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Caddisfly (Trichoptera) assemblages along major river drainages in Arizona

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CADDISFLY (TRICHOPTERA) ASSEMBLAGES ALONG MAJOR RIVER DRAINAGES IN ARIZONA

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ABSTRACT.—Seventy-two caddisfly species in 36 genera and 15 families were collected along the Little Colorado, Verde, Gila, and Colorado rivers in Arizona. Brachycentrids, hydropsychids, limnephilids, and uenoids made up nearly 50% of the assemblage in forested sites above 2200 m. Hydropsychids, hydroptilids, and leptocerids made up 75% of the assemblage in grassland watersheds between 2200 and 1000 m, and 80% at sites below 1000 m in desert watersheds. Species richness averaged 16 at sites above 2200 m elevation, 7 between 2200 and 1000 m, and 3 below 1000 m. H′ diversity was typically >3 at sites above 2200 m and <2.5 below 2200 m. Each river had distinct faunas likely due to isolation of drainages across semiarid landscapes. Low Sørensen similarity values were measured for caddisfly assemblages in the highly regulated Colorado River and the other 3 rivers. Only 17 species were collected at 14 sites along 700 km of the Colorado River. Indicator caddisfly species are provided for altered and less disturbed drainages. We added 7 species not previously reported in Arizona for a total of 154 caddisfly species in the state. We provide a baseline of caddisfly indicators for monitoring changes in ecosystem health during the predicted long-term drought and population expansion in southwestern USA.

Key words: Trichoptera, Colorado River, Gila River, Little Colorado River, Verde River, elevation, semiarid landscapes, species richness, indicator species.

Arizona has a number of streams that flow from subalpine coniferous forests to arid deserts. These streams flow through 4 major river drainages including the Little Colorado (LCR), Verde, Gila, and Colorado rivers. Watersheds as well as physicochemical conditions and biota change dramatically in stream channels along elevation gradients (Blinn and Poff 2005). Yet few invertebrates have been cataloged along these drainages.

Previous reports on caddisfly distribution in Arizona have been largely restricted to localized areas, including Oak Creek in north central Arizona (May 1972, Parrott 1975, Scott 1982, Dehoney and Gaud 1983, Moulton et al. 1994, Blinn and Ruiter 2009) and the White Mountains in eastern Arizona (Houghton 2001). Spindler (1996) correlated caddisfly genera in the Little Colorado, Verde, and Gila rivers with ecoregions. Finally, Blinn and Ruiter (2006) compared 104 caddisfly species to channel conditions at 93 sites in 49 streams throughout Arizona, but species composition was not reported at each site.

Blinn and Ruiter (2006) reported low channel embeddedness (≤5%) at sites on the LCR above 2200 m and high channel embeddedness (≥70%) for rivers below 2200 m due to heavy agriculture and grazing on the watersheds (Table 1). Watersheds above 2200 m were typically forested, while those below 2200 m were mostly semiarid grassland and desert. Riparian vegetation changed from willow-alder in the upper sites to cottonwood-sycamore at moderate elevations to mesquite and the invasive saltcedar at lower elevations (Blinn and Poff 2005).

In this study, we collected caddisfly species at sites along the Little Colorado, Verde, Gila, and Colorado rivers in Arizona and compared species assemblages with elevation, watershed, and stream-channel conditions. The information in this report provides a baseline for monitoring changes in ecosystem health during the predicted long-term drought and population expansion in southwestern USA (Seager et al. 2007).

STUDY SITES

Thirty-three sites were grouped into 3 elevation ranges based on watershed. Watersheds >2220 m were primarily forested; those

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TABLE 1. Stream site locations, percent channel embeddedness (% EMBED), percent canopy cover, and elevation (m) along the Little Colorado, Verde, Gila, and Colorado rivers, Arizona. Information was taken from Blinn and Ruiter (2006) except for Access Rd LCR, Winslow LCR, Cameron LCR, Gila River Grapevine, and several Colorado River sites (K1, K84, K140, K198, BP, and PD).

No.	Site	Location	% EMBED	% Canopy	Elevation (m)
Little Colorado River					
1	Upper East Fork (EF)	109°29′W, 33°56′N	10	10	2797
2	Sheeps Crossing West Fork (SC)	109°27′W, 33°58′N	5	90	2757
3	Greer East Fork (GE)	109°27′W, 33°60′N	5	90	2600
4	Greer West Fork (GW)	109°28′W, 33°60′N	5	90	2541
5	Greer (GR)	109°27′W, 34°00′N	10	75	2539
6	South Fork (SF)	109°25′W, 34°05′N	30	70	2290
7	Eagar LCR (EA)	109°19′W, 34°07′N	85	10	2114
8	Springerville LCR (SP)	109°18′W, 34°09′N	95	10	2042
9	Access Rd LCR (TE)	109°21′W, 34°17′N	90	10	1850
10	Holbrook (HO)	110°40′W, 34°85′N	100	0	1524
11	Winslow LCR (WI)	110°42′W, 35°15′N	100	0	1500
12	Cameron LCR (CA)	111°34′W, 35°55′N	100	0	1212
13	Grand Canyon confluence (GC)	111°47′W, 36°14′N	90	20	830
Verde River					
14	Upper Verde River Paulden (UP)	112°26′W, 39°52′N	35	75	1275
15	Tuzigoot Bridge Verde River (TB)	111°51′W, 34°33′N	85	10	1010
16	Camp Verde (CV)	111°51′W, 34°33′N	90	20	959
Gila River					
17	Gila River Grapevine, NM (GV)	108°12′W, 33°11′N	45	60	1707
18	Gila River Duncan (DU)	109°06′W, 32°44′N	85	20	1118
19	Gila River Yuma (YU)	109°25′W, 32°46′N	95	5	45
Colorado River					
20	River kilometer 0 (K1)	111°36′W, 36°52′N	95	5	947
21	River kilometer 15 (K15)	111°39′W, 36°46′N	95	5	930
22	River kilometer 50 (K50)	111°46′W, 36°41′N	95	5	871
23	River kilometer 62 (K62)	111°50′W, 36°29′N	95	5	850
24	River kilometer 84 (K84)	111°53′W, 36°17′N	95	5	835
25	River kilometer 140 (K140)	112°06′W, 36°06′N	95	5	734
26	River kilometer 198 (K198)	112°16′W, 36°07′N	95	5	629
27	River kilometer 290 (K290)	113°06′W, 36°12′N	95	5	535
28	River kilometer 309 (K309)	113°20′W, 36°04′N	95	5	475
29	River kilometer 346 (K346)	113°10′W, 35°53′N	95	5	412
30	River kilometer 402 (K402)	113°40′W, 35°51′N	95	5	400
31	Bullhead, AZ Park (BP)	114°35′W, 35°07′N	95	5	230
32	Lake Havasu Marina (LH)	114°21′W, 34°29′N	95	5	224
33	3.5 km below Parker Dam (PD)	114°11′W, 34°15′N	95	5	129

between 2200 and 1000 m were agricultural (i.e., ranching areas), and those <1000 m were desert (Fig. 1). Feeder systems of the LCR originate at about 3400 m in the White Mountains of eastern Arizona and join the Colorado River some 650 km downstream in the Colorado Plateau shrublands at an elevation of 830 m (Ricketts et al. 1999). The Gila River originates in the Black Range on the western slope of the Continental Divide in New Mexico at 3100 m, crosses into Arizona at 1325 m, and travels through the Chihuahuan and Sonoran deserts for nearly 1050 km to join the Colorado River at an elevation of about 40 m. Midsections of the LCR and Gila rivers are intermittent due to irrigation and regulation by dams, respectively (Blinn and Poff 2005). The Verde River originates in the Arizona mountain forests in western Arizona at an elevation of 1325 m and joins the Gila River near Phoenix, Arizona, at 340 m on the northern edge of the Sonoran Desert. Finally, the Colorado River in Arizona begins near the Utah–Arizona border at 947 m and has highly regulated flows from 5 mainstem dams as it meanders for over 900 km through the Mohave and Sonoran deserts before emptying into the Gulf of California at >50 m elevation (Blinn and Poff 2005). Collection sites along the LCR ranged from 830 m to 2797 m, while sites in the other 3 rivers were all <2200 m (Table 1).

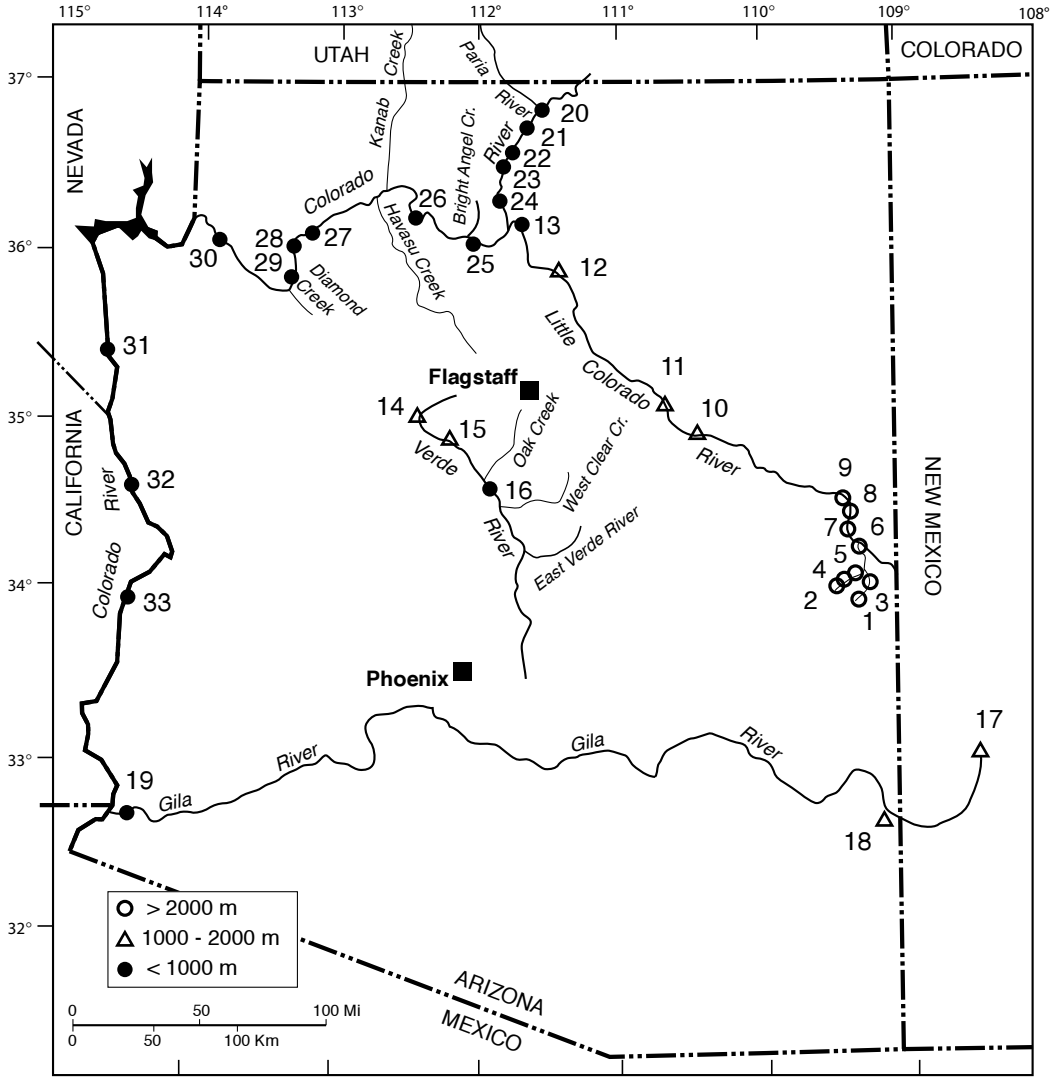

Fig. 1. Map of 33 collection sites for caddisflies at 3 elevation ranges along the Little Colorado, Verde, Gila, and Colorado rivers in Arizona during 2000–2004.

METHODS

Caddisfly larvae and pupae were hand-picked from submerged vegetation, rocks, and woody debris for approximately 30 minutes during each site visit. Adult caddisflies were collected with a vertical, 30-cm, 8-watt, portable, ultraviolet light over a 19-L white plastic bucket between early May and early September in the years 2000 to 2004. Light traps were placed near the stream site 1 hour after sunset and retrieved after 3–4 hours. All collections were placed in 70% ethanol and sorted in the laboratory. Species abundance was determined as the percentage of captured adults within an elevation range and ranked as rare (<2%), common (2%–20%), or abundant (>20%; Table 2). A diversity index (H′) was calculated for caddisfly assemblages at each site (Shannon and Weaver 1949). A Sørensen similarity index (SI; Sørensen 1948) was used to compare paired caddisfly assemblages among the 4 river systems. Specimens are in the collections of D.E. Ruiter.

RESULTS

Seventy-two caddisfly species in 36 genera and 15 families were represented in the 3010 specimens collected in the 4 river systems (Table 2). Fifty-five species were collected in the LCR, 17 in the Verde River, 15 in the Colorado River, and 13 in the Gila River.

Distinct assemblages were found at each elevation range. Caddisfly assemblages above 2200 m included 48 species in 31 genera and 15 families (Table 2). These sites were located only in the upper LCR (Fig. 1, Table 2). Brachycentrids, hydropsychids, limnephilids, and uenoids made up nearly 50% of the caddisfly assemblage. Limnephilids were most diverse but never abundant at any site. Dominant species included *Brachycentrus americanus, B. occidentalis, Ceratopsyche oslari, C. venada, Gumaga griseola, Hydroptila arctia, Ithytrichia mexicana, Lepidostoma unicolor, Oligophlebodes minutus, Polycentropus arizonensis,* and *P. gertschi.*

Twenty-eight species in 17 genera and 8 families were collected at sites between 2200 and 1000 m (Table 2). These sites were located on the lower Little Colorado and upper Gila and Verde rivers (Fig. 1, Table 2). Hydropsychids, hydroptilids, and leptocerids made up 75% of the caddisfly assemblage at this elevation range. Dominant species included *Cheumatopsyche enonis, Hydropsyche auricolor, Hydropsyche occidentalis, Hydroptila arctia, Smicridea dispar,* and *S. signata.*

Sites within desert watersheds below 1000 m included 25 species in 16 genera and 7 families. These sites were located on the lower Gila and Verde rivers and the Colorado River (Fig. 2, Table 2). Hydropsychids, hydroptilids, and leptocerids made up 80% of the caddisfly assemblage with *Hydroptila ajax, H. arctia, Ochrotrichia logana, Oxyethira arizona,* and *Smicridea fasciatella* being the dominant species.

Species richness averaged 16 ($s_{\bar{x}} = 1.5$, $n = 6$) at sites above 2200 m, 7 ($s_{\bar{x}} = 1.4$, $n = 10$) between 2200 and 1000 m, and 3 ($s_{\bar{x}} = 0.6$, $n = 17$) below 1000 m. H′ diversity also declined with decreasing elevation. Values were >3.0 at sites above 2200 m, from 2.5 to 0.2 between 2200 and 1000 m, and from 1.0 to 0.5 below 1000 m.

Caddisfly assemblages were different in each of the 4 river systems. Sørensen similarity index (SI) values ranged from 0.28 to 0.03 for paired-river comparisons. Less than 35% of the species in the Colorado, Gila, and Verde rivers were found in the LCR system, and <33% of the species were common in the Verde

TABLE 2. Location (LOCA), emergence period (EMER), and abundance (ABUN) of caddisfly species along elevational ranges in the Little Colorado, Verde, Gila, and Colorado rivers, Arizona, during 2000–2004. Species without emergence data were collected as larvae or pupae. R = rare (<2%); C = common (2–20%); A = abundant (>20%). GPS locations and acronyms are provided in Table 1. Grapevine (GV) collections were made by O.S. Flint. Sites along the Verde, Gila and Colorado rivers were typically visited once, while sites on the Little Colorado River were visited multiple times.

	Little Colorado River					
Species	LOCA	EMER	ABUN	Verde River	Gila River	Colorado River
>2200 m elevation					**No Data**	
APATANIIDAE						
Apatania arizona	SC, GW					
BRACHYCENTRIDAE						
Brachycentrus americanus	GE, SC, GW, GR	2 Jul–30 Aug	C			
B. occidentalis	EF, SC, GW, GR	25 Jul–30 Aug	C			
Micrasema sp.	GE, SF		R			
GLOSSOSOMATIDAE						
Agapetus boulderensis	GW, GR, SF	23 Jul	R			
Culoptila moselyi	GE, GR SF	5 May–22 Jun	R			
Glossosoma ventrale	GW		R			
HELICOPSYCHIDAE						
Helicopsyche borealis	GE, GR, SF	21 Jun–3 Jul	R			
H. mexicana	SF		R			

TABLE 2. CONTINUED.

Species	Little Colorado River			Verde River	Gila River	Colorado River
	LOCA	EMER	ABUN			
>2200 m elevation					**No Data**	
HYDROBIOSIDAE						
Atopsyche sperryi	GE, SC, GR , SF	4 Jul–14 Aug	R			
A. tripunctata	GW					
HYDROPSYCHIDAE						
Ceratopsyche cockerelli	SF	19 Jun	R			
C. oslari	GE, SC, GW, SF	5 May–21 Jul	A			
C. venada	GE, SC, GW, GR, SF	8 Jun–26 Jul	C			
Cheumatopsyche arizonensis	SF	19 Jun	A			
C. gelita	SF	19 Jun	A			
Hydropsyche sp.	EF, GE, GW, GR					
H. occidentalis	SF	8 Jun–21 Jul	A			
HYDROPTILIDAE						
Hydroptila arctia	GE, GW, GR, SF	5 May–4 Jul	C			
H. hamata	SC	2 Jul	R			
Ithytrichia mexicana	GE, SF	9 Jun–4 Jul	C			
Neotrichia sp.	GE	1 Jul	R			
Ochrotrichia dactylophora	SF	8–21 Jun	R			
O. lometa	GE, SF	19 Jun–4 Jul	R			
O. stylata	SF	19 Jun	R			
LEPIDOSTOMATIDAE						
Lepidostoma unicolor	EF, SC, GE	2 Jul–26 Aug	C			
LEPTOCERIDAE						
Ocetis disjuncta	EF, GE, GR, SF	8 Jun–4 Jul	R			
Ylodes reuteri	SF	19 Jun	R			
LIMNEPHILIDAE						
Amphicosmoecus canax	SC, GR	8 Oct	R			
Anabolia bimaculata	SC, GR	19 Jun–6 Oct	R			
Clistoronia maculata	EF, GW	19 Jun–1 Jul	R			
Crenophylax sperryi	SC	20 Jun–2 Jul	R			
Hesperophylax magnus	GE, SC, GR	5 May–14 Aug	R			
H. occidentalis	GE, SC, GR	5 May–14 Aug	R			
Limnephilus diversus	GR	26 Jul	R			
L. granti	GW	8 Jun	R			
L. lithus	GR	3 Jul	R			
Onocosmoecus unicolor	SC	30 Aug	R			
Psychoglypha schuhi	SC, GR	1 Jul	R			
P subborealis	SC	6 Oct	R			
PHILOPOTAMIDAE						
Chimarra sp.	GE		R			
C. utahensis	SF	21 Jul	R			
POLYCENTROPODIDAE				**No Data**		
Polycentropus arizonensis	GE, GR, SF	5 May–25 Jul	C			
P. gertschi	GE, GR, SF	4 Jul–1Sept	C			
RHYACOPHILIDAE						
Rhyacophila angelita	SC	30 Aug	R			
R. coloradensis	GW, SF	1–4 Sept	R			
SERICOSTOMATIDAE						
Gumaga griseola	EF, GE	1–4 Jul	C			
G. nigricula	EF		R			
UENOIDAE						
Oligophlebodes minutus	EF, GE, SC, GW, GR	5 May–20 Jun	C			
O. sigma	SC, GW		R			
2200–1000 m elevation						
APATANIIDAE						
A. arizona	HO	26 Jun	R			

Table 2. Continued.

Species	Little Colorado River			Verde River			Gila River			Colorado River
	LOCA	EMER	ABUN	LOCA	EMER	ABUN	LOCA	EMER	ABUN	
2200–1000 m elevation										**No Data**
GLOSSOSOMATIDAE										
Protoptila erotica				TB	30 Jun	C				
HELICOPSYCHIDAE										
H. borealis				UP	30 Jun	R				
HYDROPSYCHIDAE										
C. arizonensis	EA	22 Jun–1 Jul	C	TB	30 Jun	R				
Cheumatopsyche enonis	EA, SP	8 Jun–1 Jul	C				GV, DU	26 Jul, 19 Apr	C	
C. gelita	EA	22 Jun	R							
Cheumatopsyche pinula				TB	30 Jun	A	GV	26 Jul	R	
Hydropsyche sp.	WI, CA		R	UP						
H. auricolor				TB, UP	30 Jun, 24 Aug	A	GV, DU	19 Apr, 26 Jul	C	
H. occidentalis	EA, SP	8 Jun	A	TB	30 Jun	R	GV	26 Jul	R	
Smicridea dispar				TB	30 Jun	C	DU	19 Apr	C	
S. signata				TB	30 Jun	A	GV, DU	19 Apr, 26 Jul	C	
HYDROPTILIDAE										
Hydroptila ajax				TB, UP	30 Jun, 24 Aug	R				
H. arctia	EA, TE	8 Jun–1 Jul	C							
H. hamata	TE	21 Jun	R	TB	30 Jun	R				
Mayatrichia acuna	TE	21 Jun	R							
Neotrichia sp.	EA	1 Jul								
Ochrotrichia sp.				UP	24 Aug	R				
O. dactylophora	EA	8 Jun–1 Jul	R							
O. stylata	EA, TE	21 Jun	R							
O. *tarsalis*	TE	21 Jun	R	TB	30 Jun	R				
Oxyethira sp.	EA	1 Jul	R	UP						
O. dualis				UP	24 Aug	R				
O. pallida				UP	24 Aug	A				
Zumatrichia notosa							GV	26 Jul	R	
LEPTOCERIDAE										
Nectopsyche sp.	TE	21 Jun	R							
N. intervena							GV	26 Jul	R	
Oecetis avara	TE	21 Jun	R				GV, DU	26 Jul, 19 Apr	R	
O. disjuncta	TE	21 Jun	R				GV	26 Jul	R	
Y. reuteri	EA	1 Jul	R							
LIMNEPHILIDAE										
L. lithus	EA, SP	9 Jun–1 Jul	R							
SERICOSTOMATIDAE										
Gumaga griseola							GV	26 Jul	R	

Table 2. Continued.

	Little Colorado River			Verde River			Gila River			Colorado River		
Species	LOCA	EMER	ABUN	LOCA	EMER	ABUN	LOCA	EMER	ABUN	LOCA	EMER	ABUN
<1000 m elevation												
GLOSSOSOMATIDAE												
Culoptila cantha										PD	2 Aug	R
P. erotica				CV	17 Jul	R						
HELICOPSYCHIDAE												
H. borealis	GC	11 Sep	R	CV	17 Jul	R						
HYDROPSYCHIDAE												
Ceratopsyche oslari										K1, K15, K50, K140, K309	7 Apr–11 Jul	R
C. arizonensis				CV	17 Jul	R						
C. pinula				CV	17 Jul	R						
Hydropsyche sp.	GC											
Smicridea fasciatella							YU	9 May	R	K1, K15, PD	8 Aug	A
S. signata				CV	17 Jul	A						
HYDROPTILIDAE												
Hydroptila sp.										BP	5 Apr	R
H. ajax				CV	17 Jul	A						
H. arctia	GC	11 Sep	R							K84, K140, K290, K309, K346, K402	11 Jun–30 Jul	C
Hydroptila icona							YU	9 May	A			
M. ayama				CV	17 Jul	R						
Neotrichia sp.				CV	17 Jul	R				LH	12 Jul	R
N. olorina										PD	8 Aug	R
O. dactylophora										K290	16 Jun	R
Ochrotrichia logana										K84, K290, K309	16 Jun–23 Jul	C
O. lometa	GC	11 Sep	A									
O. stylata										K290	16 Jun	A
O. tarsalis				CV	17 Jul	R						
Oxyethira sp.										K84		
O. arizona										LH, PD	12 Jul–8 Aug	A
LEPTOCERIDAE												
Nectopsyche dorsalis										PD	8 Aug	R
Oecetis inconspicua							YU	9 May	R	PD	8 Aug	R
PHILOPOTAMIDAE												
Chimarra ridleyi										K290	15 May	R
C. utahensis										K140, K309	11 Jun–4 Jul	R
POLYCENTROPODIDAE												
Polycentropus halidus										K198, K346	8 May–30 Aug	R

and Gila rivers at comparable elevations. SI values were especially low (≤0.14) between the Colorado River and the other 3 rivers.

DISCUSSION

Caddisfly assemblages in channels changed dramatically along elevation gradients and land-use variations in the Colorado, Gila, Little Colorado, and Verde rivers in Arizona. Seventy-two species were collected along these changing watersheds, including over half of the species currently reported from the state. Nine additional species have been reported in these 4 drainages. These include *Hydroptila rono* and *Ochrotrichia ildria* in the south fork and *Lepidostoma ormeum* in the west fork of the LCR reported by Houghton (2001), *Limnephilus abbreviatus* and *Limnephilus spinatus* in the LCR drainage reported by Ruiter (1996), and *Hydroptila icona, Oecetis avara, Polycentropus arizonensis,* and *Smicridea arizonensis* in the Verde River reported by Moulton et al. (1994).

Caddisfly assemblages at elevations >2200 m were most diverse with 70% of the species collected at these sites. There was also a decrease in H′ diversity from >3 at sites >2200 m to 0.5 at elevations <1000 m. Wilhm (1970) suggested macroinvertebrate assemblages with $H' > 3$ were associated with unpolluted waters while those with $H' < 0.5$ were in polluted or disturbed waters.

Species of *Agapetus, Amphicosmoecus, Anabolia, Atopsyche, Clistorina, Crenophylax, Hesperophylax, Lepidostoma, Micrasema, Oligophlebodes, Onocosmoecus, Psychoglypha,* and *Rhyacophila* were not collected below 2200 m, and *Mayatrichia, Nectopsyche, Oxyethira, Protoptila, Smicridea,* and *Zumatrichia* were not collected above 2200 m. However, Blinn and Ruiter (2009) recently reported *Hesperophylax magnus, Lepidostoma aporna* and *Lepidostoma knulli* below 2200 m in upper Oak Creek, Arizona.

Changes from mesic to semiarid conditions along elevation gradients likely played a role in the dramatic decrease in species richness, but intense agriculture, ranching, and river regulation were mainly responsible for these declines (Blinn and Poff 2005). Blinn and Ruiter (2006) reported that channel embeddedness averaged 10% ($s_{\bar{x}} = 4.6$, $n = 22$) at >2200 m, 37.8% ($s_{\bar{x}} = 4.1$, $n = 49$) at elevations between 2200 and 1000 m, and 82.7% ($s_{\bar{x}} = 4.5$, $n = 22$) at elevations <1000 m. The limited sample frequency at lower-elevation sites, in part due to ephemeral conditions, likely reduced the overall number of species collected. Additional sampling is recommended for this region.

Channels below 1000 m were highly regulated, especially those in the Colorado and Gila rivers (Blinn and Poff 2005). Species richness at these sites was 5-times lower than it was at sites in unregulated channels >2200 m. Water diversions along the lower LCR at elevations between 2200 and 1000 m likely caused similar reductions in species richness. Only 1 caddisfly species was collected at each site with intermittent flows along the lower LCR. However, sites in the lowest 21 km of the LCR, near the Grand Canyon confluence, are fed by waters from Blue Springs (Blinn and Poff 2005). These waters have high specific conductance (>3 mS) but still provide habitat for *Helicopsyche borealis, Hydropsyche* sp., *H. arctia,* and *Ochrotrichia lometa.*

Table 3 provides a list of indicator caddisfly species in altered (highly disturbed) and less disturbed stream channels at high and low elevations in Arizona. The list is based on information from Blinn and Ruiter (2006) and from this study and includes a combined total of 104 stream sites throughout Arizona. High channel embeddedness was used as the criterion for disturbed sites; it is caused by altered landscapes and reduced canopy and oftentimes occurs concomitantly with high nutrients (Laws 2000). Species in less disturbed channels at high and mid-elevations were distinctly different with only *Atopsyche sperryi* and *H. magnus* common in the 2 upper-elevation ranges. No species were provided in the less disturbed category <1000 m due to excessive agriculture, channelization, invasion of exotic riparian vegetation, water diversion, and regulation (Blinn and Poff 2005).

Hydroptila arctia was the only species common in highly disturbed sites at all 3 elevation ranges (Table 3), while *Cheumatopsyche arizonensis* and *Cheumatopsyche pinula* were in the 2 upper ranges. This observation suggests that these species have a wide tolerance for environmental disturbance. The caddisfly assemblage in the highly disturbed channels at sites <1000 m is mainly associated with the highly regulated Colorado River since only 2 other sites (Camp

TABLE 3. Caddisfly assemblages in Arizona rivers in less disturbed and highly disturbed channels at high (>2200 m), mid (1000–2200 m), and low (<1000 m) elevations. Channel embeddedness is <10% in less disturbed river channels and >30% in highly disturbed channels.

Disturbance level and elevation Species
Less disturbed >2200 m
Agapetus boulderensis
Amphicosmoecus canax
Anabolia bimaculata
Atopsyche sperryi
Brachycentrus americanus
B. occidentalis
Clistorina maculata
Crenophylax sperryi
Gumaga griseola
Hesperophylax magnus
H. occidentalis
Oligophledodes minutus
Polycentropus arizonica
Less disturbed 1000–2200 m
Atopsyche sperryi
Gumaga griseola
Hesperophylax magnus
Hydropsyche occidentalis
Lepidostoma knulli
Polycentropus arizonica
Tinodes provo
Highly disturbed >2200 m
Cheumatopsyche arizonensis
C. pinula
Helicopsyche borealis
Hydropsyche occidentalis
Hydroptila arctia
H. hamata
Limnephilus lithus
Ochrotrichia dactylophora
Psychoglypha subborealis
Highly disturbed 1000–2200 m
C. arizonensis
C. pinula
Chimarra utahensis
Hydroptilia ajax
H. arctia
Marilia flexuosa
Ochrotrichia stylata
Polycentropus halidus
Smicridea dispar
Highly disturbed <1000 m
H. arctia
Hydroptila icona
Ochrotrichia inconspicua
O. logana
Oxyethira arizona
Neotrichia olorina
Smicridea fasciatella

Verde River and the Gila River near Yuma) were sampled at elevations <1000 m. *Ceratopysche oslari* also occurred throughout the regulated Colorado River but at a low abundance.

A nonmetric multidimensional ordination of Arizona caddisflies by Blinn and Ruiter (2005) also showed species listed in the less disturbed category of Table 3 to be closely associated with dense riparian canopies, low water temperature, low specific conductance, and low channel embeddedness, while those in the highly disturbed category were closely associated with reduced canopies, high water temperature, high specific conductance, and high channel embeddedness. Generally, Barbour et al. (1999) reported similar regional tolerances for species listed in each category.

The indicator assemblages in Table 3 may be applicable in adjacent western semiarid regions. Ward et al. (2002) found similar species assemblages in major river basins in Colorado. Barbour et al. (1999) also reported similar tolerances to water quality for these species in other regions of the United States.

Recent collections in Arizona have yielded 7 additional species records for the state. These include *Neotrichia okopa* in the Salt River, *Phylloicus mexicanus* in the south fork of Cave Creek (Chiricahua Mountains), *Helicopsyche probolata* in the north fork of the White River, and *Hesperophylax consimilis* in Upper West Fork in the White Mountains—all part of the Gila River drainage. In addition, *Neotrichia olorina* was collected below Parker Dam in the Colorado River. Also, Ruiter (2007) described *Neotrichia blinni* and *N. sandyae* from the LCR and Gila River watersheds, respectively. These reports combined update the lists in Blinn and Ruiter (2005, 2006, 2009) to a total of 154 caddisfly species reported from Arizona.

We provide a baseline of indicator caddisfly species for monitoring changes in ecosystem health along major drainages in Arizona during the predicted long-term drought and population expansion in southwestern USA (Seager et al. 2007). Some areas were not sampled due to difficult access, including the "sky islands" in the southeastern part of the state. Aquatic habitats associated with these isolated sky islands are somewhat protected from anthropogenic activities and are clearly distinct from the surrounding desert and semidesert grasslands (Ricketts et al. 1999). Therefore, investigations on these habitats as well as on those in ephemeral streams may provide further insight into caddisfly assemblages in southwestern USA.

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