***Sargassum* and The Sargasso Sea**

Sargassum is a genus of brown macroalgae with over 350 described species. (AlgaeBase, 2022). *Sargassum fluitans* and *Sargassum natans,* are the only known macroalgae with a holopelagic life cycle and reproduce entirely by fragmentation (Butler et al., 1983). Pelagic rafts contain both species in different ecological morphotypes (source) . In the caribbean *Sargasum* *fluitans* has one dominant morphotype, III and *S. natans* has two dominant morphotypes, I and VII. (Schell et al., 2015). *S. fluitans III* has been found to support significantly higher densities and a greater number of taxa than both morphotypes of *S. natans* (Martin et al., 2021).

Historically, these free-floating pelagic species aggregated and proliferated in an area known as the Sargasso Sea (Laffoley et al., 2011) where they provide essential ecosystem functions in multiple habitats. Beach cast *Sargassum* provides structure for building dunes (Laffoley et al., 2011) and nutrients that significantly enhance the growth of dune-stabilizing plants (Williams, 2010). In the Northern Atlantic, *Sargassum* is responsible for up to ten percent of the particulate organic matter reaching the deep sea community (Rowe and Staresinic, 1979). Floating patches of *Sargassum* support ten endemic species (Coston-Clements et al., 1991, Laffoley et al., 2011) and are importance in various life cycle stages of multiple fish species (Lapointe et al., 2014, National Marine Fisheries Service, 2003), such as blackfin tuna, swordfish, jacks, mahi mahi, and billfish(Coston-Clements et al., 1991, Sumaila et al., 2013). Four juvenile turtle species spend early life associated with pelagic *Sargassum* (Carr, 1987, Mansfield et al., 2021) primarily feeding on *Sargassum* and its associates (Witherington et al., 2012). The Sargasso Sea is also one of the only known spawning sites of the European and American eels (Ringuet, 2002, Miller et al., 2019).

Beginning in 2011, unprecedented influxes of *Sargassum* on beaches ranging from the Caribbean (Franks et al., 2012; Gavio et al., 2015) to the West African Coast (Oyesiku and Egunyomi, 2014) resulted in coastal *Sargassum* pile ups that in some areas that reach over a meter tall (Lamb, 2018) and have had devastating results on impacted areas. This *Sargassum* degrades, increases turbidity, water and sand temperatures (source), nutrient concentrations and bacterial activity which can result in seagrass loss, increased epiphytic and drift algae (Van Tussenbroek et al. 2017), nesting inhibition in sea turtles (Maurer et al., 2015), coral larval dispersion changes (Antonio-Martínez et al., 2020), and fish and invertebrate die offs (Cruz-Rivera et al., 2015, add source Mexico kill). *Sargassum* cleanup costs in the Caribbean in 2018 totaled 120 million dollars (LaPointe et al., 2021). Decomposing *Sargassum* produces hydrogen sulfide and ammonia gasses, which can be hazardous to human health. Affected areas have also seen negative economic impacts from declines in tourism (Bartlett and Elmer, 2021) and the loss of accessibility for small-boat fishing (Franks et al., 2012). In 2022 a large bloom in St Croix in the US Virgin Islands accumulated near the intake of the desalinization plant, necessitating the governor to declare a state of emergency via executive order (Exec. Order No. 523, 2022).

While it was initially hypothesized that rafts inundating the Caribbean originated from the Sargasso Sea, it is now known that the source is a new zone in the North Equatorial Recirculation Region (NERR) (Franks et al., 2016). These seasonal blooms, known as the Great Atlantic *Sargassum* Belt, at times extend from West Africa to the Gulf of Mexico (Wang et al., 2019). Potential nutrient sources for these blooms include the Amazon river (Gower et al., 2013), coastal African equatorial upwelling, Sahara dust and the Congo River (Johnson et al., 2013, Djakouré et al., 2017, Oviatt et al., 2019).

The ability of multiple brown algae species, including *Sargassum fluitans,* to collect and concentrate metals from the environment (Davis et al., 2000) through a process called biosorption (Fourest and Volensky, 1997) has lead them to be investigate as a potential solution to metals contamination. However, this ability limits potential uses and complicates disposal of *Sargassum* inundating beaches. Studies have been conducted profiling the metal content of *Sargassum* in Ghana (Addico and deGraft-Johnson, 2016), Nigeria (Oyesiku and Egunyomi, 2014), the Dominican Republic (Fernández et al., 2017), and the Mexican Caribbean (Rodriguez-Martinez et al., 2020) and it has been found that metal content in *Sargassum* sampled varies but is often higher than regulation limits for use in fertilizer, animal feed, and cosmetic production (Rodriguez-Martinez et al., 2020, Addico and deGraft-Johnson, 2016, Devault et al., 2021). Metals also present a concern when it comes to disposal. *Sargassum* in the Mexican Caribbean is deposited in coastal abandoned limestone quarries where leachates could make their way into groundwater and eventually back into the marine environment (Rodriguez-Martinez et al., 2020).

While studies have established the presence of high concentrations of hazardous metals such as arsenic in beach cast *Sargassum* and the potential for leachates to contribute to pollution of both coastal and groundwater sources (Oyesiku and Egunyomi, 2014, Addico and deGraft-Johnson, 2016, Fernández et al., 2017, Rodriguez-Martinez et al., 2020) there is little work investigating the dynamics of the release of metals and other nutrients from *Sargassum* as it degrades. This study examines these dynamics and investigates *Sargassum* as source of coastal metal contamination and if samples at a particular stage of decomposition might be safe for commercial use.

***Question Two: What metals are present in Sargassum, and what are the dynamics of their release in degrading Sargassum?***

2.1 Hypothesis: There is a difference in metals present in *Sargassum natans I, Sargassum natans VIII,* and *Sargassum fluitans III*.

2.2 Hypothesis: There will be a decrease in metal concentration in algal tissue over time.

2.3 Hypothesis: There will be a difference in the decrease in metal concentration between samples degrading onshore and in water.

***Methods***

*Sargassum* was collected from Tutu Bay, St Thomas, USVI on August 7th  and August 16th, 2023, processed on August 8th and August 16th, and placed in the field August 9th and August 17th. Samples were sorted by morphotype, coarsely cleaned, and spun dry in a low speed centrifuge. Sargassum fronds were divided, half going into a litter bag and half retained for initial metals determination. Enough fronds were divided until there was 35 g retained and 40 g placed in labeled litter bag with pore size. On August 7th one bag was retained for every one bag placed in the field, on August 16th in order to get more samples from collected Sargassum one bag was retained for every two samples of *S natans I* placed in the field. Total number of prepared samples of each morphotype is shown in Table One. Retained samples were stored at -18C until freeze dried. Dried samples were reweighed, crushed to powder and analyzed for metal concentration using ICPMS at x lab.

Table One: Total number of samples placed in field on each sample day

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | August 7th | | August 16th | |
|  | Shore | Water | Shore | Water |
| *S fluitans III* | 15 | 15 | 15 | 15 |
| *S natans I* | 9 | 9 | 9 | 9 |
| *S natans VIII* | 15 | 15 | 12 | 12 |

Three litter bag *Sargassum* samples per morphotype were grouped together and either placed above the high tide line at Brewers Beach, St Thomas, USVI or secured to a cinderblock nearshore. Samples were placed deep enough that they remained submerged throughout the tidal cycle. One bag per group was collected per week, for a total of three weeks. Some of the onshore litter bags were stolen, Table Two outlines total number of samples collected each week for each morphotype. *Sargassum* from sampled bags was coarsely cleaned, spun dry and reweighed. They were then freeze dried, weighed, crushed and analyzed for metal concentration.

Table Two: Total number of samples collected each week

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Shore | | | | | Water | | | | |
|  | Overall Totals | | Weekly Totals | | | Overall Totals | | Weekly Totals | | |
|  | Initial | Collected | One | Two | Three | Initial | Collected | One | Two | Three |
| *S fluitans III* | 30 | 17 | 9 | 5 | 3 | 30 | 28 | 10 | 10 | 8 |
| *S natans I* | 18 | 10 | 5 | 3 | 2 | 18 | 17 | 6 | 6 | 5 |
| *S natans VIII* | 27 | 16 | 8 | 5 | 3 | 27 | 25 | 9 | 9 | 7 |

Change in wet mass was calculated for each field sample. These changes were compared using a Kruskal Wallace test. Change in metal concentration will be determined and compated between species and treatment.