



**Report on Long-Term Aquatic Insect Monitoring
by Hawaii Biological Survey, Bishop Museum
in Pelekunu Valley, Moloka‘i, Hawai‘i**

**Hawaii
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Final Report

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**Report on Long-Term Aquatic Insect Monitoring in 2002 by Hawaii Biological Survey, Bishop Museum in
Pelekunu Valley, Moloka'i, Hawai'i**

Submitted to:

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Introduction

Aquatic insect surveys of Pelekunu Stream and its tributaries on Moloka'i were conducted from 28-29 May 2002, by Ron Englund of the Hawaii Biological Survey, Bishop Museum. Additionally, a brief reconnaissance for aquatic insects was conducted around the Pu'u Kolekole cabin (3900 ft elevation) from 26-27 May 2002 in the Kamakou Preserve of The Nature Conservancy of Moloka'i. These surveys are part of a continuing biological monitoring program first conducted by Bishop Museum personnel in 1991.

Collections of aquatic insects in the Pelekunu watershed were made in elevations ranging from sea level to approximately 800 ft in the Pilipililau tributary. This sampling was in conjunction with fish surveys conducted by biologists from the Hawaii Division of Aquatic Resources and The Nature Conservancy Moloka'i. Insect sampling consisted of aerial netting of adult aquatic insects, visual observations, and benthic sampling in and along riffles. The results of the present survey are compared to Bishop Museum surveys conducted in Pelekunu Stream since 1991. Aquatic insect species determinations were made by R. Englund, K. Arakaki, N.L. Evenhuis, and G.A. Samuelson of the Hawaii Biological Survey, Bishop Museum.

Study Area

Located in the central portion of the north shore Moloka'i, Pelekunu Stream originates at nearly 4,200 ft as a series of small tributaries on both the eastern and western sides of a large amphitheater-shaped basin. In-depth descriptions of Pelekunu watershed aquatic habitats can be found in Englund (2001). In 2002, sampling at Pelekunu Stream started at the ocean and adjacent wetlands, and extended upstream into Pilipililau tributary. The uppermost area of Pelekunu Stream sampled was located in the Pilipililau tributary (above the TNC Papa'iki Camp) at approximately 800 ft elevation.

Pilipililau tributary has a lower flow, draining a drier watershed dominated by introduced dry to mesic plant species such as sisal (*Agave sisalana*). Pilipililau tributary was sampled upstream of the trail that connects the TNC Papa'iki Camp to the USGS gaging station, from approximately 560 ft to 850 ft elevation. Not far upstream from the trail intersection there was a 8-9 ft bedrock stair step cascade, which provided a small amount of splash-zone habitat. Immediately downstream of this cascade was a 40-50 ft high mossy



seep running along the northern face of the tightly incised Pilipililau Stream channel. A small amount of water dripping on the canyon wall (downstream of the cascade) created an aquatic rheocrene seep covered by a light green species of algae. This habitat was important for an undescribed species of dolichopodid fly.

A brief reconnaissance of aquatic habitats around the TNC Kolekole cabin was also conducted at approximately 4000 ft in elevation. The Kamakou Preserve area contains some of the best remaining native Hawaiian forest habitat in the Hawaiian islands, and a small perennial stream behind the Kolekole cabin was sampled for aquatic insects. The small streamlet maintains permanent pools 1-2 ft wide, and up to 5-8 in deep, and drains a virtually pristine native forest.

Results

Weather conditions were uniformly clear and good during sampling at Pelekunu Stream and in Kamakou Reserve. Conditions were uniformly clear and sunny for the day of 28-29 May 2002. In contrast to the poor weather during sampling near the ocean in 2001, sunny conditions ensured successful observations and collections of native damselflies. In 2002, native damselflies, particularly *Megalagrion pacificum*, were abundant in the lower stream area near the ocean during the poor weather conditions. Because of poor weather, *Megalagrion xanthomelas* was not observed in 2001 but was relatively common in 2002, with three males and one female collected within the first 30 m of where Pelekunu Stream entered the ocean. Habitat for *M. xanthomelas* consisted of shallow (3-6 in deep) sidepools isolated from the mainstream channel, as shown in the adjacent photograph.



Megalagrion pacificum was the most abundant damselfly in the Pelekunu watershed from sea level to the end of the survey at Pilipililau tributary at 800 ft elevation, and was common in sidepool areas. Although intensively surveyed, native damselflies were not observed in the large wetlands/old taro field area near the ocean during the 2000, 2001, or 2002 surveys. However, poor weather conditions in 2001 likely accounted for only one species of Odonata, *Pantala flavescens*, being observed in areas near the ocean. Better weather conditions in 2002 were the

likely reason *Anax junius* and *Orthemis ferruginea* were common in this wetland area, along with the introduced damselfly *Ischnura ramburii*. Native damselflies were not observed in this disturbed wetland habitat during good weather conditions in both 2000 and 2002.

During the 2002 monitoring, a total of 39 aquatic insect species were collected or observed in Pelekunu Stream and its associated tributaries and wetlands in approximately 16 hours of sampling from 28-29 May 2002. Of the aquatic insect taxa collected in 2002, 74% were native species (Figure 1 and Table 1). The total number of both native and introduced aquatic insect species collected in 2002 was much higher than collected in previous years, and may be explained by excellent weather conditions, increased sampling effort, and better knowledge on how to sample Pelekunu Stream insects. Areas sampled included Pilipililau tributary from the confluence of Pelekunu Stream to 850 ft elevation, the extensive wetland area near the ocean, and main Pelekunu Stream from the ocean to upstream of the TNC Papa'iki Camp at approximately 440 ft elevation.

Further collections of a rare and undescribed native species of *Sigmatineurum* n. sp. were made in Pilipililau tributary at 560 ft elevation, the same location this species was found in 2001 (Englund 2001). This native aquatic fly species was collected during sweep-net sampling of the large rheocrene seep area of Pilipililau Stream, and also in a cascade-like



chute found upstream of the large seep wall. This new *Sigmatineurum* species most closely resembles *Sigmatineurum englundii* (Evenhuis 2000b) found in Waimanu and Waipi'o Valleys on Hawaii Island; both physically (N.L. Evenhuis, pers. comm.) and in its rheocrene seep habitat preference. This new dolichopodid species apparently is quite restricted in numbers and habitat in Pelekunu watershed, and has only been captured in low numbers in its favored habitat.

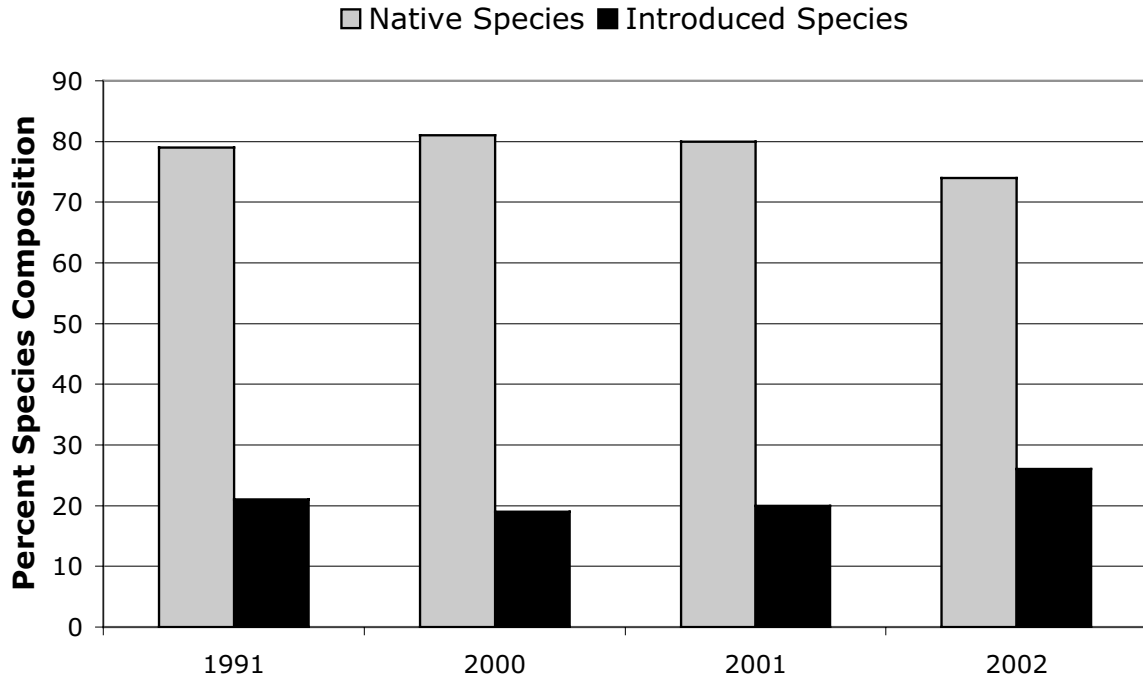


Figure 1. Percent native and introduced aquatic insect species found during long-term Bishop Museum monitoring of Pelekunu Stream from 1991-2002.

A brief reconnaissance sampling of aquatic habitats around the Pu'u Kolekole cabin streamlet area revealed an unexpectedly diverse aquatic insect fauna in permanent aquatic habitats. Two species of endemic native aquatic beetles were collected at the streamlet behind the Pu'u Kolekole TNC cabin: *Rhantus pacificus* (Boisduval) and *Limnoxenus semicylindricus*. *Limnoxenus* is a genus endemic to Hawaii, and is an aquatic beetle that has been only rarely collected, with just four specimens from Moloka'i in the Bishop Museum collection. Other findings of interest in the small stream behind the Pu'u Kolekole cabin include an endemic species of broad-shouldered water strider (*Microvelia vagans*), and three endemic species of damselfly were found, *Megalagrion blackburni*, *M. calliphya*, *M. hawaiiense*. More intensive surveys for aquatic insects in the Kamakou TNC area are needed and would yield a richer native species diversity than found during this preliminary reconnaissance. It is significant that no introduced aquatic insects were found at Pu'u Kolekole, although it is possible that introduced caddisflies would be found during more intensive surveys.

Table 1. Results of long-term Hawaii Biological Survey, Bishop Museum monitoring of aquatic insect species in Pelekunu Stream including results from the current study of 28-29 May 2002.

Taxon	Polhemus (1991)	Englund (2000)	Englund (2001)	2002- Current Study	Geographic Status
Anisoptera (Dragonflies)					
Aeschnidae					
<i>Anax junius</i>		X		X	Indigenous
<i>Anax strenuus</i>	X		X	X	Endemic
Libellulidae					
<i>Orthemis ferruginea</i>	X			X	Introduced
<i>Pantala flavescens</i>	X	X	X	X	Indigenous
Zygoptera (Damselflies)					
Coenagrionidae					
<i>Ischnura ramburii</i>		X			Introduced
<i>Megalagrion xanthomelas</i>	X	X		X	Endemic
<i>Megalagrion pacificum</i>	X	X	X	X	Endemic
<i>Megalagrion blackburni</i>	X	X	X	X	Endemic
<i>Megalagrion calliphya</i>		X	X	X	Endemic
<i>Megalagrion hawaiiense</i>	X	X	X	X	Endemic
Heteroptera					
Veliidae					
<i>Microvelia vagans</i>	X		X	X	Endemic
Mesoveliidae					
<i>Mesovelia amoena</i>	X		X		Introduced
Saldidae					
<i>Saldula exulans</i>	X	X	X	X	Endemic
Diptera (true flies)					
Canacidae					
<i>Procanace acuminata</i>	X	X	X	X	Endemic
<i>Procanace confusa</i>			X	X	Endemic
<i>Procanace constricta</i>				X	Endemic
Ceratopogonidae					
<i>Dasyhelea hawaiiensis</i>				X	Endemic
<i>Dasyhelea platychaeta</i>				X	Endemic
Chironomidae					
<i>Chironomus hawaiiensis</i>			X		Endemic
<i>Cricotopus bicinctus</i>				X	Introduced
<i>Pseudosmittia paraconjuncta</i>				X	Endemic
<i>Telmatogeton japonicus</i> ¹			X	X	Indigenous
<i>Telmatogeton torrenticola</i>	X	X	X	X	Endemic
Dolichopodidae					
<i>Campsicnemus ridiculus</i>	X	X	X	X	Endemic
<i>Condylostylus longicornis</i>				X	Introduced
<i>Chrysotus longipalpus</i>				X	Introduced
<i>Dolichopus exsul</i>			X		Introduced

Table 1 (cont). Results of long-term Hawaii Biological Survey, Bishop Museum monitoring of aquatic insect species in Pelekunu Stream including results from the current study of 28-29 May 2002.

Taxon	Polhemus (1991)	Englund (2000)	Englund (2001)	2002- Current Study	Geographic Status
<i>Euryzogaster</i> sp.				X	Endemic
<i>Thambemyia acrosticalis</i> (formerly <i>Paraphrosylus</i> sp.)	X			X	Endemic
<i>Tachytrechus angustipennis</i>				X	Introduced
<i>Sigmatineurum</i> new sp.			X	X	Endemic
Ephydriidae					
<i>Donaceus nigronotatus</i>				X	Introduced
<i>Notiphilia insularis</i>				X	Endemic
<i>Scatella cilipes</i>			X	X	Endemic
<i>Scatella clavipes</i>			X	X	Endemic
<i>Scatella hawaiiensis</i>				X	Endemic
<i>Scatella mauiensis</i>				X	Endemic
<i>Scatella warreni</i>			X	X	Endemic
<i>Scatella</i> sp.	X				Endemic
Tipulidae					
<i>Limonia advena</i>	X	X	X	X	Introduced
<i>Limonia jacobae</i>			X		Endemic
<i>Erioptera bicornifer</i>				X	Introduced
Trichoptera (Caddisflies)					
Hydropsychidae					
<i>Cheumatopsyche analis</i>	X	X	X	X	Introduction
Hydroptilidae					
<i>Hydroptila icona</i>			X	X	Introduction
Lepidoptera (Aquatic Moths)					
<i>Hyposmocoma</i> sp. 1	X	X	X	X	Endemic
<i>Hyposmocoma</i> sp. 2	X				Endemic
Number of Native/Introduced Species	15/4	13/3	20/5	29/10	
Total Insect Species	19	16	25	39	
Percent Native Species (%)	79%	81%	80%	74%	

¹Collected on wave swept boulders where freshwater entered ocean at Pelekunu Stream mouth

A species of nonindigenous aquatic insect, the caddisfly *Hydroptila icona* was first collected during the 2001 surveys (Englund 2001, Flint et al. 2003). In 2001, this small case-building species of caddisfly was collected in stream habitats just above the ocean to approximately the 100 ft elevation level, but no higher. By 2002 *H. icona* was found in Pelekunu Stream to the highest elevation surveyed of over 850 ft above sea level in Pilipililau tributary. This species thus appears to have successfully invaded the entire watershed and is now likely found throughout the highest elevations of Pelekunu Stream.

Hydroptila icona was found in high densities during both 2001 and 2002 in Pelekunu Stream riffles. The center-channel areas were the primary habitat preferred by this species, in the mid-channel areas of the most heavily flowing water. The highest water velocities of Hawaiian streams are also the most favored by native aquatic insect species (Howarth and Polhemus 1991).

Discussion and Recommendations

The 74% native taxa found in Pelekunu Stream during 2002 is biologically similar to the 80-81% native taxa found during the 2000 and 2001 surveys (Englund 2000, 2001), and the 79% native species found during the 1991 Bishop Museum surveys (Polhemus 1991) (Figure 1). For comparison, only lower elevations (below 60 ft elevation) of Pelekunu Stream were surveyed during the 1991 Bishop Museum surveys (Polhemus 1991), while the surveys conducted in 2000-2001 ranged from sea level to nearly 600 ft. The 2002 surveys began at sea level and went to 850 ft, with the higher elevations surveyed another reason for the much greater number of species collected in 2002 as compared to previous Bishop Museum surveys. During the ten years that Pelekunu Stream has been monitored Bishop Museum staff have found aquatic insect species assemblages to be fairly stable in this nearly pristine stream. The number of native aquatic species collected at Pelekunu Stream ranged from a low of 13 species in 2000 to a high of 29 in 2002, and is also related to sample effort and weather conditions, with more time and a wider variety of aquatic habitats sampled in 2002 than in previous studies.

Because of a low number of introduced aquatic insect species and no fish, amphibian, mollusk or crustacean introductions, Pelekunu Stream is one of the most important watersheds for the preservation of native biodiversity in Hawaii. For instance, native species of damselflies that have become extinct or had their ranges severely restricted on Oahu (Englund 1999) remain abundant in Pelekunu Stream. Because many rare native aquatic insect species are found there, Pelekunu Stream should be given the highest level of protection from disturbance and species introductions. Pelekunu Stream also may be an important future genetic source for native damselfly and other aquatic insect reintroductions into O'ahu, Kaua'i or other areas where *Megalagrion pacificum* and *Megalagrion xanthomelas* have become extinct.

The continued absence of alien fish species in 2002 in the Pelekunu watershed is a hopeful finding, with the crustacean *Macrobrachium lar* the only species of introduced macrofauna occurring in Pelekunu Stream. Pelekunu Stream still lacks the large introduced bullfrog *Rana catesbeiana* that is found in high densities in

adjacent Wailau Stream (R. Englund, unpubl. HBS data). The bullfrog has been unable to disperse into the Pelekunu watershed because of the steep cliffs separating Wailau and Pelekunu Valleys, but would definitely negatively impact native aquatic fauna if it became established in Pelekunu Valley. *Bufo marinus* are found in adjacent Waikolu Stream (Englund, unpubl. HBS data), but so far have not been observed in Pelekunu Stream, and similar to bullfrogs, *B. marinus* so far has been unable to surmount the steep ridges to access Pelekunu Valley.

Prior to the sampling of 2001, the introduced aquatic insect species found in Pelekunu Stream was considered relatively innocuous. The most distressing finding of the 2001 surveys was the collection of a new species nonindigenous hydroptilid caddisfly in the lowest elevations of the main Pelekunu Stream. This species has entirely invaded the Pelekunu watershed now and is found in high elevation areas. The impacts that *H. icona* will have on native torrenticolous insects are unknown and will likely be difficult to measure.

The continuing spread of the new species of potentially harmful alien aquatic caddisfly highlights the importance of regular monitoring of the aquatic biota in Pelekunu Stream. Even though this stream is exceedingly remote and difficult to access, invasive species remain the most prominent threat to Pelekunu Stream aquatic biota, and this stream is one of the last large, free-flowing streams lacking harmful introduced vertebrates that is left in the Hawaiian archipelago. The monitoring of Pelekunu Stream has provided extremely valuable information on one of the most intact aquatic ecosystems remaining in the Hawaiian Islands. On the other hand, the discovery of one new native endemic species of aquatic insect during these surveys has yielded exciting new information on the evolution and ecology of Hawaiian streams. There is also the potential for either the rediscovery of other rare native aquatic insect taxa, or the additional discovery of previously unknown species of endemic insects in upper elevation areas of the Pelekunu watershed that have not yet been surveyed.

As stated in earlier monitoring reports, annual monitoring of aquatic invertebrates in Pelekunu Stream should be conducted in conjunction with annual native fish monitoring to help effectively manage and preserve native aquatic biodiversity. Additionally, attempts should be continued to minimize feral ungulate disturbance, especially in the lower watershed as native aquatic species usually fare poorly in heavily sedimented streams and disturbed wetlands. Heavy pig damage and "rototilling" impacts were observed in

lower Pelekunu wetland area near the ocean, and correspondingly no native damselflies have yet been observed in this area during Bishop Museum surveys from 1991-2002.

Alien fish and other aquatic species continue to rapidly spread throughout the Hawaiian Islands, as evidenced by the recent *Salvenia molesta* problem at Lake Wilson on O'ahu. The recent caddisfly introduction cited in this report exemplifies that even the most remote and pristine areas such as Pelekunu Stream are threatened. Pelekunu Stream deserves special protection because it is a refuge for some of the rarest aquatic animals in the globe, and is one of the last large free-flowing streams in Hawaii lacking alien vertebrates. A contingency plan should be prepared in coordination with TNC, Hawaii Division of Aquatic Resources, and the Bishop Museum, and other interested parties that would immediately eliminate any alien aquatic vertebrate species that are either accidentally or intentionally introduced into Pelekunu Stream. For example, immediate chemical treatment of the stream with rotenone should occur if smallmouth bass or any other introduced fish species were detected during stream monitoring. Lack of action when fish or other major alien species introductions occur into Pelekunu watershed would deal a severe blow for the preservation of native Hawaiian aquatic fauna biodiversity. Chemical treatment of the stream in case of invasive aquatic species introductions would cause no-long lasting damage to Pelekunu Stream because native stream biota will return from the ocean, and aquatic insects would have refugia in the upper elevation areas above which alien fish would not be able to access. Unlike the permanent and long-lasting damage that would occur if invasive aquatic species became established, stream treatment is the preferred alternative to not doing anything in case of invasive species introductions. The detection of invasive aquatic species early on underscores the importance of regular aquatic monitoring in the Pelekunu Watershed.

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