Biogeographic and Temporal Changes in Mobile Fauna Community on Pelagic *Sargassum* in the Caribbean Sea, 2015 - 2016

Los Cambios Biogeográficos y Temporales en la Comunidad de la Fauna Móvil sobre *Sargassum* Pelágico en el Mar Caribe, 2015 - 2016

Les Changements Biogéographiques et Temporels dans la Communauté de la Faune Mobile sur *Sargassum* Pélagique dans la Mer des Caraïbes, 2015 - 2016

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EXTENDED ABSTRACT

Sargassum macroalgae is found in warm seas around the world. Two unique species of entirely pelagic *Sargassum* are found in the Sargasso and Caribbean Seas: *Sargassum fluitans III* (*SfIII*) and *S. natans*, with the latter occurring in two morphological forms known as *S. natans I* and *S. natans VIII* (*SnVIII*; Parr, 1939). *SfIII* is common in the northern Sargasso Sea, often drifting south into waters near the Greater Antilles. *S. natans I* dominates in the Sargasso Sea and is rarely observed in the Caribbean. *SnVIII*, which may be less ecologically important than *SfIII*, is believed to have an eastern Tropical Atlantic source, though has recently drifted outside its typical range and into the Caribbean Sea causing beach inundation events (Schell et al. 2015a).

Because *Sargassum* is pelagic, it provides crucial habitat in otherwise open waters for a wide variety of marine organisms. This community includes zooplankton, larval-stage organisms, invertebrates, fishes, crabs, shrimp, sea turtles, and many other creatures (Coston-Clements et al. 1991); some species are endemic to this seaweed. Many mobile fauna, especially juvenile fishes, utilize *Sargassum* as shelter from predators, while others rely upon it for substrate and nursery grounds (Coston-Clements et al. 1991). The mechanisms by which ocean circulation patterns, biogeography, physical seaweed clump structure, and inter-annual/seasonal changes affect *Sargassum* mobile fauna assemblages are poorly understood, yet substantial differences between host morphological forms have been observed (Schell et al. 2015b). As *Sargassum* distribution patterns change with both location and time, their diverse mobile fauna associates may vary in turn: this study examines how oceanographic regions and *Sargassum* species influence mobile fauna community richness and diversity.

One hundred and thirteen (113) *Sargassum* samples (n_{SfIII} = 43; n_{SnVIII} = 70) were collected over the fall and spring of 2015 and 2016 during three separate cruises onboard Sea Education Association's *Corwith Cramer*. Sampling occurred in the western Tropical Atlantic, Antilles Current, and Caribbean Sea; for analytical purposes sites were divided into three regions based on oceanographic and geographic boundaries (Figure 1). All samples were opportunistically collected by dip nets, with no more than three dip nets per half hour. Following collection, all *Sargassum* and associated organisms were removed from the net and placed in seawater. The largest clump in each yield was analyzed to determine *Sargassum* species and morphological form, composition of growth, succession and decline regions, age based on color, and wet weight via spring scale. Mobile fauna were sorted and preserved in ethanol for later analysis. Location and surface oceanographic conditions were recorded at the time of collection. When at-sea processing time was limited, whole samples were preserved in ethanol for analysis on shore.

Once back at Sea Education Association's shore lab, all preserved samples were analyzed. *Sargassum* was examined in the manner outlined above, and all mobile fauna were identified to species using Bermuda Biological Station's Identification Manual (Morris and Mogelberg 1973). Only morphological forms with a sufficient number of unique samples were used for the analyses presented here; mixed assemblages of *Sargassum* were placed in a species category only when a minimum threshold of 75% by mass was surpassed. Benthic, *S. natans I*, and all other mixed assemblages were excluded. Preliminary calculations of species richness and mobile fauna density per gram of *Sargassum* utilized Excel. Statistical analyses considering variations across different groups of mobile fauna by *Sargassum* species, year, and location were performed in R.

Community compositions associated with *SfIII* and *SnVIII* showed significant differences in mobile fauna species richness and density. Ten distinct taxa and 20 species were found, with individual frequencies of occurrence ranging from less than 1% (one individual across all samples) to 100%, with thousands of individuals occurring in some samples. Shrimp and snails were most often observed. Two-sample unpaired t-tests showed that average mobile fauna species richness (#species/g*Sarg.*) between host species was only marginally insignificant, with *SfIII* average richness higher than *SnVIII* (p = 0.059). However, average mobile fauna density (#individuals/g*Sarg.*) was significantly higher on *SfIII* than on *SnVIII* (p < 0.001). Mobile fauna community composition exhibited both similarities and differences; in total, 17 species were found

on *SfIII* and only 15 species on *SnVIII* (Table 1). 12 species were shared between the two host varieties, with all but one of those exhibiting similar frequencies of occurrence. Five species across five taxonomic groups were found on *SfIII* but not on *SnVIII*: the shrimp *H. zostericola*, the amphipod *S. pelagica*, the isopod *P. benjamensis*, the flatworm *A. notulata*, and the *Sargassum* frogfish *Histrio histrio*. Three species across two taxonomic groups were found on *SnVIII* but not on *SfIII*: the shrimp *H. coerulescens* and the nudibranchs *D. pygmaea* and *S. pelagica.* All mobile fauna species unique to one host *Sargassum* variety were present at low occurrence frequencies.

One-way unpaired analyses of variance of mean mobile fauna species richness and mean mobile fauna density showed distinct changes across space and time

Table 1. Frequency of occurrence (percent of total samples) for each species of mobile fauna observed and total species richness on *SfIII* and *SnVIII*. Shaded cells indicate community structure by *Sargassum* form. Sample sizes: *SfIII* (n=43), *SnVIII* (n=70). 12 species are shared between the two host forms, with all but one of those species exhibiting similar frequencies of occurrence. Five species across five taxonomic groups were found on *SfIII* but not on *SnVIII*; three species across two taxonomic groups were found on *SnVIII* but not on *SfIII*. All mobile fauna unique to one host variety are present at low occurrence frequencies.

		Frequency of Occurrence (% samples)	
	Species	***S. fluitans* Parr**	***S. natans VIII* Parr**
Crabs	*Portunus sayi*	65.1	39.4
Shrimp	*Leander tenuicornis*	72.1	91.5
	Latreutes fucorum	100.0	91.5
	Hippolyte zostericola	2.3	0.0
	Hippolyte coerulescens	0.0	1.4
Amphipods	*Biancolina sp.*	27.9	4.2
	Sunampithoe pelagica	2.3	0.0
	Ampithoe longimana	4.7	1.4
Isopods	*Paradynamene benjamensis*	2.3	0.0
	P. latreuticola (Parasites)	20.9	22.5
	Bagatus minitus	18.6	19.7
Snails	*Litiopa melanostoma*	95.3	83.1
Nudibranchs	*Corambella depressa*	2.3	2.8
	Doto pygmaea	0.0	1.4
	Scyllaea pelagica	0.0	1.4
Flatworms	*Gnescioceros sargassicola*	18.6	12.7
	Hoploplana grubei	7.0	8.5
	Acerotisa notulata	4.7	0.0
Polychaete worms	*Platynereis dumerillii*	11.6	16.9
Fish	*Histrio histrio*	2.3	0.0
Cumulative Species Richness		17	15

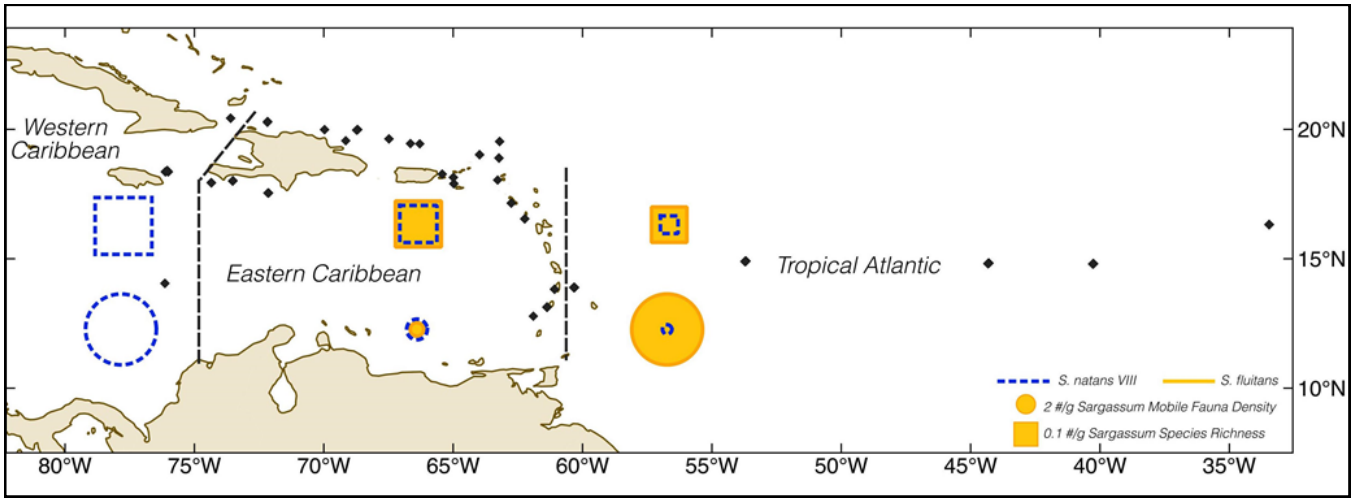

Figure 1. Geographic changes in mobile fauna community on *SfIII* (orange solid lines) and *SnVIII* (blue dotted lines). Sampling locations shown as black diamonds, with regional boundaries as black dotted lines (Tropical Atlantic all samples east of 61˚W; Eastern Caribbean everything between 61˚W and 74.5˚W; Western Caribbean all samples west of 74.5˚W). Squares represent species richness data (total species per gram *Sargassum*) and circles represent mobile fauna density (total individuals per gram of *Sargassum*). *SfIII* species richness increased slightly while mobile fauna density decreased sharply from the Tropical Atlantic to the Eastern Caribbean. Species richness and mobile fauna density on *SnVIII* both increased from east to west across all three geographic regions.

(Figure 1). Species richness and density both nearly doubled on *SnVIII* as it drifted from the Tropical Atlantic region through the Lesser Antilles to the Eastern Caribbean (both $p < 0.01$), and both metrics continued to increase as *SnVIII* clumps were further transported by dominant currents from the Eastern Caribbean to the Western Caribbean (richness $p < 0.05$, density $p < 0.001$). On *SfIII*, species richness did not change significantly as seaweed clumps traveled from the Tropical Atlantic to the Eastern Caribbean ($p > 0.05$; insufficient Western Caribbean samples to examine statistically), but mobile fauna density decreased by a factor of four across the same regions ($p < 0.001$). Temporally, *SnVIII* species richness increased slightly while mobile fauna density increased nearly tenfold from spring 2015 to spring 2016 (richness $p < 0.01$, density $p < 0.001$), and both parameters increased seasonally from fall 2015 to spring 2016 (both $p < 0.001$).

Five and nine-fold increases in mobile fauna species richness and density on *SnVIII* along an east-to-west transect demonstrated that this *Sargassum* form, once considered less ecologically important than other varieties, was capable of sustaining substantive biomass as it moved into new geographic areas. Encounters with other pelagic seaweeds, drifting substrates, and coastal ecosystems all served as potential sources of mobile fauna as *Sargassum* traveled through and around the Caribbean islands. Decreases in mobile fauna density on *SfIII* across the same transect suggested that this form's ability to support biodiversity may vary more than previously understood. Because *SfIII* was within its native range in all studied samples, these surprising results deviated from expected consistent community structure on this host species, perhaps more related to differences in sample distribution, seaweed clump size, or environmental conditions than the ecological value of *SfIII* itself. While a majority of mobile fauna species (12 out of 20) were shared across the two *Sargassum* forms and exhibited similar occurrence frequencies, differences in fauna assemblage between *SnVIII* and *SfIII* were observed at low occurrence frequencies and may be attributable to differences in clump size or morphology (ie., branching pattern, foliage density or shape) that affect mobile fauna distribution or viability. *SnVIII* has distinct ecological value in the Caribbean despite previous scientific understanding from initial observations during the 2014 - 2015 inundation event (Schell et al. 2015b), as evidenced by its complex community composition and increased capacity to support many individuals and species across the region. Furthermore, temporal increases on *SnVIII*, especially with respect to density, suggest that increased time in Caribbean waters may improve the ability of *SnVIII* to sustain an abundance of mobile fauna. Further research may evaluate whether seaweed aggregation, clump size, morphological traits, or environmental variables play a role in determining community composition across different *Sargassum* types in addition to the factors considered here.

KEYWORDS: *Sargassum natans,* SnVIII, inundation, mobile fauna, community composition, biodiversity

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