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# Freshwater Macroinvertebrates and Their Habitats in Saba, West Indies

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## ABSTRACT

A survey of macroinvertebrates inhabiting freshwater habitats of Saba was conducted during 1999 and 2006. Freshwater habitats in Saba include ornamental ponds, a spring, temporary pools, and open cisterns. A total of 18 species was collected during the research, 17 of which are reported for the first time on Saba. Generally the freshwater macroinvertebrate fauna of Saba is sparse, most likely due to the oceanic origin of the island, its small size, a limited amount of freshwater habitats, and challenges colonizing such a habitat.

**Key words:** Freshwater invertebrates, Saba, Lesser Antilles.

## INTRODUCTION

Saba is a small island located near the northern end of the Lesser Antilles in the eastern Caribbean Sea. The island is volcanic in origin and thought to have emerged from the ocean approximately 30,000 years ago, with its last major eruption about 5,000 years ago. Maximum elevation reaches 887 m and its surface area encompasses approximately 13 km<sup>2</sup> (McLean 2004).

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 and related ecological studies have been conducted on some islands including Barbados (Bass 2003a), St. Vincent (Harrison and Rankin 1975, 1976), St. Lucia (McKillop and Harrison 1980), Dominica (Flint 1968, 1970; Chace and Hobbs 1969; Stone 1969; Donnelly 1970; Baumgardner *et al.* 2003; Bass 2004a, 2007), Antigua (Bass 2005), Grenada (Flint and Sykora 1993; Baumgardner *et al.* 2003; Bass 2004b), St. Kitts (Bass 2006), Nevis (Bass 2000, 2006), Montserrat (Baumgardner *et al.* 2003), Tobago (Hart 1980; Nieser and Alkins-Koo 1991; Botosaneanu and Alkins-Koo 1993; Flint 1996; Baumgardner *et al.* 2003; 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). The only known freshwater macroinvertebrate from Saba is an aquatic hemipteran reported by Cobben (1960).

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

## MATERIALS AND METHODS

Nine collections were made from various freshwater habitats across Saba during May 1999, May 2006, and October 2006 (Figure 1). Water temperature was recorded from each site at the time of collection.

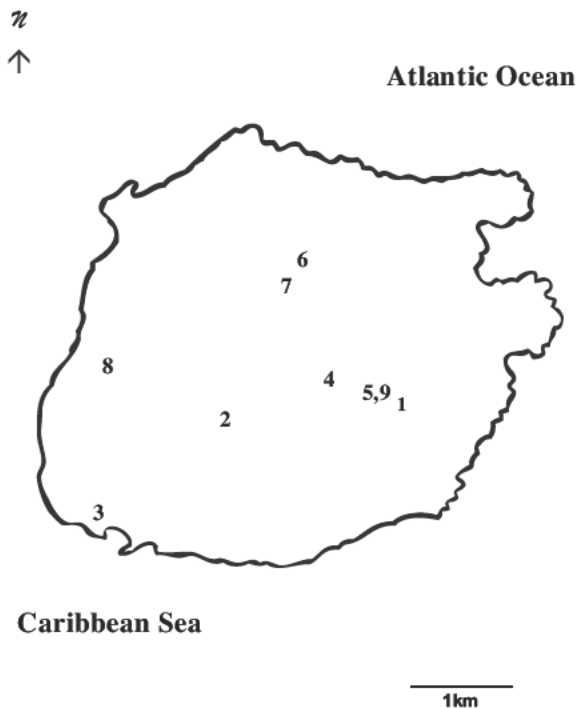
Several methods of collecting were employed to ensure as many species as possible were captured. Submerged debris, such as stones, leaves, and wood, were carefully examined and inhabitants were picked from the substrate using forceps. A dip net (mesh = 0.1mm) was swept through aquatic vegetation and 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, 2007) so comparisons of the results could be made.

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 Saba with similar endeavors on other small Caribbean islands. A published collection by Cobben (1960) was also consulted and included in the final listing of species, although it was not used in the similarity analysis, due to variations in collecting efforts between the studies.

## RESULTS AND DISCUSSION

### Freshwater Habitats

Very few natural freshwater habitats exist on Saba and none are permanent. Freshwater habitats sampled on Saba include ornamental ponds, a spring, temporary pools, and open (abandoned) cisterns. Water temperatures ranged from 23-29 °C in these habitats.



**Fig. 1.** Map indicating location of collecting sites in Saba. Specific location, collection, date, approximate elevation, and water temperature at sites are listed in legend of Table 1.

Small ornamental ponds began to be constructed on Saba during the late 1990's. These usually were composed of rock and often contained imported aquatic vascular plants. Most of these ponds have surface areas of less than 5 m<sup>2</sup> and depths of no more than 0.5 m. It is likely that some freshwater invertebrates associated with the imported plants were introduced to Saba inadvertently when those plants were placed in these artificial ponds.

Fort Bay Spring was a small spring with an emergence pool surface area of less than 2 m<sup>2</sup> and depth less than 0.1 m. This spring emerged on a steep slope on the south side of Bunker Hill approximately 10 meters above sea level. Fine silt and rock composed the bottom sediment, and goats were frequently observed to drink water from the spring. This spring was covered by a landslide that resulted from the heavy rainfall that occurred during Hurricane Lenny in November of 1999 and no longer exists.

Temporary pools may result following heavy rainfall, particularly in forested areas. The most persistent of these habitats occurs in a ravine located in the Saba National Park along the Sandy Cruz Trail. Decomposing leaves and sediments make up the substrate of this small pool that has a surface area of about 1 m<sup>2</sup> and maximum depth of 0.15 m. This particular pool holds water during all but the driest periods. However, it may be flushed and its inhabitants washed away during periods of sustained heavy rainfall,

as was observed during October of 2006. Water may also be held for about 90 days in the bracts of *Heliconia caribaea* (wild plantain) and aquatic invertebrates have been observed living in these ephemeral microhabitats.

Because there are no permanent sources of fresh water on Saba, cisterns have been constructed by individuals to store water, mostly captured and diverted rainwater. Some of the older cisterns, which are abandoned today, were constructed over 200 years ago. These old cisterns are open to the environment, making them available habitats for invertebrates to colonize. They may contain as much as 5-10 m<sup>3</sup> of water throughout the year. Bottom sediments are mostly silt and decomposing plant debris.

### Freshwater Macroinvertebrates

A total of at least 18 species representing eight major groups was collected from the freshwater habitats of Saba. Seventeen of these species are reported for the first time from the island (Table 1).

### Hirudinea

A single specimen of *Helobdella elongata* was collected from the Saba Museum Pond (Table 1). This small ornamental pond contained imported aquatic vascular plants and the leech probably came to Saba with the plants. Unless other individuals of this species are present for mating, it did not reproduce and therefore did not leave behind offspring to continue to colonize this and other Saba ponds.

### Gastropoda

Two taxa of snails were collected from ornamental ponds and cisterns, permanent man-made standing bodies of water that now exist in Saba (Table 1). The eurytolerant pond snail, *Physella*, is widespread in ponds throughout the Caribbean basin and *Tropicorbis pallidus* is common in the Lesser Antilles (Harrison and Rankin 1976; McKillop and Harrison 1980; Bass 2003a, 2003b, 2004b, 2005, 2006, 2007).

### Ostracoda

Ostracods were extremely abundant in the forest pool near the Sandy Cruz Trail during May of 2006. All appeared to be the same species and were identified as *Heterocypris margarita* (Table 1). This species has been found in temporary pools on several small islands in the southern Caribbean basin (L. D. Delorme, personal communication). Additional ostracod taxa have been reported from other Lesser Antillean islands (Harrison and Rankin 1976; Bass 2005, 2006), but none have been collected from temporary pools in forests.

**Table 1.** List of freshwater macroinvertebrates, including collecting sites, life cycle stages present, relative occurrence, and microhabitats in Saba during May 1999, May 2006, and October 2006. \*Indicates taxa previously not reported from Saba. Life cycle: A, adult; J, juvenile; L, larva; N, nymph. Occurrence: +++ abundant, ++ common, + rare.

Taxa	Collection Sites	Life Cycle	Occurrence	Microhabitat	Trophic Relationship <sup>1</sup>
<b>Hirudinea</b>					
<i>Helobdella elongata</i> *	9	A	+	Detritus	Predator
<b>Gastropoda</b>					
<i>Physella</i> sp.*	1, 5, 9	J, A	+++	Detritus, Rock	Detritivore
<i>Tropicorbis pallidus</i> *	2, 4, 5, 9	J, A	+++	Detritus, Rock	Detritivore
<b>Ostracoda</b>					
<i>Heterocypris margarita</i> *	6	J, A	++	Plankton	Detritivore
<b>Odonata</b>					
<i>Ischnura ramburi</i> *	1, 5, 9	N, A	++	Detritus	Predator
<i>Orthemis ferruginea</i> *	8	N	+	Detritus	Predator
<i>Pantala flavescens</i> *	1, 2	N	+	Detritus	Predator
<b>Hemiptera</b>					
<i>Microvelia puchella</i>	1, 2, 4, 10	N, A	+++	Neuston	Predator
<b>Coleoptera</b>					
<i>Celina</i> sp.*	6	A	+	Detritus	Predator
<i>Laccobius</i> sp.*	6	A	+	Detritus	Herbivore
<i>Tropisternus lateralis</i> *	1	L	+	Detritus	Collector
<b>Diptera</b>					
<i>Ablabesmyia</i> poss. new species*	3, 8	L	+	Sediment	Predator
<i>Aedes</i> sp.*	7	L	+	Plankton	Collector
<i>Apedilum</i> sp.*	1	L	+	Sediment	Collector
<i>Chironomus</i> sp.*	4, 8	L	++	Detritus	Collector
<i>Dasyhelea</i> sp.*	7	L	+	Detritus	Collector
<i>Stratiomys</i> sp.*	7	L	+	Detritus	Collector
<b>Acari</b>					
Hydrachnida*	8	J, A	+	Detritus	Predator

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

**Collection Sites:** 1) Lynn Pond, Windwardside, 19 May 1999 (397m, 28°C); 2) St. John Cistern, St. John, 21 May 1999 (390m, 24°C); 3) Fort Bay Spring, Fort Bay, 21 May 1999 (8m, 29°C); 4) Ecolodge Pond, Windwardside, 16 May 2006 (513m, 25°C); 5) Saba Museum Pond, Windwardside, 17 May 2006 (386m, 28°C); 6) Sandy Cruz Trail Pool, Saba National Park, 21 May 2006 (570m, 23°C); 7) *Heliconia* Inflorescence, Mt. Scenery (north slope), 21 May 2006 (780m); 8) Cow Pasture Cistern, The Gap, 21 May 2006 (150m, 25°C); 9) Museum Pond, Windwardside, 17 October 2006 (386m, 28°C); 10) Collected and reported by Cobben (1960).

**Odonata**

Three species of odonates, one damselfly and two dragonflies, were collected from permanent man-made aquatic habitats (Table 1). These act as predators, probably feeding mostly on other small insects. Nymphs were found crawling among living aquatic vascular plants and decomposing plant debris. All have been reported from

other Lesser Antillean islands (Donnelly 1970; Harrison and Rankin 1976; Bass 2003a, 2003b, 2004b, 2005, 2006, 2007). Adult odonates are strong fliers and could have easily colonized Saba from other nearby islands.

**Hemiptera**

The broad-shouldered water strider, *Microvelia*

*puchella*, was the only species of hemipteran collected in this study. *Microvelia* is reported to be widespread throughout the Caribbean islands (Harrison and Rankin 1976; Bass 2003a, 2003b, 2003c, 2004b, 2005, 2006, 2007). This species was previously reported from Saba by Cobben (1960) in collections made almost 50 years ago. All specimens collected were wingless adults, an adaptation to island habitats (Roff 1990).

### Coleoptera

Three species of beetles were collected from aquatic habitats on Saba (Table 1). Two of these, *Celina* and *Laccobius*, inhabited the temporary pool while *Tropisternus lateralis* was found in an ornamental pond. *T. lateralis* is one of the most widespread aquatic beetles in the eastern Caribbean basin, being reported from Barbados (Bass 2003), Antigua (Bass 2005), St. Kitts and Nevis (Bass 2006). Because larvae of *T. lateralis* were collected, this species is probably persisting and reproducing on Saba.

### Diptera

Six genera of dipterans were collected from a variety of freshwater habitats across the island (Table 1). Three of these, *Aedes*, *Dasyhelea*, and *Stratiomys*, were found only in the water-filled bracts of *Heliconia caribaea* on the northern slope of Mount Scenery within the Saba National Park. The remaining three, *Ablabesmyia*, *Apedilum*, and *Chironomus*, are all midges of the family Chironomidae. The eurytolerant *Chironomus* has a widespread distribution throughout the Holarctic region (Wiederholm 1983).

Larval specimens of what appears to be a new species of *Ablabesmyia* were first collected during May 1999 from Fort Bay Spring, a habitat that no longer exists.

However, no adults were encountered so this could not be described as a new species. Because this site was the only known location from where this species was found, it was thought the species had gone extinct before it could be described. Fortunately, a larva of this species was discovered in a collection from Cow Pasteur Cistern during May 2006. Although it appears this species still persists, it remains undescribed until adults are observed.

### Acari

Both juvenile and adult specimens of water mites (Ascidae) were collected from water in the bracts of *Heliconia caribaea*. These appear to be abundant in this habitat, but the water-filled bracts are the only habitat from where they were encountered. Because both juveniles and adults were found, it is reasonable to assume the population is healthy and reproducing.

The similarity analysis of fauna (Sorenson 1948) produced results that are unclear (Table 2). The two islands nearest to Saba in this study, St. Kitts and Nevis, had similarity values of 0.13 and 0.17, respectively. Saba shared the greatest faunal similarity with Antigua (0.27), a somewhat nearby island that has quite a few agricultural ponds and few streams. However, it was unexpected to find Grand Cayman, a distant island possessing a few ponds and lacking flowing water altogether, had the next highest similarity value (0.26). Because only standing water is present on Saba, it is reasonable that Antigua and Grand Cayman showed the highest faunal similarity values to Saba as the fauna of all three islands is largely composed of lentic species. In addition, the relatively low number of species present in Saba, Antigua, and Grand Cayman allow for only a few taxa in common between islands to raise the similarity values.

**Table 2.** Sorenson's index of similarity values comparing the freshwater macroinvertebrate fauna of Saba to that of other small Caribbean islands, including approximate distances to those islands from Saba 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 <sup>2</sup> )	Similarity Value
St. Kitts	50	177	0.13
Nevis	80	94	0.17
Montserrat	130	83	0.10
Antigua	150	280	0.27
Dominica	295	751	0.12
St. Lucia	440	616	0.17
Barbados	595	430	0.18
Grenada	610	346	0.12
Tobago	760	300	0.11
Cayman Brac	1,780	37	0.16
Little Cayman	1,805	26	0.00
Grand Cayman	1,920	197	0.26
Guanaja	2,430	69	0.06



Island biogeography theory (MacArthur and Wilson 1967) predicts that the number of species present on an island will increase as island size increases. Saba is considerably smaller (13 km<sup>2</sup>) than other islands of the eastern Caribbean where published surveys of freshwater macroinvertebrates have occurred and it possesses only 18 species, the lowest number observed among these studies. The nearby islands of St. Kitts (177 km<sup>2</sup>) and Nevis (94 km<sup>2</sup>) have reports of 57 and 61 species, respectively (Bass 2006). Dominica (751 km<sup>2</sup>) is the largest of these islands and it is known to have at least 116 species (Bass 2007). Not only does a smaller island have fewer suitable habitats, but it is also a smaller target for colonizers to locate.

Currently an investigation describing the community of aquatic macroinvertebrates inhabiting the water-filled bracts of *Heliconia caribaea* inflorescences in Saba is being conducted (C. Bass, personal communication). Results from this study are likely to increase the number of aquatic invertebrate species known from Saba.

## CONCLUSIONS

It is suspected that additional species of freshwater invertebrates will be found in Saba as additional plants are imported. Therefore, it is recommended that plants arriving from off the island be closely examined to reduce the number of introduced aquatic invertebrates. Additionally, imported aquatic plants should be held in quarantine long enough for eggs of aquatic invertebrates to hatch so immatures will be detected more easily. The species diversity of Saba is relatively low, primarily due to a lack of freshwater habitats. There are no naturally-occurring permanent waters on the island; only a few small cisterns and ornamental ponds have been constructed in recent times to permanently contain water. Also, the island is quite small and oceanic in origin, making it difficult to be reached and colonized by freshwater invertebrates. As some of the ephemeral habitats are further studied, such as water-filled *H. caribaea* bracts, it is likely that the number of aquatic invertebrate species reported on Saba will increase.

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