



**Systematic Inventory of Rare and Alien  
Aquatic Species in Selected O‘ahu,  
Maui, and Hawai‘i Island Streams**

**Hawaii  
Biological  
Survey**

**Final Report**

**August 2003**

**Systematic Inventory of Rare and Alien Aquatic Species  
in Selected O'ahu, Maui, and Hawai'i Island Streams**

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## **EXECUTIVE SUMMARY**

The Hawaii Biological Survey (HBS) of the Bishop Museum collected and identified aquatic insects and other stream invertebrates in selected Hawaiian streams as part of an inventory of rare native and new alien aquatic species. Three remote streams on each island (O'ahu, Maui, Hawai'i) were assessed during this study. The purpose of these surveys was to provide a systematic inventory in selected streams of rare native aquatic species and invasive alien species in remote and difficult to access portions of the Hawaiian archipelago. The results of this study also provided an indication of aquatic ecosystem health and native biodiversity in areas not normally accessible because of geographic constraints such as steep waterfalls and dense vegetation. These surveys provided a baseline inventory of aquatic insect species present in each stream assessed and also ensured museum specimens and related databases will be available for future researchers.

Stream reaches examined during this study had little to no impacts from urbanization or irrigation diversions, with the Maui and Hawai'i Island streams found to be particularly pristine. A representative cross-section of pristine stream reaches was examined on each island surveyed. The aquatic insect fauna found during these surveys contained a remarkably high percentage of native species in streams surveyed among O'ahu, Maui, and Hawai'i Islands. Only the lowest surveyed elevations of Punalu'u Stream, O'ahu at 100-200 ft elevation (50-56%) and Kawainui Stream, O'ahu (57%) contained lower proportions of native aquatic insect species than the other streams assessed during these surveys. Punalu'u Stream was the only stream where a longitudinal transect was conducted from a low to high elevation (100-900 ft), and the percent native species increased greatly as elevation increased. Hawai'i Island streams surveyed during this study yielded several range extensions and a rich assortment of aquatic insects that are either indicators of high water quality, or also can be considered uncommon. East Maui streams such as West Wailua Iki and Kopiliula were also found to contain aquatic insects that are now extremely rare and sensitive to disturbance.

The most significant finding of this study was the discovery of eight previously uncollected species of endemic Hawaiian aquatic insects; six new species were found on Maui and one each from O'ahu and Hawai'i Islands. All eight new species are Diptera (flies) that are the most diverse group of native aquatic insects in the Hawaiian archipelago. Aquatic Diptera are important in the diet of native Hawaiian stream fish; healthy and diverse populations will ensure an abundant year-round food supply for native fish such as *Lentipes concolor*. Additionally, at least five undescribed species of the aquatic moth *Hyposmocoma* were collected during these surveys.

Additionally, efforts at aquatic insect collections have been high between 1990-2003, and the collection of eight new species during this study greatly exceeds the rate found in the previous 13 years of intensive collections. This also illustrates how little basic information is known on the numbers and types of aquatic insects for Hawaiian inland waters, let alone their basic ecological, evolutionary, and life history parameters.

## **INTRODUCTION**

The Hawaii Biological Survey (HBS) of the Bishop Museum collected and identified aquatic insects and other stream invertebrates in selected Hawaiian streams as part of an inventory of rare native and new alien aquatic species. Three remote streams on each island (O'ahu, Maui, Hawai'i) were assessed during this study. Collections were conducted in coordination with fish sampling conducted by the Hawaii Division of Aquatic Resources (HDAR) and aquatic algae sampling by Dr. Alison Sherwood of the University of Hawaii. The purpose of these surveys was to provide a systematic inventory in selected streams of rare native aquatic species and invasive alien species in remote and difficult to access portions of the Hawaiian archipelago. The results of this study also provided an indication of aquatic ecosystem health and native biodiversity in areas not normally accessible because of geographic constraints such as steep waterfalls and dense vegetation. These surveys provided a baseline inventory of aquatic insect species present in each stream assessed and also ensured museum specimens and related databases will be available for future researchers.

## **STUDY AREA**

Stream reaches examined during this study had little to no impacts from urbanization or irrigation diversions, with the Maui and Hawai'i Island streams found to be particularly pristine. A representative cross-section of pristine stream reaches was examined on each island surveyed. Helicopters were required to access most of the sample sites because of inaccessibility, rough terrain, and barrier waterfalls found at each stream. Table 1 denotes stream sampled, dates of sampling, and GPS points (WGS 84) taken at each sampling station.

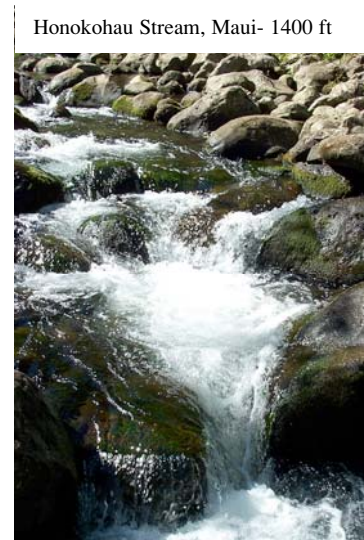


Table 1. Streams sampled, sampling sites, GPS waypoints, and dates sampled.

Stream	GPS (WGS 84)	Dates Sampled
Punalu'u, O'ahu 100 ft	N 21.57358° W 157.88835° (DAR 001)	4 Nov 2002
Punalu'u, O'ahu 140 ft	N 21.55932° W 157.89943° (DAR 025)	5 Nov 2002
Punalu'u, O'ahu 201 ft (USGS Gage)	N 21.47111° W 157.88029° (DAR 004)	6 Nov 2002
Punalu'u, O'ahu 370-400 ft	N 21.54825° W 157.89889° (DAR 39)	6 Nov 2002, 7 Nov 2002
Punalu'u, O'ahu 900 ft	N 21.53294° W 157.90806°	13 May 2003
Kawainui (Anahulu), O'ahu 800-1000ft	N 21.58029° W 158.00325° to N 21.57969° W 157.99731°	8 April 2003
Kaluanui, O'ahu 350 ft	at Sacred Falls (GPS did not work in gorge)	14 May 2003
Kopiliula, Maui 1780-2000 ft	N 20.80419° W 156.13857° to N 20.80588° W 156.13637°	21 January 2003
Piinaau, Maui 2400 ft	N 20.81445° W 156.14268°	22 January 2003
W. Wailua Iki, Maui 1620 ft	N 20.81445° W 156.14268°	22 January 2003
Honokohau, Maui 1200-1500 ft	N 20.94465° W 156.58236° to N 20.93622° W 156.58401°	23 January 2003
Umauma, Hawaii, 1560-2340 ft	N 19.88684° W 155.18263° N 19.76728° W 155.18716°	25 Mar 2003 26 Mar 2003
Honoli'i, Hawaii, 2100 ft	N 19.76629° W 155.17575°	26 Mar 2003
Wailuku, Hawaii 2200 ft	N 19.70558° W 155.19778° N 19.70428° W 155.20131° (seep-2280 ft)	27 Mar 2003

### O'ahu Streams

Punalu'u, Kaluanui, and upper Kawainui (Anahulu watershed) streams were examined during this study (Table 1). Punalu'u and Kaluanui Streams are located in windward O'ahu, while the Kawainui tributary drains into Oahu's north shore. Punalu'u Stream was examined from 100 ft to some of its highest accessible areas at 900 ft elevation. Kaluanui Stream was assessed in the vicinity of the Sacred Falls area. Because of the steep and high walled gorges in the area around Sacred Falls, we could not obtain GPS coordinates here. Kawainui Stream was assessed in the vicinity of the helicopter-landing zone from between 800–1000 ft elevation. O'ahu streams were accessed by helicopter except Kaluanui Stream which was reached by hiking to the now restricted Sacred Falls area.

### Maui Streams

Four streams were assessed on Maui, with three of the four streams located on East Maui including Kopiliula, Piinaau, and W. Wailua Iki, with Honokohau Stream located on West Maui. Piinaau Stream at 2450 ft was not fully surveyed as the helicopter schedule allowed for only 45 minutes of collection time, with the remainder of that day spent on nearby W. Wailua Iki Stream. Piinaau Stream was very low-flowing at the time sampling. Upper Honokohau Stream was located above a major 1000 ft waterfall at 3140 ft elevation, and was surveyed for a brief time period (one hour) before the helicopter transported us to the lower section (1200-1500 ft) of this stream, where the remainder of the day was spent collecting. A large perched waterfall and seep area in Honokohau Stream was sampled at 1500 ft elevation and this waterfall area contained a wide variety of splash-zones, cascades, and rheocrene seeps. All Maui streams surveyed during this study were accessed by helicopter.

### **Hawai'i Island Streams**

Three streams located on the eastern flanks of Mauna Kea were sampled at relatively high elevations ranging from 1500-2200 ft; Umauma, Honoli'i, and Wailuku Streams. Each stream was accessed by helicopter and sampled for an entire day. Honoli'i Stream was sampled just above the confluence with Pōhakupa'a tributary. All streams were very low flowing and clear, with Wailuku Stream so low that streamflow disappeared into the alluvium in places but permanent waterfalls, seeps, and pools were found at the 2200 ft elevation level. A small tributary was sampled immediately adjacent to the Wailuku Stream lower helicopter LZ (N 19.70428°, W 155.19712°). Streamflow was very clear in this heavily forested Wailuku tributary, and *koa* (*Acacia koa*), 'ōhi'a (*Metrosideros polymorpha*) and *hāpu'u* (*Cibotium* spp.) predominated. This area had signs of heavy pig disturbance, and numerous pig wallows and downed *hāpu'u* were observed. Sampling in Wailuku Stream proceeded upstream from the lower helicopter LZ, and an impassable waterfall at approximately 2280 ft elevation was the upper limit of our assessment. A large dripping seep wall area providing a diversity of aquatic habitats was located immediately below this impassable waterfall, and numerous samples were taken in this area. This seep at Wailuku Stream was the only large habitat of this type encountered during the Hawai'i Island surveys.

### **METHODS**

Aquatic insect sampling was conducted according to Englund et al. (2001) and Englund and Preston (1999). Collections of both immature and adult specimens were made with aerial sweep nets, aquatic dip nets, kick-netting, and Surber (benthic) samplers. Visual observations of aquatic insects were also conducted above and around the stream. Sampling of damselflies and dragonflies (Odonata) was emphasized, because six species are currently considered Candidate Species by the U.S. Fish & Wildlife Service.

Benthic sampling centered around kick netting and involved vigorously disturbing the substrate upstream of a fine meshed aquatic net to displace any aquatic invertebrates inhabiting the stream substrate. The use of frequent kick-netting allowed for a greater sample size and resulted in increased effort for invertebrate collections. Benthic sampling also included collecting individual rocks and using a toothbrush or forceps to remove invertebrates from variously sized stream rocks. Above and below water visual observations for aquatic invertebrates were also conducted as we traveled between sampling stations. Sampling effort was focused on all suitable aquatic habitats such as splash zones around riffles and cascades, wet rock faces associated with springs and seeps, waterfalls, nearby wetland areas associated with the streams, and variously-sized stream substrates. All aquatic habitats were sampled. All specimens were stored in 95% ethanol for curation and identification and voucher specimens are currently housed in the Bishop Museum collections.

The highest elevation sampled in a particular stream reach was recorded, and GPS points were taken at the beginning and ending of each area sampled.

## **RESULTS AND DISCUSSION**

The aquatic insect fauna found during these surveys contained a remarkably high percentage of native species in streams surveyed among O'ahu, Maui, and Hawai'i Islands. Only the lowest surveyed elevations of Punalu'u Stream, O'ahu at 100-200 ft elevation (50-56%) and Kawainui Stream, O'ahu (57%) contained lower proportions of native aquatic insect species than the other streams assessed during these surveys (Table 2). A general trend of increasing percentages of native species as elevation increased was found during these surveys (Figure 1). Punalu'u Stream was the only stream where a longitudinal transect was conducted from a low to high elevation (100-900 ft), and the percent native species increased greatly as elevation increased. This trend is common for Hawaiian streams, and has been well documented in Waipi'o Valley (Englund et al. 2001) and Pearl Harbor streams (Englund 2002).

Streams assessed during these surveys contained high percentages of native species, and even O'ahu streams such as Punalu'u at 900 ft elevation (83%) and Kaluanui (85%) contained healthy native aquatic insect populations. Kaluanui Stream is in remarkably good shape considering the reach sampled around Sacred Falls is at a low elevation of 350 ft. Even the lowest elevations (100 ft) surveyed in Punalu'u Stream contained a healthy 50% native species, with greater percentages of native species as elevations increased (Table 2). The average percent native aquatic insect composition for each island surveyed (Figure 2) was taken from the highest reaches of each stream surveyed on each island. For comparison purposes Punalu'u Stream at 900 ft was used for the O'ahu percent native average. Because sampling time was so limited at Honokohau Stream on West Maui (3100 ft elevation), this station was not included in calculating the average percent native insect species for Maui (Figure 2). Maui streams assessed during the current study had the highest percentage of native aquatic insect species with an overall average of 85% native species, although both O'ahu and Hawai'i Island streams were in excellent condition and had similarly high native biodiversity (75% and 77% respectively).





Surveys of Rare Native and New Alien Aquatic Species

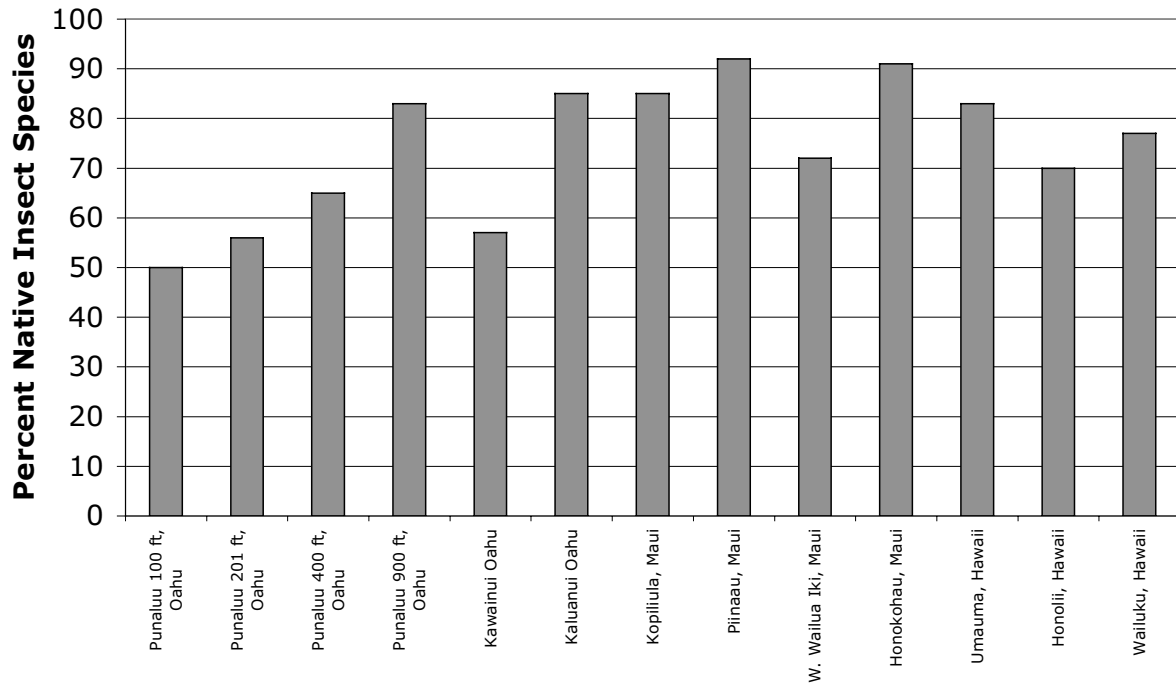


Figure 1. Percent native species in streams assessed during the Systematic Inventory of Rare and new Alien Aquatic Species Study.

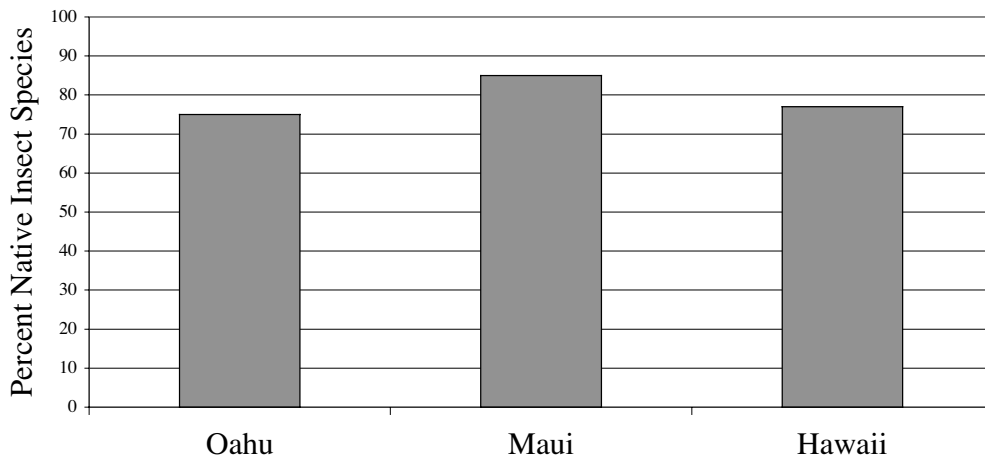


Figure 2. Overall average percent of native aquatic insect species found at the highest elevation of surveyed streams on each island during the Systematic Inventory of Rare and new Alien Aquatic Species Study (see text for explanation).

Surveys of Rare Native and New Alien Aquatic Species

Table 2. Results aquatic insects and other invertebrates collected for the Systematic Inventory of Rare and New Alien Aquatic Species Study.

Taxon	Punaluu, Oahu 100 ft	Punaluu, Oahu 201 ft	Punaluu, Oahu 400 ft	Punaluu, Oahu 900 ft	Kawainui (Anahulu), Oahu, 1000 ft	Kaluanui, Oahu 350 ft	Kopiliula, Maui, 1780-2000 ft	Piinaau, Maui, 2400 ft	W. Wailua Iki, Maui, 1620 ft	Honokohau, Maui, 1200-1500 ft	Honokohau, Maui, 3140 ft	Umauma, Hawaii, 1560-2340 ft	Honolii, Hawaii, 2100 ft	Wailuku, Hawaii 2200 ft	Status <sup>1</sup>
<b>Amphibians</b>															
<i>Rana rugosa</i>							X	X							Int
<i>Rana catesbeiana</i>					X								X	X	Int
<b>Mollusks</b>															
<i>Ferrissia sharpi</i>							X	X	X						Int
<i>Lymnaea</i> sp.									X						Cry
<b>Hirudinea (leeches)</b>															
<i>Gastrostomobdella ? quinqueannulata</i>		X													Int
<i>Barbronia weberi formosana</i>										X					Int
<b>Freshwater Sponge</b>															
<i>Heteromyenia ? baileyi</i>					X		X	X	X			X			End
<b>Acari (Freshwater mites)</b>															
<b>Hydracarina</b>															
<i>Arrhenurus</i> sp.												X	X		End
<b>Aquatic Insects</b>															
<b>Anisoptera (Dragonflies)</b>															
Aeschnidae															
<i>Anax junius</i>	X											X		X	Ind
<i>Anax strenuus</i>			X	X			X	X	X	X	X	X			End
Libellulidae															
<i>Crocothemis servilia</i>	X														
<i>Orthemis ferruginea</i>	X														Int
<i>Pantala flavescens</i>		X		X			X					X			Ind
<i>Tamea abdominalis</i>					X										Int
<b>Zygoptera (Damselflies)</b>															
Coenagrionidae															
<i>Enallagma civile</i>												X		X	Int
<i>Ischnura ramburii</i>	X	X													Int
<i>Ischnura posita</i>	X	X	X		X								X	X	Int
<i>Megalagrion blackburni</i>							X	X	X	X	X	X	X	X	End
<i>Megalagrion calliphya</i>							X			X	X	X	X	X	End
<i>Megalagrion hawaiiense</i>								X	X		X			X	End
<i>Megalagrion n. nigrohamatum</i>										X					End
<i>Megalagrion n. nigrolineatum</i>			X	X											End
<b>Heteroptera (True Bugs)</b>															
Veliidae															
<i>Microvelia vagans</i>	X	X	X		X				X	X			X	X	End

Surveys of Rare Native and New Alien Aquatic Species

Table 2 (cont.). Results aquatic insects and other invertebrates collected for the Systematic Inventory of Rare and new Alien Aquatic Species Study.

Taxon	Punaluu, Oahu 100 ft	Punaluu, Oahu 201 ft	Punaluu, Oahu 400 ft	Punaluu, Oahu 900 ft	Kawainui (Anahulu), Oahu, 1000 ft	Kaluanui, Oahu 350 ft	Kopiliula, Maui, 1780-2000 ft	Piinaau, Maui, 2400 ft	W. Wailua Iki, Maui, 1620 ft	Honokohau, Maui, 1200-1500 ft	Honokohau, Maui, 3140 ft	Umauma, Hawaii, 1560-2340 ft	Honolii, Hawaii, 2100 ft	Wailuku, Hawaii 2200 ft	Status <sup>1</sup>
Saldidae															
<i>Saldula exulans</i>	X	X	X	X	X		X		X	X			X		End
<i>Saldula oahuense</i>				X											End
<b>Coleoptera (Beetles)</b>															
<i>Rhantus pacificus</i>								X							End
<b>Diptera (Flies, gnats)</b>															
Canacidae															
<i>Procanace acuminata</i>	X						X		X	X		X	X		End
<i>Procanace bifurcata</i>		X		X	X	X									End
<i>Procanace confusa</i>							X		X	X		X			End
<i>Procanace constricta</i>							X	X	X	X		X			End
<i>Procanace wirthi</i>	X	X	X	X											End
<i>Procanace new sp. 1</i>												X	X	X	End
Ceratopogonidae															
<i>Dasyhelea digna</i>	X		X												End
<i>Dasyhelea hawaiiensis</i>					X	X			X	X		X		X	End
<i>Dasyhelea sp.</i>						X						X			End
Chironomidae															
<i>Chironomus sp.</i>										X				X	End
<i>Cricotopus bicinctus</i>	X	X					X		X	X		X	X	X	Int
<i>Micropsectra sp.</i>										X					End
<i>Orthocladus sp.</i>				X	X					X		X		X	End
<i>Telmatogeton torrenticola</i>							X	X	X	X	X	X			End
<i>Telmatogeton abnormis</i>							X		X						End
Chloropidae															
<i>Rhodesiella sp.</i>	X														Int
Dolichopodidae															
<i>Campsicnemus brevipes</i>		X		X											End
<i>Campsicnemus miritibialis</i>	X														End
<i>Campsicnemus patellifer</i>						X									End
<i>Campsicnemus longitibia (new island record)</i>								X							End
<i>Campsicnemus tibialis</i>													X		End
<i>Campsicnemus new sp. 1 (Oahu)</i>						X									End
<i>Campsicnemus new sp. 2 (Maui)</i>									X						End
<i>Campsicnemus new sp. 3 (Maui)</i>										X					End
<i>Condylostylus longicornis</i>												X			Int
<i>Chrysotus longipalpus</i>	X		X		X	X									Int
<i>Dolichopus exsul</i>	X		X				X		X				X		Int

Surveys of Rare Native and New Alien Aquatic Species

Table 2 (cont.). Results aquatic insects and other invertebrates collected for the Systematic Inventory of Rare and new Alien Aquatic Species Study.

Taxon	Punaluu, Oahu 100 ft	Punaluu, Oahu 201 ft	Punaluu, Oahu 400 ft	Punaluu, Oahu 900 ft	Kawainui (Anahulu), Oahu, 1000 ft	Kaluanui, Oahu 350 ft	Kopiliula, Maui, 1780-2000 ft	Piinaau, Maui, 2400 ft	W. Wailua Iki, Maui, 1620 ft	Honokohau, Maui, 1200-1500 ft	Honokohau, Maui, 3140 ft	Umauma, Hawaii, 1560-2340 ft	Honolii, Hawaii, 2100 ft	Wailuku, Hawaii 2200 ft	Status <sup>1</sup>
<i>Eurynogaster</i> <b>new</b> sp. 1										X					End
<i>Paraliancalus metallicus</i>										X					End
<i>Sigmatineurum englundii</i>												X		X	End
<i>Sigmatineurum</i> <b>new</b> sp. 1										X					End
Empididae															
<i>Hemerodromia stellaris</i>	X			X											Int
Ephydriidae															
<i>Scatella cilipes</i>	X	X	X	X	X	X	X	X	X	X		X	X	X	End
<i>Scatella clavipes</i>	X	X	X	X	X	X	X		X	X		X	X		End
<i>Scatella femoralis</i>							X	X	X	X					End
<i>Scatella fluvialis</i>													X	X	End
<i>Scatella hawaiiensis</i>	X					X									End
<i>Scatella mauiensis</i>							X	X	X						End
<i>Scatella oahuense</i>	X			X		X		X		X		X	X	X	End
<i>Scatella warreni</i>										X					End
<i>Scatella williamsi</i>												X	X	X	End
<i>Typopsilopa</i> sp.	X														<b>New Int</b>
Muscidae															
<i>Lispe</i> sp.															End
<i>Lispocephala</i> <b>new</b> sp. 1										X					End
<i>Lispocephala</i> <b>new</b> sp. 2							X			X					End
Sciomyzidae															
<i>Sepedon aenescens</i>									X						Pur
Tipulidae															
<i>Limonia advena</i>	X	X					X		X				X	X	Int
<i>Limonia grimshawi</i>							X	X							End
<i>Limonia jacobae</i>	X		X	X		X	X			X					End
<i>Limonia nigropolita</i>													X		End
<i>Limonia perkinsi</i>	X														End
<b>Trichoptera (Caddisflies)</b>															
Hydropsychidae															
<i>Cheumatopsyche analis</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Int
Hydroptilidae															
<i>Hydroptila icona</i>	X	X	X	X	X				X					X	New Int
<i>Hydroptila potosina</i>	X	X	X	X	X				X	X			X	X	Int

Surveys of Rare Native and New Alien Aquatic Species

Table 2 (cont.). Results aquatic insects and other invertebrates collected for the Systematic Inventory of Rare and new Alien Aquatic Species Study.

Taxon	Punaluu, Oahu 100 ft	Punaluu, Oahu 201 ft	Punaluu, Oahu 400 ft	Punaluu, Oahu 900 ft	Kawainui (Anahulu), Oahu, 1000 ft	Kaluanui, Oahu 350 ft	Kopiliula, Maui, 1780-2000 ft	Piinaau, Maui, 2400 ft	W. Wailua Iki, Maui, 1620 ft	Honokohau, Maui, 1200-1500 ft	Honokohau, Maui, 3140 ft	Umauma, Hawaii, 1560-2340 ft	Honoli'i, Hawaii, 2100 ft	Wailuku, Hawaii 2200 ft	Status <sup>1</sup>
<b>Lepidoptera (Aquatic Moths)</b>															
<i>Hyposmocoma</i> sp. 1: Oahu <sup>a</sup>	X	X	X	X	X	X									End
<i>Hyposmocoma</i> sp. 2: Oahu <sup>b</sup>			X												End
<i>Hyposmocoma</i> sp. 3: Maui <sup>a</sup>									X	X					End
<i>Hyposmocoma</i> sp. 4: Maui <sup>b</sup>									X	X					End
<i>Hyposmocoma</i> sp. 5: Hawaii <sup>b</sup>												X	X	X	End
Total Aquatic Species (excluding fish):	28	17	17	18	16	13	23	16	28	33	6	25	22	23	
Total Aquatic Insect Species	28	16	17	18	14	13	20	13	25	32	6	23	20	22	
Total Native Aquatic Insect Species	14	9	11	15	8	11	17	12	18	29	5	19	14	17	
(%) Native Aquatic Insect Species <sup>2</sup>	50	56	65	83	57	85	85	92	72	91	83	83	70	77	

<sup>1</sup>End = Endemic, Ind = Indigenous, Int = Introduced, Cry = Cryptogenic, Pur = Purposefully Introduced

<sup>2</sup>Unknown spp. not included in % native calculation

<sup>a</sup>Narrow pointy, cone-shaped case; <sup>b</sup>Mitten-shaped case,

### New and Rare Species of Aquatic Insects Found

The most significant finding of this study was the discovery of eight previously uncollected species of endemic Hawaiian aquatic insects; six new species were found on Maui and one each from O'ahu and Hawai'i Islands (Table 3). All eight new species are Diptera (flies) that are the most diverse group of native aquatic insects in the Hawaiian archipelago. Aquatic Diptera are important in the diet of native Hawaiian stream fish; healthy and diverse populations will ensure an abundant year-round food supply for native fish such as *Lentipes concolor*. For example, a preliminary diet study (Way and Burky 1991) found aquatic Diptera (mainly chironomids and dipteran pupae) comprised at least 85% of *L. concolor* diet in Honoli'i Stream, Hawai'i Island, and were found in 100% of their stomachs. At least five undescribed species of the aquatic moth *Hyposmocoma* were collected during these surveys. However, all of these species have been previously collected during earlier Bishop Museum surveys and are currently being described by Dan Rubinoff at the University of Hawai'i.

*Surveys of Rare Native and New Alien Aquatic Species*

Table 3. New species of endemic aquatic Diptera discovered during the Systematic Inventory of Rare and new Alien Aquatic Species Study.

Genus	Species	Stream
Canacidae	<i>Procanace</i> new sp. 1	Umauma; Honoli'i; Wailuku; Hawai'i Island
Dolichopodidae	<i>Campsicnemus</i> new sp. 1 (n. sp. nr. <i>lawakua</i> )	Kaluanui, O'ahu
	<i>Campsicnemus</i> new sp. 2 (same group as <i>nigricollis</i> and <i>tibialis</i> )	W. Wailua Iki, East Maui
	<i>Campsicnemus</i> new sp. 3 (n. sp. nr. <i>ridiculus/miritibialis</i> )	Honokohau, West Maui
	<i>Eurynogaster</i> new sp. 1	Honokohau, West Maui
	<i>Sigmatineurum</i> new sp. 1 (n. sp. nr. <i>binodatum</i> )	Honokohau, West Maui
Muscidae	<i>Lispocephala</i> new sp. 1	Honokohau, West Maui
	<i>Lispocephala</i> new sp. 2 (reddish female)	Kopiliula, East Maui; Honokohau, West Maui

The collection of eight new aquatic Diptera species during the current study is noteworthy as a literature review of the period 1990-2003 revealed an average of only 0.9 new aquatic insect species described per year from the Hawaiian Islands (Table 4). Additionally, efforts at aquatic insect collections have been high throughout the 1990-2003 period and the collection of eight new species during this study greatly exceeds the rate found in the previous 13 years. This also illustrates how little basic information is known on the numbers and types of aquatic insects for Hawaiian inland waters, let alone their basic ecological, evolutionary, and life history parameters.

Table 4. New species of native endemic Hawaiian aquatic insects described between 1990-2003.

Genus	Species	Location	Reference
Coenagrionidae	<i>Megalagrion mauka</i>	Kaua'i	Daigle (1997)
Nabidae	<i>Nabis gagneorum</i>	Maui/Moloka'i	Polhemus (1999)
Dolichopodidae	<i>Campsicnemus lawakua</i>	Kaua'i	Evenhuis (2003)
	<i>Campsicnemus makua</i>	Kaua'i	Evenhuis (2003)
	<i>Sigmatineurum englundii</i>	Hawai'i	Evenhuis (2000)
	<i>Sigmatineurum iao</i>	W. Maui	Evenhuis (1994)
	<i>Sigmatineurum meaohi</i>	Hawai'i	Evenhuis (1997)
	<i>Sigmatineurum mnemogagne</i>	E. Maui	Evenhuis (1994)
	<i>Sigmatineurum napali</i>	Kaua'i	Evenhuis (1994)
	<i>Sigmatineurum nigrum</i>	E. Maui	Evenhuis (1997)
	<i>Sigmatineurum omega</i>	Hawai'i	Evenhuis (1994)
	<i>Sigmatineurum parenti</i>	E. Maui	Evenhuis (1997)

Photos of new species collected during this study (Diptera photos by N.L. Evenhuis, *Hyposmocoma* photo by R.A. Englund)

New *Campsicnemus* nr. *ridiculus*.  
Honokohau Stream, Maui



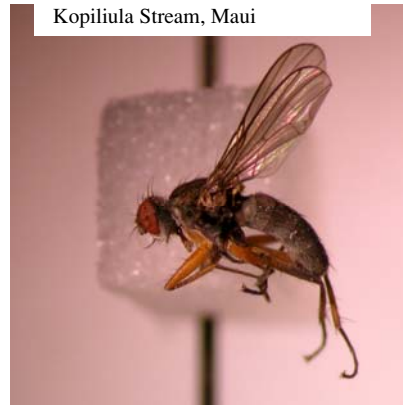
*Eurynogaster* new sp. - male  
Honokohau Stream, Maui



*Lispocephala* new sp. 1- male  
Honokohau Stream, Maui



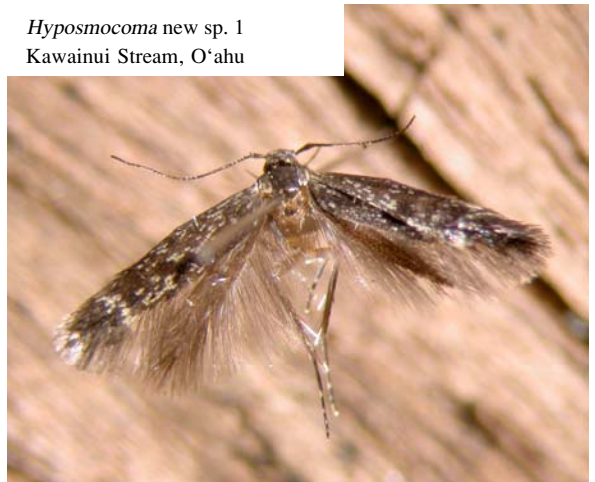
*Lispocephala* new sp. 2- female  
Kopiliula Stream, Maui



*Sigmatineurum* new sp. male  
Honokohau Stream, Maui



*Hyposmocoma* new sp. 1  
Kawainui Stream, O'ahu



The new O'ahu species was collected around the area near Sacred Falls at a low elevation of 350 ft. The discovery of a new *Campsicnemus* species (n. sp. nr. *lawakua*) in a low elevation O'ahu stream after a century of intensive collection is amazing, especially as Kaluanui Stream has been intensively sampled by some of the most noted Hawaiian entomologists such as F.X. Williams in the 1930's and D.A. Polhemus in 1990s (Polhemus 1995). This new species should be considered extremely rare as only one individual male *Campsicnemus* new sp. was collected at Kaluanui Stream. Further collections of this species at Kaluanui Stream will need to be conducted if permissions can be obtained to access this area again. Additionally, it was unusual to find the *Campsicnemus* new sp. at such a low elevation in Kaluanui Stream as most species in this endemic Hawaiian genus are found at elevations above 600 m (Evenhuis 2003). *Campsicnemus* are sensitive to any type of disturbance such as poor water quality, introduced species, or water diversions and this finding indicates Kaluanui Stream contains largely unimpacted and high quality aquatic habitats.

Hawai'i Island streams surveyed during this study yielded several range extensions and a rich assortment of aquatic insects that are either indicators of high water quality, or also can be considered uncommon. Prior to these surveys, *Campsicnemus longitibia* had only been recorded from Moloka'i but during these surveys was found in both Maui at Piinaau Stream and at Honoli'i Stream on Hawai'i Island. *Sigmatineurum englundii* was known previously only from the Waipi'o and Waimanu Valleys (Kohala) but was found in seep wall areas at Umauma and Wailuku Streams, thus extending its range to the southern slope areas of Mauna Kea. The large seep wall area sampled in Wailuku Stream was particularly productive for aquatic insects and three species of ephydrid flies were collected here, along with moderate numbers of *S. englundii*.

East Maui streams such as West Wailua Iki and Kopiliula were also found to contain aquatic insects that are now extremely rare and sensitive to disturbance. A key indicator species found in East Maui streams is the genus *Telmatogeton*, or the giant Hawaiian midges. *Telmatogeton abnormis* is one of the rarest aquatic insect species in Hawai'i, and has substantially declined throughout its former range of Kaua'i, O'ahu, and Maui. Prior to this study, the known range of *T. abnormis* existed of only one watershed on O'ahu (Polhemus 1995) at upper Kaluanui Stream between 2200-2500 ft (this area of Kaluanui Stream was not examined in the present study). *Telmatogeton torrenticola* was the relatively more common species yet this species is still sensitive to water diversions and disturbance. *Telmatogeton torrenticola* was found in all Maui and one Hawai'i Island surveyed streams. Another rare and federally listed candidate species of aquatic insect found in east Maui is the endemic flying earwig damselfly (*Megalagrion nesiotes*) that was recently been observed in adjacent East Wailua Iki Stream in the past 3 years (D.J. Preston, unpubl. data). Suitable habitats were found in West Wailua Iki Stream for *M. nesiotes* and sunny conditions prevailed during most of the sampling period, however, none were observed or captured. It is possible that seasonal influences precluded the capture of this extremely rare native damselfly as sampling of East Maui streams occurred in January.



West Maui streams and in particular Honokohau Stream were found to have a rich fauna of new species, with five of the eight new native species found in a relatively short and high gradient reach that extended from 1200-1500 ft elevation. Honokohau Stream at this elevation consists of high gradient cascades and riffles, with numerous small seeps and side pools. Particularly striking in Honokohau Stream was the great abundance of the locally rare endemic blackhook Hawaiian damselfly (*Megalagrion nigrohamatum nigrohamatum*) in Honokohau Stream. Several new aquatic Diptera species from Honokohau Stream were collected on a large seep and perched waterfall area (N 20.93622° W 156.58401°) at 1520 ft elevation this waterfall on the eastern side of the canyon wall contributed substantial amounts of waterflow to Honokohau Stream. High gradient riffle areas with exceptionally clear water were also sampled near the perched waterfall area, and were highly productive for native insects. The reaches of Honokohau Stream surveyed were undiverted, and flowed through a watershed undergoing intensive pig-control efforts by biologists from Maui Land and Pine. Consequently, this stream has a high diversity of pristine aquatic habitats lacking alien species and continues to foster a rich biodiversity. Greater in-depth investigations of Maui streams would most likely yield more undescribed aquatic insect taxa.

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Kaluanui Stream, O'ahu  
above Sacred Falls



Kaluanui Stream, O'ahu  
M.K.K. McShane collecting



Perched falls and large seep  
Honokohau Stream, Maui