Spiders (Arachnida: Araneae) of Saba Island, Lesser Antilles: Unusually high species richness indicates the Caribbean Biodiversity Hotspot is woefully undersampled

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Abstract. Saba Island (Caribbean Netherlands) is one of the northernmost islands of the Lesser Antilles. It is only 13 square kilometers but contains a wide variety of potential spider habitats including dry, moist, and elfin forests. As part of a collaborative effort between Conservation International and Saba Conservation Foundation, during a several week period in March and May 2008 we briefly surveyed the island for spiders and other arthropods. This survey, the first for spiders of Saba, resulted in the identification of 18 families and 76 spider species, including six new species that will be described elsewhere and may be endemic to Saba. The species richness of Saba’s spider fauna is considerably higher than that reported from other small Caribbean islands. We conclude this is probably a combined result of undersampling and lower habitat diversity on these other islands.

Keywords. Araneae, Biodiversity Hotspot, Caribbean, Species list.

Introduction

Saba Island (17°38’N, 63°14’W) is one of the northernmost volcanic islands among the Lesser Antilles island arc chain. Geologically the island has undergone many periods of volcanic activity and lava flows followed by dense revegetation (Defant et al. 2001) since its presumed origin above sea level sometime between 500,000 and 10,000 years ago (Westermann and Kiel 1961). With relevance to the island’s biogeographic history, Saba was never connected to any extant island but was possibly connected to a large island, now submerged, four kilometers to the southwest known as the Saba Bank (Westermann 1957). Although small (13 km²), Saba has a variety of plant communities including subtropical dry-forest scrub, moist forest, palm breaks, and elfin woodland (Stoffers 1956). The center of the island is a volcanic cone, Mt. Scenery, reaching 877 m in elevation, and characterized by steep hillsides, bluffs and narrow valleys. The rugged topography of the island has limited human expansion, although an airport and dock now exist. No previously published records for spiders could be located for Saba although the island has had its larger organisms such as plants and vertebrates, and some invertebrates inventoried (Rojer 1997 and citations therein).

Saba is found within what has been defined as the Caribbean Island Hotspot (CIH) (Smith et al. 2005). This area, which includes the Bahamas, the Greater Antilles, and the Lesser Antilles, shows high levels of endemism for the available surface area in many of the taxa occurring on the islands. Remarkably high endemism in the CIH has been found in the reptiles (468 of 499 species are endemic) and amphibians (162 of 164 species are endemic) (Smith et al. 2005). High species’ extinctions in the hotspot are mainly due to western-style developments and agriculture, as well as from the introduction of invasive species. It is estimated that 36 vertebrate species have gone extinct in the area since 1500 A.D. (Smith et al. 2005).
Methods

Specimens were collected from 33 sites in 11 macrohabitats (Fig. 1, Table 1) primarily from 9-16 March 2008. Various collection methods were employed, these included sweep net, beat sheet, pitfall trap (10 cm diam.), flight intercept trap, blacklight, and hand collecting at night with the aid of a headlamp. Sampling effort involved, on average, 6-8 hours per day of active collection. Sweep net and beat sheet effort was not recorded and varied depending on the habitat of the collection site. Transects were also not employed, rather, collections were made within a 20 m area of the recorded location. Night collecting was limited to close proximity of roadways for easy access.

Spiders were collected primarily by the first author. Pitfall traps were allowed to remain active for a period of three weeks and were collected by the second author during 18-26 May 2008. Additional specimens were collected by Gary Alpert who surveyed ants, Piotr Naskrecki who targeted orthopteroids, and Michael Ivie who, along with the second author, focused on beetles. Vouchers of ants and orthopteroids are deposited in the Museum of Comparative Zoology, Harvard University, and beetles are in the WIBF (West Indies Beetle Fauna Collection) Montana State University. Spiders were collected in 75% ethanol, transferred to 95% propylene glycol for travel, then rinsed and returned to 75% ethanol. Identifications were made primarily by the first author using the Denver Museum of Nature and Science arachnological collection. Additional identifications were made by Darrell Ubick (California Academy of Sciences), Dr. Herb Levi (Harvard University, retired), Dr. Sarah Crews (University of California), and Dr. G. B.
Table 1. Collection locations of spider specimens on Saba Island (17°38′N, 63°14′W), Lesser Antilles. Geocoordinates obtained via a Garmin GPS unit in the field under the WGS 84 Datum with errors ranging from 20m to 100m. Macrohabitat data taken from flora classification map by Stoffers (1956).

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>N</th>
<th>W</th>
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<td>63.2267</td>
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<td>63.2341</td>
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<td>palm brake / elfin woodlands</td>
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<td>63.2200</td>
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<td>woodland derived from seasonal forest</td>
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<tr>
<td>29</td>
<td>Spring Bay beach</td>
<td>17.6374</td>
<td>63.2213</td>
<td>0</td>
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<td>Spring Bay Trail, ~1.5km in</td>
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<td>63.2240</td>
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<td>63.2280</td>
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<td>63.2300</td>
<td>350</td>
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</table>

Results

In all, 286 spiders were collected from 18 families, representing 76 species (see ‘Records’ below). Of these, six are undescribed, and 27 could only be identified to generic or family level. Records are sorted alphabetically by family. Location of collection on Saba is also noted (Fig. 1, Table 1). Nomenclature follows the World Spider Catalog Version 11.5 (Platnick 2011).

Discussion

Caribbean spider diversity is poorly known. This survey identified six new species but many more new species may exist because revisionary work on many Caribbean genera has not been undertaken. Moreover, taxonomic expertise does not exist for many genera found in this survey, resulting in identifications being limited at the generic or family level. One possible cause of this high number of unidentifiable specimens may be due to the possible endemic nature of some Caribbean spider genera (Crews et al. 2009, Crews and Gillespie 2010, Huber et al. 2010). This endemcity may be responsible for the four unidentifiable species of Modisimus Simon 1893 (Pholcidae), six of Thymoites Keyserling 1884 and two of
Styposis Simon 1894 (both Theridiidae). It is interesting to note that several forms of well revised genera, Tetragnatha Latreille 1804 (Tetragnathidae), Misumenops F. O. Pickard-Cambridge 1900, Tmarus Simon 1875 (both Thomisidae), and Eustala Simon 1895 (Araneidae), could not be identified and may also be new species. Heteroonops saba Platnick and DuPérré (2010) is the first new species to be described from specimens of this survey as part of a Planetary Biodiversity Inventory project focused on goblin spiders (Oonopidae). Additional new species listed as such in this paper will be described in subsequent publications.

Recent surveys of smaller Caribbean islands over similar short periods of time have resulted in far fewer numbers of species being collected. [Nevis, 93 km², 12 species (Sewlal and Starr 2007); St. Kitts, 168 km², 36 species (Sewlal 2008); Grenada, 344 km², 22 species (Sewlal 2009a); Antigua, 281 km², 34 species (Sewlal 2009b); Barbados, 431 km², 47 species (Alayon-Garcia and Horrocks 2004); Turks and Caicos, 430 km², 66 species (S. Crews unpublished data)]. The observation that species richness increases with area sampled has been called one of the few laws of ecology (Rosenzweig 1995, Tjørve 2003, Sizling and Storch 2004). The higher number of species (76) listed from Saba, a mere 13 km² (Fig. 2), may be explained by greater collecting effort, and most likely, more diverse habitats being located in closer proximity to each other, allowing for relatively more extensive sampling per unit time. These results are far fewer than the

![Figure 2. Spider species richness by island area showing dramatic undersampling of most islands and lack of expected positive species-area relationship. Islands are ordered by size from smaller to larger as follows: Saba, Nevis, St. Kitts, Antigua, Grenada, Turks and Caicos, Barbados. See text for data sources.](image-url)
potential diversity of species on larger Caribbean islands [Cuba, 602 species (Alayón-Garcia 1995)] or island chains [St. Vincent and the Grenadines, 181 species (de Silva et al. 2006)].

The slope of the species-area line (Fig. 2) suggests little to no relationship between species richness and area for these islands. This resembles the “small island effect” noticed by earlier workers and explained by Brown and Lomolino (1998) and Lomolino (2000). This effect describes a lack of relationship between size and species numbers for the smallest of areas sampled due to richness being more strongly driven by factors other than area, such as habitat characteristics, disturbance (e.g. volcanism), patch shape, and degree of isolation (Lomolino 2000). However, we argue that undersampling on other islands and relatively high habitat diversity on Saba are probably the dominant factors in this case.

A remote and intriguing possibility exists that Saba might have far more species than predicted by island biogeographic theory for an island of its size and isolation, as a result of its possible former association with the now submerged, and much larger, Saba Bank. This land mass is ~2,200 km², about 4 km to the southeast of Saba (Etnoyer et al. 2010), and was an island until about 5,000 years ago (Van der Land 1977). However, until all the small islands in the region have had their spider faunas more thoroughly sampled it is premature to attribute our results to the Saba Bank.

Conclusion

This preliminary survey has provided some information as to the potential diversity found on Saba and the surrounding islands. This information is useful in conservation planning for not only invertebrates but all members of the island’s ecosystems. Arthropods comprise the majority of any ecosystem’s animal biodiversity. Knowing the diversity provides managers with information that allows for habitat distinction and the assessment of overall ecosystem health (Kremen et al. 1993). Nowhere is this more important than in biodiversity hotspots. Conservation efforts in these areas should make use of all available data ensuring correctly allocated efforts (Myers et al. 2000). That other islands’ spider counts are far lower per unit area than Saba indicates survey efforts should be substantially increased throughout the Caribbean Biodiversity Hotspot. A solid understanding of the species area relationships for these islands would enable managers to predict richness for incompletely sampled islands and predict extinctions as habitable island area is reduced. This approach has already been undertaken with the beetle fauna of the Lesser Antilles (Peck 2009) based on the relatively thorough sampling of Montserrat by Ivie et al. (2008).

Acknowledgments

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Literature Cited


APPENDIX - Records
All specimens were identified by J. Slowik except as noted below. Numbers correspond to collection sites listed in Table 1 and Figure 1.

Anyphiidae
*Hibana tenuis* (L. Koch) ...................................................................................................... 7, 20, 27, 28, 31

Araneidae
*Argiope argentata* (Fabricius) ............................................................................................ 28
*Cyclosa caroli* (Hentz) ........................................................................................................ 10, 11, 18, 32
*Cyclosa walckenaeri* (O. P-Cambridge) .............................................................................. 30, 31, 32
*Eustala* sp. – det. H. Levi ..................................................................................................... 4, 11, 18, 23, 25, 32
*Gasteracantha cancriformis* (Linnaeus) ............................................................................. 2, 5, 30, 25
*Metepeira labrinthea* (Hentz) ........................................................................................ 32

Corinnidae
*Erendira* sp. – det. D. Ubick .............................................................................................. 13, 15, 17

Dictynidae
*Thallumetis* new sp. ........................................................................................................... 2

Gnaphosidae
*Camillina elegans* (Bryant) .............................................................................................. 1
*Camillina nevis* Platnick and Shadab .................................................................................. 31

Hahniidae
*Hahnia naguaboi* (Lehtinen) .......................................................................................... 13

Linyphiidae
*Agyneta* sp.1 ...................................................................................................................... 16
*Agyneta* sp.2 ...................................................................................................................... 12
*Linyphiidae* sp.1 ............................................................................................................... 17
*Linyphiidae* sp.2 ............................................................................................................... 17
*Oaphantes* sp.1 ................................................................................................................ 17

Lycosidae
*Arctosa fusca* (Keyserling) ............................................................................................. 31
Ochyroceridae
Ochyroceres new sp.1 .......................................................... 4, 17, 18
Ochyroceres new sp.2 .......................................................... 13, 16, 18, 23, 31

Oonopidae
Heteroonops saba Platnick and Dupérré – det. D. Ubick ........................................... 12, 13, 31
Oopaea sp. .................................................................................. 31
Scaphiella agocena Chickering – det. D. Ubick ........................................................... 31
Stenoonops nitens Bryant – det. D. Ubick .............................................................. 25, 31, 32
Stenoonops sp. – det. D. Ubick ........................................................................ 2, 31
Triaeris stenaspis Simon – det. D. Ubick ......................................................... 12

Pholcidae
Modisimus montanus Petrunkevitch ..................................................... 10, 13, 17, 32
Modisimus sp.1 ...................................................................................... 13, 18, 17, 31, 32
Modisimus sp.2 ...................................................................................... 18, 32
Modisimus sp.3 ........................................................................................ 21
Modisimus sp.4 ....................................................................................... 8

Salticidae
Anicius sp. – det. G. Edwards ........................................................................... 2
Beata octopunctata (Peckham and Peckham) – det. G. Edwards .................................. 31
Corythalia banksi Roewer – det. G. Edwards ....................................................... 26
Eris flava (Peckham and Peckham) – det. G. Edwards .......................................... 20
Hentzia whitcombi Richman – det. G. Edwards ................................................. 9, 28, 31
Hentzia antillana Bryant – det. G. Edwards ...................................................... 4, 6, 19
Hentzia sp. – det. G. Edwards ................................................................... 6
Jollas new sp. – det. G. Edwards ..................................................................... 8
Lyssomanes portoricensis Petrunkevitch – det. G. Edwards .................................... 2, 22
Synemosyna ankeli Cutler and Miller – det. G. Edwards ........................................ 17

Scytodidae
Scytodes dissimulans Petrunkevitch ................................................................. 5, 7, 18, 31, 33
Scytodes longipes Lucas ........................................................................ 13, 14, 21

Selenopidae
Selenops new sp. – det. S. Crews ..................................................................... 7, 8

Sparassidae
Olios bicolor Banks ......................................................................................... 28

Tetragnathidae
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Alcimosphenus licinus Simon ........................................................................... 32
Chrysometa eugeni Levi ................................................................................ 11, 22
Homalometra nigritarsis Simon ..................................................................... 20, 32
Leucauge regnyi Simon .................................................................................. 2, 10, 11, 13, 18, 21, 22, 23, 25, 32
Leucauge sp. ................................................................................................. 13
Tetragnatha earmira Levi .......................................................................... 32
Tetragnatha sp. ......................................................................................... 6, 10, 22, 23, 30

Theridiidae
Achaearanea porteri (Banks) ........................................................................... 32
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<td>(O. P.-Cambridge)</td>
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**Thomisidae**

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