Caribbean Islands

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Overview

Caribbean springs are sites of early indigenous human presence, legends, and fossils (Beeker et al. 2002, Peros et al. 2006, Cristóbal 2007, Aranda et al. 2017; Figure 9-111). Diffuse, contact, artesian, and solution conduit springs are all known to occur in the region. Thousands of springs have been identified in Cuba, Jamaica, Hispaniola, and Puerto Rico (Giusti 1978, Rodríguez-Martínez 1997, Miller et al. 2001, Troester and Turvey 2004, Lluberes et al. 2013, Gómez-Gómez et al. 2014, Wishart 2015, Gordon-Smith and Greenaway 2019). A quarter of these may be named or identified in maps. There are only a few perennial freshwater springs the British and U.S. Virgin Islands. Local streams known as ghuts or guts, depend on springs within headwater pools to maintain habitat for wetlands, migratory birds, shrimp, fish, and amphibians (Howell and Towle 1976, Nemeth and Platenburg, 2007; Gardner, 2008). Active volcanos and volcanic areas result in broadly distributed hydrothermal springs in Saba, St. Eustatius, St. Kitts and Nevis, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St.Vincent and the Grenadines, and Grenada (Huttrer 2000). These springs have high total dissolved solids and a range in water temperatures due to the combination of infiltrated rainfall from meteoric waters

Figure 9-111. Map of the Caribbean region.
Map boundary data were derived from the Database of Global Administrative Areas [GADM], version 2.8 (https://gadm.org/index.html). The background reference map was developed by National Geographic and Esri (https://server.arcgisonline.com/arcgis/rest/services/NatGeo_World_Map/MapServer). The map was projected into the USA Contiguous Albers Equal Area Conic coordinate system; Central Meridian = 0.00°, 1st Standard Parallel = 10.04°, 2nd Standard Parallel = 27.27°.

mixed with deeper groundwater and hydrothermal fluids of magma origin (Rad et al. 2013, Hemmings et al. 2015). In Puerto Rico, spring water composition is predominantly calcium-magnesium-bicarbonate in karst aquifers, sodium-chloride-sulfate in thermal springs, and volcanic rock springs are grouped as Ca-Mg-HCO waters. One exception is "Pozo de la Virgen" spring, located in serpentinite substrates, with high silica concentration from hydrated magnesium silicate mineral (Guzmán-Ríos 1988).

Ecology

Although macroinvertebrates and gastropods from freshwater springs have been described for Antigua, Barbados, Barbuda, Puerto Rico, St. Kitts and Nevis, details of sampled sites as being true springs, or streams or wells associated to springflow, or sites named "spring" are not clearly categorized because it was not a main research objective (Bass 2005, Bass 2006, MacKay and Williams 2011, Pérez-Reyes et al. 2013, Boger et al. 2014). Exceptions are the species lists of sulfur-tolerant fauna (with the endemic fish, *Limia sulphurophila*) in the Dominican Republic (Greenway et al. 2014), and the microbial diversity study of Baños de Coamo in Puerto Rico using a metagenomic approach, which yielded genes associated to iron, phosphorous and sulfur biological processing (Padilla-Del Valle et al. 2017).

Coastal submarine fresh and brackish water springs have been documented in various islands (Giusti 1978, Blume et al. 1981, Lugo et al. 2001, Adame et al. 2013, Gordon-Smith and Greenaway 2019). The flow dynamics from those springs alter the near shore wetland forests and seagrass communities via changes in water physical-chemical attributes. Springs are part of ecosystem flows to coastal ecosystems, and sea-level rise will alter the role of springs in many parts of the region (Adame et al. 2013, Lambs et al. 2018). The highest carbon stocks in mangroves have been associated with submarine freshwater springs (Adame et al. 2013). Springs buffer soil salinity and water level height in forested wetlands, marshes and other forest types during drought periods and contribute to balancing freshwater budgets (Lambs et al. 2015). In Puerto Rico, spring-fed marshes create habitat for a recently identified (coqui llanero, *Eleutherodactylus juanariveroi*) riverine frog species (Ríos-López and Thomas, 2007). Less than 5 km from the coast, springs support forested *Pterocarpus officinalis* and *Annona glabra* wetlands, marshes, and quartz-dominated blanket sands bogs with carnivorous bladderworts (*Utricularia*) and sundews (*Drosera*). These communities differ from other coastal sites due to important spring water inputs from underlying karst and alluvium (Medina et al. 2007, Lugo et al. 2001 Feagin et al. 2013).

Contaminants

Discharge from industrial and sewage treatment plants and land cover changes that alter recharge capacity, water flow, and soil surface elevation have been documented to affect spring discharge and ecosystem dynamics (Guzmán-Ríos 1988, Lugo et al. 2001). Atypical algal growths, agricultural pesticide residues, phthalates and chlorinated volatile organic compounds have been identified in springs from Jamaica and Puerto Rico (Guzmán-Ríos 1988, Witter et al. 1999, Torres et al. 2019). Padilla et al. (2011) describe that long-term contamination found in karst aquifers reflects the characteristics that make the aquifer productive, which is the capacity for storing and releasing over long-terms, which also increases potential for contaminant exposure at spring discharge areas. Hydrogeological research on recharge and contamination dynamics suggests that karst springs are complex, combine inter-basin diffuse and conduit, and are affected by seasonal fluctuations of head boundaries in relation to distance from the ocean (Ghasemizadeh et al. 2016).

Information regarding the condition of springs as ecological systems in the insular Caribbean is dispersed and fragmented. Water quality and hydrogeology data are generally available, but descriptions and classifications of springs need to integrate ecological knowledge about springs.

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