



Short communication

Continued expansion of the trans-Atlantic invasive marine angiosperm *Halophila stipulacea* in the Eastern Caribbean

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ABSTRACT

Halophila stipulacea (Hydrocharitaceae) is reported for the first time from Aruba, Curaçao, Grenadines (Grenada), St. Eustatius, St. John (US Virgin Islands), St. Martin (France), and St. Vincent and the Grenadines, bringing the total number of known occurrences from eastern Caribbean islands to 19. Native to the Red Sea and western Indian Ocean, *H. stipulacea* spread to the Mediterranean Sea in the late 1800s and became established in the eastern Caribbean in 2002. The species has dispersed north and south of its first sighting in Grenada and now spans a latitudinal distance of 6° (>700 km), most likely facilitated by a combination of commercial and recreational boat traffic. The continuing range expansion of *H. stipulacea* indicates the species has successfully acclimated to surviving in the Caribbean environment, warranting further investigation into its ecological interactions with the indigenous seagrasses.

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1. Introduction

Invasions of non-indigenous species into marine habitats are increasingly common and often troublesome (Cohen and Carlton, 1998; Williams and Smith, 2007; Molnar et al., 2008). Further, some invasive species have expanded globally, across a wide range of environmental parameters and into diverse native communities. To date, two marine angiosperms have shown recent trans-oceanic range expansions; *Zostera japonica* from the northwest to the northeast Pacific Ocean, and *Halophila stipulacea* from the Indian Ocean to the Mediterranean Sea and the Caribbean Sea (Williams, 2007).

H. stipulacea Fosskal is a tropical, euryhaline marine angiosperm in the family Hydrocharitaceae. The genus *Halophila* is composed of ten species. Five species (*H. beccarii*, *H. decipiens*, *H. minor*, *H. ovalis* and *H. stipulacea*) are native to the Red Sea and western Indian Ocean and five are native to the Caribbean Sea (*H. baillonii*,

H. decipiens, *H. engelmanni*, *H. johnsonii*, and *H. ovalis*) (Green and Short, 2003; Short et al., 2010a). There are no *Halophila* in the Mediterranean except *H. stipulacea*; however, *H. decipiens* does occur along the Atlantic northwest coast of Africa and around the Canary Islands (Green and Short, 2003).

The native range of *H. stipulacea* includes the Red Sea and Persian Gulf, as well as the coastal islands of eastern Africa and the southeast coast of the Indian subcontinent (den Hartog, 1970). *H. stipulacea* was first reported in the Mediterranean in 1894 and is believed to have arrived from the Red Sea after the opening of the Suez Canal in 1869 (Lipkin, 1975; notably this reference to the invasive *H. stipulacea* appears in the very first issue of Aquatic Botany). The species first became established along the eastern Mediterranean coastlines of Egypt, Greece, and Lebanon (den Hartog, 1970; Lipkin, 1975) with subsequent expansion northward to Turkey and Albania (Alpinar, 1987; Kashta and Pizzuto, 1995) and westward to Italy, Libya and Tunisia (Gambi et al., 2009; Sghaier et al., 2011).

H. stipulacea was first reported in the Caribbean in Grenada in 2002 (Ruiz and Ballantine, 2004), followed by reports from Dominica and Saint Lucia in 2007 and 2008, respectively (Willette

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and Ambrose, 2009). Since then, the seagrass has been found in Bonaire, Guadeloupe, Les Saintes, Martinique and St. Maarten (Netherlands) (DEAL, 2011; Debrot et al., 2012; Kerninon, 2012; Debrot et al., in review; Table 1). The invasive seagrass was not observed in Antigua in 2008 or 2010 during seagrass surveys (Willette and Ambrose, 2009; Short et al., 2010a). Here we provide first reports of *H. stipulacea* from eleven additional islands, and summarize the geographic distribution in the eastern Caribbean one decade after its first report.

2. Methods

To determine the geographic extent of the seagrass *H. stipulacea* beyond published reports, inquiries were made to institutes and colleagues located throughout the eastern Caribbean. A description of the habitat, diagnostic features and photographs of *H. stipulacea* were provided in the initial communication. To verify the presence of the seagrass, collaborators were requested to collect specimens and photograph the putative *H. stipulacea* seagrass for identification via diagnostic characteristics (den Hartog, 1970). Five indigenous *Halophila* species occur in the Caribbean; however, most are clearly distinguishable from *H. stipulacea*. *Halophila bailonii* Ascherson and *H. engelmanni* Ascherson are morphologically distinct with four to eight blades at the tip of a pronounced petiole (den Hartog, 1970). *Halophila ovalis* (R. Brown) Hooker f. and *H. johnsonii* Eiseman are geographically restricted to Antigua and Florida, respectively; typically have petioles longer than blades, a smooth blade surface and leaf margin, and blade scales less than 6 mm (den Hartog, 1970; Eiseman and McMillan, 1980; Short et al., 2010a). *Halophila decipiens* Ostenfeld is the most widespread and abundant native Caribbean *Halophila* and co-occurs with *H. stipulacea* in Dominica (Willette and Ambrose, 2009). *H. decipiens* has paddle-shaped, translucent blades (1–2½ cm long) with 6–9 pairs of cross veins. Blades extend in pairs from non-sheathed petioles growing from the rhizome. *H. decipiens* and *H. stipulacea* both have serrated leaf margins and minute hairs on the leaf surface. *H. stipulacea* is distinguished from *H. decipiens* by its long, linear and occasional bullate blades (3–6 cm long) with 10–20 pairs of cross veins. Further, at each rhizome node of *H. stipulacea*, a large, lopsided leaf sheath covers the short petioles, of which each has two blades.

Where *H. stipulacea* was confirmed to be present, site data including coordinates, depth of the seagrass, visual estimation of abundance and distribution, conspicuous presence of associated flora and fauna, conspicuous presence of flowers or seed pods, if the invasive seagrass occurred in a Marine Protected Area (MPA)/marine reserve, and if the location was the site of frequent anchoring (i.e. a harbor or anchorage) were collected.

3. Results

H. stipulacea was reported as present along the coastlines of Aruba, Bonaire, Curaçao, Grenada, the Grenada Grenadines, Dominica, Guadeloupe, Les Saintes, Martinique, St. Eustatius, St. Vincent and the Grenadines, St. John (US Virgin Islands), St. Martin (France) and St. Maarten (Netherlands) (Table 1 and Fig. 1). Species identification was confirmed using diagnostic morphological features of *H. stipulacea* (Fig. 2). Descriptions from Aruba, Curaçao, the Grenadines of Grenada, St. Eustatius, St. John, St. Martin, St. Vincent and five of the St. Vincent Grenadine islands represent new sightings. The invasive seagrass was reported as “not present” in Barbados and South Caicos (Turks and Caicos Islands), and inconclusive evidence precludes us from confirming *H. stipulacea* in St. Kitts and Nevis.

Table 1

Reported *H. stipulacea* in eastern Caribbean islands. Site descriptions include island name, location where seagrass was first observed, year of first observation, latitude and longitude, approximate depth of seagrass, abundance (rare, common, abundant), substrate type, presence/co-occurrence of native seagrasses (Sf – *Syringodium filiforme*, Tt – *Thalassia testudinum*, Hd – *Halophila decipiens*, Hw – *Halodule wrightii*), if *H. stipulacea* occurs in a Marine Protected Area (MPA) on the island, and whether the location is or near fishing or recreational boat anchorage.

Island	Year first observed	Location	Latitude	Longitude	Depth	Abundance	Substrate	Other seagrasses	<i>H. stipulacea</i> in MPA?	Anchorage	Reference
Grenada	2002	Flamingo Bay	12° 05' N	61° 45' W	4 m	Rare	Sand	None	No	Yes	Ruiz and Ballantine (2004)
Martinique	2006 ^a	Fort-de-France Bay	14° 36' N	61° 05' W	30 m	Abundant	Sand	Tt, Sf, Hd, Hw	No	Yes	DEAL (2011), This report
Dominica	2007	Lamothe Bay	15° 37' N	61° 27' W	7–18 m	Common	Sand	Sf, Hd	Yes	No	Willette and Ambrose (2009)
St. Lucia	2008	Marigot Bay	13° 57' N	61° 01' W	1 m	Rare	Sand	None	No	Yes	Willette and Ambrose (2009)
Bonaire	2010	Lac Bay	12° 05' N	68° 14' W	<1–5 m	Abundant	Sand	Tt, Sf, Hw	Yes	No	Debrot et al. (2012)
Guadeloupe	2010	Anse du petit Malendure	16° 10' N	61° 46' W	n/d	n/d	Sand	n/d	No	Yes	Kerninon (2012)
Les Saintes	2010	Terre-de-Haut	15° 51' N	61° 37' W	7–15 m	Common	Sand	Tt, Sf	No	Yes	Kerninon (2012)
St. Vincent	2011	Villa	13° 08' N	61° 12' W	3–6 m	Abundant	Sand	None	No	Yes	This report
Curaçao	2012	St. Jorisbay	12° 07' N	68° 49' W	2 m	Abundant	Sand	Tt	No	No	This report
St. Maarten (Dutch)	2012	Simpson Bay	18° 01' N	63° 05' W	5 m	Abundant	Sand	None	No	Yes	Debrot et al. (in review)
St. John USVI	2012	Mennebeck Reef	18° 21' N	64° 41' W	16 m	Abundant	Sand	Sf, Tt	Yes	No	This report
St. Martin (French)	2012	Baie du Cul-de-Sac	18° 06' N	63° 01' W	3 m	Rare	Sand	Sf, Tt	No	Yes	This report
St. Eustatius	2012	Jenkins Bay	17° 30' N	63° 00' W	16–26 m	Common	Sand	Sf	Yes	No	This report
Aruba	2013	San Nicolas	12° 27' N	69° 55' W	10 m	Abundant	Sand	None	No	Yes	This report
Grenadines (St. Vincent)	2013	Admiralty Bay, Bequia	13° 0' N	61° 14' W	1–8 m	Abundant	Sand	None	Yes	Yes	This report
	2013	Salt Whistle Bay, Mayreau	12° 39' N	61° 23' W	3–4 m	Common	Sand	Tt, Sf	No	Yes	This report
	2013	Tobago Cays	12° 38' N	61° 21' W	3–5 m	Rare	Sand	Sf	Yes	Yes	This report
	2013	Richmond Bay, Union Is.	12° 36' N	61° 26' W	1–3 m	Common	Sand	Tt	No	No	This report
	2013	Petit St. Vincent	12° 32' N	61° 23' W	4–8 m	Abundant	Sand	None	No	Yes	This report
Grenadines (Grenada)	2013	Sandy Island, Carriacou	12° 29' N	61° 28' W	1–4 m	Common	Sand	None	Yes	Yes	This report

^a Martinique first report in 2006, table data from 2010 by F. Védie as summation of island-wide survey. N/d indicates no data available.

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