simulium* sp.

F. Chironomidae
~~S.F. Orthoclaadiinae~~
G. *Cricotopus* sp.
G. *Cardiocladius* sp. ?

~~S.F. Chironominae~~
Tribe Chironomini
G. *Harnischia* complex

F. Stratiomyidae
G. *Caloparyphus* sp.

F. Tabanidae
G. *Tabanus* sp.

F. Empididae
G. *Chelifera* sp.

Site VIII

GCCA 08-97

O. Ephemeroptera
F. Baetidae

O. Odonata
S.O. Zygoptera
F. Coenagrionidae
G. *Coenagrion* or *Enallagma* sp.

F. Lestidae
G. *Archilestes* sp.

O. Hemiptera
F. Corixidae
G. *Graptocorixia* sp. ?

F. Notonectidae
G. *Notonecta* sp.

O. Trichoptera
F. Hydroptilidae
G. *Oxyethira* sp.

O. Coleoptera
F. Dytiscidae
G. *Thermonectus* sp. - adults
G. *Acilius* sp. - larva

O. Diptera
F. Chironomidae
S.F. Chironominae
Tribe Tanytarsini
G. *Micropsectra* sp. or *Lauterbornia* sp.

S.F. Tanypodinae
Tribe Pentaneurini
G. *Ablabesmyia* sp.

C. Arachnida
O. Acari

6CCA09-97

Site IX

O. Ephemeroptera

F. Baetidae

G. *Baetis* sp.

G. *Callibaetis* sp.

G. *Cloeodes* sp. ?

O. Odonata

S.O. Zygoptera

F. Lestidae

G. *Archilestes* sp.

O. Hemiptera

F. Notonectidae

G. *Notonecta* sp. ? - too immature to identify

O. Neuroptera

F. Corydalidae

G. *Corydalis* sp.

O. Trichoptera

F. Hydropsychidae

G. *Ceratopsyche* sp.

F. Philopotamidae

G. *Chimarra* sp.

F. Psychomyiidae

G. *Tinodes* sp.

O. Coleoptera

F. Gyrinidae

G. *Gyrinus* sp.

F. Dytiscidae

G. *Liodessus* sp. - adult

G. *Acilius* sp. - larva

F. Hydrophilidae

G. *Tropisternus* sp. ? - larva

F. Elmidae

G. *Neocylloepus boeseli*

O. Diptera

F. Tipulidae

G. *Limonia* sp.

F. Chironomidae

S.F. Chironominae

Tribe Chironomini

G. *Stictochironomus* sp.

F. Stratiomyidae
G. *Caloparyphus* sp.
G. *Euparyphus* sp.

F. Muscidae - larva

Site X

GCCA 10-97

O. Ephemeroptera
F. Baetidae
G. *Callibaetis* sp. ?

O. Odonata
~~S.O. Zygoptera~~
F. Coenagrionidae
G. *Coenagrion* or *Enallagma* sp.

O. Hemiptera
F. Corixidae
G. *Neocorixia* sp. ?

F. Belostomatidae
G. *Lethocerus* sp.

O. Coleoptera
F. Dytiscidae
G. *Acilius* sp. - larva

C. Arachnida
O. Acari

Terrestrial Taxa

O. Coleoptera
F. Scarabaeidae
G. *Polyphylla decimlineata* - ten-lined june beetle

O. Hymenoptera
F. Ichneumonidae
G. *Megarhyssa* sp.

Site XI

GCCA 11-97

O. Ephemeroptera
F. Baetidae - No legs, cannot identify

O. Odonata
~~S.O. Anisoptera~~
F. Aeshnidae
G. *Anax* sp.

F. Libellulidae - too immature to identify

S.O. Zygoptera
F. Coenagrionidae
G. *Coenagrion* or *Enallagma* sp.

O. Hemiptera
F. Corixidae
G. *Neocorixia* sp.

F. Veliidae
G. *Microvelia* sp.

F. Naucoridae
G. *Ambrysus* sp.

O. Trichoptera
F. Polycentropodidae
G. *Polycentropus* sp.

F. Psychomyiidae
G. *Tinodes* sp.

O. Coleoptera
F. Dytiscidae
G. *Graphoderus* sp. - adult, large specimen
G. *Hydroporus* sp. ? - larva
G. *Liodessus* sp. - adult, small specimen

O. Diptera
F. Chironomidae
~~S.F. Chironominae~~
Tribe Chironomini
G. *Stictochironomus* sp.

~~Tribe Tanytarsini~~
G. *Rheotanytarsus* sp.

S.F. Tanypodinae
~~Tribe Pentaneurini~~
G. *Natarsia* sp. ?

F. Ceratopogonidae
G. *Bezzia* sp.
G. *Dasyhelea* sp.

* Site XII

O. Diptera
F. Tipulidae
G. *Ormosia* sp. ?

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F. Chironomidae
S.F. Tanypodinae
Tribe Pentaneurini
G. Natarsia sp. ?

F. Stratiomyidae
G. Stratiomys sp.

F. Dolichopodidae
G. Rhaphium sp. ?

Site XIII

GCCA 13-97

O. Odonata
S.O. Zygoptera
F. Coenagrionidae
G. Argia sp.

O. Hemiptera
F. Veliidae
G. Microvelia sp.

O. Trichoptera
F. Hydroptilidae
G. Hydroptila sp.

O. Lepidoptera
F. Pyralidae
G. Petrophila sp.

O. Coleoptera
F. Dytiscidae
G. Liodessus sp. ? - adult

F. Hydroscaphidae
G. Hydroscapha sp. - adults and larvae

F. Hydrophilidae
G. Paracymus sp. - adult
G. Hydrobius sp. ? - larva

O. Diptera
F. Tipulidae
G. Dicranota sp.

F. Chironomidae
S.F. Tanypodinae
Tribe Macropelopiini
G. Procladius sp.

S.F. Orthocladiinae
G. Thienemanniella sp.

F. Ceratopogonidae
G. *Dasyhelea* sp.

F. Stratiomyidae
G. *Caloparyphus* sp.
G. *Stratiomys* sp.

F. Tabanidae
G. *Tabanus* sp.

F. Dolichopodidae
G. *Rhaphium* sp. ?

Site XIV

O. Diptera
F. Tipulidae
G. *Hexatoma* sp.

F. Chironomidae
S.F. Orthocladinae
G. *Paracricotopus* sp. ?

F. Empididae
G. *Chelifera* sp.

GCCA 14-97

Site XV

O. Collembola
F. Entomobryidae
G. *Corynothrix* sp. ?

O. Ephemeroptera
F. Baetidae
G. *Baetis* sp.

O. Hemiptera
F. Gerridae
G. *Aquarius* sp.

F. Veliidae
G. *Microvelia* sp.

O. Coleoptera
F. Hydrophilidae
G. *Paracymus* sp. - adults
G. *Hydrobius* sp. ? - larva

F. Hydraenidae
G. *Ochthebius* sp.

F. Elmidae
G. *Zaitzevia parvula* ? - adults
G. *Zaitzevia* sp. - larvae

GCCA 15-97

O. Diptera

F. Tipulidae

- G. *Dicranota* sp.
- G. *Hexatoma* sp.
- G. *Gonomyia* sp. ?
- G. *Pseudolimnophila* sp. ?

F. Chironomidae

S.F. Chironominae

Tribe Tanytarsini

- G. *Rheotanytarsus* sp.

S.F. Tanypodinae

Tribe Macropelopiini

- G. *Procladius* sp.

S.F. Orthoclaadiinae

- G. *Thienemanniella* sp.
- G. *Eukiefferiella* sp.

F. Tabanidae

- G. *Tabanus* sp.

F. Empididae

- G. *Chelifera* sp.

Site XVI

O. Odonata

S.O. Zygoptera

F. Coenagrionidae

- G. *Argia* sp.

O. Diptera

F. Chironomidae

S.F. Orthoclaadiinae

GCCA 16-97

Site XVII

O. Odonata

S.O. Zygoptera

F. Coenagrionidae

- G. *Argia* sp.

O. Lepidoptera

F. Pyralidae

- G. *Petrophila* sp.

O. Coleoptera

F. Dytiscidae

- G. *Hydaticus* sp. ? - larva - also keys to Carabidae ??

GCCA 17-97

F. Hydrophilidae
G. *Paracymus* sp. - adult
G. *Hydrobius* sp. ? - larva

O. Diptera

F. Tipulidae
G. *Dicranota* sp.

F. Chironomidae
S.F. Chironominae
Tribe Chironomini
G. *Microtendipes* sp.

S.F. Tanypodinae
Tribe Macropelopiini
G. *Procladius* sp.

S.F. Orthocladiinae
G. *Cricotopus* sp. or *Orthocladius* sp.

F. Ceratopogonidae
G. *Dasyhelea* sp.

F. Stratiomyidae
G. *Caloparyphus* sp.

F. Tabanidae
G. *Tabanus* sp.

Site XVIII and XIX - no sample included in mailing

no inverts present

Site XX

O. Coleoptera
F. Hydraenidae
G. *Ochthebius* sp.

GLCA 20-97

O. Diptera
F. Tipulidae
G. *Dicranota* sp.

F. Ceratopogonidae
G. *Atrichopogon* sp.
G. *Dasyhelea* sp.

F. Stratiomyidae
G. *Caloparyphus* sp.
G. *Euparyphus* sp.

Site XXI

O. Hemiptera
F. Saldidae
G. *Saldula* sp.

GLCA 21-97

Coenagrionidae
Argia sp.

37-98

Diptera
 Tipulidae
Tipula sp.

142 mile spring - Site 98-10, sample 17

GRCA 10-98

Diptera
 Ceratopogonidae
Bezzia sp.
 Chironomidae
Lauterborniella sp. or *Xenochironomus* sp.
 Dolichopodidae
Rhaphium sp.?

38-98

River Mile 147 Right ("Flaveria Spring")- site 98-11, sample 18

GRCA 11-98

Odonata
 Coenagrionidae
Argia sp.

Hemiptera
 Hebridae
Hebrus sp.

39-98

Lepidoptera
 Pyralidae
Petrophila sp.
 Noctuidae
Archana sp.

Coleoptera
 Hydrophilidae
Tropisternus sp. - larvae
Enochrus sp. - adults
 Chrysomilidae - probably terrestrial
 Lampyridae - terrestrial larva

Diptera
 Chironomidae
 Orthocladiinae

Tipulidae
Tipula sp.
 Stratiomyidae
Caloparyphus sp.
Euparyphus sp.
Stratiomys sp.

Ledges Camp Site - site 98-13, sample 19

GRCA 13-98

Odonata
 Coenagrionidae
Argia sp.

41-98

Coleoptera
 Hydrophilidae

O. Coleoptera
F. Hydraenidae
G. *Ochthebius* sp.

F. Hydrophilidae
S.F. Sphaeridiinae - no keys to genera

O. Diptera
F. Chironomidae
S.F. Chironominae
Tribe Tanytarsini
G. *Micropsectra* sp. or *Lauterbornia* sp.

S.F. Tanypodinae
Tribe Pentaneurini
G. *Krenopelopia* sp.

F. Ceratopogonidae
G. *Dasyhelea* sp.

F. Tipulidae
G. *Dicranota* sp.

F. Stratiomyidae
G. *Caloparyphus* sp.
G. *Stratiomys* sp.

F. Dolichopodidae
G. *Rhaphium* sp. ?

C. Arachnida
O. Araneae
F. Tetragnathidae
G. *Tetragnatha* sp.

Site XXII

GLCA 22-97

O. Ephemeroptera
F. Baetidae
G. *Callibaetis fluctuans* or *Callibaetis montanus*

O. Odonata
S.O. Anisoptera
F. Libellulidae
G. *Libellula* sp.

S.O. Zygoptera
F. Lestidae
G. *Archilestes* sp.

O. Hemiptera
F. Gerridae
G. *Gerris* sp.

F. Corixidae

G. *Neocorixia* sp. or *Graptocorixia* sp. - cannot go further with immatures

O. Coleoptera

F. Gyrinidae

G. *Gyrinus* sp.

F. Dytiscidae

G. *Thermonectus* sp. - Adult

G. *Laccophilus* sp. - Larvae

G. *Acilius* sp. - Larvae

O. Diptera

F. Chironomidae

S.F. Chironominae

Tribe Chironomini

G. *Phaenopsectra* sp.

G. *Stictochironomus* sp.

Tribe Tanytarsini

G. *Tanytarsus* sp.

S.F. Tanypodinae

Tribe Macropelopiini

G. *Apsectrotanypus* sp.

Tribe Pentaneurini

G. *Krenopelopia* sp.

GCCA 23-77 - unid coll. still at GCCA

Orders and Families of Invertebrates Present in Glen Canyon

Seeps and Springs

Preliminary Findings

Site I Description

GLEA 01-97

Site I is located in the Glen Canyon area. The seep originates from a sandstone wall approximately 60 feet above the lake level on 6-18-97 at 1:10 pm. The origination point of the seep was heavily vegetated and very difficult to sample. The lower portion of the seep had many small shelved pools with a wide variety of micro-habitats.

Sample A was taken from a small shelved pool roughly 19"x 12" x 1" deep. Orders and families present include:

C. Insecta

O. Diptera

F. Tabanidae

F. Chironimidae

O. Trichoptera

F. Hydroptilidae

G. *Hydroptila*

Sample B was collected from slow seepage over a large sandstone boulder. Thick growth of unidentified algae was present and a portion was collected (microhabitat). Two gastropod specimens were collected of two distinct, separate genus. Check for **Oxyloma**. Orders and Families present include:

C. Insecta

O. Diptera

F. Chironimidae

F. Stratiomyidae

F. Tipulidae

O. Odonata

S.O. Zygoptera

O. Trichoptera

F. Hydroptilidae

G. *Hydroptila*

O. Coleoptera

F. Elmidae ?

O. Hemiptera

F. Reduviidae

S.F. Emisinae

C. Turbellaria

O. Unknown

Sample C was also collected from slow seepage over a large angular boulder. Collection was made via scraper. Orders and Families present include:

C. Insecta

O. Diptera

F. Chironimidae

F. Tipulidae

F. Stratomyidae

Plus several unknowns.

O. Trichoptera

F. Hydroptilidae

G. *Hydroptila*

O. Coleoptera

F. Unknown terrestrial

O. Odonata

S.O. Zygoptera

C. Gastropoda

O. Basommatomorpha

F. Physidae ??

Sample D was collected in a small shelved pool that had a sand and sandstone substrate. Small stone and 10 mm piece of moss collected for close examination. Orders and Families collected include:

C. Insecta

O. Diptera

F. Chironimidae

F. Stratomyidae

F. Tipulidae

O. Odonata

S.O. Zygoptera

O. Coleoptera

F. Elmidae

- O. Hemiptera
 - F. Reduviidae
 - Sub F. Emesinae ?

C. Gastropoda

- O. Basommatomorpha -- two small specimens with egg case.

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Site II. Large seep/ spring complex located at end of 0.5 mile long canyon in the Escalante arm of Lake Powell. All samples were consolidated into respective orders. *Ribbon Canyon*

Sample A. Littoral zone of a large 50' pool. Heavily vegetated with riparian plants which were infested with aphids. Aphid concentration very high and is a likely source of food for many of the aquatic hemipterans. The macro-alga *Chara* dominated the pool.

C. Insecta

O. Hemiptera

- F. Notonecturidae *
- F. Gerridae *
- F. Corixidae *
- F. Reduviidae
- SF. Emesinae
- F. Belostomatidae *

O. Odonata

- S.O. Anisoptera
- S.O. Zygoptera

O. Ephemeroptera

C. Crustacea

O. Amhipoda

- S.O. Gammaridea
- F. Hyallellidae

Hyallela azteca

C. Ostracoda

Famliy and Genus unknown

C. Copepoda

O. Cyclopoida ?

Famliy and Genus unknown

C. Hydrozoa

O. Hydroida

- SO. Anthomedusae

P. Annelida

C. Hirudinae

O. Rhynchobdellida

F. Glossiphoniidae

G. *Helobdella*

C. Gastropoda

O. Basommatomorpha

F. Physidae?

* Indicates observed at the site but not captured.

Sample B Collected from an isolated pool next to the main pool. Heavy growth of *Chara* present.

C. Insecta

O. Coleoptera

F. Gyrinidae

O. Diptera

F. Chironimidae

O. Odonata

S.O. Zygoptera

O. Hemiptera

F. Saldidae

F. Gerridae*

F. Notonecturidae*

F. Corixidae*

O. Trichoptera

F. Hydropsychidae

G. most likely *Hydropsyche*

C. Gastropoda

O. Basommatomorpha

F. Physidae

C. Crustacea

O. Amphipoda

F. Hyallelidae

Hyallela azteca

C. Ostracoda-very abundant, too small to pick every individual

C. Hydozoa

O. Hydroida

S.O. Anthomedusae

very abundant, too small to pick every individual

Sample C Seep wall above pool. Used scraper to collect approximately twelve square inches of algal film.

C. Insecta

O. Hemiptera

F. Reduviidae

S.F. Emisinae

O. Coleoptera

F. Elmidae

O. Diptera

F. Tipulidae

F. Stratomyidae

F. Chironimidae

F. Ceratipogonidae

G. *Bezzia* ?

O. Trichoptera

F. Hydroptilidae

G. *Hydroptila*

O. Odonata

S.O. Zygoptera

C. Hirudinae

O. Rhynchobdellida

F. Glossiphoniidae

G. *Helobdella*

C. Gastropoda

O. Basommatomorpha

F. Physidae ??

C. Turbellaria--unknown planaria

Sample D Mass of *Chara* collected from large 50' pool.

C. Crustacea

O. Amphipoda

F. Hyalllelidae

G. *Hyallela azteca*

C. Ostracoda

C. Hydrozoa

O. Hydroida

S.O. Anthomedusae

C. Turbellaria

C. Gastropoda

O. Basommatomorpha

P. Annelida

O. Oligochaeta--aquatic earthworms

C. Insecta

O. Odonata

S.O. Zygoptera

O. Hemiptera

F. Corixidae

F. Notonecturidae

O. Homoptera

F. Aphididae

O. Nueroptera

O. Coleoptera

F. Dytiscidae

666A 03-97

Site III. Seep wall habitat just above lake level in the Escalante arm. Taxa include:

C. Insecta

O. Trichoptera

F. Hydroptilidae

G. *Hydroptila*

F. Hydropyschidae

O. Odonata

S.O. Zygoptera

O. Ephemeroptera

O. Diptera

F. Tabanidae

F. Chironimidae

F. Tipulidae

F. Dolichopodidae

O. Coleoptera

F. Elmidae

P. Annelida

C. Oligochaeta--aquatic earthworms

C. Arachnida

O. Araneida

6CCA 04-97

Site 4. Steep seep wall composed mainly of clean sandstone. Scraped algal film from three elevations. Taxa include:

C. Gastropoda

O. Basommatomorpha

F. Physidae ??

C. Oligochaeta

aquatic "earthworms"

C. Insecta

O. Diptera

F. Stratiomyidae

F. Tipulidae

F. Tabanidae

F. Chironimidae

F. Psycodidae

G. *Maruina* ?

- O. Trichoptera
 - F. Hydroptilidae
 - G. *Hydroptila*
 - F. Hydropsychidae
 - O. Ephemeroptera
 - O. Coleoptera
 - F. Elmidae
 - O. Lepidoptera
 - F. Pyralidae ?
 - G. *Parargyractis*
 - O. Odonata
 - S.O. Zygoptera
-

6CCA 05-17

Site 5. Contained pool, stream and seep wall habitat. Located in Long Canyon and accessed via helicopter. Taxa include:

- C. Gastropoda
 - O. Basommatomorpha
 - F. Physidae??
- C. Insecta
 - O. Diptera
 - F. Stratiomyidae
 - F. Tabanidae
 - F. Culicidae
 - F. Chironimidae
 - F. Tipulidae
 - O. Ephemeroptera
 - O. Odonata
 - S.O. Zygoptera
 - S.O. Anisoptera
 - O. Coleoptera
 - F. Elmidae
 - F. Dytiscidae
 - O. Hemiptera

F. Gerridae
F. Reduviidae
S.F. Emisinae
F. Corixidae

GLCA 06-98

Site 6. Site is divided into seep wall and pool habitat to emphasize differences in taxa collected.
Taxa include:

Pool Habitat

C. Arachnida

O. Acarina- water mites

P. Nematoda -aquatic nematodes found in plant roots

C. Gastropoda

O. Basommatomorpha

F. Physidae

C. Crustacea

O. Amphipoda

F. Hyallelidae

Hyallela azteca

C. Hirudinea

O. Rhynchobdellida

F. Glossiphoniidae

G. Helobdella

C. Insecta

O. Hemiptera

F. Corixidae

F. Naucoridae

O. Odonata

S.O. Anisoptera

S.O. Zygoptera

O. Ephemeroptera

O. Diptera

F. Chironimidae

F. Tipulidae

- O. Coleoptera
 - F. Dytiscidae
 - F. Elmidae

Seep Wall Habitat

- C. Gastropoda
 - O. Basommatomorpha
 - F. Physidae
- C. Arachnida
 - O. Acarina--water mites
- C. Insecta
 - O. Odonata
 - S.O. Zygoptera
- O. Diptera
 - F. Chironimidae
 - F. Tipulidae
 - F. Tabanidae
 - F. Blephariceridae

Site 7: Upper Escalante Area. Seep Wall Habitat.

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- C. Insecta
 - O. Coleoptera
 - F. Elmidae
 - O. Diptera
 - F. Tipulidae
 - F. Tabanidae
 - F. Chironimidae
 - F. Simuliidae
 - O. Trichoptera
 - F. Hydroptilidae
 - F. Limnophildae ?
 - O. Ephemeroptera
 - O. Odonata
 - S.O. Zygoptera

O. Lepidoptera
F. Pyralidae

Site 8: Pool in side canyon of Cow Canyon.

GCCA 08-97

- C. Ostracoda
- C. Cladocera
- C. Crustacea
 - O. Amphipoda
 - F. Hyallelidae
 - Most likely *Hyallela azteca*
- C. Copepoda
- C. Arachnida
 - O. Acarina--water mites
- C. Gastropoda
 - O. Basommatomorpha
 - F. Physidae
- C. Insecta
 - O. Coleoptera
 - F. Dytiscidae
 - O. Diptera
 - F. Chironimidae
 - O. Ephemeroptera
 - O. Trichoptera
 - F. Hydroptilidae
 - O. Odonata
 - S.O. Zygoptera
 - O. Hemiptera
 - F. Corixidae

GCCA 09-97

Site 9: Clear unvegetated pool with small outlet stream in Cow Canyon.

- C. Crustacea
 - O. Amphipoda
 - F. Hyallelidae
 - Most likely *Hyallela azteca*
- C. Ostracoda
- C. Gastropoda
 - O. Basommatomorpha
 - F. Physidae
- P. Bryozoa
 - C. Phylactolaemata
 - Possibly *Plumatella*
- C. Insecta
 - O. Coleoptera
 - F. Gyrinidae
 - F. Elmidae
 - O. Diptera
 - F. Stratiomyidae
 - F. Chironimidae
 - O. Ephemeroptera
 - O. Trichoptera
 - O. Odonata
 - S.O. Zygoptera
 - O. Trichoptera
 - O. Neuroptera
 - F. Corydalidae
 - O. Hemiptera
 - F. Corixidae

Site 10: Large, heavily vegetated pool at end of Cow Canyon.

6CCA-10-97

- C. Crustacea
 - O. Amphipoda
 - F. Hyallelidae

Hyallela azteca

C. Ostracoda

C. Gastropoda

O. Basommatomorpha

P. Bryozoa

C. Phylactolaemata

Possibly *Plumatella*

C. Arachnida

O. Acarina --water mites

C. Insecta

O. Coleoptera

F. Dytiscidae

O. Odonata

S.O. Zygoptera

S.O. Anisoptera

O. Ephemeroptera

O. Hemiptera

F. Notonecturidae

F. Reduviidae

S.F. Emisinae?

F. Belastomatidae

Site 11: Rana Canyon

GCCA 11-97

C. Crustacea

O. Amphipoda

F. Hyallelidae

Hyallela azteca

C. Copepoda

O. Calanoida

C. Gastropoda

O. Basommatomorpha

C. Hirudinea

O. Arncynchobdellida

F. Erpobdella

Erpobdella punctata

C. Bivalvia

S.C. Heterodonta

O. Veneroida ?

Unknown Clam--need a bivalve person!!

P. Porifera

Unknown siliceous sponge

C. Insecta

O. Coleoptera

F. Dytiscidae

F. Elmidae

O. Diptera

F. Tipulidae

F. Chironimidae

O. Ephemeroptera

O. Trichoptera

F. Limnophilidae

O. Odonata

S.O. Anisoptera

S.O. Zygoptera

O. Hemiptera

F. Naucoridae

F. Corixidae

Site 12: Seep wall habitat located 100 feet above the lake.

CCCA 12-92

C. Arachnida

O. Acarina

C. Insecta

O. Diptera

F. Stratiomyidae

F. Chironimidae

GCCA 13-97

Site 13: Seep wall habitat.

C. Gastropoda

O. Basommatomorpha

C. Insecta

O. Coleoptera

F. Elmidae

O. Diptera

F. Chironimidae

F. Stratiomyidae

F. Tipulidae

O. Odonata

S.O. Zygoptera

O. Lepidoptera

F. Pyralidae

O. Hemiptera

F. Reduviidae

S.F. Emisinae

GCCA 14-97

Site 14: Flash flooded seep and stream.

C. Insecta

O. Diptera

F. Chironimidae

GCCA 15-97

Site 15: Flash flooded stream.

C. Gastropoda

O. Basommatomorpha

C. Insecta

O. Coleoptera

F. Elmidae

O. Diptera

F. Chironimidae

O. Ephemeroptera

O. Collembola

O. Hemiptera

F. Gerridae

F. Reduviidae

S.F. Emisinae

6CCA 16-97

Site 16: Flash floded stream.

C. Crustacea

O. Decapoda

F. Cambaridae

Orconectes ?

C. Insecta

O. Diptera

F. Chironimidae

O. Odonata

S.O. Zygoptera

6CCA 17-97

Site 17: Seep wall habitat.

C. Insecta

O. Coleoptera

F. Elmidae

O. Diptera

F. Chironimidae

F. Tipulidae

F. Stratiomyidae

O. Odonata

S.O. Zygoptera

O. Lepidoptera

F. Pyralidae

6CCA 18, 19 - 97

Site 18 and 19: These sites were flash flooded just prior to sampling. Scraped material and sediment contained only a few Chironimids.

Site 20: Flash flooded stream.

6CCA 20-97

C. Insecta
O. Coleoptera
F. Elmidae

O. Diptera
F. Chironimidae

Site 21: Small pool and stream.

GCCA 21-97

C. Insecta
O. Coleoptera
F. Elmidae

O. Diptera

F. Chironimidae
F. Stratiomyidae
F. Tipulidae

Site 22: Pool habitat.

GCCA 22-97

C. Crustacea
O. Amphipoda
F. Hyallelidae
Hyallela azteca

C. Gastropoda
O. Basommatomorpha

C. Hydroza
O. Hydroida

C. Hirudinea
O. Archnychobdellida
F. Erpobdellida
Erpobdella punctata

C. Insecta
O. Coleoptera
F. Dytiscidae
F. Elmidae

O. Diptera
F. Chironimidae

O. Ephemeroptera

O. Odonata

S.O. Anisoptera

S.O. Zygoptera

O. Hemiptera

F. Gerridae

F. Corixidae

End of preliminary taxa list. With further identification the number of insect families should double. Families listed are by no means the only families present in vials (they represent my best guess and are subject to change).

GRAND CANYON Collections: John F. MacDonald, May 1998

Buck Farm-site 98-01

GRCA 01-98

91-98 Diptera Empididae: adult *Neoplasta paramegorchis*

Bert's Canyon-site 98-02

02-98

GRCA 02-98

Hemiptera

Ochteridae: adult *Ochterus* sp.Veliidae: *Microvelia* sp.30-98 Coleoptera Staphylinidae: adult *Psephidorus* sp? form?Diptera Empididae: adult *Clinocera lecta*

Saddle Canyon-site 98-03

GRCA 03-98

Hemiptera

Ochteridae: adult *Ochterus* sp.Veliidae: *Microvelia* sp.

31-98 Coleoptera: adult Heteroceridae

Diptera Empididae

adult *Asymphyloptera* sp.adult *Clinocera lecta*adult *Clinocera* sp. # 26adult *Neoplasta paramegorchis*

Nankoweap-site 98-05

GRCA 05-98

33-98 Diptera: larva Tabanidae

Hance Spring-site 98-06

34-98 Diptera Empididae

adult *Clinocera* sp. # 22adult *Clinocera* sp. # 26

Elves Chasm-site 98-07

GRCA 07-98

35-98 Diptera Empididae

adult *Asymphyloptera* sp.adult *Clinocera binotata*adult *Clinocera lecta*adult *Clinocera* sp. # 26adult *Clinocera* sp. # 41

Trichoptera Philopotamidae:

Adult *Chimarra* sp. - two taxa

Psychomyiidae

Adult *Tinodes provo* ?

Mile 127.5 spring-site 98-08

GRCA 08-98

36-98 Hemiptera Veliidae: *Microvelia* sp.

Diptera Stratiomyidae: larval *Caloparyphus* sp.

River Mile 147 right ("Flaveria Spring")

GRCA 12-98

39-98 Diptera Empididae: adult *Clinocera* sp. # 26

Trichoptera Philopotamidae: adult *Chimarra* sp.

Ledges-site 98-13

GRCA 13-98

41-98 Hemiptera

adult Corixidae sp.

adult Saldidae sp.

Veliidae: *Microvelia* sp.

Slimy Tick-site 98-14

GRCA 14-98

Hemiptera

42-98 Notonectidae: larva and adult *Notonecta* sp.

Veliidae: *Microvelia* sp.

Diptera

Empididae: adult *Clinocera* sp. # 26

Stratiomyidae: larvae of *Caloparyphus* sp. and *Euparyphus* sp.

Trichoptera Philopotamidae: adult *Chimarra* sp.

Fern Glen-site 98-15

GRCA 15-98

Hemiptera Veliidae: *Microvelia* sp.

Coleoptera: adult Heteroceridae sp.

43-98 Diptera

Empididae:

adult *Asymphyloptera* sp.

adult *Clinocera* sp. # 26

Psychodidae: larvae of *Pericoma* or *Telmatoscopus* sp.

Simuliidae: larvae of *Simulium* sp.

Mohawk Canyon-site 98-16

GRCA 16-98

44-98 Diptera Empididae: adult of *Clinocera* sp. (females)

Cove Canyon-site 98-17

GRCA 17-98

45-98 Hemiptera Veliidae: *Microvelia* sp.

Odonata
 Coenagrionidae
 Argia sp.
 Coleoptera
 Hydrophilidae
 Tropisternus sp.
 Diptera
 Chironomidae
 Polypedilum sp.
 Macropelopia sp.

Sleepy Hollow - Arches 0198, sample 3

ARCH 01-98

Odonata
 Coenagrionidae
 Argia sp.
 Diptera
 Chironomidae
 Rheotanytarsus sp.
 Tipulidae
 Pedicia sp.
 Stratiomyidae
 Euparyphus sp.
 Stratiomys sp.
 Tabanidae
 Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.
 Hymenoptera
 Formicidae
 Pteromalidae

Sleepy Hollow - Arches 0198, sample 4

Trichoptera
 Rhyacophilidae
 Rhyacophila sp.
 Diptera
 Chironomidae
 Macropelopia sp.
 Orthoclaadiinae
 Tipulidae
 Dicranota sp.
 Limonia sp.
 Pedicia sp.
 Tipula sp.
 Stratiomyidae
 Caloparyphus sp.

Sleepy Hollow - Arches 0198, sample Madiculous scrapes #?

Coleoptera
 Staphylinidae - terrestrial
 Diptera
 Chironomidae
 Natarsia sp.
 Tipulidae
 Limonia sp. A
 Limonia sp. B
 Stratiomyidae
 Caloparyphus sp.

Sleepy Hollow - Arches 0198, sample ledge below seep wall #?

Trichoptera
 Rhyacophilidae
 Rhyacophila sp.

Diptera

Tipulidae

Dicranota sp.
Gonomyia sp.
Hexatoma sp.
Limonia sp.
Rhabdomastix sp.

Stratiomyidae

Caloparyphus sp.
Euparyphus sp.

CNAY 0198 - sample 6

Lepidoptera

Arctiidae - terrestrial

CNAY 01-98 Cabin Spring

Coleoptera

Hydraenidae

Hydraena sp.
Ochthebius sp.

Dytiscidae

Hydroporus sp. larva
Uvarus sp. adult

Hydrophilidae

Paracymus sp.

Sphaeridiinae

Diptera

Chironomidae

Krenopelopia sp.
Rheotanytarsus sp.

Stratiomyidae

Caloparyphus sp.
Euparyphus sp.

Tipulidae

Dicranota sp.
Gonomyia sp.
Pedicia sp.

CNAY 0198 - sample 7

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Aeshnidae

Aeshna sp.

Trichoptera

cases only - possibly Limnephilidae

Coleoptera

Hydraenidae

Hydraena sp.

Dytiscidae

Agabus sp.
Hydrovatus sp.

Diptera

Chironomidae

Micropsectra sp. or *Lauterborniella* sp.
Chironomus sp.
Phaenopsectra sp.

Culicidae

Culiseta sp.

Tabanidae - terrestrial adult

Tipulidae
Dicranota sp.
Tipula sp.
 Stratiomyidae
Euparyphus sp.
 Hymenoptera
 Apidae
Apis mellifera
 Arachnidae
 Tetragnathidae
Tetragnatha sp. - Longjawed orb-weaver

Canyonlands at Island in the Sky - CNAY 0198, sample 8

Ephemeroptera
 Baetidae
Baetis sp.
 Coleoptera
 Dytiscidae
Agabus sp.
 Curculionidae
 Diptera
 Chironomidae
Apsectrotanypus sp.
Krenopelopia sp.
Rheotanytarsus sp.
Chironomus sp.

Canyonlands at Island in the Sky - ~~Arches-0598~~, sample 8, pool

Coleoptera
 Hydraenidae
Ochthebius sp.
 Diptera
 Ceratopogonidae
Dasyhelea sp.
 Chironomidae
Natarsia sp.
 Tipulidae
Pedicia sp.
 Tabanidae
Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Canyonlands at Island in the Sky - ~~Arches-0598~~, sample ?, freshwater creek pools

Coleoptera
 Heteroceridae
 Hydrophilidae
Berosus sp.
 Diptera
 Chironomidae
Tanytarsus sp.
Polypedilum sp.
Procladius sp.

CNAY 0298, sample 11

Coleoptera
 Hydrophilidae
Hydrobiomorpha sp. larva
 Diptera
 Ceratopogonidae
Atrichopogon sp.
 Stratiomyidae
Caloparyphus sp.

CNAY 02-98

Big Springs

CNAY 0298, sample 12

Odonata

Coenagrionidae

Argia sp.

Coleoptera

Carabidae - terrestrial

Hydraenidae

Hydraena sp.

Diptera

Chironomidae

Natarsia sp.

Tipulidae

Tipula sp.

Hymenoptera

Crabronidae - terrestrial

CNAY 0398, sample ?, 15 July 1998, pool

Odonata

Lestidae

Archilestes sp.

Hemiptera

Gerridae

Aquarius sp.

Notonectidae

Notonecta sp.

Trichoptera - cases, possibly Limnephilidae

Coleoptera

Gyrinidae

Gyrinus sp.

Dytiscidae

Hydrovatus sp.

Diptera

Chironomidae

Apsectrotanypus sp.

Natarsia sp.

Tanytarsus sp.

Polypedilum sp.

GLEN CANYON AND CATARACT CANYON

Knowles Canyon - site 98-01, sample 1

Coleoptera

Hydrophilidae

Tropisternus sp. larva

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Natarsia sp.

Stratiomyidae

Caloparyphus sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Tipulidae

Pedicia sp.

Araneae

Lycosidae

Cave Spring - Needles

GLCA 01-98

Gypsum Canyon - site 98-02, sample 3

GLCA 02-98

Ephemeroptera

Leptophlebiidae

Coleoptera

Dytiscidae

Rhantus sp.

Diptera

Chironomidae

Apsectrotanytus sp.*Phaenopsectra* sp.

Stratiomyidae

Euparyphus sp.

Culicidae

Culex sp.

Gypsum Canyon - site 98-02, sample 4

Ephemeroptera

Leptophlebiidae

Thraulodes sp. adults

Hemiptera

Gerridae

Aquarius sp.

Easter Pasture Canyon - site 98-03, sample 5

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Lestidae

Archilestes sp.

Coenagrionidae

Argia sp.

Tichoptera - cases, possibly Limnephilidae

Coleoptera

Dytiscidae

Acilius sp. larvae*Ilybius* sp. adults

Diptera

Chironomidae

Phaenopsectra sp.

Tabanidae

Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Easter Pasture Canyon - site 98-03, seep wall scrapes

GLCA 03-98

Coleoptera

Hydraenidae

Ochthebius sp.

Diptera

Chironomidae

Natarsia sp.

Tabanidae

Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Dolichopodidae

Rhaphium sp.

Easter Pasture Canyon - site 98-03, sample 6

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Aeshnidae

Aeshna sp.

Coenagrionidae
Argia sp.
Hemiptera
Gerridae
Aquarius sp.
Hebridae
Hebrus sp.
Coleoptera
Dytiscidae
Acilius sp. larva
Diptera
Chironomidae
Krenopelopia sp.
Phaenopsectra sp.
Tabanidae
Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Swett Canyon - site 98-04, sample 7

GLCA 04-98

Ephemeroptera
Baetidae
Callibaetis sp.
Odonata
Coenagrionidae
Argia sp.
Hemiptera
Veliidae
Microvelia sp.
Trichoptera - cases only, possibly Limnephilidae
Coleoptera
Hydraenidae
Ochthebius sp.
Dytiscidae
Agabus sp.
Ilybius sp.
Uvarus sp. A
Uvarus sp. B
Hydrophilidae
Berosus sp. A
Berosus sp. B
Diptera
Chironomidae
Tanytarsus sp.
Polypedilum sp.
Stratiomyidae
Caloparyphus sp.

No Name - site 98-06, sample 8

GLCA 06-98

Odonata
Lestidae
Archilestes sp.
Hemiptera
Gerridae
Aquarius sp.
Veliidae
Microvelia sp.
Diptera
Chironomidae
Ablabesmyia sp.
Culicidae
Anopheles sp.
Psychodidae
Pericoma sp. or *Telmatoscopus* sp.

Araneae

Dictynidae

Mallus sp.

Opiliones

GRAND CANYON/ARCHES/CANYONLANDS/GLEN CANYON
COLLECTIONS 1998

GRAND CANYON

Buck Farm - site 1, sample 1

24-98

GRCA-01-98

Diptera

Ceratopogonidae

Dasyhelea sp.

Chironomidae

Procladius sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Caloparyphus sp.

Tipulidae

Cryptolabis sp.?

Tabanidae

Tabanus sp.

No label - single vial

Coleoptera

Dytiscidae adults

Ilybius sp.

Burts Canyon - site 2, sample 3

30-98

GRCA 02-98

Odonata

Aeshnidae

Aeshna sp.

Lestidae

Archilestes sp.

Coenagrionidae

Argia sp.

Ephemeroptera

Baetidae

Callibaetis sp.?

Hemiptera

Gerridae

Limnoporus sp.

Lepidoptera

Geometridae

Trichoptera

Limnephilidae - pupa (can't i.d. lower than family)

Hydroptilidae - cases, no larvae

Diptera

Ceratopogonidae

Bezzia sp.

Burts Canyon - sample 4

Diptera

Chironomidae

Procladius sp.

Monopelopia sp.

Rheotanytarsus sp.

Phaenopsectra sp.

Burts Canyon - sample 5

Diptera

Chironomidae

Monopelopia sp. ?

Polypedilum sp.

Ceratopogonidae

Bezzia sp.*Dasyhelea* sp.

Muscidae

Limnophora sp.

Saddle Canyon - Site 3, sample 1

Hemiptera

Geridae

Limnopus sp.

Trichoptera

Psychomyiidae

Tinodes sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Staphylinidae

Psephenus sp.

Hydrophilidae

Enochrus sp.

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Krenopelopia sp.*Cardiocladius* sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Caloparyphus sp.

Tipulidae

Erioptera sp.

Nankoweap Creek - site 4, large bottle

Hymenoptera

Apidae

Apis mellifera

Nankoweap Creek - Sample 8

Ephemeroptera

Baetidae

Baetis sp.

Odonata

Coenagrionidae

Argia sp.

Trichoptera

Sericostomatidae

Gumaga sp.

Diptera

Chironomidae

Krenopelopia sp.*Procladius* sp.

Orthoclaadiinae

Tipulidae

Hexatoma sp.

Outflow of Nankoweap Creek - site 5

Ephemeroptera

Baetidae

Baetis sp.

G R C A 03-48

dorus

? ~~Kephale~~ Spring

G R C A 05-98

Odonata

Aeshnidae

Boyeria sp.

Coenagrionidae

Argia sp.

Orthoptera

Tridactylidae

Trichoptera

Philopotamidae

Wormaldia sp.

Sericostomatidae

Gumaga sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Hydrophilidae

Paracymus sp.

Sphaeridiinae - cannot go further

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Procladius sp.

Orthocladiinae

Stratiomyidae

Euparyphus sp.

Muscidae

Limnophora sp.

Hance Rapid - site 6, sample 9

Hemiptera

Veliidae

Microvelia sp.

Lepidoptera

Pyralidae

Petrophila sp.

Coleoptera

Hydrophilidae

Enochrus sp.

Diptera

Stratiomyidae

Euparyphus sp.*Stratiomys* sp.

Tipulidae

Tipula sp.

Chilopoda - terrestrial centipede

Hance Rapid - site 6, sample 10 - pool

Odonata

Coenagrionidae

Argia sp.

Hemiptera

Veliidae

Microvelia sp.

Diptera

Chironomidae

Natarsia sp.

Tipulidae

Hexatoma sp.

Dolichopodidae

Rhaphium sp.

GRCA 06-98

Hymenoptera
Ichneumonoidea - Terrestrial

Hance Rapid - site 6, sample 11

Odonata

Cenagrionidae

Argia sp.

Hemiptera

Ochteridae

Ochterus sp.

Lepidoptera

Pyalidae

Petrophila sp.

Diptera

Chironomidae

Paralauterborniella sp.

Stratiomyidae

Caloparyphus sp.

Stratiomys sp.

Tipulidae

Pedicia sp.

Gonomyia sp.

Elves' Chasm - site 7 - pool habitat - separate from flowing pool (no labels in vials)

Ephemeroptera

Leptophlebiidae

Thraulodes sp. ?

Baetidae

Baetis sp.

Odonata

Libellulidae

Paltothemis sp.

Coenagrionidae

Argia sp.

Hemiptera

Notonectidae

Buenoa sp.

Trichoptera

Limnephilidae - empty cases

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Gyrinidae

Gyrinus sp.

Dytiscidae

Oreodytes sp. - larvae

Derovatellus sp. - adults

Elmidae

Microcylloepus sp. - larvae

Dascillidae - terrestrial adult

Diptera

Chironomidae

Trissopelopia sp.

Polypedilum sp.

Orthocladiinae

Tipulidae

Tipula sp.

GIRCA 07-48

Elves' Chasm - site 7, sample 12&13 - flowing pool habitat

Ephemeroptera

Baetidae

*Baetis magnus**Callibaetis pictus*

Odonata

Lestidae

Archilestes sp.

Libellulidae

Paltothermis sp.

Coleoptera

Dytiscidae

Derovatellus sp.

Dascillidae - terrestrial adult

Diptera

Chironomidae

Psectrocladius sp.*Cricotopus* sp. or *Orthocladius* sp.*Polypedilum* sp.

Tipulidae

Erioptera sp.

Elves' Chasm - site 7, sample 14 - seep walls

Ephemeroptera

Baetidae

Baetis magnus

Hemiptera

Ochteridae

Ochterus sp.

Veliidae

Microvelia sp.

Trichoptera

Psychomyiidae

Tinodes sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Hydraenidae

Ochthebius sp.

Diptera

Ceratopogonidae

Atrichopogon sp.

Chironomidae

Pentaneura sp.*Krenopelopia* sp.*Cardiocladius* sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Caloparyphus sp.

Tipulidae

Pedicia sp.

Muscidae

Limmophorus sp.

Ephydriidae

Scatella sp.

Mile 127.5 Spring - site 8, sample 15

Odonata

Coenagrionidae

Argia sp.

Coleoptera

Hydrophilidae

Tropisternus sp. - larva*Enochrus* sp. - adult

Diptera

Chironomidae

Natarsia sp.*Krenopelopia* sp.*Micropsectra* sp. or *Lauterbornia* sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Stratiomys sp.

Tipulidae

Hexatoma sp.*Cryptolabis* sp.?

Dolichopodidae

Rhaphium sp.

GRC A 08-98

Deer Creek - site 9, sample 16

Odonata

Coenagrionidae

Argia sp.

Diptera

Tipulidae

Tipula sp.

GRC A 09-98

Above Kanab Creek - Site 10, sample 17

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Lauterborniella sp. or *Xenochironomus* sp.

Dolichopodidae

Rhaphium sp.?

River Mile 147 Right - site 11, sample 18

Odonata

Coenagrionidae

Argia sp.

Hemiptera

Hebridae

Hebrus sp.

Lepidoptera

Pyralidae

Petrophila sp.

Noctuidae

Archanara sp.

Coleoptera

Hydrophilidae

Tropisternus sp. - larvae*Enochrus* sp. - adults

Chrysomilidae - probably terrestrial

Lampyridae - terrestrial larva

Diptera

Chironomidae

Orthocladiinae

GRC A 11-98

Tipulidae

Tipula sp.

Stratiomyidae

Caloparyphus sp.

Euparyphus sp.

Stratiomys sp.

Arachnida

Araneae

Lycosidae

Ledges Camp Site - site 13, sample 19

Odonata

Coenagrionidae

Argia sp.

Coleoptera

Hydrophilidae

Enochrus sp.

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Procladius sp.

Stratiomyidae

Euparyphus sp.

Stratiomys sp.

Downstream of Slimey Tick - site 13, sample 20

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Lestidae

Archilestes grandis?

Coleoptera

Hydrophilidae

Berosus sp.

Tropisternus sp.

Arachnida

Pseudoscorpion or tailless whipscorpion - very badly damaged

Slimey Tick - site 13, sample 21

Ephemeroptera

Baetidae

Baetis sp.

Odonata

Aeshnidae

Anax sp.

Coenagrionidae

Argia sp.

Lestidae

Archilestes sp.

Trichoptera

Psychomyiidae

Tinodes sp.

Coleoptera

Dytiscidae

Neoscutopterus sp. or *Rhantus* sp.

Hydrophilidae

Tropisternus sp. larva

Dascillidae adult

GPCA 13-98

GPCA 14-98

Diptera

Ceratopogonidae

Bezzia sp.*Dasyhelea* sp.

Chironomidae

Labrundinia sp.*Microtendipes* sp.

Simuliidae

Simulium sp.Fern Glen~~n~~ - site 1~~4~~⁵, sample 22

Hemiptera

Hebridae

Hebrus sp.

Thysanoptera

Phleothripidae

Diptera

Ceratopogonidae

Dasyhelea sp.

Chironomidae

Macropelopia sp.

Tipulidae

Helius sp.

Tabanidae

Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Empididae

Clinocera sp.

Araneae

Dictynidae - difficult to identify, no legs

Fern Glen~~n~~ - site 1~~4~~⁵, sample 23

Coleoptera

Carabidae

Dytiscidae

Carrhydrus sp.*Agabus* sp.*Derovatellus* sp. or *Uvarus* sp.

Diptera

Culicidae

Culiseta sp.Fern Glen~~n~~ - site 1~~4~~⁵, sample 24

Ephemeroptera

Baetidae

Baetis sp.

Trichoptera

Psychomyiidae

Tinodes sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Carabidae

Dytiscidae

Hydrovatus sp.

Diptera

Chironomidae

Phaenopsectra sp.

Orthocladinae

Stratiomyidae

Euparyphus sp.

Tipulidae

Limonia sp. or *Dicranota* sp.

Mohawk Canyon - site 15, sample 25

G R C A 16-98

Diptera

Chironomidae

Procladius sp.

Xenochironomus sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Cove Canyon - site 16, sample 26

G R C A 17-98

Trichoptera

Hydroptilidae

Hydroptila sp.

Diptera

Chironomidae

Natarsia sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Hymenoptera

Sphecidae - terrestrial

CANYONLANDS AND ARCHES

Sleepy Hollow - site Arches 0198, sample 1

ARCA 01-98

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Coenagrionidae

Argia sp.

Lestidae

Lestes sp.

Aeshnidae

Aeshna sp.

Hemiptera

Notonectidae

Notonecta sp.

Gerridae

Aquarius sp.

Gelastocoridae

Gelastocoris sp.

Coleoptera

Carabidae

Omophron sp.

Gyrinidae

Gyrinus sp.

Dytiscidae

Hydaticus sp. larva

Laccophilus sp. larva

Dryopidae

Helichus confluentus

Hydrophilidae

Tropisternus sp.

Diptera

Chironomidae

Macropelopia sp.

Krenopelopia sp.

Muscidae - adult

Sleepy Hollow - Arches 0198, sample 2

Ephemeroptera

Baetidae - just cast skin, cannot go farther

GRAND CANYON/ARCHES/CANYONLANDS/GLENCANYON

COLLECTIONS

Jerry Monk 1998

1

Total 97-98
1408

GRAND CANYON

Buck Farm - site 98-01, sample 1

Diptera

Ceratopogonidae

Dasyhelea sp.

Chironomidae

Procladius sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Caloparyphus sp.

Tipulidae

Cryptolabis sp.?

Tabanidae

Tabanus sp.

Coleoptera (no label in vial)

Dytiscidae adults

Ilybius sp.

29-98

GRCA 01-98

Berts Canyon - site 98-02, sample 3

GRCA 02-98

Odonata

Aeshnidae

Aeshna sp.

Lestidae

Archilestes sp.

Coenagrionidae

Argia sp.

Ephemeroptera

Baetidae

Callibaetis sp.?

Hemiptera

Gerridae

Limnoporus sp.

Trichoptera

Limnephilidae - pupa (can't i.d. to genus)

Hydroptilidae - cases, no larvae

Diptera

Ceratopogonidae

Bezzia sp.

30-98

Berts Canyon - site 98-02, sample 4

Diptera

Chironomidae

Procladius sp.

Monopelopia sp.
Rheotanytarsus sp.
Phaenopsectra sp.

Berts Canyon - site 98-01, sample 5

Diptera

Chironomidae

Monopelopia sp. ?

Polypedilum sp.

Ceratopogonidae

Bezzia sp.

Dasyhelea sp.

Muscidae

Limnophora sp.

30-98

Saddle Canyon - Site 98-03, sample 1

Hemiptera

Gerridae

Limnopus sp.

G R C A 03-98

31-98

Trichoptera

Psychomyiidae

Tinodes sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Staphylinidae

Psephenus sp.

Hydrophilidae

Enochrus sp.

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Krenopelopia sp.

Cardiocladius sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Caloparyphus sp.

Tipulidae

Erioptera sp.

(32-98 Keyhole 4)

Nankoweap Creek - site 98-05, sample 8

Ephemeroptera

Baetidae

Baetis sp.

33-98

G R C A - 05 - 98

Odonata

Coenagrionidae

Argia sp.

Trichoptera

Sericostomatidae

Gumaga sp.

Diptera

Chironomidae

Krenopelopia sp.*Procladius* sp.

Orthocladiinae

Tipulidae

Hexatoma sp.

Outflow of Nankoweap Creek - site 98-05

Ephemeroptera

Baetidae

Baetis sp.

Odonata

Aeshnidae

Boyeria sp.

Coenagrionidae

Argia sp.

Trichoptera

Philopotamidae

Wormaldia sp.

Sericostomatidae

Gumaga sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Hydrophilidae

Paracymus sp.

Sphaeridiinae - cannot go further

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Procladius sp.

Orthocladiinae

Stratiomyidae

Euparyphus sp.

Muscidae

Limnophora sp.

Hance Spring - site 98-06, sample 9

Hemiptera

Veliidae

Microvelia sp.

Lepidoptera

Pyralidae

Petrophila sp.

Coleoptera

Hydrophilidae

Enochrus sp.

Diptera

Stratiomyidae

Euparyphus sp.

34-98

6 PCA 06-98

Stratiomys sp.
Tipulidae
Tipula sp.

Hance Spring - site 98-06, sample 10 - pool

Odonata
Coenagrionidae
Argia sp.

Hemiptera
Veliidae
Microvelia sp.

Diptera
Chironomidae
Natarsia sp.
Tipulidae
Hexatoma sp.
Dolichopodidae
Rhaphium sp.

Hance Spring - site 98-06, sample 11

Odonata
Cenagrionidae
Argia sp.

Hemiptera
Ochteridae
Ochterus sp.

Lepidoptera
Pyrilidae
Petrophila sp.

Diptera
Chironomidae
Paralauterborniella sp.
Stratiomyidae
Caloparyphus sp.
Stratiomys sp.
Tipulidae
Pedicia sp.
Gonomyia sp.

Elves' Chasm - site 98-07 - pool habitat - separate from flowing pool (no labels in vials)

62CA-07-98

Ephemeroptera
Leptophlebiidae
Thraulodes sp. ?
Baetidae
Baetis sp.

Odonata
Libellulidae
Paltothermis sp.
Coenagrionidae
Argia sp.

Hemiptera

35-98

Notonectidae

Buenoa sp.

Trichoptera

Limnephilidae - empty cases

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Gyrinidae

Gyrinus sp.

Dytiscidae

Oreodytes sp. - larvae

Derovatellus sp. - adults

Elmidae

Microcylloepus sp. - larvae

Dascillidae - terrestrial adult

Diptera

Chironomidae

Trissopelopia sp.

Polypedilum sp.

Orthocladiinae

Tipulidae

Tipula sp.

Elves Chasm - site 98-07, samples 12 & 13 - flowing pool habitat

Ephemeroptera

Baetidae

Baetis magnus

Callibaetis pictus

Odonata

Lestidae

Archilestes sp.

Libellulidae

Paltothemis sp.

Coleoptera

Dytiscidae

Derovatellus sp.

Dascillidae - terrestrial adult

Diptera

Chironomidae

Psectrocladius sp.

Cricotopus sp. or *Orthocladius* sp.

Polypedilum sp.

Tipulidae

Erioptera sp.

Elves Chasm - site 98-07, sample 14 - seep walls

Ephemeroptera

Baetidae

Baetis magnus

Hemiptera

Ochteridae

Ochterus sp.

Veliidae

Microvelia sp.

Trichoptera

Psychomyiidae

Tinodes sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Hydraenidae

Ochthebius sp.

Diptera

Ceratopogonidae

Atrichopogon sp.

Chironomidae

Pentaneura sp.*Krenopelopia* sp.*Cardiocladius* sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Caloparyphus sp.

Tipulidae

Pedicia sp.

Muscidae

Limnophorus sp.

Ephydriidae

Scatella sp.

Mile 127.5 Spring - site 98-08, sample 15

GPCA 08-98

Odonata

Coenagrionidae

Argia sp.

Coleoptera

Hydrophilidae

Tropisternus sp. - larva*Enochrus* sp. - adult

Diptera

Chironomidae

Natarsia sp.*Krenopelopia* sp.*Micropsectra* sp. or *Lauterbornia* sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

Stratiomyidae

Stratiomys sp.

Tipulidae

Hexatoma sp.*Cryptolabis* sp.?

Dolichopodidae

Rhaphium sp.

Deer Creek - site 98-09, sample 16

GPCA 09-98

Odonata

Enochrus sp.

Diptera

Ceratopogonidae

Bezzia sp.

Chironomidae

Procladius sp.

Stratiomyidae

Euparyphus sp.

Stratiomys sp.

The Ledges - site 13, sample 20

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Lestidae

Archilestes grandis?

Coleoptera

Hydrophilidae

Berosus sp.

Tropisternus sp.

Slimy Tick - site 98-14, sample 21

620A 14-98

Ephemeroptera

Baetidae

Baetis sp.

Odonata

Aeshnidae

Anax sp.

Coenagrionidae

Argia sp.

Lestidae

Archilestes sp.

42-98

Trichoptera

Psychomyiidae

Tinodes sp.

Coleoptera

Dytiscidae

Neoscutopterus sp. or *Rhantus* sp.

Hydrophilidae

Tropisternus sp. larva

Dascillidae adult

Diptera

Ceratopogonidae

Bezzia sp.

Dasyhelea sp.

Chironomidae

Labrundinia sp.

Microtendipes sp.

Simuliidae

Simulium sp.

Fern Glenⁿ - site 98-15, sample 22

GRCA 15-98

Hemiptera

Hebridae

Hebrus sp.

Diptera

Ceratopogonidae

Dasyhelea sp.

Chironomidae

Macropelopia sp.

Tipulidae

Helius sp.

Tabanidae

Tabanus sp.?

Empididae

Clinocera sp.

43-98

Fern Glenⁿ - site 98-15, sample 23

Coleoptera

Carabidae

Dytiscidae

Carrhydrus sp.

Agabus sp.

Derovatellus sp. or *Uvarus* sp.

Diptera

Culicidae

Culiseta sp.

Fern Glenⁿ - site 98-15, sample 24

Ephemeroptera

Baetidae

Baetis sp.

Trichoptera

Psychomyiidae

Tinodes sp.

Hydroptilidae

Ochrotrichia sp.

Coleoptera

Carabidae

Dytiscidae

Hydrovatus sp.

Diptera

Chironomidae

Phaenopsectra sp.

Orthocladinae

Stratiomyidae

Euparyphus sp.

Tipulidae

Limonia sp. or *Dicranota* sp.

GRCA 16-98

Mohawk Canyon - site 98-16, sample 25

Diptera

Chironomidae

Procladius sp.*Xenochironomus* sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

4/4-98

Cove Canyon - site 98-17, sample 26

GRC 17-48

Trichoptera

Hydroptilidae

Hydroptila sp.

Diptera

Chironomidae

Natarsia sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

4/5-98

CANYONLANDS AND ARCHES

Sleepy Hollow - site Arches 0198, sample 1

ARCH 01-98

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Coenagrionidae

Argia sp.

Lestidae

Lestes sp.

Aeshnidae

Aeshna sp.

Hemiptera

Notonectidae

Notonecta sp.

Geridae

Aquarius sp.

Gelastocoridae

Gelastocoris sp.

Coleoptera

Carabidae

Omophron sp.

Gyrinidae

Gyrinus sp.

Dytiscidae

Hydaticus sp. larva*Laccophilus* sp. larva

Dryopidae

Helichus confluentus

Hydrophilidae

Tropisternus sp.

Diptera

Chironomidae

Macropelopia sp.*Krenopelopia* sp.

Sleepy Hollow - Arches 0198, sample 2

Ephemeroptera

Baetidae - just cast skin, cannot go farther

Odonata

Coenagrionidae

Argia sp.

Coleoptera

Hydrophilidae

Tropisternus sp.

Diptera

Chironomidae

Polypedilum sp.*Macropelopia* sp.

Sleepy Hollow - Arches 0198, sample 3

Odonata

Coenagrionidae

Argia sp.

Diptera

Chironomidae

Rheotanytarsus sp.

Tipulidae

Pedicia sp.

Stratiomyidae

Euparyphus sp.*Stratiomys* sp.

Tabanidae

Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Sleepy Hollow - Arches 0198, sample 4

Trichoptera

Rhyacophilidae

Rhyacophila sp.

Diptera

Chironomidae

Macropelopia sp.

Orthoclaadiinae

Tipulidae

Dicranota sp.*Limonia* sp.*Pedicia* sp.*Tipula* sp.

Stratiomyidae

Caloparyphus sp.

Sleepy Hollow - Arches 0198, sample Madiculous scrapes #?

Diptera

Chironomidae

Natarsia sp.

Tipulidae

Limonia sp. A*Limonia* sp. B

Stratiomyidae

Caloparyphus sp.

Sleepy Hollow - Arches 0198, sample ledge below seep wall #?

Trichoptera

Rhyacophilidae

Rhyacophila sp.

Diptera

Tipulidae

Dicranota sp.*Gonomyia* sp.*Hexatoma* sp.*Limonia* sp.*Rhabdomastix* sp.

Stratiomyidae

Caloparyphus sp.*Euparyphus* sp.

CNAY 0198 - sample 6

GANY 01-98

Coleoptera

Hydraenidae

Hydraena sp.*Ochthebius* sp.

Dytiscidae

Hydroporus sp. larva*Uvarus* sp. adult

Hydrophilidae

Paracymus sp.

Diptera

Chironomidae

Krenopelopia sp.*Rheotanytarsus* sp.

Stratiomyidae

Caloparyphus sp.*Euparyphus* sp.

Tipulidae

Dicranota sp.*Gonomyia* sp.*Pedicia* sp.

CNAY 0198 - sample 7

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Aeshnidae

Aeshna sp.

Trichoptera

cases only - possibly Limnephilidae

Coleoptera

Hydraenidae

Hydraena sp.

Dytiscidae

Agabus sp.*Hydrovatus* sp.

Diptera

Chironomidae

Micropsectra sp. or *Lauterborniella* sp.*Chironomus* sp.*Phaenopsectra* sp.

Culicidae

Culiseta sp.

Tabanidae - terrestrial adult

Tipulidae

Dicranota sp.*Tipula* sp.

Stratiomyidae

Euparyphus sp.

Canyonlands at Island in the Sky - CNAY 0198, sample 8

Ephemeroptera

Baetidae

Baetis sp.

Coleoptera

Dytiscidae

Agabus sp.

Diptera

Chironomidae

Apsectrotanypus sp.*Krenopelopia* sp.*Rheotanytarsus* sp.*Chironomus* sp.~~Canyonlands at Island in the Sky~~ - Arches 0598, sample 8, pool

Coleoptera

Hydraenidae

Ochthebius sp.

Diptera

Ceratopogonidae

Dasyhelea sp.

Chironomidae

Natarsia sp.

Tipulidae

Pedicia sp.

Tabanidae

Tabanus sp. ?

Canyonlands at Island in the Sky - Arches 0598, sample ?, freshwater creek pools

Coleoptera

Heteroceridae

Saline Spring

26-98

ARCH 03-98

Freshwater Spring

27-98

Hydrophilidae
Berosus sp.

Diptera
Chironomidae
Tanytarsus sp.
Polypedilum sp.
Procladius sp.

CNAY 0298, sample 11

BANY 02-98

Coleoptera
Hydrophilidae
Hydrobiomorpha sp. larva

Diptera
Ceratopogonidae
Atrichopogon sp.

Stratiomyidae
Caloparyphus sp.

CNAY 0298, sample 12

Big Spring

28-98

Odonata
Coenagrionidae
Argia sp.

Coleoptera
Hydraenidae
Hydraena sp.

Diptera
Chironomidae
Natarsia sp.
Tipulidae
Tipula sp.

CNAY 0398, sample ?, 15 July 1998, pool

Cave Spring

Odonata
Lestidae
Archilestes sp.

Hemiptera
Gerridae
Aquarius sp.
Notonectidae
Notonecta sp.

Trichoptera - cases, possibly Limnephilidae

Coleoptera
Gyrinidae
Gyrinus sp.
Dytiscidae
Hydrovatus sp.

Diptera
Chironomidae

Big Cave Spring

Apsectrotanypus sp.
Natarsia sp.
Tanytarsus sp.
Polypedilum sp.

GLEN CANYON AND CATARACT CANYON

Knowles Canyon - site 98-01, sample 1

~~GLCA~~

GLCA 01-98

Coleoptera
 Hydrophilidae
Tropisternus sp. larva

Diptera
 Ceratopogonidae
Bezzia sp.
 Chironomidae
Natarsia sp.
 Stratiomyidae
Caloparyphus sp.
 Psychodidae
Pericoma sp. or *Telmatoscopus* sp.
 Tipulidae
Pedicia sp.

S1-98

Gypsum Canyon - site 98-02, sample 3

GLCA 02-98

Ephemeroptera
 Leptophlebiidae

Coleoptera
 Dytiscidae
Rhantus sp.

Diptera
 Chironomidae
Apsectrotanypus sp.
Phaenopsectra sp.
 Stratiomyidae
Euparyphus sp.
 Culicidae
Culex sp.

S2-98

Gypsum Canyon - site 98-02, sample 4

Ephemeroptera
 Leptophlebiidae
Thraulodes sp. adults

Hemiptera
 Gerridae
Aquarius sp.

Easter Pasture Canyon - site 98-03, sample 5

GLCA 03-98

Ephemeroptera
 Baetidae
Callibaetis sp.

Odonata

Lestidae

Archilestes sp.

Coenagrionidae

Argia sp.

Tichoptera - cases, possibly Limnephilidae

Coleoptera

Dytiscidae

Acilius sp. larvae*Ilybius* sp. adults

Diptera

Chironomidae

Phaenopsectra sp.

Tabanidae

Tabanus sp. ?

Easter Pasture Canyon - site 98-03, seep wall scrapes

53-98

Coleoptera

Hydraenidae

Ochthebius sp.

Diptera

Chironomidae

Natarsia sp.

Tabanidae

Tabanus sp., *Whitneyomyia* sp., or *Atylotus* sp.

Dolichopodidae

Rhaphium sp.

Easter Pasture Canyon - site 98-03, sample 6

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Aeshnidae

Aeshna sp.

Coenagrionidae

Argia sp.

Hemiptera

Gerridae

Aquarius sp.

Hebridae

Hebrus sp.

Coleoptera

Dytiscidae

Acilius sp. larva

Diptera

Chironomidae

Krenopelopia sp.*Phaenopsectra* sp.

Tabanidae

Tabanus sp.?

Swett Canyon - site 98-04, sample 7

6LCA 04-98

Ephemeroptera

Baetidae

Callibaetis sp.

Odonata

Coenagrionidae

Argia sp.

Hemiptera

Veliidae

Microvelia sp.

Trichoptera - cases only, possibly Limnephilidae

54-98

Coleoptera

Hydraenidae

Ochthebius sp.

Dytiscidae

Agabus sp.*Ilybius* sp.*Uvarus* sp. A*Uvarus* sp. B

Hydrophilidae

Berosus sp. A*Berosus* sp. B

Diptera

Chironomidae

Tanytarsus sp.*Polypedilum* sp.

Stratiomyidae

Caloparyphus sp.

No Name - site 98-06, sample 8

6LCA 06-98

Odonata

Lestidae

Archilestes sp.

Hemiptera

Gerridae

Aquarius sp.

Veliidae

Microvelia sp.

Diptera

Chironomidae

Ablabesmyia sp.

Culicidae

Anopheles sp.

Psychodidae

Pericoma sp. or *Telmatoscopus* sp.

55-98

Grand Canyon Collections 5-10-98 to 5-19-98

Site Number: 1
Site Name: Buck Farm
Sample Number: 1
Habitat Type: SP
Microhabitat Type: M
Collection Date: 5-10-98
Comments:

GRCA 01-98

O. Diptera
F. Stratiomyiidae
F. Chironimidae
F. Tipulidae
F. unknowns

Site Number: 1
Site Name: Buck Farm
Sample Number: 2
Habitat Type: SP
Microhabitat Type: ST
Collection Date: 5-10-98
Comments: Whirl-Pac torn apart by ravens (avian bastards!).

O. Diptera
F. Chironimidae
O. Hemiptera
F. Mesoveliidae
O. Coleoptera
F. Dytiscidae

Site Number: 2
Site Name: Buck Canyon
Sample Number: 3
Habitat Type: P2
Microhabitat Type:
Collection Date: 5-11-98
Comments: Net sweep of pool

GRCA 02-98

C. Insecta
O. Odonata
S.O. Anisoptera

F. Aeshnidae
S.O. Zygoptera
F. Lestidae

Archilestes sp.
F. Coenagrionidae
Argia sp.
O. Lepidoptera
F. terrestrial
O. Trichoptera
F. Limnephilidae
F. Hydropsychidae
O. Hemiptera
F. Gerridae
O. Ephemeroptera

Site Number: 2
Site Name: Burt Canyon
Sample Number: 4
Habitat Type: P2
Microhabitat Type: SS
Collection Date: 5-11-98
Comments: Sediment/silt sample

O. Diptera
F. Chironimidae

Site Number: 2
Site Name: Burt Canyon
Sample Number: 5
Habitat Type: SP
Microhabitat Type: M
Collection Date: 5-11-98
Comments:

O. Diptera
F. Chironimidae
F. Ceratopogonidae
F. Tipulidae
F. unknowns

Site Number: 3
Site Name: Saddle Canyon
Sample Number: 6
Habitat Type: S
Microhabitat Type: M
Collection Date: 5-11-98
Comments:

6 PCA 03-98

- O. Diptera
 - F. Chironimidae
 - F. Tipulidae
 - F. Stratiomyiidae
- O. Coleoptera
 - F. Dytiscidae
- O. Trichoptera
 - F. Hydroptilidae
- O. Hemiptera

P. Mollusca

C. Gastropoda

- O. Basommatomorpha
- F. Planorbidae

Site Number: 4
 Site Name: Nankoweap Creek-Springs
 Sample Number: 7
 Habitat Type: ST
 Microhabitat Type: LP-SS
 Collection Date: 5-12-98
 Comments: Fish noted in spring outflow

GICA 05-98

- O. Diptera
 - F. Chironimidae
 - F. Ceratopogonidae
 - F. unknowns
- O. Trichoptera
 - F. Hydroptilidae
 - F. Philopotamidae
 - F. Limnephidae
- O. Odonata
 - S.O. Anisoptera
 - F. Libellulidae
 - S.O. Zygoptera
 - F. Coenagrionidae
 - Argia* sp.
- O. Coleoptera
 - F. Elmidae
 - F. unknown
- O. Orthoptera
 - F. unknown-possibly semiaquatic
- O. Ephemeroptera
 - F. Baetidae

Site Number: 4
Site Name: Nankoweap Creek
Sample Number: 8
Habitat Type: P2
Microhabitat Type: LP-SS
Collection Date: 5-12-98
Comments: Fish noted in spring complex

O. Diptera
 F. Chironimidae
O. Trichoptera
 F. Limnephidae
O. Odonata
 S.O. Zygoptera
 F. Coenagrionidae
 Argia sp.

Site Number: 5
Site Name: Outflow of Nankoweap Creek
Sample Number: no sample taken
Habitat Type: ?
Microhabitat Type: ?
Collection Date: 5-13-98
Comments: Samples not taken due to separation of team members.

Site Number: 6
Site Name: Hance Rapid
Sample Number: 9
Habitat Type: SP
Microhabitat Type: LS
Collection Date: 5-13-98
Comments:

6 RCA 06-98

O. Diptera
 F. Stratiomyidae
 F. Tabanidae
O. Lepidoptera
 F. Pyralidae
O. Coleoptera
 F. Terrestrial
O. Hemiptera
 F. Veliidae
C. Myriapoda
 S.C. Chilopoda
 terrestrial centipede

Site Number: 6
Site Name: Hance Rapid
Sample Number: 10
Habitat Type: P
Microhabitat Type: SS
Collection Date: 5-13-98
Comments:

O. Diptera
 F. Chironimidae
O. Odonata
 S.O. Zygoptera
 F. Coenagrionidae
 Argia sp.
O. Hemiptera
 F. Veliidae

Site Number: 6
Site Name: Hance Rapid
Sample Number: 11
Habitat Type: SP
Microhabitat Type: M
Collection Date: 5-13-98
Comments:

O. Diptera
 F. Stratiomyidae
 F. Chironimidae
O. Lepidoptera
 F. Pyralidae
 Petrophila sp.

P. Annelida

O. Oligochaeta

O. Acarina
O. Odonata
 S.O. Zygoptera
 Argia sp.
O. Hemiptera
 F. Ochteridae

Site Number: 7
Site Name: Elves' Chasm
Sample Number: 12 and 13 combined
Habitat Type: P2-ST

GRCA 07-98

Microhabitat Type: SW

Collection Date: 5-15-98

Comments: Flowing pool - part of terraced stream in Elves Chasm

- O. Diptera
 - F. Chironimidae
 - F. Tipulidae
- O. Coleoptera
 - F. Dytiscidae
 - F. Unknown Terrestrial
- O. Ephemeroptera
 - F. Baetidae
 - Callibaetis* sp.
 - Unknown sp.
- O. Trichoptera
 - F. Hydroptilidae
- O. Odonata
 - S.O. Zygoptera
 - F. Lestidae
 - Lestes* sp.
 - S.O. Anisoptera
 - F. Libellulidae
 - Sympetrum* sp.

C. Ostracoda

- Unknown ostracod
- O. Basommatomorpha
 - F. Physidae

Site Number: 7

Site Name: Elves' Chasm

Sample Number: 14

Habitat Type: S

Microhabitat Type: LS

Collection Date: 5-15-98

Comments: Seep walls above stream in Elves' Chasm

- O. Diptera
 - F. Stratiomyidae
 - F. Tipulidae
 - F. Chironimidae
 - F. Either Sciomyzidae or Athericidae, difficult family ID
 - F. 2 probable unknowns
- O. Ephemeroptera
 - F. Baetidae
- O. Hemiptera
 - F. Ochteridae
 - Ochterus* sp.

F. Veliidae
O. Trichoptera
 F. Hydroptilidae
 Agraylea sp.
 Hydroptila sp.
 F. Polycentropidae
O. Coleoptera
 F. Elmidae
C. Ostracoda
 Unknown ostracods

Site Number: 8
Site Name: Mile 127.5 Spring
Sample Number: 15
Habitat Type: S
Microhabitat Type: LS
Collection Date: 5-13-98
Comments: Very shady, overgrown seep. Had low diversity and low density of specimens.

GRECA 01-98

O. Diptera
 F. Chironimidae
 F. Tipulidae
 Several unknowns
O. Thysanoptera
 Badly damaged thrip
O. Hemiptera
O. Homoptera
 F. Aphididae
O. Araneida
 Terrestrial spider

Site Number: 9
Site Name: Deer Creek
Sample Number: 16
Habitat Type: ST
Microhabitat Type: SS
Collection Date: 5-16-98
Comments: Heavily overgrown portion of stream. Substrate predominantly sand. Low diversity and abundance of insects.

GRECA 09-98

O. Diptera
 F. Tabanidae
O. Odonata
 S.O. Zygoptera
 F. Coenagrionidae
 Argia sp.

O. Basommatomorpha
F. Unknown-looks like *Catinella* sp.

Site Number: 10
Site Name: Above Kanab Creek
Sample Number: 17
Habitat Type: S
Microhabitat Type: M
Collection Date: 5-16-98
Comments: Madiculous scrapes and invertes individually collected by Dr. MacDonald

GRCA 10-98

O. Diptera
F. Chironimidae
F. Tipulidae
F. Ceratopogonidae

Site Number: 11
Site Name: River Mile 147 Right
Sample Number: 18
Habitat Type: S
Microhabitat Type: M
Collection Date: 5-17-98
Comments:

GRCA 11-98

O. Diptera
F. Stratiomyiidae
F. Chironimidae
F. Tipulidae
O. Lepidoptera
F. Cossidae
F. Pyralidae
O. Odonata
S.O. Zygoptera
F. Coenagrionidae
Argia sp.
O. Coleoptera
F. Elmidae
F. At least 3 Unknowns

Site Number: 12
Site Name: Ledges Camp Site
Sample Number: 19
Habitat Type: S and P2
Microhabitat Type: M and SW

GRCA 12-98

Collection Date: 5-16-98

Comments: Madiculous scrapes and pool sampled at Ledges camp site.

O. Diptera

F. Chironimidae

F. Ceratopogonidae

F. Stratiomyiidae

O. Coleoptera

F. Unknown

O. Odonata

S.O. Zygoptera

Argia sp.

C. Oligochaeta

Unknown aquatic earthworm

Site Number: 13

Site Name: Seep/stream complex downstream of Slimey Tick camp site.

Sample Number: 20

Habitat Type: P2

Microhabitat Type: SW and C

Collection Date: 5-18-98

Comments: Seep-stream complex appears to have been recently impacted by flash flood. Algal cover on seep walls was sparse.

O. Ephemeroptera

F. Baetidae

O. Coleoptera

F. Dytiscidae

F. Unknown -possibly terrestrial

O. Odonata

S.O. Zygoptera

Archilestes grandis

Site Number: 13

Site Name: Slimey Tick

Sample Number: 21

Habitat Type: S and P2

Microhabitat Type: LS and SW

Collection Date: 5-18-98

Comments: Seep wall scrapes and pool sampled in Slimey Tick Canyon - combined due to time constraints. Flash flood damage appears recent.

O. Diptera

F. Chironimidae

F. Ceratopogonidae

- F. Simuliidae
- O. Coleoptera
 - F. Dytiscidae
 - F. Elmidae
 - F. Hydrophilidae
- O. Ephemeroptera
 - F. Baetidae
- O. Trichoptera
 - F. Hydroptilidae
- O. Odonata
 - S.O. Zygoptera
 - F. Coenagrionidae
 - Argia* sp.
 - S.O. Anisoptera
 - F. Aeshnidae
 - Anax* sp.

Site Number: 14
 Site Name: Fern Glenx
 Sample Number: 22
 Habitat Type: S
 Microhabitat Type: M
 Collection Date: 5-19-98
 Comments:

GRCA 14-98

- O. Diptera
 - F. Chironimidae
 - F. Tipulidae
- O. Thysanoptera
- O. Hemiptera
 - F. Veliidae
- O. Araneida
 - Terrestrial spider

Site Number: 14
 Site Name: Fern Glenx
 Sample Number: 23
 Habitat Type: P1
 Microhabitat Type: SW
 Collection Date: 5-19-98
 Comments: Pool recently isolated, stream/wash in process of drying up.

- O. Diptera
 - F. Culicidae
 - F. Ceratopogonidae
- O. Ephemeroptera
 - F. Baetidae

O. Coleoptera
F. Dytiscidae
F. Unknown

Site Number: 14
Site Name: Fern Glen^{er}
Sample Number: 24
Habitat Type: S and P1
Microhabitat Type: LS and SW
Collection Date: 5-19-98
Comments: Pool recently isolated, stream/wash in process of drying up. Sample taken from base of Fern Glenn Falls, small trickle of water left and small pool.

O. Ephemeroptera
F. Baetidae
O. Diptera
F. Stratiomyidae
F. Chironimidae
O. Trichoptera
F. Hydroptilidae
O. Coleoptera
F. Unknown

Site Number: 15
Site Name: Mohawk Canyon
Sample Number: 25
Habitat Type: S
Microhabitat Type: M
Collection Date: 5-19-98

GPCA 15-98

Comments: Collection made on Hualapai land w/ no formal permit. Collection site nearly dry with high concentrations of salts or carbonates. Areas in madiculous splash zones were heavily encrusted with precipitates. Low diversity and abundance of insects.

O. Diptera
F. Ceratopogonidae
C. Oligochaeta
unknown aquatic earthworm

Site Number: 16
Site Name: Cove Canyon
Sample Number: 26
Habitat Type: S
Microhabitat Type: M
Collection Date: 5-19-98
Comments:

O. Diptera

F. Chironimidae

O. Trichoptera

F. Hydroptilidae

C. Oligochaeta

END of Grand Canyon Samples

Canyonlands, UT Collections 7-13-98 to 7-15 -98.

Site Number: Arches 0198

Site Name: Sleepy Hollow

Sample Number: 1

Habitat Type: P2

Microhabitat Type: C

Collection Date: 7-13-98

Comments: Large seep with madiculuos areas, mostly inaccessible. Sample taken from large plunge pool.

Archt 01-98

O. Odonata

S.O. Zygoptera

F. Coenagrionidae

Argia sp.

F. Lestidae

Lestes sp.

S.O. Anisoptera

F. Libellulidae

O. Hemiptera

F. Gerridae

F. Corixidae

F. Gelastocoridae

Nerthra sp.

O. Coleoptera

F. Dytiscidae

F. Gyrinidae

F. 2 unknowns

O. Diptera

F. Chironimidae

F. Unknown adult

O. Ephemeroptera

F. Baetidae

O. Amphipoda

F. Hyallelidae

Hyallela azteca

O. Isopoda

O. Acarina

O. Thysanoptera

O. Basommatomorpha

F. Physidae ?

C. Ostracoda

unknown ostracods

Site Number: Arches 0198

Site Name: Sleepy Hollow

Sample Number: 2
Habitat Type: P2
Microhabitat Type: C
Collection Date: 7-13-98
Comments: *Chara* sample

- O. Diptera
 - F. Chironimidae
 - F. Ceratopogonidae
- O. Odonata
 - S.O. Zygoptera
 - F. Coenagrionidae
 - Argia* sp.
- O. Ephemeroptera
 - F. Baetidae
- O. Coleoptera
 - F. Dytiscidae
- O. Amphipoda
 - F. Hyallelidae
 - Hyallela azteca*
- O. Basommatomorpha
 - F. Physidae?

Site Number: Arches 0198
Site Name: Sleepy Hollow
Sample Number: 3
Habitat Type: S
Microhabitat Type: M
Collection Date: 7-13-98
Comments: Seep wall scrapes

- O. Odonata
 - S.O. Zygoptera
 - F. Coenagrionidae
 - Argia* sp.
- O. Diptera
 - F. Tipulidae
 - F. Chironimidae
 - F. Stratiomyiidae
 - F. Unknown
- O. Hymenoptera
 - F. Unknown terrestrial adult

Site Number: Arches 0198
Site Name: Sleepy Hollow
Sample Number: 4
Habitat Type: P2 and S

Microhabitat Type: L and SW

Collection Date: 7-13-98

Comments: Seep with some madiculus habitat high up on cliff face. Small ledge also present has 2-10mm deep "pool" system with dense amphipod population.

C. Gastropoda

unknown semi-aquatic snails in seepage

O. Amphipoda

F. Hyallelidae

Hyallela azteca

O. Isopoda

Terrestrial isopod

O. Diptera

F. Tipulidae

F. Chironimidae

F. Ceratopogonidae

F. Stratiomyidae

F. Unknown adults collected for Dr. MacDonald

O. Trichoptera

F. Polycentropidae

Site Number: CNAY 0198

Site Name:

Sample Number: 6

Habitat Type: ST

Microhabitat Type: SW

Collection Date: 7-14-98

Comments: Small stream issuing from seep-spring complex

CNAY 01-98

O. Diptera

F. Stratiomyidae

F. Athericidae

F. Chironimidae

F. Unknown

O. Coleoptera

F. Dytiscidae

F. Unknown

O. Lepidoptera

Site Number: CNAY 0198

Site Name:

Sample Number: 7

Habitat Type: P2

Microhabitat Type: SS

Collection Date: 7-14-98

Comments: Pool and sediment sample

- O. Diptera
 - F. Tabanidae
 - F. Culicidae
 - F. Chironimidae
 - F. Stratiomyidae
 - F. Unknown
- O. Coleoptera
 - F. Dytiscidae
 - F. Elmidae
 - F. Unknown
- O. Ephemeroptera
 - F. Baetidae
- O. Trichoptera
- O. Odonata
- S.O. Anisoptera
- O. Hymenoptera
 - F. Apoidea
 - Terrestrial bee
- O. Arachnida
 - Longjaw spider
- O. Acarina

Site Number: CNAY 0198
 Site Name: At Island in the Sky, Canyonlands
 Sample Number: 8
 Habitat Type: S
 Microhabitat Type: LS
 Collection Date: 7-15-98
 Comments: Leaf pack composed mainly of *Quercus* leaves.

CANY-01-98

- O. Diptera
 - F. Chironimidae
 - F. Ceratopogonidae
- O. Ephemeroptera
 - F. Baetidae
- O. Coleoptera
 - F. Dytiscidae
 - F. Unknown
 - F. Curculionidae

Site Number: Arches 0598
~~Site Name: At Island in the Sky, Canyonlands~~
 Sample Number: 8
 Habitat Type: P2
 Microhabitat Type: SW and SS
 Collection Date: 7-14-98

ARCH 03-98

Comments: Large side canyon with long narrow seep areas between rock strata. No much discharge.

- O. Diptera
 - F. Athericidae
 - F. Tipulidae
 - F. Ceratopogonidae
- O. Coleoptera
 - F. Elmidae
- O. Basommatomorpha
 - Unknown snails

Site Number: CNAY 0198
Site Name: At Island in the Sky, Canyonlands
Sample Number: 10
Habitat Type: P2
Microhabitat Type: SW
Collection Date: 7-15-98

CANY-01-98

Comments: Large side canyon with long narrow seep areas between rock strata. Overall, not very much water.

- O. Diptera
 - F. Chironimidae
 - F. Tipulidae
 - F. Ceratopogonidae
- O. Coleoptera
 - F. Elmidae
- O. Basommatomorpha
 - Unknown snails

Site Number: CNAY 0298
Site Name:
Sample Number: 11
Habitat Type: S
Microhabitat Type: M
Collection Date: 7-15-98
Comments: Seep wall with tiny madiculous area and pool

CANY 02-98

- O. Diptera
 - F. Tipulidae
 - F. Chironimidae
 - F. Unknown
- O. Coleoptera
 - F. Elmidae
- O. Odonata
 - S.O. Zygoptera

F. Coenagrionidae
Argia sp.
O. Acarina

Site Number: CNAY 0298
Site Name:
Sample Number: 12
Habitat Type: P2
Microhabitat Type: SW
Collection Date: 7-15-98
Comments: Seep wall with tiny madiculous area and pool.

O. Diptera
F. Chironimidae
F. Ceratopogonidae
O. Odonata
S.O. Zygoptera
F. Lestidae
Archilestes sp.
F. Libellulidae
O. Hemiptera
F. Gerridae
F. Saldidae
F. Notonecturidae
O. Coleoptera
F. Gyrinidae
O. Trichoptera

Site Number: ?
Site Name: Cave Springs
Site Number: 13
Habitat Type: S
Microhabitat Type: LS
Collection Date: 7-15-98
Comments: Seep walls with associated small pools.

Cave Springs

O. Diptera
F. Stratiomyiidae
F. Ceratopogonidae
O. Coleoptera
F. Dytiscidae

Glen Canyon and Cataract Canyon Collections 8-4-98 to 8-6-98.

Site Number: 98-01

Site Name: Knowles Canyon

Sample Number: 1

Habitat Type: S

Microhabitat Type: LS

Collection Date: 8-4-98

Comments: Seep wall scrape with low diversity and abundance of insects.

O. Diptera

F. Chironimidae

F. Stratiomyidae

F. Unknown

Site Number: 98-01

Site Name: Knowles Canyon

Sample Number: 2

Habitat Type: P2

Microhabitat Type: SW

Collection Date: 8-4-98

Comments: Tiny pool below drip line.

O. Basommatomorpha

Unknown snail

Site Number: 98-02

Site Name: Gypsum Canyon

Sample Number: 3

Habitat Type: ST

Microhabitat Type: SW

Collection Date: 8-5-98

Comments: Samples taken from small stream, no good spring/seep habitat available

O. Diptera

F. Culicidae

F. Chironimidae

F. Stratiomyidae

O. Ephemeroptera

F. Baetidae

O. Coleoptera

F. Dytiscidae

C. Ostracoda

Site Number: 98-02

Site Name: Gypsum Canyon

Sample Number: 4
Habitat Type: P2
Microhabitat Type: SW
Collection Date: 8-5-98
Comments: Incidental pool sample

O. Ephemeroptera
 F. Baetidae
O. Hemiptera
 F. Gerridae

Site Number: 98-03
Site Name: Easter Pasture Canyon
Sample Number: 5
Habitat Type: P2
Microhabitat Type: SW
Collection Date: 8-5-98

GLCA 03-98

Comments: Two springs present with good flow, support willow and cottonwood. Many tadpoles present in pools.

O. Diptera
 F. Chironimidae
 F. Tiplidae
O. Coleoptera
 F. Dytiscidae
O. Ephemeroptera
 F. Baetidae
O. Trichoptera
 F. Limnephilidae
O. Odonata
 S.O. Zygoptera
 F. Coenagrionidae
 Argia sp.
 F. Lestidae
 Archelestes sp.

Site Number: 98-03
Site Name: Easter Pasture Canyon
Sample Number: 6
Habitat Type: P2
Microhabitat Type: SW
Collection Date: 8-5-98
Comments: Incidental pool sample

O. Ephemeroptera

- F. Baetidae
- O. Hemiptera
 - F. Gerridae
 - F. Saldidae
- O. Diptera
 - F. Chironimidae
 - F. Tipulidae
 - F. Unknown adult
- O. Odonata
 - S.O. Zygoptera
 - F. Coenagrionidae
 - Argia* sp.
- O. Coleoptera
 - F. Dytiscidae

Site Number: 98-04
 Site Name: Swett Canyon
 Sample Number: 7
 Habitat Type: P2
 Microhabitat Type: SW
 Collection Date: 8-5-98
 Comments:

GLCA 04-98

- O. Diptera
 - F. Chironimidae
 - F. Stratiomyidae
- O. Trichoptera
 - F. Limnephilidae
- O. Odonata
 - S.O. Zygoptera
 - F. Coenagrionidae
 - Argia* sp.
- O. Coleoptera
 - F. Dytiscidae
 - F. 2unknowns
- O. Ephemeroptera
 - F. Baetidae
- O. Hemiptera
 - F. Saldidae

Site Number: 98-05

Site Name: No Name

Sample Number: 8

Habitat Type: P2

Microhabitat Type: SW

Collection Date: 8-6-98

Comments: Small pools with little visible seepage. Thick over story with heavy shade. Water striders abundant.

O. Arachnida

Terrestrial spiders

O. Diptera

F. Culicidae

F. Chironimidae

O. Hemiptera

F. Gerridae

F. Saldidae

O. Odonata

S.O. Zygoptera

F. Lestidae

A8. Geology and hydrology of the springs and seeps in the Grand Canyon, Arizona. Observations from research trip, May 1998, by E. Wilson. Dept. of Geology, Northern Arizona University.

**Geology and Hydrogeology of the Springs and Seeps in the
Grand Canyon, Arizona.**

Observations from research trip, May, 1998.

July 10, 1998

**By Eric Wilson
Northern Arizona University
Flagstaff, Arizona**

Introduction

Hundreds of seeps and springs discharge into Grand Canyon, Arizona. Discharge ranges next to nothing to nearly 220 cubic feet per second at Blue Springs. Where these seeps and springs discharge exist unique environments in the desert where both flora and fauna flourish. For this reason it is important to understand the hydrologic and geologic systems which feed the springs.

Background

Geology

The geology of the Grand Canyon has been studied more than almost any geologic setting in the world. Thorough descriptions of the geology of the Grand Canyon has been published in a book by Beus and Morales (1990).

Hydrogeology

The most recent and controversial work done on Grand Canyon Hydrogeology is the Montgomery and Associates (1996) numerical model of ground-water flow in the Redwall-Muav Aquifer on the South Rim of the Grand Canyon. Montgomery and Associates indicate that most of the decrease in discharge due to aquifer pumping will only occur at the largest springs (i.e. Havasu Spring, Indian Garden, and Hermit Spring). The argument that even a minute change in discharge at the smaller springs would be detrimental was not approached.

Other pertinent research in the region includes studies by Goings (1985) researching spring flow into the Grand Canyon; Fitzgerald (1996) investigating the residence time of groundwater issuing from the south rim aquifer in the eastern Grand Canyon; Zukosky (1996) assessing of the potential to use water chemistry parameters to define ground-water flow pathways in Grand Canyon National Park. Peter Huntoon (1968, 1970, 1974) has published numerous papers on the characteristics of ground-water flow on the north rim of the Grand Canyon. The north rim exhibits many of the same hydrogeologic features as the south rim.

Metzger (1961) discussed the relationship between geology and the ground-water resources along the South Rim of the Grand Canyon. Johnson and Sanderson (1968)

published a complete report on the spring flow into the Colorado River from Lee's Ferry to Lake Mead, Arizona. Cooley (1976) published a report on the spring flow from pre-Pennsylvanian rocks in the southwestern part of the Navajo Indian Reservation, Arizona. In depth descriptions of the geologic features in the Grand Canyon are given in a publication edited by Beus and Morales (1990). The Grand Canyon National Park Water Resources Management Plan (1984) provides a summary of hydrogeologic data within the canyon. McGavock and others (1986) reported on surface and ground water resources of southern Coconino County, Arizona. Brown and Moran (1979) provided an inventory surface water resources in Grand Canyon National Park.

Geologic Setting

The stratigraphy, structure, and hydrogeology all play an important role in dictating where and in what manner water will move. By characterizing each of these different aspects of the geology, we can identify how water in this system will behave.

Stratigraphy

The stratigraphy of the Grand Canyon has been studied in great detail and thoroughly reported in the literature. Table 1 lists the stratigraphy in the area of study and includes a brief description of the hydrologic characteristics of the strata.

The Precambrian rocks which crop out along the bottom of the Grand Canyon can be divided into two groups. The first group includes the Vishnu Schist, the Trinity and Elves Chasm Gneisses, and the Zoroaster plutonic complex. The Grand Canyon Series comprises the second group of Precambrian rocks and can be further divided into the Unkar and Chuar Groups. These are predominantly sedimentary rocks that exhibit little evidence of metamorphism.

The Paleozoic formations, listed in ascending order, are as follows: the Tapeats Sandstone, Bright Angel Shale, Muav Limestone, Temple Butte Limestone, Redwall Limestone, the Supai Group, Hermit Shale, Coconino Sandstone, Toroweap Formation, and the Kaibab Limestone.

The Cambrian rocks present low in the canyon are the Tapeats Sandstone, Bright Angel Shale, and the Muav Limestone. Tapeats Sandstone consists of clastic material eroded from the Precambrian basement (Middleton and Elliot, 1990). Normal grading is

present in the formation, with beds that are typically less than 1 meter (3.3 feet) thick (Middleton and Elliot, 1990). The Bright Angel Shale consists of interbedded sandstone, siltstone, and shale which thicken to the west. Nearly all the water percolating downward through the overlying beds is stopped by this layer. Even where faulted, the

Table 1. Grand Canyon Stratigraphy and Hydrologic Characteristic (Goings, 1985)

Age	Unit	Rock Type	Thickness	Hydrologic Characteristics
Permian	Kaibab	limestone	300'	permeable(solution, fractures)
"	unconformity			
"	Toroweap	limestone	280'	permeable(solution, fractures)
"	Coconino	sandstone	600'	permeable (primary, fractures)
"	Hermit	shale	300'	aquitard (locally permeable)
Permian-Pennsylvanian	Supai	sandstone-shale	950'	aquitard(locally permeable)
"	unconformity			
Mississippian	Redwall	limestone	500'	permeable(solution, fractures)
"	unconformity			
Devonian	Temple Butte	limestone	0-100'	unknown
"	unconformity			
Cambrian	Muav	limestone	400'	permeable(solution, fractures)
"	Bright Angel	shale	325'	aquiclude
"	Tapeats	sandstone	300'	permeable (bedding, fractures)
Precambrian	Chuar	varied	6610'	unknown
"	unconformity			
"	Nankoweap	sandstone	330'	unknown
"	unconformity			
"	Unkar	varied	5321'	unknown
"	unconformity			
"	Zoroaster	granite to quartz diorite	-	highly impermeable
"	Trinity/Elves	gneiss	-	highly impermeable
"	Chasm			
"	Vishnu	metasedimentary/ metaigneous	-	highly impermeable

shales are pulverized to an impermeable gouge that effectively seals the fault zones (Huntoon, 1970). Carbonate beds in the Muav Limestone are complexly interbedded with shale layers in the Bright Angle Shale. The formation consists of mottled dolomitic and calcareous mudstone and packstone (Middleton and Elliott, 1990). Solution of the

carbonates has allowed the formation of channels through the rock, promoting rapid water flow (Metzger, 1961).

The Devonian Temple Butte Limestone lies unconformably over the Cambrian Muav Limestone. The Temple Butte occurs primarily as local and discontinuous channel fill deposits. The Temple Butte Formation consists of dolomite with a minor percentage of sandstone and limestone beds and is bound by unconformities (Beus, 1990).

The Mississippian Redwall Limestone is one of the most dominant, cliff forming formations in the Grand Canyon. The Redwall is comprised of limestones and dolostones and reaches thicknesses of 600 feet. McKee and Gutschick (1969) divided the Redwall into four members on the basis of distinct lithologies and minor unconformities. From bottom to top, these members are the Whitmore Wash, Thunder Springs, Mooney Falls, and Horseshoe Mesa members.

Directly above the great Redwall cliff is the Pennsylvanian and Permian Supai Formation which can reach thicknesses of nearly 1000 feet. The Supai is composed of alternating layers of reddish brown sandstone, mudstone, and shale.

The Permian rocks in the Grand Canyon consist of the Hermit Shale, Coconino Sandstone, Toroweap Limestone, and the Kaibab Limestone. The Hermit Shale, overlying the Supai Group, is called a shale, but this terminology is misleading because the formation is composed mainly of silty sandstone and sandy mudstone (Blakey, 1990). The Coconino Sandstone is 400-500 feet thick in the Grand Canyon and forms beautiful white cliffs overlying the brick red slopes of the Hermit Shale. The unit is composed of huge crossbeds of pale orange to white, well sorted, very fine grained quartz sandstone cemented by silica. The Toroweap Formation is up to 300 feet and comprises carbonates, sandstones, packstones, wackestones, and mudstones (Turner, 1990). The Kaibab Formation is the cap rock in the Grand Canyon and ranges in thickness from 300 to 450 feet thick. The Kaibab is a sandy dolomitic limestone to calcareous sandstone (McKee, 1974).

Structural Features

Most of the spring discharge in the Grand Canyon is directly controlled by the presence of faults. Fracture systems associated with major structural features function as

conduits for recharge, transmission, and discharge of ground water. On the South rim, large faults can be seen for example where both Havasu Springs and Indian Garden Springs discharge. On the North Rim, we see even better examples of the conduits formed in these fractures at springs such as Thunder River, Roaring Springs, and Vasey's Paradise. Even where there are small springs or seeps, we often will see some sort of fracture through which the spring discharges

Hydrogeology

Ground water moves from areas of recharge to areas of discharge. In the Grand Canyon, aquifers are located in the strata above a confining layer sparse in fractures. These conditions occur in the Toroweap Formation, the Coconino Sandstone, and the Supai Formation. Ground water is perched in the coarser-grained sediments (i.e. Coconino Sandstone) or fractured strata (i.e. Redwall Limestone) that overlie fine-grained confining strata.

None of the Precambrian basement rocks are considered ground-water sources. The Vishnu Schist and the Zoroaster Granite are highly impermeable and Metzger (1961) stated that no springs are known to flow from either the Unkar or Chuar Groups.

The Tapeats Sandstone is hydrologically unimportant because it has a very small permeability due to a high degree of quartz cementation. Directly above the Tapeats, the Bright Angel Shale is hydrologically a very important formation in the Grand Canyon due to its nature as an aquiclude.

The Muav and Redwall limestones together make up the most significant aquifer in the Grand Canyon. The combination of the excellent permeability and the confining effect of the underlying Bright Angel Shale account for the number of springs that issue from the Muav Limestone. Most of the springs on the south side of the river flow from this layer. Intermittently sandwiched between the Muav and the Redwall is the Temple Butte Limestone. No springs flow from the Temple Butte Limestone and it is not considered of importance in the flow of ground water in the Grand Canyon (Metzger, 1961). The Redwall is an aquiclude where not fractured. However, faults and joints which cut through the entire unit have extremely large permeabilities and act as vertical and lateral conduits for ground water movement and recharge.

The Supai Formation is an aquitard that inhibits downward circulation of ground water except in fault zones. Good evidence exists which shows that the bulk of the ground-water circulation occurs along vertical joints and bedding partings. Like the underlying Supai, the Hermit Shale acts as a regional aquitard where it is unfaulted (Huntoon, 1970).

Ground water circulation in the Coconino Sandstone is not restricted to joints as in the underlying units (Huntoon, 1970). This helps the Coconino act as a perched aquifer when the underlying Hermit Shale is unfaulted. Being a lithologically intricate formation, the Toroweap is also hydrologically intricate. Coarser grained layers may act as a perched aquifer on top of some of the finer-grained layers of strata. Small springs and seeps are commonly found in the Toroweap Formation. The Kaibab is the principle recharge medium for the Coconino Plateau. Permeability is controlled by secondary factors including solution widening of faults and joints. Evidence for solution is abundant in the Kaibab and includes innumerable sinkholes and small solution channels (Huntoon, 1970).

Table 2. Springs Visited May 1998

Spring	Source Rock
Vasey's Paradise	Redwall-Muav Aquifer
Buckfarm	Redwall-Muav Aquifer
Bert's Canyon Spring	Redwall-Muav Aquifer
Saddle Canyon Spring	Redwall-Muav Aquifer
Keyhole Spring	Redwall-Muav Aquifer
Nankoweap #1	Redwall-Muav Aquifer
Nankoweap #2	Precambrian Rocks
Nankoweap # 3 "Twin Springs"	Precambrian Rocks
Below Hance (river right)	Precambrian Rocks (Shinumo Quartzite)
Elves Chasm	Redwall-Muav Aquifer
125½ mile spring (river left)	Redwall-Muav Aquifer
Deer Creek (lower Seep/spring)	Redwall-Muav Aquifer**
142 mile seep (river right)	Redwall-Muav Aquifer
Lower Kanab Creek Springs	Redwall-Muav Aquifer

147.8 mile seep (river right)	Redwall-Muav Aquifer
Ledges seep	Redwall-Muav Aquifer
Slimy Tick (155 right)	Redwall-Muav Aquifer
Fern Glen	Redwall-Muav Aquifer
Mohawk Spring	Redwall-Muav Aquifer
Cove Canyon	Redwall-Muav Aquifer
Honga Spring	Redwall-Muav Aquifer
Pumpkin Springs	Tapeats Sandstone

**** Seep/spring discharges between Tapeats and colluvium of the Deer Creek Slump. But the source rock of this water is most likely the Redwall-Muav Aquifer.**

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