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Freshwater Macroinvertebrates and Their Habitats in Dominica

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ABSTRACT
A survey of macroinvertebrates inhabiting freshwater habitats of Dominica was conducted from 1995 to 2005. Qualitative collections were made by sweeping a dip net through the water column, agitating the bottom substrate, and by hand examination of rocks, plants, and debris submerged in both standing and flowing bodies of water across the island. Water temperature and elevation were also recorded at each site. Ecological conditions were generally suitable to support many groups of freshwater macroinvertebrates, although high water temperatures, suspected low dissolved oxygen concentrations, and low pH values at some sites may have limited some populations. These collections yielded at least 62 taxa, 29 of which are reported for the first time from Dominica, bringing the total number of freshwater macroinvertebrates known from this island to 116. Dominant taxa collected included gastropods, ephemeropterans, odonates, hemipterans, trichopterans, and dipterans. Waterfalls, which were thought to act as barriers to upstream movement of non-flying invertebrates, appear not to limit the distribution of most decapods, but may impede nerite snails. Generally the freshwater macroinvertebrate fauna of Dominica is sparse, most likely due to the oceanic origin of the island and challenges colonizing such a habitat.

Key words: Freshwater invertebrates, Dominica, Lesser Antilles, stream, waterfall.

INTRODUCTION

Dominica is the southernmost of the Windward Islands in the Lesser Antilles. This island is volcanic in origin, emerging from the sea floor about 25 million years ago, with associated geothermal activities continuing today. Dominica comprises an area of approximately 746 square kilometers and rises to an elevation of 1,424 meters. The combination of high elevation and humid trade winds results in high precipitation which drains into the many streams and rivers that flow swiftly down the mountains toward the sea.

A limited amount of information regarding the freshwater invertebrates of the Lesser Antilles and other small Caribbean islands is available. Biodiversity surveys of aquatic macroinvertebrates have been conducted on some islands including Barbados (Bass 2003a), St. Vincent (Harrison and Rankin 1975, 1976a, 1976b), St. Lucia (McKillop and Harrison 1980), Antigua (Bass 2005), Grenada (Flint and Sykora 1993; Bass 2004b), St. Kitts (Bass 2006), Nevis (Bass 2000, 2006), Tobago (Hart 1980; Nieser and Alkins-Koo 1991; Botosaneanu and Alkins-Koo 1993; Flint 1996; Bass 2003b), and Trinidad (Hynes 1971; Alkins *et al*. 1981; Alkins-Koo 1990; Nieser and Alkins-Koo 1991; Botosaneanu and Alkins-Koo 1993; Flint 1996). Investigations describing the fauna of decapods (Chace and Hobbs 1969), odonates (Donnelly 1970), trichopterans (Flint 1968), and invertebrate stream drift (Bass 2004a) have already been conducted in Dominica. However, these previous investigations in Dominica were limited in scope or may be outdated, and additional collections may yield previously unknown populations or species.

The objectives of this investigation include: 1) to determine the species of aquatic macroinvertebrates inhabiting freshwaters of Dominica, 2) to note the microhabitat preferences of each species, 3) to determine the relative abundance of each species, and 4) to compare the Dominica freshwater macroinvertebrate fauna to other such fauna on the different Lesser Antillean islands.

MATERIALS AND METHODS

Sixty-six sampling sites were established in various freshwater habitats across Dominica (Fig. 1). Collections were made during December 1995, January 1996, June 1996, May 2001, and March 2005. Water temperature was also recorded from each site at the time of collection. Some of those sites were visited more than once. In addition, the effect of waterfalls on the species composition of stream macroinvertebrate communities was addressed in Dominica by comparing collections made from streams 200 m above and below five waterfalls during March 2005.

Several methods of collecting were employed to ensure as many species as possible were captured. Submerged debris, such as stones, leaves, and wood, were carefully examined and inhabitants were picked from the substrate using forceps. A dip net (mesh = 0.5 mm) was swept through aquatic vegetation and the water column to capture macroinvertebrates occupying those microhabitats. The microhabitat from where each specimen occurred was noted. Collecting efforts continued at each site until no additional species were encountered. These collecting methods were similar to those used on other islands (Bass 2003a, 2003b, 2003c, 2004b, 2005, 2006) so comparisons of the results could be made. In addition, drift nets were used twice at one site to collect samples

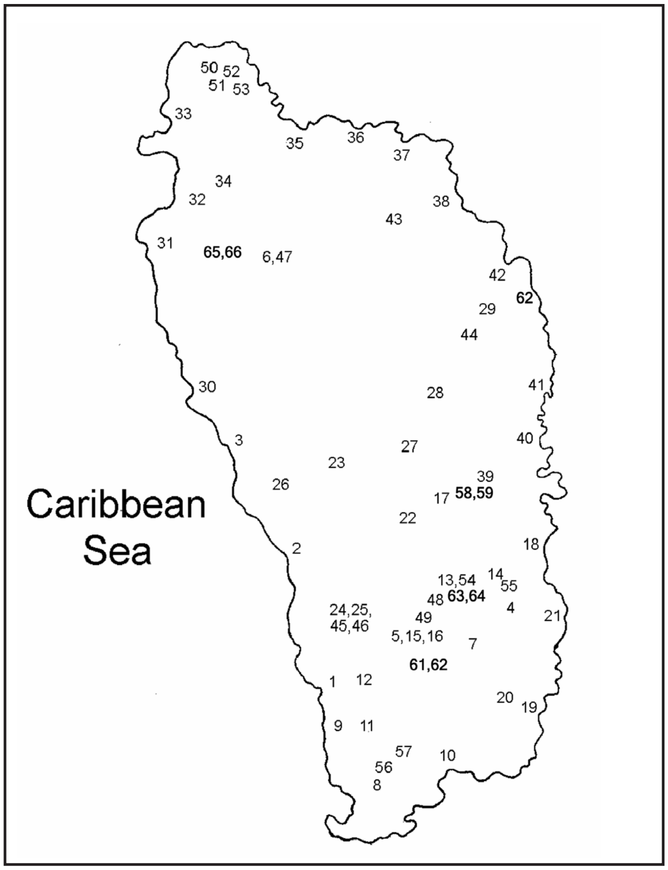

Fig. 1. Map indicating location of collecting sites in Dominica. Specific locations, dates, approximate elevations, and water temperatures at sites of collections are listed in legend of Table 1.

during the diel cycle.

Decapod crustaceans were sometimes noted and released because they have been already well-studied in Dominica (Chace and Hobbs 1969). Other specimens were preserved in 70% ethanol and returned to the laboratory for further identification. Taxa that could not be identified to the species level were separated into morphospecies for subsequent analysis. Sorenson's index of similarity (1948) was used to compare these collections in Dominica with similar endeavors on other small Caribbean islands. Published collections by other researchers were also consulted and included in the final listing of species, although they were not used in the similarity analysis, due to variations in collecting efforts.

RESULTS AND DISCUSSION

Freshwater Habitats

There is probably no other island of the Lesser Antilles that has more freshwater habitats than Dominica. These include streams, rivers, lakes, and springs.

There are 365 named streams on Dominica. High annual rainfall provides the water necessary to maintain flow year round in most streams and rivers, even during the relatively drier winter months. The few streams that do cease to flow and become dry are re-colonized quickly by populations that survived in the persistent headwaters or moved upstream when flow resumed (Chace and Hobbs 1969). The steep slopes result in many areas of fast flowing water, presumably contributing to high dissolved oxygen levels. In addition, Chace and Hobbs (1969) suggest Dominican waters are the least polluted of any in the Caribbean region due to the lack of upstream development and high flushing rates. Large waterfalls also exist in several of the drainages.

Only three lakes exist on Dominica: Freshwater Lake, Boeri Lake, and Boiling Lake. Freshwater Lake is actually a reservoir created to store water. Boeri Lake, formed within the crater of an old volcano, possesses steep sides and a maximum depth of approximately 40 meters. Boiling Lake resulted from a flooded fumarole and is the second largest lake in the world that actually boils. All of these lentic environments are located on the southern portion of the island.

Some of the lesser-known freshwater habitats on Dominica are its springs and seeps, locally known as soufreires. Water emerging from these soufreires may be either hot or cold, depending on the geology of the local area and the origin of the emerging water. High water temperatures, sometimes exceeding 41° C and pH values measured as low as 3.0 would likely lead to low dissolved oxygen concentrations. Usually these waters are rich in sulfur as evidenced from the strong odor they emit.

Freshwater Macroinvertebrates

I collected a total of at least 62 species representing 13 major groups from the freshwater habitats of Dominica. Twenty-nine of these species are reported for the first time from the island (Table 1). This brings the total number of freshwater macroinvertebrates known from Dominica to 116 taxa.

Platyhelminthes

Only one flatworm, *Girardia* sp., was found with specimens being collected from only two stream sites in south-central Dominica (Table 1). Although this is the first report of an aquatic flatworm from Dominica, this genus has been reported from the other Lesser Antillean islands of Barbados (Bass 2003a), Grenada (Bass 2004b), St. Kitts (Bass 2006), and Nevis (Bass 2006).

Gastropoda

A total of five species of freshwater snails were collected from Dominica (Table 1). Two of these, *Neritina punctulata* and *N. virginea*, are nerites which require marine waters during a portion of their life cycle. *N. virginea* has a highly variable shell pattern and is widespread in

Table 1. List of freshwater macroinvertebrates, including collecting sites, life cycle stages present, relative occurrence, and microhabitats in Dominica during December 1995, January 1996, June 1996, May 2001, and March 2005. *Indicates taxa previously not reported from Dominica. **Indicates individuals of this group were often observed, but not always collected, at many sites. Life cycle: A, adult; J, juvenile; L, larva; N, nymph. Occurrence: +++ abundant, ++ common, + rare.

Taxa	Collection	Life Cycle	Occurrence	Microhabitat	Trophic Relationship[1]
Platyhelminthes					
Girardia sp.*	25, 64	Adult	+	Detritus	Predator
Gastropoda					
Melanoides tuberculata	1, 4, 9-10, 12, 18, 23, 27-29, 31-34, 36-37, 39-41, 43-44, 53, 62	Juvenile, Adult	+++	Rock, Detritus	Herbivore
Neritina punctulata	1-2, 18, 23, 26-27, 29-35, 37-38, 42-43	Juvenile, Adult	+++	Rock	Herbivore
Neritina virginea	18, 38, 46	Adult	++	Rock	Herbivore
*Physella acuta**	4, 55	Juvenile, Adult	+	Detritus	Detritivor
Biomphalaria sp.	4, 13	Adult	+	Detritus	Detritivor
Amphipoda					
*Hyalella azteca**	13, 54-55	Juvenile, Adult	++	Detritus	Detritivor
Decapoda**					
Atya innocous	63, 67	Juvenile, Adult	++	Detritus	Detritivor
Atya scabra	67				Detritivor
Coenobita clypeatus	62, 67	Adult	+	Detritus	Detritivor
Guinotia dentata	46, 48-49, 58-60, 67	Juvenile, Adult	++	Detritus	Detritivor
Jonga serrei	67				Detritivor
Macrobrachium acanthurus	67				Predator
Macrobrachium carcinus	67				Predator
Macrobrachium crenulatum	67				Predator
Macrobrachium faustinum	45-46, 48, 62, 65, 67	Juvenile, Adult	++	Detritus	Predator
Macrobrachium heterochirus	67				Predator
Micratya poeyi	45, 58-59, 62, 64, 67	Juvenile, Adult	++	Detritus	Detritivor
Potimiram glabra	45-46, 48, 62, 65, 67	Juvenile, Adult	++	Detritus	Detritivor
Xiphocaris elongata	67				Detritivor
Acari					
Hydrachnida*	12	Adult	+	Detritus	Predator
Ephemeroptera					
Baetidae	2, 5-6, 9-12, 14-18, 20, 23-25, 27-29, 32-33, 35-40, 44-45, 52, 61-64, 66	Nymph	+++	Detritus	Collector
Baetidae - new species?*	27	Nymph	+	Detritus	Collector
Borinquena traverae	67				
Caenis sp.*	30	Nymph	+	Detritus	Collector
Allenhyphes flinti	1, 5, 9-12, 16, 18, 20, 24-25, 27-29, 31, 35, 39-40, 43-45	Nymph	+++	Detritus	Collector
Tricorythodes sp.*	10-12, 15, 20, 23, 25, 27, 32, 35-36, 39-41, 62	Nymph	+++	Detritus	Collector
Odonata					
Anax concolor	67				Predator
Anomalagrion hastatum	67				Predator
Aeshna psilus	67				Predator
Argia concinna	5, 24, 27-29, 31-33, 35, 39, 44-45, 58, 61-64, 67	Nymph	+++	Detritus	Predator
Brachymesia furcata	50, 67	Nymph	+	Detritus	Predator
Brechymorhoga praecox grenadensis	9, 11, 14, 49	Nymph	++	Detritus	Predator
Cannacria herbida	67				Predator
Dythemis sterilis	67				Predator
Enallagma coecum	44, 67	Nymph	+	Detritus	Predator
Erythrodiplax umbrata	67				Predator
Ischnura ramburi	30, 67	Nymph	+	Detritus	Predator
Leptothemis vesiculosa	67				Predator
Lestes forficula	67				Predator
Micrathyria aequalis	67				Predator
Micrathyria didyma	67				Predator
Orthemis ferruginea	56-57, 67	Nymph	+	Detritus	Predator
Pantala flavescens	67				Predator
Protoneura ailsa	67				Predator
Scapanea archboldi	67				Predator
Telebasis sanguinalis	67				Predator
Tramea abdominalis	67				Predator
Triacanthagyna trifida	67				Predator
Unknown Coenagrionidae	53	Nymph	+	Detritus	Predator
Hemiptera					
*Brachymetra albinervis**	3, 6, 17, 24, 26, 28, 31, 33-38, 41-42, 44, 46	Nymph, Adult	+++	Neuston	Predator
Buenoa sp.*	24	Adult	+	Water Column	Predator
*Mesovelia mulsanti**	31	Adult	+	Neuston	Predator
Microvelia sp.*	7, 12, 22, 24, 48, 50-52, 65	Nymph, Adult	+++	Neuston	Predator
*Rhagovelia pulchra**	5-6, 9-15, 17-18, 23-33, 35-36, 38-44, 46-47, 49-50, 53-55, 58-59, 61-63, 65	Nymph, Adult	+++	Neuston	Predator
Lepidoptera					
Noctuidae*	27	Larva	+	Rock	Herbivore

Petrophila sp.*	17, 24-26, 28, 33, 35, 37-42, 46, 49, 52-53, 59-62	Larva	+++	Rock	Herbivore
Trichoptera					
Alisotrichia dominicensis	67				Collector
Alisotrichia lobatus	67				Collector
Alisotrichia orophila	67				Collector
Alisotrichia septempunctata	67				Collector
Alisotrichia wirthi	67				Collector
Atanatolica dominicana	67				Collector
Brachysetodes insularis	67				Collector
Bredinia dominicensis	67				Collector
Cerotina lutea	67				Collector
Chimarra (Chimarra) antilliana	5, 16, 18, 24-25, 28-29, 31-33, 35, 37, 39-41, 43-46, 53, 58, 63-64, 66-67	Larva	+++	Detritus	Collector
Chimarra dominicana	37				Collector
Helicopsyche apicauda	37				Collector
Helicopsyche guadeloupensis	7, 17, 20, 23, 27-28, 31, 34, 36, 67	Larva	+++	Detritus	Collector
Leptonema archboldi	13-14, 67	Larva	+	Detritus	Collector
Neotrichia coniculans	67				Collector
Ochrotrichia brayi	67				Collector
Ochrotrichia campana	67				Collector
Ochrotrichia exclamationis	67				Collector
Ochrotrichia ponta	67				Collector
Ochrotrichia similis	67				Collector
Ochrotrichia spinossima	67				Collector
Oecetis pratti	67				Collector
Oxyethira cirrifera	67				Collector
Oxyethira tega	67				Collector
Phylloicus montisolus	67				Collector
Polyplectropus bredini	67				Collector
Polycentropus insularis	51, 55, 67	Larva	+	Detritus	Collector
Prototilia dominicensis	7, 64, 67	Larva	+	Detritus	Collector
Smicridea (Smicridea) cariba	5, 10, 12, 16, 20, 24-28, 31-32, 43-46, 53, 58, 64, 66-67	Larva	+++	Detritus	Collector
Xiphocentron albolineatum	67				Collector
Xiphocentron fuscum	67				Collector
Xiphocentron sp.	11, 46, 49	Larva	+	Detritus	Collector
Zumatrichia anomaloptera	67				Collector
Zumatrichia antilliensis	67				Collector
Unidentified Trichoptera	52	Larva	+	Detritus	Collector
Megaloptera					
Chloronia antilliensis	7, 67	Larva	+	Detritus	Predator
Coleoptera					
Aleocharinae*	26, 31, 33, 37, 40, 66	Adult	++	Detritus	Predator
Cyphon sp.*	50-51	Larva	+	Detritus	Collector
*Hexanchorus caraibus**	11, 16-18, 25, 27, 58	Larva, Adult	++	Detritus	Collector
*Laccophilus proximus**	13	Adult	+	Detritus	Predator
*Psephenops smithi**	64	Larva	+	Detritus	Scraper
Diptera					
Atrichopogon sp.*	33	Larva	+	Detritus	Collector
Canacidae*	66	Larva	+	Detritus	Scraper
Ceratopogonidae	57	Larva	+	Sediment	Predator
Chironomus sp.*	50-51, 56-57	Larva	++	Sediment	Collector
Corynoneura sp.	29-31, 53, 62	Larva	++	Sediment	Collector
Cricotopus sp.	62, 64, 66	Larva	+	Sediment	Collector
Cryptochironomus sp.*	26	Larva	+	Sediment	Collector
Empididae	48, 57	Larva	+	Detritus	Predator
Endochironomus sp.*	26, 35, 43	Larva	+	Sediment	Collector
Eukiefferiella sp.*	7, 55, 60	Larva	+	Sediment	Collector
Paltostoma sp.	25, 46, 48, 67	Larva	++	Detritus	Collector
Paramerina sp.*	28, 52	Larva	+	Sediment	Collector
Rheocricotopus sp.*	11, 31-33, 35-36, 40, 45-46	Larva	+++	Sediment	Collector
Rheotanytarsus sp.*	33	Larva	+	Sediment	Collector
Simulium antillarum	67				Collector
Simulium spilmani	67				Collector
Simulium tarsale	67				Collector
Simulium sp.	11, 14-16, 28, 45-46, 53, 59, 61, 63, 66	Larva	+++	Sediment	Collector
Thienemanniella sp.	62	Larva	+	Sediment	Collector
Tvetinia sp.*	7, 32-33	Larva	++	Rock	Collector

Trophic relationship[1] – Trophic relationships of insects based on Merritt and Cummins (1996) and non-insects on Thorp and Covich (2001).

Collection Sites (including location, date, approximate elevation, and water temperature at time of collection): 1) Roseau River, Roseau, 30 December 1995 (Elevation = 10m, Water temperature = 24°C); 2) Belfast River, Mahaut, 30 December 1995 (Elevation = 10m, Water temperature = 23°C); 3) Macoucheri River, Macoucheri Estate, 30 December 1995 (Elevation = 10m, Water temperature = 24°C); 4) Freshwater Lake, Morne Macaque, 1 January 1996 (Elevation = 770m, Water temperature = 22°C); 5)

Mourne Paix Bouche River, Providence Estate, 2 January 1996 (Elevation = 500m, Water temperature = 21ºC); 6) Syndicate Creek, Syndicate Estate, 2 January 1996 (Elevation = 540m, Water temperature = 21ºC); 7) Trois Pitons River (Breakfast River), Boiling Lake Trail, 3 January 1996 (Elevation = 690m, Water temperature = 21ºC); 8) Glou Gyak Stream, Soufriere, 6 June 1996 (Elevation = 75m, Water temperature = 44ºC); 9) Loubiere Creek, Loubiere, 6 June 1996 (Elevation = 70m, Water temperature = 25ºC); 10) Geneva River, Geneva, 7 June 1996 (Elevation = 70m, Water temperature = 26ºC); 11) Loubiere Creek Tributary, Chateau Estate, 7 June 1996 (Elevation = 25m, Water temperature = 25ºC); 12) Roseau River, Morne Louis, 7 June 1996 (Elevation = 70m, Water temperature = 27ºC); 13) Boeri Lake, Morne Macaque, 7 June 1996 (Elevation = 905m, Water temperature = 21ºC); 14) Clarkes River, Boeri Lake Trail, 7 June 1996 (Elevation = 770m, Water temperature = 21ºC); 15) Morne Paix Bouche River, Providence Estate, 7 June 1996 (Elevation = 500m, Water temperature = 23ºC); 16) Morne Paix Bouche River - Drift Sample, Providence Estate, 7-8 June 1996 (Elevation = 500m, Water temperature = 23ºC); 17) Emerald Pool, 8 June 1996 (Elevation = 410m, Water temperature = 24ºC); 18) Roselie River, Roselie, 8 June 1996 (Elevation = 2m, Water temperature = 26ºC); 19) Pointe Mulatre River, Ford, 8 June 1996 (Elevation = 10m, Water temperature = 26ºC); 20) River Blanche, Laroche, 8 June 1996 (Elevation = 115m, Water temperature = 26ºC); 21) Taberi River, Corosol, 8 June 1996 (Elevation = 5m, Water temperature = 26ºC); 22) River Deux Branches, Morne Trois Pitons, 8 June 1996 (Elevation = 540m, Water temperature = 23ºC); 23) Layou River, Suspension Bridge, 8 June 1996 (Elevation = 60m, Water temperature = 27ºC); 24) Check Hall River, Springfield Estate, 9 June 1996 (Elevation = 290m, Water temperature = 22ºC); 25) Check Hall River - Drift Sample, Springfield Estate, 8-9 June 1996 (Elevation = 290m, Water temperature = 22ºC); 26) Layou River, near Boxing Shed, 9 June 1996 (Elevation = 15m, Water temperature = 26ºC); 27) River Deux Branches, Bells, 9 June 1996 (Elevation = 225m, Water temperature = 25ºC); 28) Riviere d'Or, Bassin Will, 9 June 1996 (Elevation = 225m, Water temperature = 25ºC); 29) Pagua River, Concord, 9 June 1996 (Elevation = 65m, Water temperature = 28ºC); 30) Bateli River, Morne Raquette, 9 June 1996 (Elevation = 5m, Water temperature = 23ºC); 31) Espagnol River, Pointe Ronde, 9 June 1996 (Elevation = 10m, Water temperature = 25ºC); 32) Picard River, Picard Estate, 10 June 1996 (Elevation = 15m, Water temperature = 26ºC); 33) Manicou River, Tanetane, 10 June 1996 (Elevation = 30m, Water temperature = 26ºC); 34) Indian River, Sugar Loaf Estate, 10 June 1996 (Elevation = 25m, Water temperature = 26ºC); 35) Blenheim River, Blenheim Estate, 10 June 1996 (Elevation = 15m, Water temperature = 27ºC); 36) Hampstead River, Hampstead Estate, 10 June 1996 (Elevation = 10m, Water temperature = 28ºC); 37) Hodges River, Hodges Estate, 10 June 1996 (Elevation = 15m, Water temperature = 26ºC); 38) Melville Hall River, Melville Hall, 10 June 1996 (Elevation = 2m, Water temperature = 28ºC); 39) L 'Or River, Fond Melle, 11 June 1996 (Elevation = 115m, Water temperature = 24ºC); 40) Castle Bruce River, Raymondstone, 11 June 1996 (Elevation = 25m, Water temperature = 26ºC); 41) Richmond River, Richmond, 11 June 1996 (Elevation = 55m, Water temperature = 26ºC); 42) Pagua River, Barakua, 11 June 1996 (Elevation = 10m, Water temperature = 26ºC); 43) Melville Hall River, Vauxhall, 11 June 1996 (Elevation = 60m, Water temperature = 25ºC); 44) Banana Gutter Creek, Stonefield Estate, 11 June 1996 (Elevation = 145m, Water temperature = 25ºC); 45) Check Hall River - Drift Sample, Springfield Estate, 14-15 May 2001 (Elevation = 290m, Water temperature = 22ºC); 46) Check Hall River, Springfield Estate, 15 May 2001 (Elevation = 290m, Water temperature = 22ºC); 47) Syndicate Creek, Syndicate Estate, 16 May 2001 (Elevation = 540m, Water temperature = 22ºC); 48) Middleham Falls, Middleham Estate, 17 May 2001 (Elevation = 620m, Water temperature = 21ºC); 49) Mourne Paix Bouche River, Providence Estate, 17 May 2001 (Elevation = 500m, Water temperature = 21ºC); 50) Soufriere River, Bellevue Mountain, 19 May 2001 (Elevation = 610m, Water temperature = 23ºC); 51) Cold Soufriere, Harrogate Estate, 19 May 2001 (Elevation = 490m, Water temperature = 24ºC); 52) Demitrie River, Delaford Estate, 19 May 2001 (Elevation = 285m, Water temperature = 25ºC); 53) Aouya River, Aouya, 19 May 2001 (Elevation = 130m, Water temperature = 25ºC); 54) Boeri Lake, Morne Macaque, 20 May 2001 (Elevation = 905m, Water temperature = 21ºC); 55) Freshwater Lake Inflow Stream, Morne Macaque, 20 May 2001 (Elevation = 780m, Water temperature = 21ºC); 56) Soufreire Sulpher Springs Pool, Terre Elm, 21 May 2001 (Elevation = 150m, Water temperature = 29ºC); 57) Glou Gayk Stream, Terre Elm, 21 May 2001 (Elevation = 575m, Water temperature = 27ºC); 58) Emerald Pool, below Emerald Falls, 13 March 2005 (Elevation = 410m, Water temperature = 23ºC); 59) Emerald Pool, above Emerald Falls, 13 March 2005 (Elevation = 425m, Water temperature = 23ºC); 60) Breakfast River, below Trafalgar Falls, 13 March 2005 (Elevation = 310m, Water temperature = 25ºC); 61) Breakfast River, above Trafalgar Falls, 13 March 2005 (Elevation = 415m, Water temperature = 25ºC); 62) Crayfish River, above Isulukati Falls, 14 March 2005 (Elevation = 30m, Water temperature = 27ºC); 63) Middleham Falls, above Middleham Falls, 15 March 2005 (Elevation = 660m, Water temperature = 19ºC); 64) Middleham Falls, below Middleham Falls, 15 March 2005 (Elevation = 615m, Water temperature = 20ºC); 65) DuBlanc River, below Milton Falls, 16 March 2005 (Elevation = 240m, Water temperature = 21ºC); 66) DuBlanc River, above Milton Falls, 16 March 2005 (Elevation = 270m, Water temperature = 20ºC); 67) Previously reported by other researchers.

streams on other small eastern Caribbean islands, including Tobago (Bass 2003b), Grenada (Bass 2004b), St. Kitts (Bass 2006), and Nevis (Bass 2006). The most abundant freshwater snail in these collections was *Melanoides tuberculata*, an introduced species reported on other small islands of the eastern Caribbean basin (Bacon *et al*. 1978; Bass 2003a, 2003b, 2003c, 2004b, 2005, 2006). Although limited to a couple of sites on Dominica, *Physella* is possibly the most widespread freshwater mollusk in the Caribbean basin (Bass 2003c). It should be noted that genetic analysis by Dillion *et al.* (2005) indicates that specimens previously reported as *Physella cubensis* should actually be a synonym of *P. acuta. Biomphalaria* is also common in cool standing waters of Dominica. It is possible there may be several species of this genus present, but it is extremely difficult to distinguish these species morphologically (P. Jarne, pers. comm).

Amphipoda

The widespread amphipod, *Hyalella azteca*, was common in Freshwater and Boeri Lakes, and nearby sites (Table 1). This species is common among plant detritus in other standing water habitats of Barbados (Bass 2003a), Grenada (Bass 2004b), and Antigua (Bass 2005).

Decapoda

An extensive study of the decapod crustaceans by Chace and Hobbs (1969) yielded 13 species associated with freshwater habitats on Dominica. Because data from their study were easily available, I chose not to collect additional decapod specimens and limited my data to field observations. I noted at least six different decapod species from various streams across the island (Table 1), all of which were previously reported by Chace and Hobbs.

Acari

A single specimen of water mite was collected among a leaf pack from the Roseau River at Morne Louis. These small predators are often abundant in aquatic ecosystems (Thorp and Covich 2001) so it is likely they exist elsewhere, but this appears to be the first report of a hydrachnid from the Lesser Antilles.

Ephemeroptera

Five taxa of mayflies were collected in this study, increasing the number known from Dominica to six (Table 1). Of these, three are being reported from the island for the first time, including a nymph of a possible new species of Baetidae found in the River Deux Branches at Bells. However, it is necessary to collect an adult in order to describe a new species. Other baetids and *Tricorythodes* were abundant collectors, occurring in numerous streams across the island. Another abundant species in Dominica, *Allenhyphes flinti*, was previously reported from Montserrat (Baumgardner *et al.* 2003).

Odonata

Donnelly (1970) reported 21 species of odonates from Dominica. I found five of these and one additional species, *Brechymorhoga praecox grenadensis*, which he did not report (Table 1). The most abundant species was the damselfly, *Argia concinna*. Both of these species are also known from other mountainous islands in the eastern Caribbean region (Bass 2003b, 2004b, 2006).

Hemiptera

Five species of aquatic hemipterans were collected (Table 1). All of these are being reported for the first time from Dominica. *Brachymetra albinervis*, *Microvelia,* and *Rhagovelia pulchra* were abundant in streams throughout the island. *Microvelia* is extremely widespread throughout the Caribbean region and occurs on most islands having freshwater environments (Bass 2003c). Several species of *Rhagovelia* have been found on other nearby islands, but *R. pulchra* was recorded only from Dominica. Often these water striders exhibited wing polymorphism, a phenomenon that has been well documented among hemipterans living in isolated habitats (Roff 1990; Schuh and Slater 1995; Thorp and Covich 2001), and as observed on other small Caribbean islands (Bass 2003c).

Lepidoptera

The larvae of two species of aquatic moths were found on submerged rocks in stream riffles (Table 1). *Petrophila* was abundant in Dominica, as it was on other mountainous Caribbean islands (Bass 2003b, 2006). However, the larvae were inconspicuous as they existed in tiny crevices of the rocks beneath layers of silk during the daylight, only emerging during periods of darkness to scrape algae growing on the rocks.

Trichoptera

Flint (1968) reported 33 species of caddisflies from Dominica during his investigation and I collected at least seven of those species during the present study (Table 1). His efforts were focused on caddisflies, especially adults, and as a result he collected many more species than I encountered. The most common species found in my collections included *Chimarra antilliana*, *Helicopsyche guadeloupensis*, and *Smicridea cariba*. These three species appear to be widespread throughout the Caribbean region (Botosaneanu 2002).

Megaloptera

Flint (1970) collected only adults of *Chloronia antilliensis* near streams, but failed to find any larvae. His collections were made during April, May, and June while the single larvae I found was collected in early January, indicating the aquatic larval stage was not present during the spring, as suggested by Flint (1970). This species has also been found on the nearby island of Guadaloupe (Flint 1970).

Coleoptera

Only five species of aquatic beetles were collected from Dominica and all of these are new records for the island. Considering the size of Dominica and the large amount of freshwater present, it is surprising that so few species have been collected there (Bass 2003c). Adults of an unidentified species of Aleocharinae were commonly found among submerged leaf packs in streams. Both larvae and adults of the riffle beetle, *Hexanchorus caraibus*, were also common among submerged leaf debris. This species has also been reported from the nearby islands of Guadaloupe (Leng and Mutchler 1914), Martinique, St. Vincent, and Trinidad (Hinton 1971). A species of psephenid, *Psephenops smithi*, was collected at one site.

Diptera

Prior to this investigation, only nine species of aquatic dipterans had been reported from Dominica. I found 17 taxa in my collections, 10 of which are new records for the island, thus increasing the number of aquatic Diptera species known from Dominica to 19. The most abundant of these were larvae of the blackfly, *Simulium*, which could have included as many as three species (Stone 1969). These blackfly larvae often occurred in clusters on rocks where water flow was the greatest. As in St. Kitts and Nevis (Bass 2006), the majority of dipterans collected belonged to one family – the Chironomidae. Larvae of this family are very small and often live inconspicuously in the substrate, making it difficult to determine their abundances and distributions. In an investigation by Helson *et al.* (2006), densities exceeding 100 chironomid individuals / m^2 were observed in similar streams in Trinidad. Larvae of *Rheocricotopus* were the most frequently encountered chironomid in stream sediments across the island.

The Effect of Waterfalls on Species Composition

Covich (1988) reported that the richness of non-insect species declined upstream as insect species richness increased upstream in some Caribbean streams. Similar patterns also have been documented in Pacific island streams (Kinzie & Ford 1977; Resh *et al.* 1990).

It was hypothesized that any waterfalls encountered may impede further upstream movement for those species lacking a flying adult stage or unable to crawl on land. Therefore, the species composition of the macroinvertebrate community above a waterfall might be expected to be different from that below a waterfall. The waterfalls selected to test this hypothesis included Emerald Falls, Trafalgar Falls, Isulukati Falls, Middleham Falls, and Milton Falls. These falls have vertical faces that range in height from approximately 10 m to 90 m.

A total of 26 species of freshwater macroinvertebrates were found in samples collected above and below the waterfalls investigated (Table 1). These included both flying and non-flying taxa. Results of Sorenson's similarity analysis were inconclusive with values between the species compositions of upstream and downstream sites ranging from 0.0 to 0.5.

Several factors may be working in concert to determine the distribution of freshwater macroinvertebrates above and below waterfalls. Insects possessing wings and the ability to fly are able to disperse upstream and beyond waterfalls as adults. Baetidae, *Argia concinna, Rhagovelia pulchra, Chimarra antilliana, Petrophila, Cricotopus*, and *Simulium* are examples of insects commonly observed at collecting sites above waterfalls (Table 1). Studies by Muller (1954, 1982) have shown that adult insects innately fly upstream following mating to lay eggs. Certainly waterfalls do not represent a barrier to these taxa of flying invertebrates.

Waterfalls do not appear to be a barrier to some groups of non-flying aquatic invertebrates. In fact, most taxa of the decapod crustaceans were found above at least one waterfall (Table 1). Some of these species may disperse by leaving the stream, provided their gills remain moist. For example, the shrimps, *Macrobrachium* and *Atya*, were observed climbing on damp, moss-covered vertical rocks and presumably are able to climb waterfalls in this manner. These shrimps were observed to be unable to climb barren rocks in torrential flows, just as shrimps could not move upstream through smooth culverts at road crossings in Moorea (Resh 2004). Several individuals of the crab, *Guinotia dentata*, were observed crawling through damp leaves of the forest floor in the vicinity of Emerald Falls, Trafalgar Falls, and Middleham Falls. The only site above a waterfall where this crab occurred was Emerald Falls, the waterfall having the least vertical drop of all the falls studied. These observations indicate that *G. dentata* exits the water and moves through the forest around smaller waterfalls. Yule (1995) suggested decapod crustaceans in a South Pacific island stream may avoid extremely high flowing reaches of a stream by walking upstream along the banks.

Diadromous snails, such as nerites (Neritidae), that require the marine environment during part of their life cycle (Maciolek 1978; Ford 1979) find that large waterfalls might act as barriers as they return from the sea. Although nerites were common in collections from several stream sites in Dominica, none was encountered above waterfalls. Starmuhlner (1979) reported that nerites occurring in streams of Indo-Pacific islands were generally limited to lower reaches of the rivers influenced by brackish water. *Neritina canalis* was found over 3 km upstream from the mouth of the Opunochu River on Moorea (Resh *et al.* 1992). In another investigation, Resh (2004) described how elevated culverts used at bridge crossings were barriers to upstream movements of nerites.

The presence of a waterfall alone may not always explain the differences in community composition between upstream and downstream sites. The differences could be due to differences in microhabitats or other environmental conditions at those sites as well. This was observed while collecting at Isulukati Falls and Milton Falls. Isulukati Falls flows directly into the Caribbean Sea, a marine environment unsuitable to freshwater stages of aquatic life. A spring containing high iron and sulfur concentrations emerges at the base of Milton Falls altering the water chemistry and thus changing the downstream community composition. Even if the waterfalls at those two sites were not barriers to upstream movements, it would be expected that differences in species composition would exist due to environmental changes in the waters between the areas above and below the falls.

The data obtained indicate that waterfalls do not represent a barrier to upstream migration for flying insects. In addition, some species of non-flying invertebrates, such as shrimps and crabs, may have the ability to climb or move around waterfalls while others, such as nerites, may find waterfalls impede their upstream movement. If proper microhabitats or suitable environmental conditions are lacking above a waterfall, then an individual that successfully moved over or around the falls may not be able to remain there.

Dominica contained more species of freshwater macroinvertebrates than any of the other small Caribbean islands studied (Bass 2003c). This result was predicted by island biogeography theory (MacArthur and Wilson 1967) because Dominica has considerably larger surface area and has much greater relief. Furthermore, there is a greater abundance of freshwater environments, due to the large amount of precipitation. In addition, there is less development and other detrimental human activities on Dominica that may have negatively impacted the freshwater habitats than on many of the other islands.

Sorenson's similarity index indicates the greatest faunal similarities were between Dominica and Grenada (0.349) and Dominica and St. Kitts (0.341) (Table 2). The similar similarity values shown by St. Kitts and Grenada are somewhat surprising given that Grenada is approximately half the size of St. Kitts and 50% further from Dominica than St. Kitts. This would not have been predicted by island biogeography theory. All three islands have similar mountain stream habitats and there is much overlap in the species assemblages of those flowing waters. Comparisons with other islands of the eastern Caribbean had values ranging from 0.123 to 0.262. The island of the Lesser Antilles having the least faunal similarity with Dominica was Saba, a very small, steep island that lacks streams entirely. Generally the more distant islands of the western Caribbean had lower similarity values when compared with Dominica, as was predicted by island biogeography theory.

Table 2. Sorensen's index of similarity values comparing the freshwater macroinvertebrate fauna of Dominica to that of other small Caribbean islands, including approximate distances to those islands from Dominica and approximate island sizes. Range of values: 0.00 = 0% common taxa and 1.00 = 100% common taxa.

Island	Approximate Distance (km)	Approximate Size (km^2)	Similarity Value
St. Lucia	130	616	0.198
Montserrat	140	83	0.206
Antigua	155	280	0.212
Nevis	200	94	0.175
St. Kitts	220	751	0.341
Barbados	290	430	0.262
Saba	295	13	0.123
Grenada	335	346	0.349
Tobago	450	300	0.252
Cayman Brac	2,045	37	0.029
Little Cayman	2,065	26	0.081
Grand Cayman	2,175	197	0.151
Guanaja	2,675	69	0.074

Dominica is an oceanic island so its freshwater macroinvertebrate fauna had to colonize this island from elsewhere. These immigrants must have suitable dispersal mechanisms and be able to tolerate unfavorable conditions encountered while crossing ocean waters (Bass 2003c). Upon arrival, they must then locate suitable freshwater microhabitats to colonize. Although numerous freshwater taxa, especially trichopterans and dipterans, have been reported only from Dominica, it is uncertain whether they evolved in isolation there and are endemic to the island. As further investigations are conducted on Dominica and nearby islands, additional species may be found and the distribution of freshwater invertebrates on small Caribbean islands will be better understood.

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REFERENCES

Alkins-Koo, M. 1990. The aquatic fauna of two intermittent streams in the Southwestern Peninsula, Trinidad. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club,* 1989/90: 36-42.

Alkins, M., Desouza, G., Koo, M., Lip, R. L. C. and **Shadid, S.** 1981. A study of the aquatic fauna of the Aripo Savannas. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club,* 1981/82: 16-19.

Bacon, P. R., Jaikaransingh, E. and **Seeberan, G.** 1978. Notes on some freshwater mollusks from Nariva Swamp, Trinidad. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club,* 1978: 14-15.

Bass, D. 2000. Freshwater invertebrates. *In* **D. Robinson** and **J. Lowery,** eds. The Natural History of the Island of Nevis. Ithaca, NY: Nevis Historical and Conservation Society Press. 69 p.

Bass, D. 2003a. Freshwater macroinvertebrates of Barbados. *Journal Barbados Museum and Historical Society*, 49: 269-280.

Bass, D. 2003b. A survey of freshwater macroinvertebrates in Tobago, West Indies. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club*, 2003: 64-69.

Bass, D. 2003c. Comparison of freshwater macroinvertebrate communities from small Caribbean islands. *BioScience*, 53: 1094-1100.

Bass, D. 2004a. Diurnal stream drift of benthic macroinvertebrates on the small oceanic island of Dominica, West Indies. *Caribbean Journal Science*, 40: 245-252.

Bass, D. 2004b. A survey of freshwater macroinvertebrates on Grenada, West Indies. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club*, 2004: 26-31.

Bass, D. 2005. A survey of freshwater macroinvertebrates on Antigua, West Indies. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club*, 2005: 11-14.

Bass, D. 2006. A comparison of the freshwater macroinvertebrate assemblages of St. Kitts and Nevis, West Indies. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club*, 2006: 30-37.

Baumgardner, D., Burian, S. and **Bass, D.** 2003. Life stage descriptions, taxonomic notes, and new records for the mayfly family Leptohyphidae (Ephemeroptera). *Zootaxa*, 332: 1-12.

Botosaneanu, L. 2002. An annotated checklist of caddisflies from the Caribbean islands, with distribution and bibliography (Insecta: Trichoptera). *Bulletin de la Societe entomologique de France,* 107 (1): 79-108.

Botosaneanu, L. and **Alkins-Koo, M.** 1993. The caddisflies (Insecta: Trichoptera) of Trinidad and Tobago, West Indies. *Bulletin de L'Institut Royal des Sciences Naturrelles de Belgique, Entomologie,* 60: 39-48.

Chace, F. A. Jr. and **Hobbs, H. H.** 1969. Bredin-Archbold-Smithsonian Biological Survey of Dominica. The freshwater and terrestrial decapod crustaceans of the West Indies with special reference to Dominica. *US National Museum Bulletin*, 292. 258 p.

Covich, A. P. 1988. Geographical and historical comparisons of neotropical streams: biotic diversity and detrital processing in highly variable habitats. *Journal of the North American Benthological Society*, 7: 361-386.

Dillon, R. T. Jr., Robinson, J. D., Smith, T. P. and **Wethington, A. R.** 2005. No reproductive isolation between freshwater pulmonate snails *Physa virginata* and *P. acuta*. *Southwestern Naturalist,* 50: 415-422.

Donnelly, T. W. 1970. The odonata of Dominica, British West Indies. *Smithsonian Contributions in Zoology*, 37: 1-20.

Flint, O. S. Jr. 1968. Bredin-Archbold-Smithsonian Biological Survey of Dominica. 9. The Trichoptera (Caddisflies) of the Lesser Antilles. *Proceedings US National Museum*, 125: 1-86.

Flint, O. S. Jr. 1970. The Megaloptera of Dominica. *Proceedings of the Entomological Society of Washington,* 72: 240-242.

Flint, O. S. Jr. 1996. Studies of Neotropical caddisflies LV: Trichoptera of Trinidad and Tobago. *Transactions of the American Entomological Society,* 122: 67-113.

Flint, O. S. Jr. and **Sykora, J.** 1993. New species and records of caddisflies (Insecta: Trichoptera) from the Lesser Antilles, with special reference to Grenada. *Annals of Carnegie Museum*, 62: 47-62.

Ford, J. I. 1979. Biology of a Hawaiian fluvial gastropod *Neritina granosa* Sowerby (Prosobranchia: Neritidae). M.S. Thesis, University of Hawaii, 94 p.

Harrison, A. D. and **Rankin, J. J.** 1975. Forest litter and stream fauna on a tropical island, St. Vincent, West Indies. *Verhanderlungen International Vereins Limnologie,* 19: 1736-1745.

Harrison, A. D. and **Rankin, J. J.** 1976a. Hydrobiological studies of eastern Lesser Antillean islands. I. St. Vincent: freshwater habitats and water chemistry. *Archives of Hydrobiology/Supplement,* 50: 96-144.

Harrison, A. D. and **Rankin, J. J.** 1976b. Hydrobiological studies of eastern Lesser Antillean islands. II. St. Vincent: freshwater fauna – its distribution, tropical river zonation and biogeography. *Archives of Hydrobiology/Supplement,* 50: 275-311.

Hart, C. W. Jr. 1980. New freshwater shrimp records for Tobago, West Indies, with a summary of records for the Lesser Antilles (Atyidae and Palaemonidae). *Proceedings of the Biological Society of Washington*, 93: 845-848.

Helson, J., Williams, D. D. and **Turner, D.** 2006. Larval chironomid community organization in four tropical rivers:

human impacts and longitudinal zonation. *Hydrobiologia*, 559: 413-431.

Hinton, H. E. 1971. The Elmidae (Coleoptera) of Trinidad and Tobago. *Bulletin of the British Museum of Natural History (Entomology),* 26: 245-265.

Hynes, H. B. N. 1971. Zonation of the invertebrate fauna in a West Indian stream. *Hydrobiologia,* 38: 1-8.

Kinzie, R. A. and **Ford, J. I.** 1977. A Limnological Survey of Lower Palikes and Pipwai Streams, Kipahula, Maui, Manoa: Cooperative National Park Resources Study Unit, Department of Botany, University of Hawaii at Manoa. Technical Report 17.

Leng, C. W. and **Mutchler, A. J.** 1914. A preliminary list of the coleopteran of the West Indies as recorded to Jan. 1, 1914. *Bulletin of the American Museum of Natural History*, 3: 391-493.

MacArthur R. H. and **Wilson, E. O.** 1967. The Theory of Island Biogeography. Princeton, NJ: Princeton University Press. 203 p.

Maciolek, J. A. 1978. Shell character and habitat of non-marine Hawaiian neritid snails. *Micronesica*, 14: 209-214.

McKillop, W. B. and **Harrison, A. D.** 1980. Hydrobiological studies of eastern Lesser Antillean islands. I. St. Lucia: freshwater habitats, water chemistry and distribution of freshwater mollusks. *Archives of Hydrobiology/Supplement*, 57: 251-290.

Merritt, R. W. and **Cummins, K. W.** 1996. An Introduction to the Aquatic Insects of North America. Dubuque, IA: Kendall/Hunt Publ. Co. 862 p.

Muller, K. 1954. Investigations on the organic drift in North Swedish streams. *Report of the Institute of Freshwater Research, Drottningholm*, 35: 133-148.

Muller, K. 1982. The colonization cycle of freshwater insects. *Oecologia*, 52: 202-207.

Nieser, N. and **Alkins-Koo, M.** 1991. The Water Bugs of Trinidad and Tobago. St. Augustine, Trinidad and Tobago: Zoology Department, Univ. of the West Indies, Occasional Paper No. 9.

Resh, V. H. 2004. Stream crossings and the conservation of diadromous invertebrates in South Pacific island streams. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 15: 313-317.

Resh, V. H., Barnes, J. R., Benis-Steger, B. and **Craig, D. A.** 1992. Life history features of macroinvertebrates in a French Polynesia stream. *Studies on Neotropical Fauna and Environment*, 27: 145-153.

Resh, V. H., Barnes, J. R. and **Craig, D. A.** 1990. Distribution and ecology of benthic macroinvertebrates in the Opunochu River catchment, Moorea, French Polynesia. *Annals of Limnology,* 26: 195-214.

Roff, D. A. 1990. The evolution of flightlessness in insects. *Ecological Monographs*, 60: 389-421.

Schuh, R. T. and **Slater, J. A.** 1995. True Bugs of the World (Hemiptera: Heteroptera). Classification and Natural History. Ithaca, NY: Cornell University Press, 416 p.

Sorenson, T. 1948. A method of establishing groups of equal amplitude in a plant society based on similarity of species content and its application to analysis of vegetation on Danish commons. *Biologiske Skrifter Kongelige Danske Videnskabernes Selskab*, 5: 1-34.

Starmuhlner, F. 1979. Distribution of freshwater mollusks in mountain streams of tropical Indo-Pacific islands (Madagascar, Ceylon, New Caledonia). *Malacologia*, 18: 245-255.

Stone, A. P. 1969. The black flies of Dominica. *Proceedings of the Entomological Society of Washington*, 71: 312-318.

Thorp, J. H. and **Covich, A. P.** 2001. Ecology and Classification of North American Freshwater Invertebrates. 2nd ed. San Diego, CA: Academic Press, 1056 p.

Yule, C. 1995. Benthic invertebrate fauna of an aseasonal tropical mountain stream on Bougainville Island, Papua Guinea. *Marine and Freshwater Research*, 46: 507-518.