MARINE BIODIVERSITY SURVEY OF ST. EUSTATIUS, DUTCH CARIBBEAN, 2015

Preliminary results of the Statia Marine Biodiversity Expedition, 2015

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Abstract The Statia Marine Biodiversity Expedition (2015) was organized by Naturalis Biodiversity Center in Leiden (the national museum of natural history of the Netherlands) and ANEMOON Foundation (a Dutch organisation of citizen scientists) in Bennebroek, The Netherlands. This field survey served as a baseline study to explore the marine biota of St. Eustatius, a small island on the boundary between the eastern Caribbean and the West Atlantic. Since 2010, St. Eustatius is part of the Caribbean Netherlands. Various undescribed species were discovered during the expedition. In addition, taxa were reported that previously were not known to occur in the Caribbean or even in the Atlantic Ocean. Species lists were produced of several groups of organisms, which include many new records for St. Eustatius. DNA was isolated from tissue samples for molecular analyses in a barcoding project concerning the biodiversity of the Netherlands.

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Cover: Long-snouted sea horse (*Hippocampus reidi*) attached to an octocoral (photo: B.W. Hoeksema)

General introduction Statia Marine Biodiversity Expedition, 2015

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St. Eustatius, affectionately called "Statia", is a volcanic island in the northern Windward Group of the Lesser Antilles in the eastern Caribbean. Since 10 October 2010 this island is a Dutch municipality in the Caribbean Netherlands. It is part of the Dutch Caribbean, which was previously known as the Netherlands Antilles, constituting the ABC Islands (Aruba, Bonaire and Curaçao) in the southern Caribbean and the SSS Islands (Saba, St. Eustatius, southern part of St. Maarten, and the submerged Saba Bank) on the boundary between the Caribbean Sea and the western Atlantic Ocean (Fig. 1).

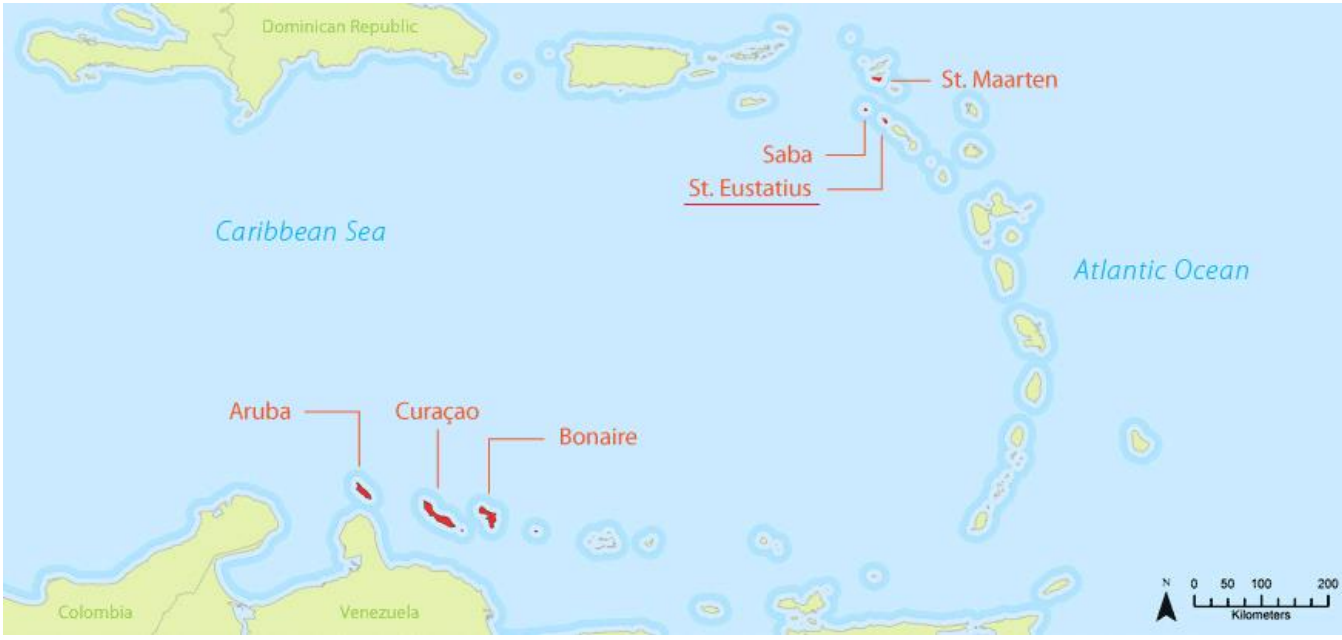

Fig. 1. Location of St. Eustatius in the Dutch Caribbean: the leeward ABC Islands and the windward SSS Islands. Source: http://www.dcnanature.org/islands/

Previous surveys

The marine biota of St. Eustatius is poorly investigated. Some available information is from historical studies. In 1884–1885, Dr. Suringar, at that time director of the Rijksherbarium in Leiden, joined the Netherlands West Indian Scientific Expedition. He collected many plants from the Dutch Caribbean islands, including St. Eustatius. These plants included some algae, which were identified many years later by Dr. Vroman. These herbarium specimens are held in the botanical collections of Naturalis Biodiversity Center. The Dutch naturalist Dr. Wagenaar Hummelinck (1953: 19) published data on four collection stations where he sampled marine specimens on 10–15 July 1949 (Fig. 2B: Stations 1116–1119) besides some fresh and brackish water habitats (Fig. 2B: Stations 504–515). He returned in October 1963 when he visited another locality, Concordia Bay (Wagenaar Hummelinck 1977: 23). The phycologist Dr. Vroman (1968: pp. 59–61) published maps (Fig. 3) in which he indicated six shore localities where he collected algae (20–21 May 1958). Roos (1971) reported on corals collected at six localities (< 10 m depth) in the period 24–27 July 1965 (Fig. 4).

Naturalis Biodiversity Center (previously known as Rijksmuseum van Natuurlijke Historie) was involved in the organization of an expedition to the neighbouring Saba Bank (Van der Land 1977), which included two sampling stations (Sta. 29, 121) at the west coast of St. Eustatius and two at Saba Island (Fig. 5). These localities were visited in May–June 1972. Samples have been deposited in the

Naturalis research collections, where they are available for further research. This material can be used for studies concerning possible changes in the marine fauna and flora (Hoeksema et al. 2011). Bak (1975) visited the three windward Antilles (SSS) from where he reported 35 scleractinian species (< 35 m depth). He considered coral growth here as poorly developed in comparison with that at the leeward Antilles (ABC). Sybesma et al. (1993) listed 16 reef coral species. Klomp and Kooistra (2003) found 23 scleractinian species (partly specified), which they recorded from the windward islands, including 10 dive sites off southwest St. Eustatius. Jongman et al. (2010) listed a total of 41 scleractinians for scleractinians but it is unclear how this information was obtained. The most recent inventory included 24 scleractinian species for Statia (Debrot et al. 2014).

Coomans (1958) published on marine littoral gastropods of the Netherlands Antilles, including St. Eustatius, for which he used material collected by Dr. Wagenaar Hummelinck. Finally, Hewitt (2015) reported on the marine mollusc fauna of St. Eustatius, which was based on her own field surveys.

A new baseline

In order to establish a new baseline, Naturalis Biodiversity Center organized a marine expedition to St. Eustatius in June 2015 in collaboration with ‘ANEMOON Foundation’. The Caribbean Netherlands Science Institute (CNSI) served as host by offering laboratory space and lodging. St. Eustatius National Parks Foundation (STENAPA) was the local counterpart. Local partners benefit when the results are made publicly available for conservation through scientific reports and publications, websites, and exhibits. The local dive center Scubaqua supplied diving logistics.

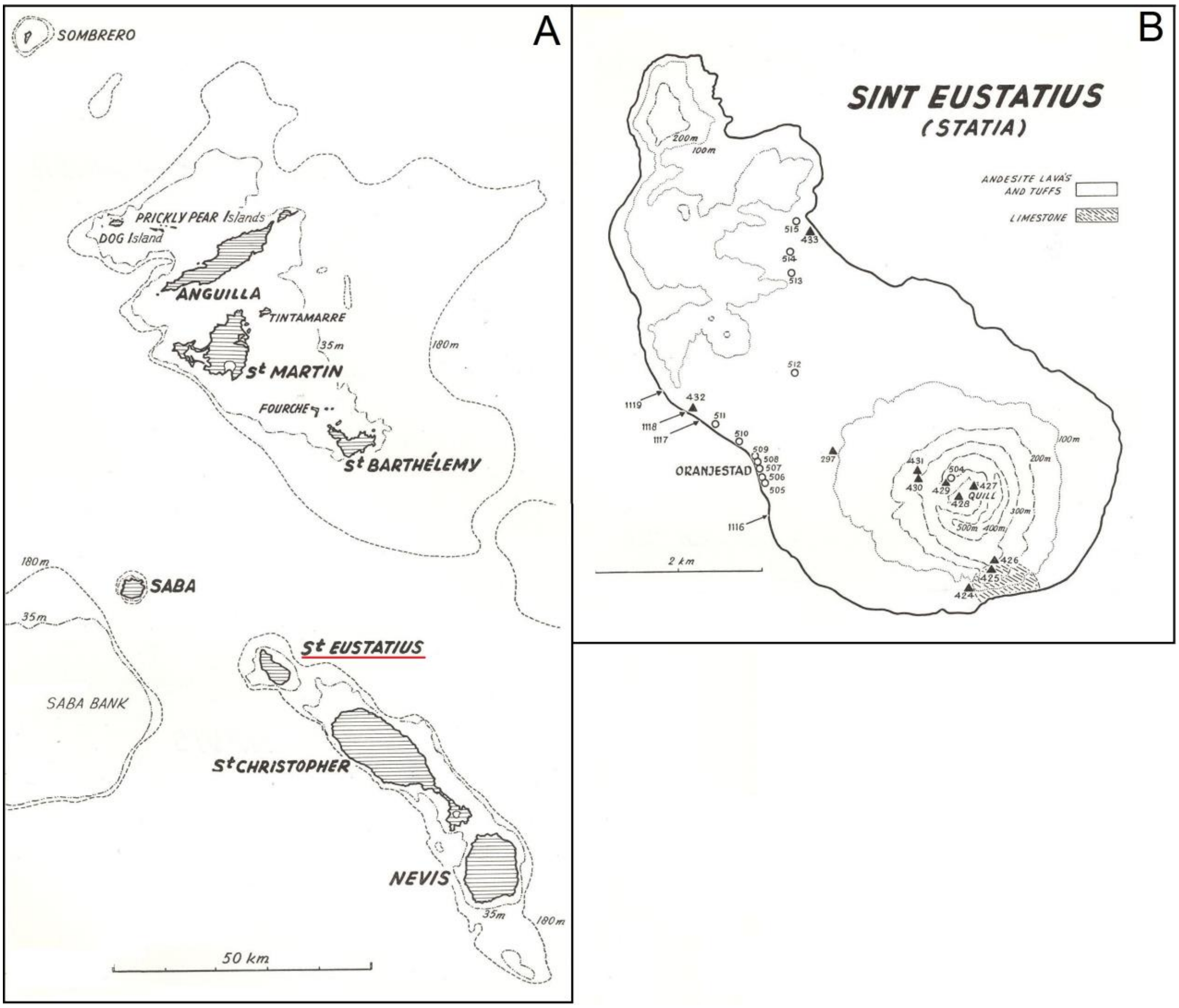

Fig. 2. Maps by Wagenaar Hummelinck (1953). **A** Windward Group of Antilles where material was collected. **B** Four collection stations at St. Eustatius: 1116 = Southern Part of Gallows Bay, 1117 = Downtown near Billy Gut, 1118 = Billy Gut near Downtown, 1119 = South of Tumble Down Dick Bay.

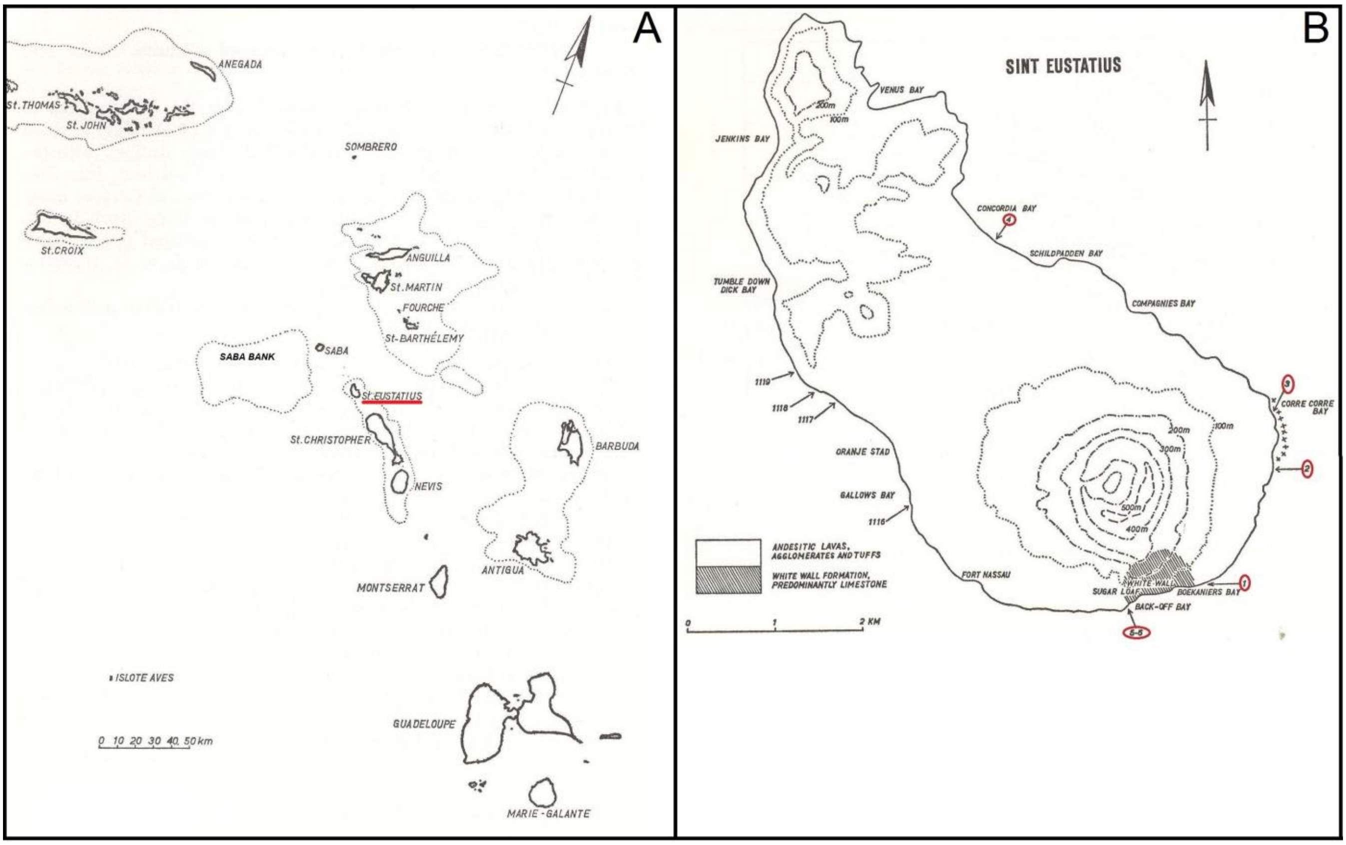

Fig. 3 Maps by Vroman (1968). **A** Windward Group of Antilles where material was collected (St. Eustatius underlined). **B** Collection stations at St. Eustatius (marked): 1 = Boekaniers Bay, 2 = Bay between Boekaniers Bay and Corre Corre Bay, 3 = Corre Corre Bay, 4 = Concordia Bay, 5 = Back-off Bay (Sugarloaf and White Wall), 6 = Back-off Bay (sublittoral). Descriptions of the localities are given by Vroman (1968: 59–61)

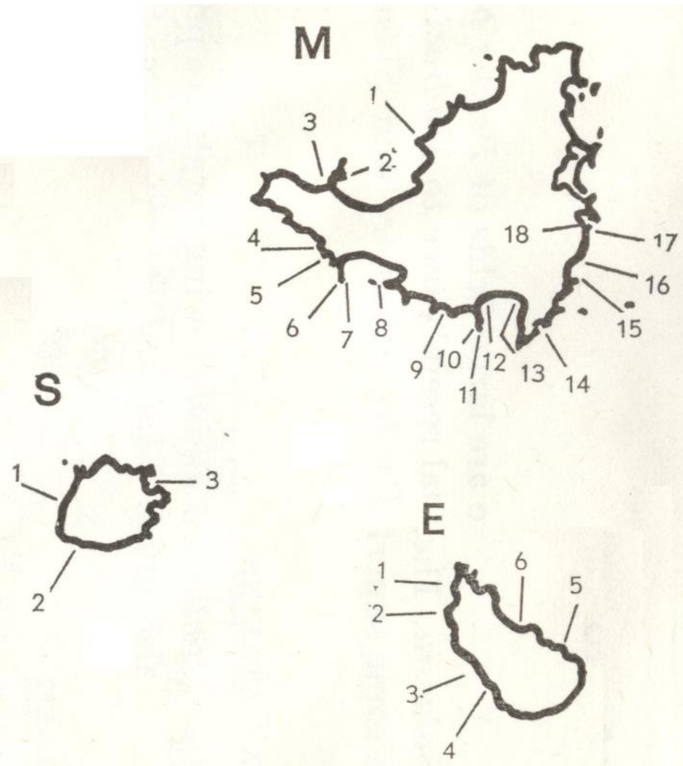

Fig. 4 Collecting stations of Roos (1971) around Saba (S), St. Martin (M), and St. Eustatius (E) in 1965.
St. Eustatius: 1 = Cocoluch Bay – Jenkins Bay, 2 = Jenkins bay – Tumbledown Dick Bay, 3 = Oranjestad Bay, 4 = Gallows Bay, 5 = Compagnie Baai, 6 = Schildpadden Baai

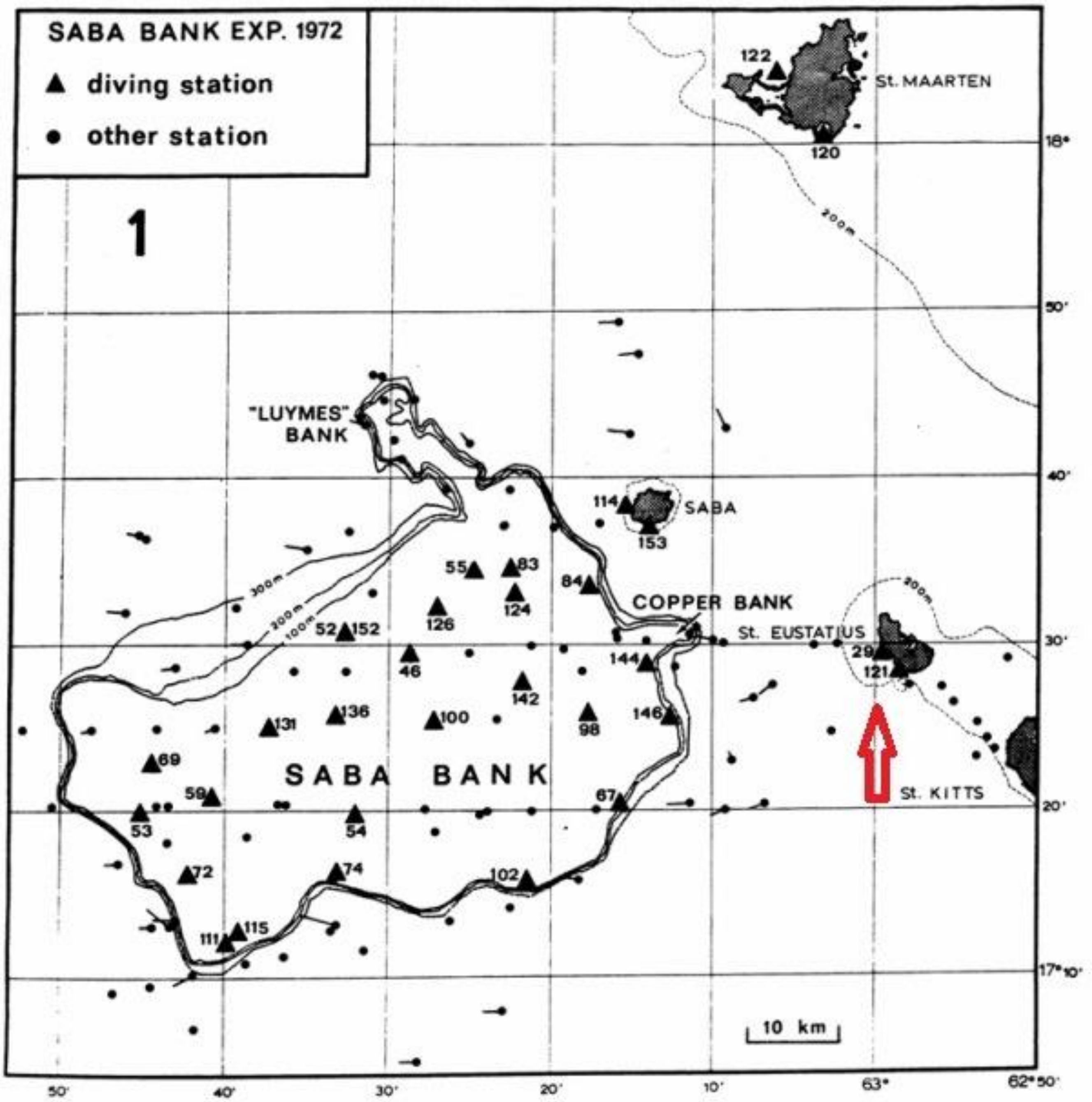

Fig. 5 Position of St. Eustatius (arrow) in relation to Saba Bank and Saba with sampling stations visited during the Saba Bank Expedition in 1972 (Van der Land 1977).

Goals and main research question

The primary goal of the field survey was to set up a baseline, which can be used for future studies on biotic change (marine fauna and flora) after hurricanes or periods of coral bleaching that may cause large-scale coral mortality (Carpenter et al. 2008). The logistic set-up of the expedition was similar to previous ones in which Naturalis Biodiversity Center was involved, mostly in Southeast Asia (Hoeksema and Tuti 2001; Hoeksema 2004, Hoeksema and Van der Meij 2008, 2010). The scientific goal of the Statia Marine expedition differed because of the baseline focus.

The importance of symbiosis for marine biodiversity is studied by the inclusion of associated fauna. The host dependence may be generalist or specialist (host-specific). Specimens of these species are difficult to find (due to their small size and hidden life style) and usually only by experts. Several of these species are expected to be new to science. Examples are coral-associated copepods and symbiotic hydroids on scleractinians and octocorals. Some coral-associated species are well known but their host preference is not well studied, such as Christmas tree worms (*Spirobranchus* spp.). The results will help to improve our knowledge of the marine biodiversity of St. Eustatius and the rest of the Caribbean.

Species richness around Statia is variable, depending on various environmental elements. It is hypothesized that the following factors play a role: bathymetry, substrate volcanic rock / limestone rock / sand / shipwrecks, wind exposure, coastline morphology, seascape (Debrot et al. 2014) and rules and regulations concerning the marine parks (Figs. 6–9).

The following aspects were studied
1 A study of the species composition and distribution patterns of taxa covered by taxonomic expertise of the research team will be used to show.
  a marine species that are widely spread or locally distributed
  b the variation in species diversity (species richness) among the various localities
  c the marine benthic diversity of Statia in comparison with other areas in the Caribbean
  d whether a baseline can be established for studies concerning changes over time
  e whether species can be discovered that are new to science
  f the distribution of keystone taxa important for conservation (endangered species, invasive species)
  g new records of interspecific associations (host species and parasites, commensals, other symbionts)
2 Photographic documentation and a reference collection will support the establishment of the baseline.
3 DNA samples will be taken for molecular analyses and DNA bar coding.

Expedition stations
Originally, approximately 35 dive sites around St. Eustatius were planned (2 / day; 6 days / week) for the whole survey, representing various coral reef and non-reefal environments for covering maximum habitat diversity. In addition, a number of stations along the coastline was selected for the sampling of intertidal molluscs and algae.

Sampling strategy
Subtidal The roving diver technique (RDT) or timed-swim sampling (presence / absence records per dive with ca. 60 min observation time, including photography and collecting of voucher specimens and DNA samples). Maximum diving depth was 30 m. Species records will be used in a species richness estimation analysis for species presence-absence comparisons.
Intertidal Samples of molluscs and algae were taken from the seashore during low-tide.

Species presence / absence records for the dive sites are employed to find which species are common and which ones are rare. For the monitoring of some species groups the expertise of taxonomic specialists is required. The species richness data will be analysed with the help of statistics.The following species groups were monitored.
- dominant benthic species groups: stony corals, octocorals, sponges, macro algae.
- associated fauna: species living in symbiosis with benthic organsims.
- iconic species: species represented by specimens that are relatively easy to identify by non-taxonomists and key / indicator species that are expected to be important for reef management because of their rarity or economic value (queen conch, coral diseases).
- species richness patterns around Statia are studied by molecular analyses

Taxonomic expertise and tasks of participants
Participants contribute to the expedition results regarding: stony corals, soft corals, hydroids, sponges, molluscs, fish, macro algae, associated fauna, interstitial fauna, and metagenomics. Tasks:
- to produce marine species lists as baseline for Statia
- to analyse biodiversity of dive sites around Statia based on exemplar taxa and species that are protected, rare, invasive, or of other interest
- to make reference collections (Naturalis and CNSI)
- to sample specimens for barcoding
- to produce scientific publications
- to produce photographic materials, films and documentation for outreach: websites, blogs, fieldguides

Participants field surveys
The team members were from Naturalis Biodiversity Center (research, collections), universities (students), ANEMOON Foundation (volunteers for long-term monitoring), and various foreign institutes. STENAPA was local counterpart. All particpants were SCUBA divers except when mentioned otherwise. CNSI provided logistic support.

Naturalis Biodiversity Center, Leiden, The Netherlands
1. Dr. Bert W. Hoeksema (co-expedition leader, stony corals and coral-associated fauna)
2. Ms. Yee Wah Lau, MSc (student UL, octocorals)
3. Dr. Willem F. Prud'homme van Reine (marine algae) non-SCUBA
4. Dr. Arjen Speksnijder (molecular biodiversity bottom fauna)
5. Mr. Frank Stokvis, MSc (technician molecular analyses)
6. Ms. Luna M. van der Loos (student RUG, marine algae) – also member of ANEMOON team
7. Mr. Koos van Egmond (collection technician)
8. Dr. Ronald Vonk (interstitial bottom fauna)

ANEMOON Foundation
1. Mr. Niels Schrieken, MSc (co-expedition leader, coordinator ANEMOON; ascideans, sponges)
2. Mr. Marco Faasse, MSc (hydrozoans, bryozoans, general marine fauna)
3. Ms. Marion Haarsma (photography, general marine fauna)
4. Ms. Susan J. Hewitt (molluscs) – non-SCUBA, also foreign taxonomic expert
5. Mr. Steve Piontek, MSc (fishes) – based on St. Eustatius, Caribbean Netherlands
6. Ms. Luna M. van der Loos (marine algae) – also MSc intern at Naturalis
7. Ms. Sylvia van Leeuwen, MSc (molluscs) – non-SCUBA
8. Dr. Godfried W.N.M. van Moorsel (scleractinians, fishes)

STENAPA
1. Ms. Jessica Berkel (park manager)
2. Mr. Matt Davies (park ranger)

Foreign taxonomic experts (not from the Netherlands)
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2. Ms. Susan J. Hewitt (molluscs) – non-SCUBA, also member of ANEMOON team
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4. Dr. Simone Montano, University of Milano-Bicocca, Milano, Italy (hydrozoans)
5. Dr. James D. Reimer, University of the Ryukyus, Okinawa, Japan (zoantharians)
6. Dr. Jim D. Thomas, Reef Foundation Inc., Dania, Florida, USA (amphipods)

Scubaqua
1. Mr. Mike Harterink (diving logistics)
2. Mr. Menno Walther (diving logistics, boat man)
3. Ms. Marieke van de Wetering (diving logistics)

4–6. Laura, Noortje, Vincent (dive guides)

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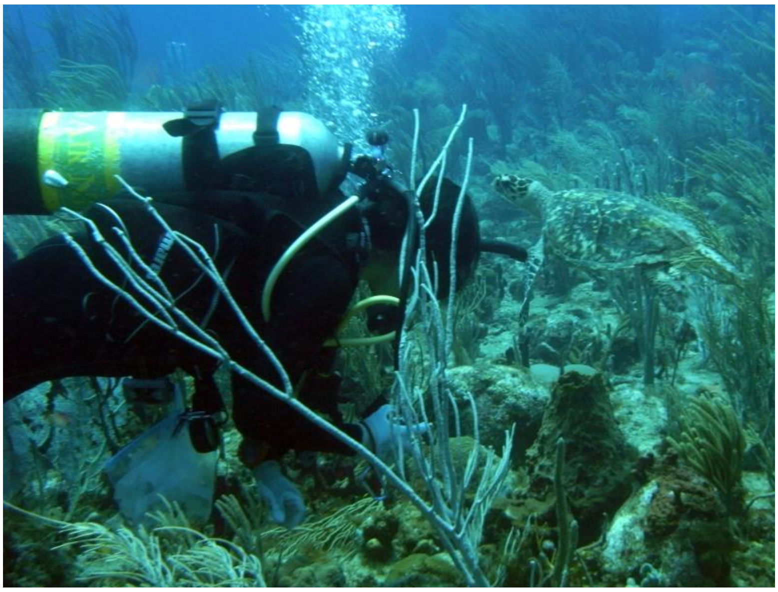

Scientist searching for marine organisms

Statistics based on observations taken between 02/2005 - 05/2014 daily from 7am to 7pm local time. You can order the raw wind and weather data in Excel format from our historical weather data request page.

Month of year	Jan 01	Feb 02	Mar 03	Apr 04	May 05	Jun 06	Jul 07	Aug 08	Sep 09	Oct 10	Nov 11	Dec 12	Year 1-12
Dominant Wind dir.	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙
Wind probability >= 4 Beaufort (%)	61	63	50	48	40	53	59	52	26	31	36	52	**47**
Average Wind speed (kts)	12	12	11	11	10	11	12	11	9	9	10	11	**10**
Average air temp. (°C)	27	27	27	28	29	30	29	30	30	29	28	27	**28**

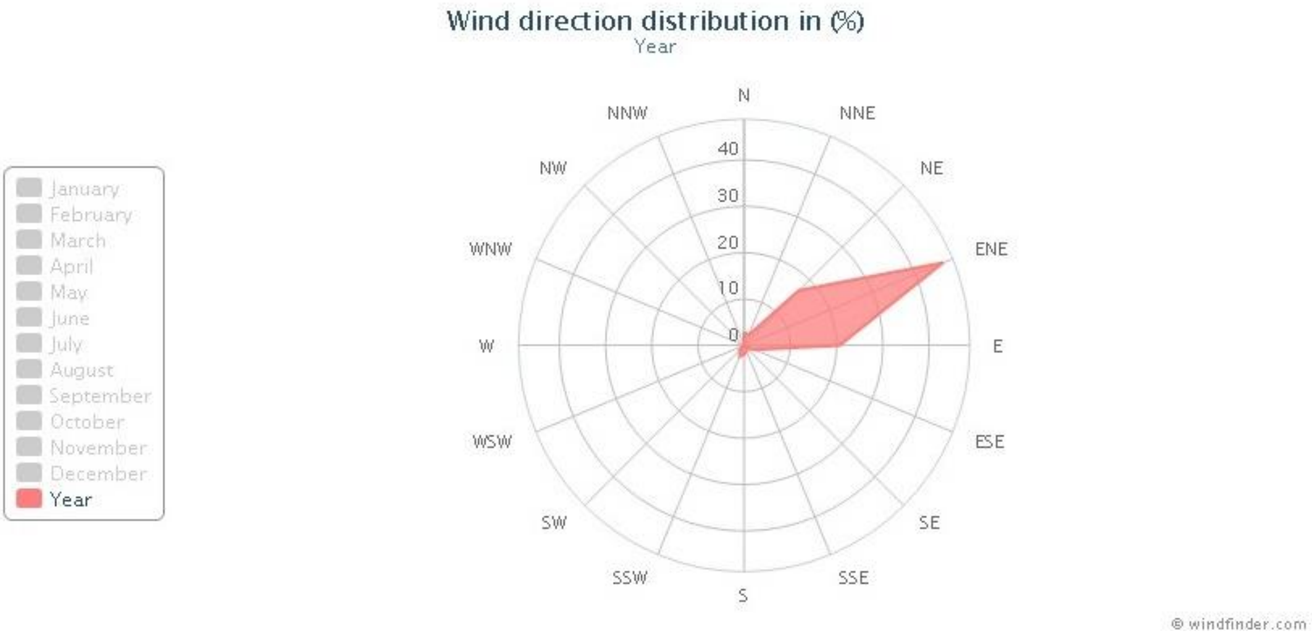

Fig. 6 Wind statistics of St-Eustatius: http://www.windfinder.com/windstatistics/st_eustatius

Fig. 7 Location of official dive sites at St. Eustatius. Source: http://www.statiapark.org/parks/marine/img/statia_dive_map.pdf

Fig. 8 Bathymetry around St. Eustatius. Nautical map 2716 (2014 edition).

Fig. 9 Coastline of St. Eustatius showing wave exposure on the NE shore (Google Earth)

Survey sites on St. Eustatius (compiled by Niels Schrieken)

Sampling stations: subtidal

Station #	Location name	Date	Coordinates	Max depth	Station description
EUX 001	Princess Corner	7 June	17°27'49.7" N, 62°59'12.7" W	19 m	Reef on lava ridges with sand patches and overhangs
EUX 002	Triple wreck	7 June	17°28'45.6" N, 62°59'40.8" W	19 m	Reef on lava, with sand patches
EUX 003	Stenapa Reef	8 June	17°29'03.7" N, 62°59'50.5" W	20 m	Shipwreck, surrounded by sand, sea grass
EUX 004	Hangover	8 June	17°27'51.6" N, 62°59'08.9" W	17 m	Reef on lava, with sand patches and overhangs
EUX 005	Charles L Brown South	9 June	17°27'51.3" N, 62°59'36.3" W	30 m	Shipwreck, surrounded by sand, sea grass
EUX 006	The Humps	9 June	17°27'48.5" N, 62°58'41.5" W	14 m	Patchy reef with big rocks and sand
EUX 007	The Cliffs	10 June	17°27'44.2" N, 62°58'46.7" W	32 m	Reef on lava flows, with sand, drop-off
EUX 008	Five Fingers South	10 June	17°27'53.9" N, 62°59'00.7" W	17 m	Reef on lava flows, with sand
EUX 009	Grand Canyon	11 June	17°27'42.1" N, 62°58'41.2" W	40 m	Reef with sand, drop-off
EUX 010	Crooks Castle	11 June	17°28'19.2" N, 62°59'15.6" W	13 m	Patchy reef with sand and lava blocks
EUX 011	Gibraltar	12 June	17°30'30.5" N, 63°00'00.2" W	18 m	Patchy reef, sand and boulders
EUX 012	Aquarium	12 June	17°30'22.6" N, 63°00'22.0" W	17 m	Patchy reef, sand and boulders
EUX 013	Scubaqua House Reef	13 June	17°28'56.3" N, 62°59'20.3" W	4 m	Submerged city wall with overhangs, adjacent sand
EUX 014	Chien Tong	14 June	17°29'00.6" N, 62°59'52.9" W	24 m	Shipwreck with sand, rubble and seagrass around
EUX 015	The Blocks	14 June	17°27'50.9" N, 62°59'06.8" W	17 m	Reef on lava flows, with sand
EUX 016	Nursing Station	15 June	17°28'05.6" N, 62°59'30.3" W	20 m	Sands with rocks around
EUX 017	Blue Bead Hole	15 June	17°28'31.5" N, 62°59'33.6" W	19 m	Sand with rocks and seagrass
EUX 018	Shark Reef	16 June	17°30'37.1" N, 63°00'27.1" W	30 m	One big rock with sand around
EUX 019	Blairs reef	16 June	17°28'13.6" N, 62°59'30.2" W	21 m	Large rocks and sand
EUX 020	Double wreck	17 June	17°28'48.3" N, 62°59'39.4" W	19 m	Reef ridge with rocks with sand around
EUX 021	Anchor Point	17 June	17°27'50.4" N, 62°59'15.0" W	17 m	Large rocks with sand
EUX 022	Queens Reef	18 June	17°27'56.6" N, 63°00'07.2" W	26 m	Rocks with sand
EUX 023	The Ledge II	18 June	17°27'44.5" N, 62°59'08.1" W	21 m	Reef on lava ridge with sand around
EUX 024	Boven Bay	19 June	17°31'35.7" N, 62°59'35.3" W	20 m	Large boulders
EUX 025	English Quarter	19 June	17°30'16.4" N, 62°57'47.8" W	19 m	Small rocks with sand
EUX 026	Scubaqua House Reef	20 June	17°28'55.9" N, 62°59'20.5" W	4 m	Submerged city wall with overhangs, adjacent sand
EUX 027	Chien Tong (night dive)	20 June	17°29'00.6" N, 62°59'52.9" W	25 m	Shipwreck with sand, rubble and seagrass around
EUX 028	Lost Anchors	21 June	17°28'17.7" N, 63°00'20.2" W	26 m	Reef on lava ridges with sand around
EUX 029	Twelve Guns	21 June	17°28'12.8" N, 62°58'58.7" W	6 m	Reef on lava ridges with sand around
EUX 030	The Ledge I	22 June	17°27'48.2" N, 62°59'04.7" W	20 m	Reef on lava ridges with sand around
EUX 031	Mushrooms	22 June	17°27'45.7" N, 62°58'40.0" W	13 m	Lava rocks with sand around
EUX 032	Twin Sisters	23 June	17°31'00.1" N, 63°00'10.9" W	18 m	Patches of small rocks with sand
EUX 033	Inner Jenkins Bay	23 June	17°30'44.1" N, 63°00'03.9" W	10 m	Big rocks and sand
EUX 034	Castle Rock	24 June	17°27'59.4" N, 62°59'29.1" W	21 m	Big rocks and sand
EUX 035	Anchor Reef	24 June	17°27'48.4" N, 62°59'13.6" W	19 m	Rocks and sand
EUX 036	Barracuda's Reef	25 June	17°28'01.6" N, 62°59'28.1" W	21 m	Reef on lava ridges with sand around
EUX 037	Blue Bead Hole II	25 June	17°28'37.4" N, 62°59'29.6" W	16 m	Sand with rocks and seagrass
EUX 038	Drop off west	26 June	17°27'40.3" N, 62°58'31.1" W	35 m	Steep lava rocks with sand patches, drop-off
EUX 039	Blind Shoal	26 June	17°30'37.1" N, 63°00'27.1" W	9 m	Patch reef with rocks and sand
EUX 040	Gallows Bay	27 June	17°28'30.3" N, 62°59'10.3" W	12 m	Rocky shoreline

Sampling stations: intertidal

Station #	Location name	Date	Coordinates	Max depth	Station description
EUX 101	Zeelandia Beach	7 June	17°30'38.5" N, 62°58'85.8" W	NA	E coast, long sand beach
EUX 102	Lynch Beach	8 June	17°30'05.7" N, 62°58'07.6" W	NA	E coast, rocky cobble beach with three sandy areas
EUX 103	Old pier Oranje Bay	10 June	17°28'97.0" N, 62°59'27.2" W	NA	W coast, on the concrete stones
EUX 104	Crooks Castle ruins	11 June	17°28'34.7" N, 62°59'08.1" W	NA	W coast, sandy area on rocky coast near ravine
EUX 105	Lynch Beach	13 June	17°30'05.7" N, 62°58'07.6" W	NA	E coast, rocky cobble beach with three sandy areas
EUX 106	Small jetty Oranjestad Bay	14 June	17°28'50.9" N, 62°59'13.5" W	NA	W coast, rocks and small sand areas
EUX 107	Corre Corre Bay	15 June	17°29'11.2" N, 62°56'49.6" W	NA	E coast, rocks in sheltered bay
EUX 108	Zeelandia Bay	16 June	17°30'23.6" N, 62°58'51.9" W	NA	E coast, long sand beach
EUX 109	Baby Beach	16 June	17°28'40.6" N, 62°59'10.3" W	NA	W coast, sheltered sand beach next to the port jetty
EUX 110	Crooks Castle both sides	16 June	17°28'27.8" N, 62°59'07.1" W	NA	W coast, gravel and rocky beach
EUX 111	Venus Bay	19 June	17°30'57.4" N, 62°59'21.6" W	NA	E coast, rocky beach
EUX 112	Lynch Beach	20 June	17°30'05.7" N, 62°58'07.6" W	NA	E coast, rocky cobble beach with three sandy areas
EUX 113	North end of Oranje Bay	21 June	17°29'08.2" N, 62°59'29.8" W	NA	W coast, sand beach with rocks and ruins
EUX 114	Billy's Gut	21 June	17°29'16.0" N, 62°59'42.8" W	NA	W coast, sand beach with rocks and ruins
EUX 115	Platform in Billy's Gut	21 June	17°29'13.0" N, 62°59'36.0" W	NA	W coast, concrete platform in the mouth of the gully
EUX 116	Fisherman and Boat pier	21 June	17°28'45.8" N, 62°59'11.5" W	NA	W coast, concrete pier and rocky coast
EUX 117	South of Corre Corre Bay	23 June	17°28'35.9" N, 62°56'52.2" W	NA	E coast, rocks in high littoral zone, rough waves
EUX 118	Jenkin's Bay	24 June	17°30'35.7" N, 62°59'57.3" W	NA	W coast, rocky beach
EUX 119	Lynch Beach	25 June	17°30'05.7" N, 62°58'07.6" W	NA	E coast, rocky cobble beach with three sandy areas
EUX 120	de Windt Battery	20 June	17°27'52.8" N, 62°57'51.2" W	NA	E coast, rocky cobble beach

Sampling stations: terrestrial

Station #	Location name	Date	Coordinates	Elevation	Station description
EUX 200	Botanical garden	15 June	17°28'27.2" N, 62°57'05.2" W	75 m	Ornamental dried-out pond
EUX 201	Toby's Gut	17 June	17°28'07.9" N, 62°57'54.8" W	100 m	Gully in forest north of the road
EUX 202	Boven National Park, north slope	19 June	17°30'34.2" N, 62°59'23.9" W	100 m	Along path to Venus Bay, northern slope
EUX 203	Boven National Park, small woodland	19 June	17°30'37.0" N, 62°59'24.7" W	75 m	Small woodland of Acacia spec B (small leaves, no spines), along path to Venus Bay
EUX 204	Boven National Park, entrance	19 June	17°30'25.5" N, 62°59'01.3" W	50 m	Dry shrubs and rocks
EUX 205	The Quill, Southwest slope	20 June	17°28'35.1" – 17°28'43.9" N 62°58'06.3" – 62°58'29.3"W	150–325 m	Along path through forest between entrance and viewpoint
EUX 206	The Quill, west slope	20 June	17°28'40.4" N, 62°58'01.1" W	325–400 m	Along path through forest between viewpoint and crater rim
EUX 207	The Quill, Crater bottom	20 June	17°28'40.8" N, 62°57'48.4" W	300 m	Forested crater bottom
EUX 208	The Quill, south southwest slope	22 June	17°28'18.5" N, 62°57'51.2" W	300–350 m	Deciduous forest, along trail around the Quill
EUX 209	The Quill, White wall	22 June	17°28'11.0" N, 62°57'36.1" W	250–350 m	Deciduous forest, along trail around the Quill, with some calcareous outcrops
EUX 210	Oranjestad, James S. Rhoda Road	25 June	17°29'27.9" N, 62°58'52.3" W	50 m	Garden with ornamental plants

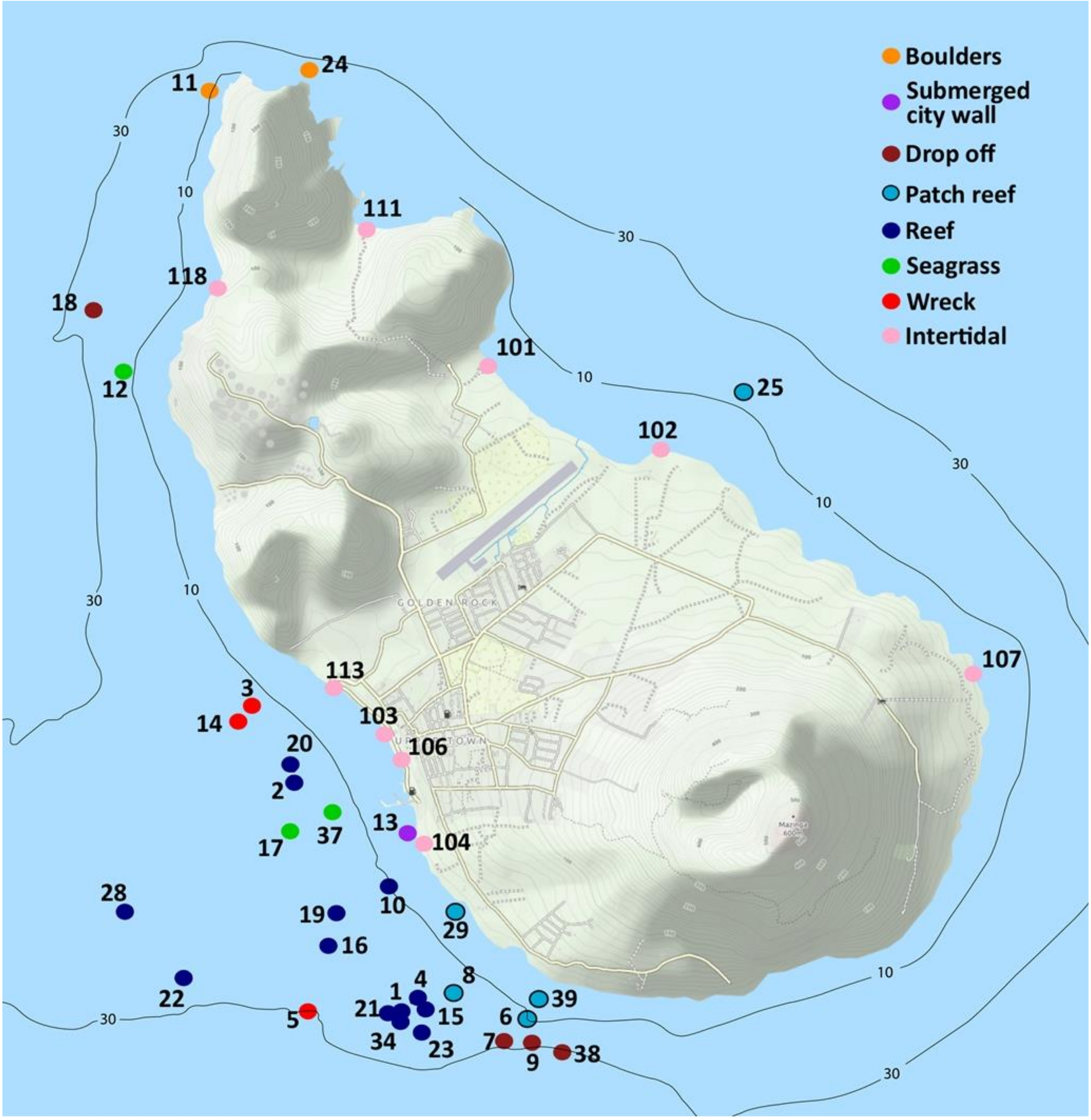

Fig. 1 Map of St. Eustatius, with intertidal and subtidal sample localities and dominant substrate type (after Van der Loos 2016: Fig. 1. Bathymetry by Erik-Jan Bosch)

Reference

Van der Loos LM (2016) Macroalgal communities around the tropical island of St. Eustatius - Combining ecology with phylogenetics. MSc thesis, University of Groningen.

Macroalgae of Statia

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Introduction

Macroalgae play an important role in the functioning of coral reefs and seagrass beds. They do not only constitute a major part of marine biota, but they are also responsible for the high primary productivity that is typical of coral reef ecosystems (Littler and Littler 1994). In addition, they provide mechanical stability and support, which is essential for the formation of coral reefs (Littler and Littler 2013). In seagrass fields they provide habitat for other organisms, increase the complexity of food web dynamics, whereas the macroalgal epiphytes can greatly add to the primary production of the seagrass fields (Moncreiff et al. 1992).

Methods

During the Statia Marine Expedition species-habitat relations of algal communities were explored to identify biodiversity patterns, to assess whether certain species are unique to a particular environment and if species are clustered by chance or clustered by habitat preference.

Macroalgae and seagrasses were sampled on 40 different locations around the island, 31 of which are subtidal locations at 5–40 m depth and nine intertidal locations. Locations were chosen to maximize the variation in substrates, exposure, and depth. Living specimens were photographed in situ. For each collected specimen, its depth, substrate and preliminary identification were noted. Habitat substrate categories were: wrecks, ropes, submerged city wall, coral, coral rubble, rock or sand, as well as occurrence within seagrass beds or an epiphytical habitat. Some species were only found as drift, washed up at the coast. Furthermore, at every location, the presence of each species was noted by use of the roving diver technique with a ca. 60 min observation time. This method allows the diver/researcher to swim/walk freely around the location to record as many species as possible. Samples were press-dried or fixed and preserved in 6% formalin in seawater for further determination. If possible, subsamples were taken and dried in silica for molecular analysis. A photo collection of all herbarium material has been made.

Voucher specimens have been deposited in the herbarium collection of Naturalis Biodiversity Center. The collection consists of 455 voucher specimens and samples; 288 of these were subsampled for molecular analysis.The specimens are expected to belong to at least 60 genera and more than 175 species (Tables 1-4). Many of these will be new records for St. Eustatius. The nomenclature of the species is following AlgaeBase (Guiry and Guiry 2016) through the World Register of Marine Species (WoRMS Editorial Board 2016). Apart from not yet identified specimens, field identifications record the following genera.

New record for the Atlantic: *Parvocaulis exiguus* (Van der Loos and Prud'homme van Reine 2016)

Acknowledgements This project was supported by the Alberta Mennega Stichting and Stichting het Van Eeden-fonds.

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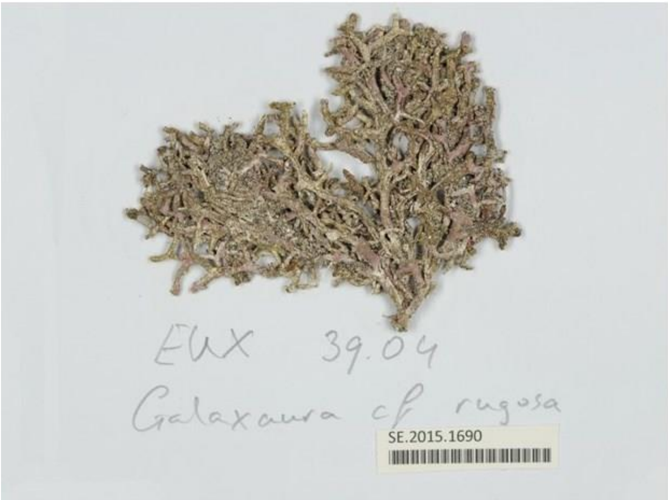
Acetabularia crenulata

Udotea dixonii



Galaxaura cf rugosa

Taonia abbottiana

Fig. 1 Interesting phycological records for St. Eustatius

Table 1 Green macroalgae (Chlorophyta: Ulvophyceae) recorded on St. Eustatius

Order Bryopsidales J.H.Schaffner, 1922
Family Bryopsidaceae Bory, 1829
Bryopsis pennata J.V. Lamour.
Family Caulerpaceae Kützing, 1843
Caulerpa ambigua Okamura
Caulerpa chemnitzia (Esper) J.V. Lamououx
Caulerpa cupressoides (Vahl) C. Agardh
Caulerpa cupressoides var. *flabellata* Børgesen
Caulerpa mexicana Sonder ex Kützing
Caulerpa prolifera (Forssk.) J.V. Lamour.
Caulerpa serrulata (Forssk.) J. Agardh
Caulerpa sertularioides (S.G. Gmel.) M. Howe
Caulerpa verticillata J. Agardh
Family Derbesiaceae Hauck, 1884
Derbesia fastigiata W.R. Taylor
Derbesia osterhoutii (L.R. Blinks & A.C.H. Blinks) J.Z. Page
Family Dichotomosiphonaceae G.M. Smith, 1950
Avrainvillea hayi D.S. Littler & Littler
Family Halimedaceae Link, 1832
Halimeda discoidea Decne.
Halimeda goreaui W.R. Taylor
Halimeda gracilis Harv. ex J. Agardh
Halimeda incrassata (J. Ellis) J.V. Lamour.
Halimeda monile (Ellis & Sol.) J.V. Lamour.
Halimeda tuna (J. Ellis & Sol.) J.V. Lamour.
Halimeda tuna f. *platydisca* (Decaisne) E.S. Barton
Family Udoteaceae J. Agardh, 1887
Penicillus capitatus Lam.
Penicillus lamourouxii Decne.
Penicillus pyriformis A. Gepp & E. Gepp
Udotea cyathiformis f. *infundibulum* (J. Agardh) D.S. Littler & Littler
Udotea cyathiformis f. *sublittoralis* (W.R. Taylor) D.S. Littler & Littler
Udotea dixonii D.S. Littler & Littler
Udotea flabellum (J. Ellis & Sol.) M. Howe
Udotea spinulosa M. Howe
Order Cladophorales Haeckel, 1894
Family Anadyomenaceae Kützing, 1843
Anadyomene saldanhae A.B. Joly & E.C. Oliveira
Anadyomene stellata (Wolf) C. Agardh
Family Boodleaceae Børgesen, 1925
Cladophoropsis membranacea (C. Agardh) Børgesen
Cladophoropsis sundanensis Reinbold
Struvea elegans Børgesen
Family Cladophoraceae Wille in Warming, 1884
Bryobesia johannae Weber Bosse
Chaetomorpha antennina (Bory) Kütz.
Chaetomorpha clavata Kütz.
Chaetomorpha gracilis Kütz.
Cladophora herpestica (Mont.) Kütz.
Cladophora laetevirens (Dillwyn) Kütz.
Family Siphonocladaceae F.Schmitz, 1879
Dictyosphaeria cavernosa (Forssk.) Børgesen
Dictyosphaeria ocellata (M. Howe) Olsen-Stojkovich

Family Valoniaceae Kützing, 1849

Valonia macrophysa Kütz.
Valonia utricularis (Roth) C. Agardh
Ventricaria ventricosa (J. Agardh) J.L. Olsen & J.A.West

Order Dasycladales

Family Dasycladaceae Kützing, 1843

Neomeris annulata Dickie

Family Polyphysaceae Kützing, 1843

Acetabularia caliculus J.V. Lamouroux
Acetabularia schenckii Möbius
Parvocaulis exiguus (Solms-Laubach) S. Berger et al.
Parvocaulis parvulus (Solms-Laubach) S. Berger et al.
Parvocaulis polyphysoides (P.Crouan & H.Crouan) S. Berger et al.
Parvocaulis pusillus (M. Howe) S. Berger et al.

Order Ulvales Blackman & Tansley, 1902

Family Ulvaceae J.V. Lamouroux ex Dumortier, 1822

Ulva compressa L.
Ulva flexuosa subsp. *flexuosa* Wulfen

Table 2 Brown macroalgae (Phaeophyceae) recorded on St. Eustatius

Order Dictyotales Bory, 1828

Family Dictyotaceae J.V. Lamouroux ex Dumortier, 1822

Dictyopteris delicatula J.V. Lamour.
Dictyopteris jolyana E.C. Oliveira & R.P. Furtado
Dictyota bartayresiana J.V. Lamour.
Dictyota caribaea Hörnig & Schnetter
Dictyota cervicornis Kütz.
Dictyota ciliolata Sond. ex Kütz.
Dictyota crenulata J. Agardh
Dictyota guineensis (Kütz.) P. Crouan & H. Crouan
Dictyota hamifera Setch.
Dictyota menstrualis (Hoyt) Schnetter, Hörning & Weber
Dictyota mertensii (C. Mart.) Kütz.
Dictyota pfaffii Schnetter
Dictyota pinnatifida Kütz.
Dictyota pulchella Hörnig & Schnetter
Lobophora variegata (J.V. Lamour.) Womersley
Padina boergesenii Allender & Kraft
Padina perindusiata Thivy
Padina sanctae-crucis Børgesen
Stypopodium zonale (J.V. Lamour.) Papenf.
Taonia abbottiana D.S. Littler & Littler

Order Fucales Bory, 1827

Family Sargassaceae Kützing, 1843

Sargassum filipendula C. Agardh
Sargassum fluitans (Børgesen) Børgesen
Sargassum hystrix J. Agardh
Sargassum natans (L.) Gaillon
Sargassum platycarpum Mont.
Sargassum polyceratium var. *ovatum* (Collins) W.R. Taylor
Sargassum pteropleuron Grunow
Sargassum vulgare C. Agardh
Turbinaria tricostata E.S. Barton

Order Sphacelariales Migula, 1908

Family Sphacelariaceae Decaisne, 1842

Sphacelaria rigidula Kützing

Table 3 Red macroalgae (Rhodophyta: Florideophycaea) recorded on St. Eustatius

Order Ceramiales Oltmanns, 1904

Family Ceramiaceae Dumortier, 1822

Ceramium nitens (C. Agardh) J. Agardh
Gayliella sp.

Family Delesseriaceae Bory, 1828

Hypoglossum hypoglossoides (Stackh.) Collins & Herv.
Hypoglossum tenuifolium (Harv.) J. Agardh
Martensia pavonia (J. Agardh) J. Agardh

Family Callithamniaceae Kützing, 1843

Crouania attenuata (C. Agardh) J. Agardh

Family Dasyaceae Kützing, 1843

Dasya baillouviana (S.G.Gmel.) Mont.
Dasya corymbifera J. Agardh
Dasya mollis Harv.
Dasya ramosissima Harvey
Dasya rigidula (Kütz.) Ardiss.

Family Rhodomelaceae Areschoug, 1847

Chondria cnicophylla (Melvill) De Toni
Chondria collinsiana M. Howe
Chondria leptacremon (Melvill ex G. Murray) De Toni
Digenea simplex (Wulfen) C. Agardh
Herposiphonia secunda (C. Agardh) Ambronn
Heterodasya mucronata (Harv.) M.J. Wynne
Laurencia filiformis (C. Agardh) Mont.
Laurencia gemmifera Harv.
Laurencia intricata J.V. Lamour.
Laurencia obtusa (Huds.) J.V. Lamour.
Laurencia papillosa (Forssk.) Grev.
Lophocladia trichoclados (C. Agardh) F. Schmitz
Lophosiphonia cristata Falkenb.
Lophosiphonia obscura (C. Agardh) Falkenb.
Peyssonnelia flavescens D.L. Ballant. & H. Ruiz
Peyssonnelia simulans Weber Bosse
Polysiphonia binneyi Harv.
Polysiphonia scopulorum Harv.
Polysiphonia sphaerocarpa Børgesen
Wrightiella blodgettii (Harv.) F. Schmitz

Family Spyridiaceae J. Agardh, 1851

Spyridia filamentosa (Wulfen) Harv.
Spyridia hypnoides (Bory) Papenf.
Spyridia hypnoides subsp. *complanata* (J. Agardh) M.J. Wynne

Family Wrangeliaceae J. Agardh, 1851

Griffithsia globulifera Harv. ex Kütz.
Wrangelia argus Mont.
Wrangelia gordoniae K.E. Bucher, D.L. Ballant., C. Lozada

Order Corallinales P.C. Silva & H.W.Johansen, 1986

Family Corallinaceae J.V. Lamouroux, 1812

Amphiroa beauvoisii J.V. Lamour
Amphiroa brasiliana Decne
Amphiroa fragilissima (L.) J.V. Lamour
Amphiroa rigida J.V. Lamour
Amphiroa tribulus (Ellis & Sol.) J.V. Lamour
Haliptilon cubense (Mont. ex Kütz.) Garbary & Johansen
Haliptilon subulatum (J. Ellis & Sol.) H.W. Johans.

Hydrolithon farinosum (J.V. Lamour.) Penrose & Y.M. Cham
Hydrolithon farinosum f. *callithamnioides* (Foslie) Serio
Jania adhaerens J.V. Lamour.
Jania capillacea Harv.
Jania pumila J.V. Lamour.
Jania rubens (L.) J.V. Lamour.
Order Gelidiales Kylin, 1923
Family Pterocladiaceae G.P. Felicini & C. Perrone in C. Perrone et al. 2006
Pterocladiella capillacea (S.G. Gmel.) Santel. & Hommer
Order Gigartinales F.Schmitz in Engler, 1892
Family Phyllophoraceae Nägeli, 1847
Erythrodermis haematis (Hollenb.) Denizot
Family Solieriaceae J. Agardh, 1876
Flahaultia tegetiformans W.R. Taylor
Wurdemannia miniata (Spreng.) Feldmann & G.Hamel
Family Cystocloniaceae Kützing, 1843
Hypnea spinella (C. Agardh) Kütz.
Hypnea valentiae (Turner) Mont.
Order Gracilariales S.Fredericq & M. H.Hommersand, 1989
Family Gracilariaceae Nägeli, 1847
Gracilaria bursa-pastoris (S.G. Gmel.) P.C. Silva
Gracilaria caudata J. Agardh
Order Halymeniales G.W.Saunders & Kraft, 1996
Family Halymeniaceae Kützing
Cryptonemia crenulata (J. Agardh) J. Agardh
Order Nemaliales F.Schmitz in Engler, 1892
Family Galaxauraceae P.G.Parkinson, 1983
Galaxaura marginata (Sol.) J.V. Lamour.
Galaxaura rugosa (Ellis & Sol.) J.V. Lamour.
Galaxaura subverticillata Kjellm.
Tricleocarpa cylindrica (J. Ellis & Sol.) Huisman & Bor
Family Liagoraceae Kützing, 1843
Ganonema farinosum (J.V. Lamour.) K.C. Fan & Yung C. Wang
Ganonema pinnatum (Harv.) Huisman
Helminthocladia calvadosii (J.V. Lamour. ex Duby) Setch
Liagora albicans J.V. Lamour.
Liagora valida Harv.
Order Rhodymeniales F.Schmitz in Engler, 1892
Family Rhodymeniaceae Harvey, 1849
Botryocladia caraibica Gavio & Fredericq
Family Champiaceae Kützing, 1843
Champia vieillardii Kütz.
Coelothrix irregularis (Harv.) Børgesen
Family Lomentariaceae J. Agardh, 1876
Gelidiopsis planicaulis (W.R. Taylor) W.R. Taylor

Table 4 Seagrasses (Tracheophyta: "Monocots") recorded on St. Eustatius

Order Alismatales
Family Cymodoceaceae N.Taylor
Syringodium filiforme Kütz.
Family Hydrocharitaceae Jussieu
Halophila stipulacea (Forssk) Ascherson
Thalassia testudinum K.D. Koenig

Sponges (Porifera) of St. Eustatius

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[3] Did not participate in the expedition

Introduction

This section of the report focuses on the diversity of marine sponges from various coral reef environments around the coastal waters of St. Eustatius. A total of 36 sites were surveyed during the course of the marine expedition in order to catalogue the marine sponge fauna. Sponge surveys were performed using the roving diver technique, and presence of each sponge species was recorded by digital photography and underwater paper.

Voucher specimens

A total of 276 voucher sponge specimens were collected during the course of the expedition (Table 1). Preliminary field identification was performed with the help of Sponge Guide (Zea et al. 2014) and yielded approximately 165 different species of sponges. The nomenclature follows that of the World Register of Marine Species (WoRMS Editorial Board (2016). Molecular and classic taxonomical analysis is currently performed in order to confirm the preliminary species count. Final sponge identification will be done by Dr. Nicole de Voogd, sponge taxonomist at Naturalis Biodiversity Center. By class, Demospongiae was observed and collected the most; 216 voucher specimens with 134 possible different species. A total of 32 sponges belonging to the class Calcarea were collected, with 16 possible different species. Finally, a total of 28 sponges belonging to the class Homoscleromorpha were collected, with 15 possible different species (Fig. 1A). No sponges belonging to the class Hexactinellida were collected since these tend to inhabit deeper waters.

Presence / absence records

A total of 1,457 sponges were counted in the presence-absence analyses across 36 survey sites (Fig. 2). Due to dive-time limitations, sampling constraints were encountered during each dive. Along with sampling voucher specimens, hundreds of pictures were taken along the exploratory dives for later review in order to separate the sponges that were collected from those that were not collected as voucher specimens. Different environments (including sciophilous habitats) were explored within each survey site in order to get an overall sponge fauna census. Based on the surveys, the top six sponge biodiversity hotspots within St. Eustatius are proposed, all surveyed at depths from 16 to 22 m (Table 2).

By class, Demospongiae were observed to be the most (90%), followed by Homoscleromorpha (7%), and lastly Calcarea (3%) (Fig. 1B). Among the top ten sponge species observed throughout the surveys, nine belonged to the class Demospongiae, and only one to the class Homoscleromorpha (Fig. 3). Based on photographic documentation, 26 species that were not collected as voucher samples were also included in the presence-absence surveys (Table 3). Based on these observations, the preliminary number of sponge species at St. Eustatius is 191.

Notable sponge observations

The health of the Caribbean great barrel sponge (*Xestospongia muta*, Schmidt, 1870) can be categorized as stable. Barrel sponges were one of the most common sponge species across St. Eustatius, observed at 31 of the 36 surveyed sites (Fig. 3). Barrel sponges were also the largest sponges on the reef, thus, providing shelter for hundreds of other organisms as well as increasing rugosity within the reef. It is important to note that several specimens of the barrel sponge across various sites were observed being affected by some type of illness and/or bleaching (Fig. 4). The affected barrel sponges would "crumble" when touched, which revealed tissue necrosis throughout the sponge. The health of *X. muta* should be monitored closely for signs of population disease outbreaks since it is one of the largest sponge species across the Caribbean. Other sponges such as *Amphimedon compressa* (Duchassaing and Michelotti, 1864) were also observed to be showing signs of bleaching and/or illness (Fig. 5). Furthermore, sponges were observed to host and array or inhabitants, including crabs and zoantharians (Garcia-Hernandez et al. 2016a), as well as interesting interactions with scleractinian corals (Garcia-Hernandez et al. 2016b).

Conclusion

The sponge collections and observations performed during this expedition will serve as the foundation for future studies regarding the sponge fauna at St. Eustatius. This data will also serve to compare sponge faunas with other Caribbean islands and how these may be changing through time.

It is important to note that there is still plenty of work and exploration to be done at shallow depths around St. Eustatius. Future sponge studies should focus on exploring with more detail shallow (< 30 m) cryptic environments, this will surely yield new species of sponges. Mesophotic reefs (> 30 m) should also be a focus of future sponge research within St. Eustatius.

It is recommended that any future marine expedition within the Dutch Caribbean will continue to include the collection of marine sponges since these are usually left out of major coral reef surveys and management plans in other parts of the Caribbean.

Acknowledgements My gratitude goes to my wife, Beatriz, for supporting and putting up my scientific adventures. I would like to thank every single member of the expedition for helping each other out and working as a tightly knit team (some specimens would not have been collected if it were not for other team members). I would also like to thank Dr. Bert Hoeksema and Niels Schrieken for keeping the team on track and for organizing this expedition. I am extremely grateful to Drs. Nicole de Voogd and Rob van Soest for hosting me at Naturalis Biodiversity Center and for sharing their knowledge and expertise in the art of sponge taxonomy.

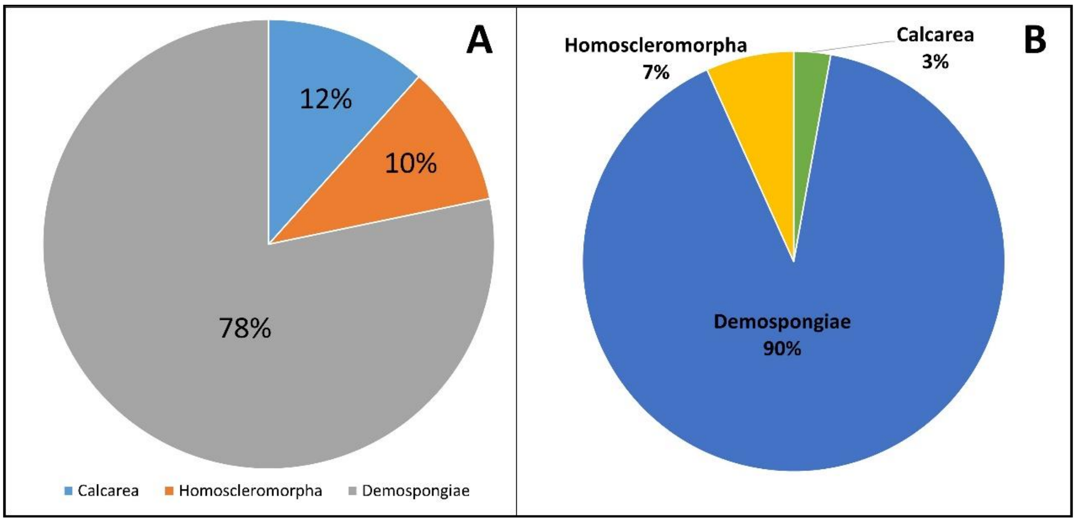

Fig. 1 A Percentual voucher sponge species diversity collected by Class from St. Eustatius. **B** Percentual by sponge class found across 36 dive sites surveyed at St. Eustatius

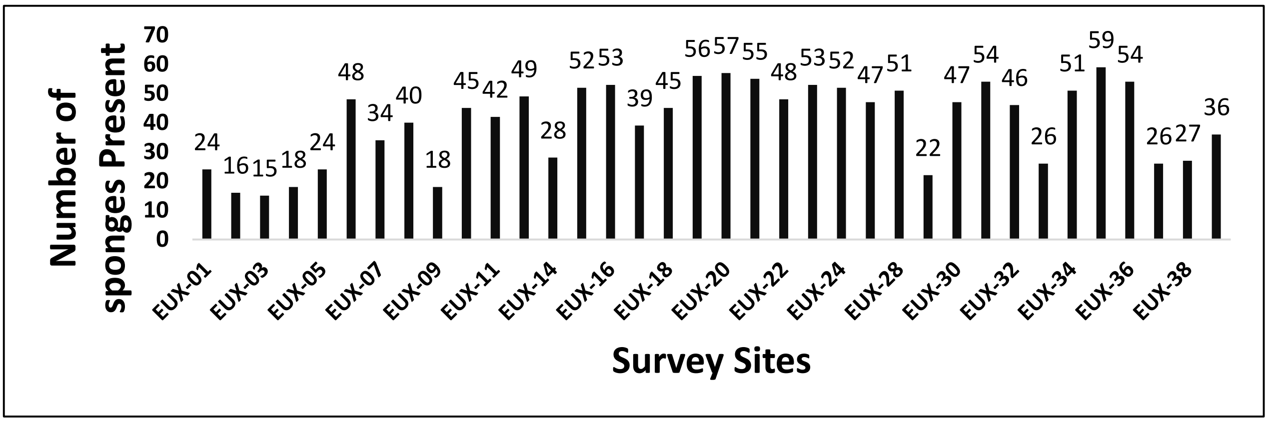

Fig. 2 Number of sponge species present at each of the 36 survey sites at St. Eustatius

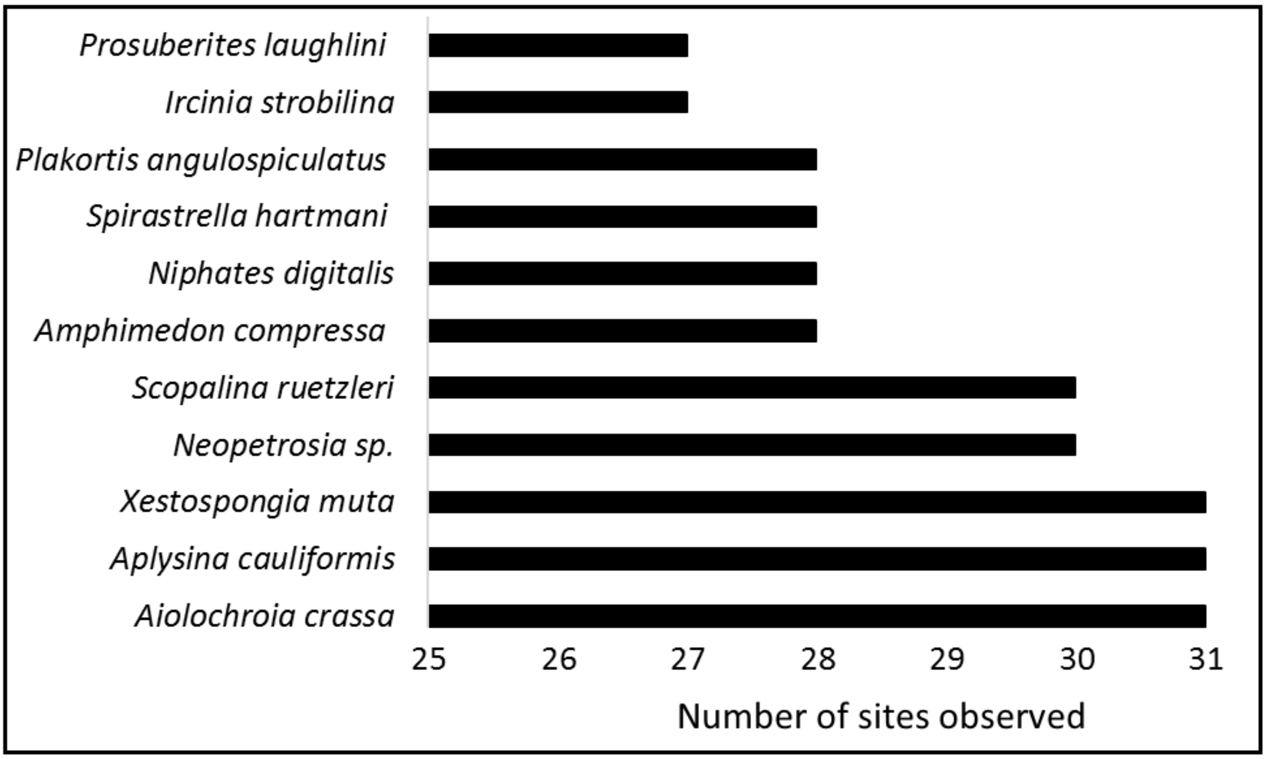

Fig. 3 Top 10 sponge species found across 36 survey sites in St. Eustatius

Table 1 Preliminary list of sponges of St. Eustatius. Voucher specimens are deposited at Naturalis Biodiversity Center

Class	Order	Family	Genus-species-Author-Year	EUX number	Voucher ID (JAA-#)
Calcarea					
	Clathrinida	Clathrinidae	*Clathrina* sp. 1	3, 6, 7, 11, 12, 33	51, 88, 95, 139, 144, 274
			Clathrina sp. 2	4	58
			Nicola tetela (Borojevic & Peixinho, 1976)	6, 36, 36	87, 286, 287
			Clathrina sp. 3	11, 12, 29	132, 148, 243
			Clathrina sp. 4	23	223
			Clathrina sp. 5	35	280
			Leucetta floridana Haeckel, 1872	10, 12, 15, 25	127, 149, 173, 233
			Leucetta sp. 2	25	238
			Leucetta sp. 3	30	247
			Leucetta sp. 4	35	284
			Leucetta sp. 5	15	176,
	Leucosolenida	Sycettidae	*Sycon* sp. 1	3, 3, 3	46, 47, 49
			Sycon sp. 2	14, 14, 14	159, 160, 161
			Sycon sp. 3	17	186
			Sycon sp. 4	20	209
			Sycon sp. 5	35	281
Homoscleromorpha					
	Homosclerophorida	Plakinidae	*Plakina jamaicensis* Lehnert & van Soest, 1998	3, 5, 12	54, 70, 151
			Plakinastrella sp. 1	4, 19	63, 205
			Plakortis angulospiculatus (Carter, 1879)	4	60
			Plakortis halichondrioides (Wilson, 1902)	9	121
			Plakortis sp. 1	6	90
			Plakortis sp. 2	8	103
			Plakortis sp. 3	15, 30	170, 248
			Plakortis sp. 4	28	240
		?	*Homoscleromorpha sp. 1	3, 3, 14	48, 52, 158
		?	*Homoscleromorpha sp. 2	3, 5	50,75
		?	*Homoscleromorpha sp. 3	4, 4, 15, 20, 23	59, 65, 172, 214, 225
		?	*Homoscleromorpha sp. 4 (*Oscarella* / *Corticium* sp.)	4, 20, 20	64, 212, 213
		?	*Homoscleromorpha sp. 5	24	229
		?	*Homoscleromorpha sp. 6	33	273
		?	*Homoscleromorpha sp. 7	15	166
Demospongiae					
	Agelasida	Agelasidae	*Agelas citrina* Gotera & Alcolado, 1987	1, 17	27, 196
			Agelas clathrodes (Schmidt, 1870)	6, 8	84, 112
			Agelas dispar (Duchassaing & Michelotti, 1864)	15, 16	171, 184
			Agelas sp. 3	19	206
			Agelas tubulata (Lehnert & van Soest, 1996)	31	257
	Astrophorida	Ancorinidae	*Asteropus* sp. 1 cf. *niger*	7	100
		Geodiidae	*Geodia coricostylifera* (Hajdu, et al. 1992)	24, 32	228, 262
		Pachastrellidae	*Dercitus* (*Halinastra*) *luteus* (Pulitzer-Finali, 1986)	6, 10, 23	86, 126, 222
	Chondrosia	Chondrillidae	*Chondrosia* sp. 1 (*C. reniformis* ?)	5	73
			Chondrilla sp. 1	12	145
			Chondrilla sp. 2	23	224

Dictyoceratida	Dysideidae	*Pleraplysilla* sp. 1	10, 12	125, 142
		Dysidea janiae (Duchassaing & Michelotti, 1864)	5, 14, 18	76, 162, 198
		Dysidea sp. 1	14	155
		Dysidea sp. 2	17	194
		Dysidea sp. 3	17	197
		Dysidea sp. 4	29	246
		Dysidea sp. 5	32	259
		Dysidea sp. 6	32	264
		Dysidea sp. 7	33	269
	Irciniidae	*Ircinia campana* (Lamarck, 1814)	10, 32	130, 263
		Ircinia felix (Duchassaing & Michelotti, 1864)	2	41
		Ircinia sp. (*trigina* morphotype)	2	43
		Ircinia sp. 1	3	53
		Ircinia sp. 2	8,	111
		Ircinia sp. 3	18	201
		Ircinia strobilina (Lamarck, 1816)	2, 8, 19	40, 109, 203
	Thorectidae	*Hyrtios* sp. 1 cf. *cavernosus*	1, 37	29, 57
		Smenospongia sp. 1	5	72
		Smenospongia sp. 2	31	249
		Smenospongia sp. 3	31	251
Hadromerida	Clionaidae	*Cliona* sp.1	9, 12	119, 147
		Cliona sp. 2	10,	128,
		Spheciospongia vesparium (Lamarck, 1815)	21, 33	218, 267
	Placospongiidae	*Placospongia* sp. 1	1, 33	26, 266
		Placospongia sp. 3	11	140
		Placospongia sp. 2	11, 29	133, 244
		Placospongia sp. 4	25	234
	Polymastiidae	*Polymastia* sp. 1	7	96
		Polymastia sp. 2	12	153
		Polymastia sp. 3	29	242
	Spirastrellidae	*Spirastrella coccinea* (Duchassaing & Michelotti, 1864)	1	28
	Suberitidae	*Prosuberites laughlini* (Diaz, Alvarez & van Soest, 1987)	2	36
	Dictyonellidae	*Scopalina ruetzleri* (Widenmayer, 1977)	1	24
	Dictyonellidae	*Svenzea zeai* (Alvarez et al. 1998)	1, 8, 15	30, 106, 163
	Axinellidae	*Dragmacidon reticulatum* (Ridley & Dendy, 1886)	6	93
	Axinellidae	*Ptilocaulis* sp. (?*walpersii* or *marquezii*)	2, 8, 11, 16, 20	33, 107, 134, 182, 215
	Halichondriidae	*Topsentia* sp. 1	11	137
	Heteroxyidae	*Myrmekioderma* sp. (?*gyroderma* or *rea*)	4, 8, 15	61, 114, 169
	Heteroxyidae	*Higginsia coralloides* (Higgin 1877)	6	78
	Callyspongiidae	*Callyspongia* (*Cladochalina*) *vaginalis* (Lamarck, 1814)	1, 5, 8	16, 71, 104
		Callyspongia (Cladochalina) plicifera (Lamarck, 1814)	1	23
		Callyspongia (*Cladochalina*) *armigera* (Duchassaing & Michelotti, 1864)	31	250
		Callyspongia (Callyspongia) fallax Duchassaing & Michelotti, 1864	34	276
	Chalinidae	*Chalinula* sp. 1	28	241
		Haliclona sp. 1 (*Halichoclona - magnifica*)	17	187
		Haliclona sp. 2	38	288
	Niphatidae	*Amphimedon compressa* (Duchassaing & Michelotti, 1864)	1	21
		Amphimedon sp. 1	1, 8	18, 108
		Amphimedon sp. 2	8	105
		Amphimedon sp. 3	16	185

Haplosclerida	Niphatidae	*Amphimedon* sp. 4	18	199
		Amphimedon sp. 5	24	231
		Amphimedon sp. 6	17	190
		Gelliodes sp. 1	15	175
		Gelliodes sp. 2	5	74
		Gelliodes sp. 3	33	272
		Niphates amorpha Van Soest, 1980	6	85
		Niphates digitalis (Lamarck, 1814)	1, 1	17, 22
		Niphates recondita (Wiledenmayer, 1977)	9	120
		Niphates sp. 1	20	210
	Petrosiidae	*Neopetrosia subtriangularis* (Duchassaing, 1850)	6	92
		Petrosia (Petrosia) pellasarca (de Laubenfels, 1934)	9, 16, 19	116, 180, 204
		Petrosia (Petrosia) weinbergi (van Soest, 1980)	6, 11, 28	89, 138, 239
		Petrosia sp. 1	12	152
		Xestospongia muta (Schmidt, 1870)	1, 2, 4, 6, 7, 9, 15, 16, 17, 18, 19, 21, 22, 23, 24, 32, 34, 36	14, 45, 66, 82, 98, 118, 167, 183, 192, 200, 208, 217, 221, 226, 230, 260, 277, 285
	Phloeodictyidae	*Oceanapia bartschi* (de Laubenfels, 1934)	7	94
		Oceanapia peltata (Schmidt, 1870)	35	283
		Siphonodictyon sp. 1 (*coralliphagum* or *brevitubulatum*)	12, 24, 33	143, 232, 270
		Siphonodictyon xamaycaense Pulitzer-Finali, 1986	17, 22	191, 220
Poecilosclerida	Crambeidae	*Monanchora arbuscula* (Duchassaing & Michelotti, 1864)	6	79
	Desmacellidae	*Neofibularia nolitangere* (Duchassaing & Michelotti, 1864)	2	44
		Desmapsamma anchorata (Carter, 1882)	2	32
	Microcionidae	*Artemisina melana* Van Soest, 1984	3, 14, 17	56, 157, 195
		Clathria (Thalysias) curacaoensis Arndt, 1927	6	83
	Mycalidae	*Mycale (Mycale) laevis* (Carter, 1882)	4, 9	67, 122
		Mycale (Arenochalina) laxissima (Duchassaing & Michelotti, 1864)	1, 2	15, 37
	Raspailiidae	*Ectyoplasia ferox* (Duchassaing & Michelotti, 1864)	1	31
	Tedaniidae	*Tedania* sp. 1 (?*ignis*) (Duchassaing & Michelotti, 1864)	17	189
Spirophorida	Tetillidae	*Cinachyrella* sp. (?*kuekenthali* or *apion*)	1, 6, 8, 19	20, 81, 110, 207
Tethyida	Tethyidae	*Tethya* sp. 1	34	275
Verongida	Aplysinellidae	*Suberea* sp. (?*A. lacunosa*)	8	102
		Aiolochroia crassa (Hyatt, 1875)	1	19
		Aplysina archeri (Higgin, 1875)	8	101
		Aplysina cauliformis (Carter 1882) creeping morphotype	6	91
		Aplysina fistularis (Pallas, 1766)	2	35
		Aplysina sp. 1	10	124
		Aplysina sp. 2	5	77
		Verongula gigantea (Hyatt, 1875)	32	258
		Verongula rigida (Esper, 1794)	2	39
		Verongula sp. 1	4,	69
		Verongula sp. 2	14	156
Unidentified Specimens				
		NA sp. 1 (green)	37	25
		NA sp. 3 (?*Svenzea cristinae*)	2	34
		NA sp. 4	2, 20	38, 211

NA sp. 5 Encrusting - orange	2, 10, 31	42, 123, 255
NA sp. 6 Encrusting - red	3, 6, 7, 16	55, 80, 99, 179
NA sp. 7 Cryptic - Round single osculum – yellow/cream	4, 15	62, 165
NA sp. 8 ? Callyspongia fallax	4, 12, 34,	68, 146, 278
NA sp. 10 ?*Haliclona* sp. or *S. xamaycaense*	7, 12	97, 115
NA sp. 11 Encrusting red/orange	8	113
NA sp. 13 White cryptic	9, 11, 25	117, 136, 235
NA sp. 14 Encrusting light orange (?*Batzella rubra*)	10	129
NA sp. 15 ?*Haliclona* sp.	11	135
NA sp. 16 Black burrowing sponge	12, 15, 29	141, 168, 245
NA sp. 17 Magenta - yellow gold -similar to NA sp.4	12	150
NA sp. 18 Collected by Dr. Reimer	11	154
NA sp. 19 Burrowing - grey charcoal sponge	15, 31, 31, 32	164, 252, 254 261
NA sp. 20 Orange encrusting octocoral	15	174
NA sp. 21 Orange ball sponge	16	177
NA sp. 22 Red white speckled	16	178
NA sp. 23 ? *Neopetrosia rosariensis* and /or *Calyx podatypa*	10, 16, 22, 34, 35	131, 181, 219, 279, 282
NA sp. 24 Encrusting magenta	17, 31	188, 256
NA sp. 25 Encrusting bright blue sponge	17	193
NA sp. 26 Yellow cryptic sponge (within a cavern)	39	202
NA sp. 27 Purple encrusting	21	216
NA sp. 28 Yellow	24	227
NA sp. 29 Round cryptic	25	236
NA sp. 30 red-violet	25	237
NA sp. 31 Encrusting yellow	31	253
NA sp. 32 Blue burrowing sponge	32	265
NA sp. 33 Purple violet sediment sponge	33	268
NA sp. 34 Yellow boring	33	271
NA sp. 35 Encrusting purple violet	39	289

* Station and Voucher ID number match respectively; Collectors: *JAA-283 by Bert Hoeksema; *JAA-186, 209 by Niels Schrieken; *JAA-38 by Godfried van Moorsel; *JAA-131, 181, 248, 256 by James Thomas; *JAA-154 by James Reimer; *JAA-174 by Yee Wah Lau; *JAA-176 by Sylvia van Leeuwen; *JAA-113 by Simone Montano; *JAA-175 by Willem F. Prud'homme van Reine; *Remaining samples by Jaaziel E. Garcia-Hernandez

Table 2 Sponge Biodiversity Hotspots (top 6) at St. Eustatius

Site ID	Site name	Number of species records	Depth (m)
EUX 35	Anchor Reef	59	21
EUX 20	Double Wreck	57	19
EUX 19	Blair's Reef	56	21
EUX 21	Anchor Point	55	19
EUX 36	Barracuda Reef	54	22
EUX 31	Mushroom Reef	54	16

Table 3 Sponges encountered during surveys that were ***not*** collected as voucher samples

Sponges (Genus, Species)	Number of sites present
Spirastrella hartmani Boury-Esnault, Klautau, Bézac, Wulff & Solé-Cava, 1999	28
Iotrochota birotulata (Higgin, 1877)	25
Niphates caribica (Pulitzer-Finali, 1986)	22
Agelas conifera (Schmidt, 1870)	19
Aplysina fulva (Pallas, 1766)	16
Verongula reiswigi Alcolado, 1984	13
Agelas sventres Lehnert & van Soest, 1996	11
Aplysina insularis (Duchassaing & Michelotti, 1864)	11
Agelas sceptrum (Lamarck, 1815)	10
Halisarca caerulea Vacelet & Donadey, 1987	9
Niphates erecta Duchassaing & Michelotti, 1864	9
Dragmacidon lunaecharta (Ridley & Dendy, 1886)	7
Smenospongia aurea (Hyatt, 1875)	4
Aplysina lacunosa (Lamarck, 1814)	3
Axinella sp. 1	3
Scopalina sp. 1	3
Ircinia sp. 1	2
Agelas cerebrum Assmann, van Soest & Köck, 2001	1
Agelas dilatata Duchassaing & Michelotti, 1864	1
Biemna sp.	1
Chalinula sp. 2	1
Clathria (Microciona) echinata (Alcolado, 1984)	1
Cliona caribbaea Carter, 1882	1
Cliona tenuis Zea & Weil, 2003	1
Diplastrella sp. 1	1
Pleraplysilla sp. 2	1

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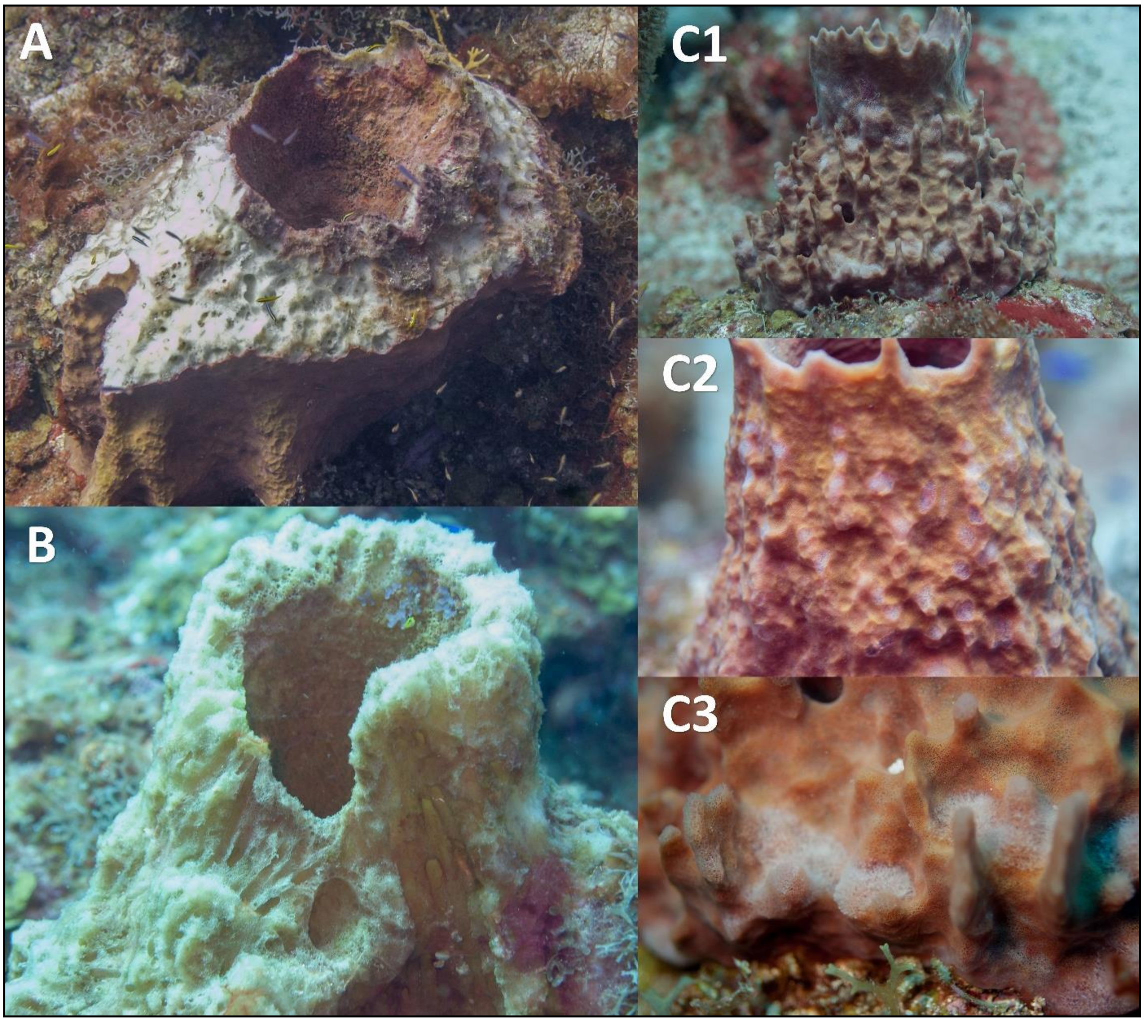

Fig. 5 Barrel sponges (*Xestospongia muta*) showing signs of what appears to be a disease (such as orange band disease) and/or bleaching. **A** Advance disease stage. **B** Final stages of the disease, sponge crumbled upon touch. **C1-3** Barrel sponge showing signs of what appears to be initial stages of a disease and/or bleaching

Fig. 6 *Amphimedon compressa* (Duchassaing & Michelotti, 1864) showing signs of tissue necrosis **A** affecting mid part of the sponge; **B** affecting top part of the sponge

Stony corals of St. Eustatius

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Introduction

Previous surveys of the coral fauna of St. Eustatius were usually of short duration and part of a larger research that included all of the windward Netherlands Antilles (SSS = Saba, Saba Bank, St. Eustatius, and St. Martin). This may have caused an underestimation of its species richness. In an expedition to the Saba Bank in 1972, one sampling station (maximum depth 15 m) was added at the west coast of St. Eustatius, which resulted in a record 16 stony corals species from this island (Van der Land 1977). Bak (1975) visited all SSS islands from where he reported a total of 35 scleractinian species (< 35 m depth). Sybesma et al. (1993) listed 16 reef coral species. Klomp and Kooistra (2003) found 23 scleractinian species (partly specified), which they recorded from the windward islands, including 10 dive sites off St. Eustatius. Jongman et al. (2010) listed a total of 41 scleractinians but it is unclear how this information was obtained. The most recent inventory included 24 scleractinian species for St. Eustatius (Debrot et al. 2014). Since the coral faunas of Saba, Saba Bank, St. Eustatius, and St. Martin do not show a clear variation (Klomp and Kooistra 2003) the present results are compared with the previously published records (except for those in Jongman et al. 2010). In this way it may become clear if certain species have disappeared or became introduced (Hoeksema et al. 2011).

Methods

Historical records. The following historical sources were used: surveys of Saba, St. Eustatius and St. Martin in July–August 1965 (Roos 1971) and in April 1972 (Bak 1975); the Saba Bank Expedition in May–June 1972 visiting Saba, Saba Bank, St. Eustatius and St. Martin (Van der Land 1977) and a rapid assessment of the same localities in November–December 1999 (Klomp and Kooistra 2003); surveys of St. Eustatius in 1992 (Sybesma et al. 1993) and in 2012–2013 (Debrot et al. 2014); surveys of Saba Bank in 1996 (Meesters et al. 1996) and in January 2006 (McKenna and Etnoyer 2010).

Sampling strategy St. Eustatius 2015. The roving diver technique was employed by two divers independently, based on presence / absence records per dive down to 30 m depth with ca. 60 min observation time, including photographing and the collecting of DNA samples. The roving diver technique is designed to record as many species as possible, in contrast to inventories by transect work, which aim to measure species densities based on replicate observations (Hoeksema and Koh 2009). Occasionally other expedition members contributed by reporting on additional species. Thirty-nine sites around St. Eustatius (2 / day; 6 days / week) were selected, representing various coral reef environments for covering maximum habitat diversity. Most sites were regular dive sites (> 15 m and < 30 m deep) accessible by boat at the sheltered Caribbean (western) side of the island. Two boat dive sites were situated at the Atlantic wind-exposed (eastern) side. Two shallow sites (< 15 m deep) were located at the western shore. Overall, the sites varied mainly with regard to bathymetry, substrate (volcanic / limestone / shipwrecks), and wind exposure. Corals were identified with the help of two field guides (Bright and Lang 2013; Humann and De Loach 2013), which use an updated nomenclature consistent with the World Register of Marine Species (WoRMS Editorial Board 2016).

When possible, new observations of associations between corals and other invertebrates were recorded, mostly involving coral gall crabs (Van der Meij 2014; Van der Meij et al. 2015) and serpulid worms (Hoeksema and Ten Hove 2016).

Results and discussion

During the Statia Marine Biodiversity Expedition 52 species of stony corals (Scleractinia, Milleporidae, Stylasteridae) were observed and 50 of these could be identified with certainty (Table 1). This record is higher than previously published species counts, which is partly related to the inclusion of small azooxanthellate species. It also includes a shallow-living hybrid, *Acropora prolifera*, with a very distinctive morphology (Volmer and Palumbi 2002; Japaud et al. 2014; Lucas and Weil 2015).

Some species were not represented in earlier records because they have been described recently (*Madracis carmabi, Meandrina jacksoni*) or because they were considered synonyms (*Orbicella* spp.) in earlier surveys prior to their separation (Knowlton et al 1992). Missing species are *Millepora squarrosa*, appearing absent from the area since 1996 and a deep-water species. *Agaricia grahamae.* Most inconsistencies in species records over time may be related to identification errors. Therefore photographs will be added in the eventual publication on the reef corals of the windward Dutch Caribbean.

Various host corals for associated gall crabs and Christmas tree worms were recorded. The most remarkable observations concern a new record of *Helioseris cucullata* as host for a christmas tree worm and a gall crab species. A few specimens of the relatively rare free-living coral *Manicina areolata* were observed; all of these had associated gall crabs (Fig. 1).

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Fig. 1 The free-living rose coral, *Manicina areolata*, with a coral gall crab (arrow), *Troglocarcinus corallicola* Verrill, 1908

Table 1. Published records of stony corals (Scleractinia, Milleporidae, Stylasteridae) in the windward Dutch Caribbean (Saba, Saba Bank, S.t Eustatius, St. Martin) observed in 1965 (Roos 1971), 1972a (Bak 1975), 1972b (Van der Land 1977), 1992 (Sybesma et al. 1993), 1996 (Meesters et al. 1996), 1999 (Klomp and Kooistra 2003), 2006 (McKenna and Etnoyer 2010), 2012 (Debrot et al. 2014), 2015 (present study)

	1965	1972a	1972b	1992	1996	1999	2006	2012	2015
Scleractinia									
Acroporidae									
Acropora cervicornis (Lamarck, 1816)	1	1	1	1	1	1	1	-	1
Acropora palmate (Lamarck, 1816)	1	1	1	1	-	1	-	-	1
Acropora prolifera (Lamarck, 1816) *	-	-	-	-	-	-	-	-	1
Agariciidae									
Agaricia agaricites (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1
Agaricia fragilis Dana, 1848	-	-	-	-	-	-	-	-	1
Agaricia grahamae Wells, 1973	-	-	-	-	-	-	1	-	-
Agaricia humilis Verrill, 1901	-	-	-	-	-	-	1	1	1
Agaricia lamarcki Milne Edwards and Haime, 1851	-	-	-	1	1	-	1	1	1
Agaricia tenuifolia Dana, 1848	-	-	-	-	-	-	-	-	-
Agaricia sp.	-	-	-	-	-	-	1	-	-
Helioseris cucullata (Ellis and Solander, 1786) [1]	-	1	1	1	1	-	1	1	1
Astrocoeniidae									
Madracis auretenra Locke, Weil and Coates, 2007 [2, 3]	1	1	1	1	1	1	1	1	1
Madracis carmabi Vermeij, Diekmann and Bak, 2003	-	-	-	-	-	-	-	-	1
Madracis decactis (Lyman, 1859) [2]	-	1	1	1	1	1	1	1	1
Madracis formosa Wells, 1973	-	-	-	-	-	-	-	1	-
Madracis pharensis (Heller, 1868)	-	-	-	1	-	-	-	-	1
Madracis senaria Wells, 1973	-	-	-	-	-	-	-	-	1
Madracis sp.	-	-	-	-	-	-	1	-	-
Stephanocoenia intersepta (Lamarck, 1836) [4]	1	1	1	1	1	1	1	1	1
Caryophyllidae									
Colangia immersa Pourtalès, 1871	-	-	-	-	-	-	-	-	1
Rhizosmilia maculata (Pourtalès, 1874)	-	-	-	-	-	-	-	-	1
Dendrophylliidae									
Tubastraea coccinea Lesson, 1829 [5]	1	1	1	1	-	-	1	-	1
Meandrinidae									
Dendrogyra cylindrus Ehrenberg, 1834	-	1	1	1	1	-	1	1	1
Dichocoenia stokesii Milne Edwards and Haime, 1848	1	1	1	1	1	1	1	-	1
Eusmilia fastigiata Pallas, 1766	1	1	1	1	1	-	1	1	1
Meandrina danae (Milne Edwards and Haime, 1848) [6]	-	-	-	-	-	-	1	-	1
Meandrina jacksoni Pinzón and Weil, 2011	-	-	-	-	-	-	-	-	1
Meandrina meandrites (Linnaeus, 1758)	1	1	-	1	1	-	1	1	1
Merulinidae									
Orbicella annularis (Ellis and Solander, 1786) [7]	1	1	1	1	1	1	1	1	1
Orbicella faveolata (Ellis and Solander, 1786) [7]	-	-	-	-	1	1	1	1	1
Orbicella franksi (Gregory, 1895) [7]	-	-	-	-	1	1	1	1	1
Montastraeidae									
Montastraea cavernosa (Linnaeus, 1767)	1	1	1	1	1	1	1	1	1
Montastraea sp.	-	-	-	-	-	-	1	-	-
Mussidae									
Colpophyllia natans (Houttuyn, 1772)	1	1	1	1	1	1	1	1	1
Diploria labyrinthiformis (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1
Favia fragum (Esper, 1795)	1	1	-	-	-	-	1	1	1
Manicina areolata (Linnaeus, 1758)	1	1	1	1	-	-	1	-	1
Pseudodiploria clivosa (Ellis and Solander, 1786) [8]	1	1	1	1	-	-	1	1	1
Pseudodiploria strigosa (Dana, 1846) [8,]	1	1	1	1	1	1	1	1	1
Isophyllia rigida (Dana, 1848) [9]	1	1	1	1	1	-	1	-	1
Isophyllia sinuosa (Ellis and Solander, 1786)	1	1	1	-	1	-	1	-	1
Mussa angulosa Pallas, 1766	-	1	1	1	-	1	1	-	1
Mycetophyllia aliciae Wells, 1973	-	1	-	1	-	-	-	-	1
Mycetophyllia danaana Milne Edwards and Haime, 1849 [10]	-	-	-	-	1	-	-	-	-
Mycetophyllia ferox Wells, 1973	-	1	-	-	-	-	-	-	-
Mycetophyllia lamarckiana Milne Edwards and Haime, 1848 [11]	-	-	1	1	-	-	-	-	-
Mycetophyllia sp.	-	-	-	-	-	1	-	1	-
Scolymia cubensis (Milne Edwards and Haime, 1848)	-	1	-	1	-	-	1	-	1
Scolymia lacera (Pallas, 1766)	-	-	1	1	-	-	-	-	1
Scolymia sp.	-	-	-	-	-	-	1	1	1

Poritidae									
Porites astreoides Lamarck, 1816	1	1	1	1	1	1	1	1	1
Porites divaricata Le Sueur, 1820	-	-	-	1	1	-	1	1	1
Porites furcata Lamarck, 1816	-	1	-	-	-	-	-	-	1
Porites porites (Pallas, 1766)	1	1	1	1	1	1	-	-	1
Porites sp.	-	-	-	-	-	-	1	-	-
Rhizangiidae									
Astrangia solitaria (Le Sueur, 1818)	-	1	1	-	-	-	-	-	1
Siderastreidae									
Siderastrea radians (Pallas, 1766)	1	1	1	1	-	1	-	1	1
Siderastrea siderea (Ellis and Solander, 1768)	1	1	-	1	1	1	-	-	1
Siderastrea sp.	-	-	-	-	-	-	1	-	-
Scleractinia incertae sedis									
Cladocora arbuscula (Le Sueur, 1820)	-	1	-	-	-	-	-	-	-
Solenastrea bournoni Milne Edwards and Haime, 1849	-	1	1	-	-	-	-	-	1
Solenastrea sp.	-	-	-	-	-	-	1	-	-
Non-Scleractinia									
Milleporidae									
Millepora alcicornis Linnaeus, 1758	1	1	1	1	1	-	1	1	1
Millepora complanata Lamarck, 1816	1	1	1	-	1	1	1	-	1
Millepora squarrosa Lamarck, 1816	-	1	1	1	1	-	-	-	-
Stylasteridae									
Stylaster roseus (Pallas, 1766)	-	1	-	-	-	-	1	-	1
Stylaster sp.	-	-	-	-	-	-	1	-	1
Species numbers	**25**	**38**	**30**	**34**	**28**	**21**	**42**	**26**	**52**

Notes: * Hybrid species but with a distinct morphotype. Some species have been recorded by their synonyms, alternative combinations, wrong identities or misspelled names: 1 genus *Leptoseris*; 2 *Madracis asperula* Milne Edwards & Haime, 1849; 3 *Madracis mirabilis* (Duchassaing & Michelotti, 1860); 4 *Stephanocoenia michelini* Milne Edwards & Haime, 1848; 5 *Tubastraea aurea* (Quoy & Gaimard, 1833) and *T. tenuilamellosa* (Milne Edwards & Haime, 1848); 6 *Meandrina brasiliensis* (Milne Edwards & Haime, 1848); 7 genus *Montastraea* / *Montastrea* and three varieties of *M. annularis*; 8 genus *Diploria*; 9 genus *Isophyllastrea*; 10 *Mycetophyllia daniana;* 11 *Mycetophyllia lamarcki*.1 *Helioseris cucullata* was not mentioned by Van der Land (1977) but appeared to be represented in the reference collection of Naturalis Biodiversity Center by samples taken during the "Luymes" SabaBank expedition: Saba Bank (Sta 146, depth 30 m, RMNH Coel 8570; Sta.55, unknown depth, RMNH Coel. 8573) and Saba (Sta 114 = Ladder Bay, depth 35 m, RMNH Coel 8569).

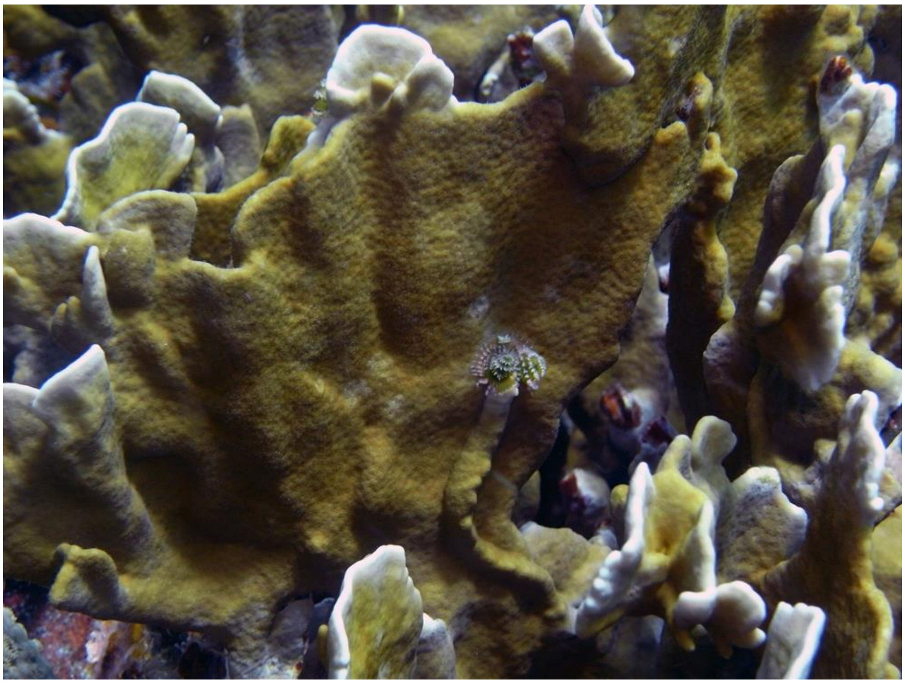

Fig. 2 The hydrocoral *Millepora complanata* with an associated serpulid worm, *Spirobranchus polycerus*

Fig. 3 A fire coral *Millepora alcicornis* as substrate for a lace coral, *Stylaster roseus*

Octocorals of St. Eustatius

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Introduction

Octocorallia (Cnidaria: Anthozoa) are a dominant component of Caribbean coral communities. There can be up to 60 octocoral species on a single Caribbean coral reef (Sanchez *et al*., 1997). Despite the fact that they are dominant macrofauna on many Caribbean reefs, taxonomic questions related to Caribbean octocorals have received relatively little attention (Sánchez *et al*., 2003).

Hardly any studies have been done concerning the octcoral fauna of St. Eustatius. Previous research here was mainly focussed on shallow water reachable by snorkelling. Therefore a good species list is lacking for octocorals, as their bulk resides at > 5 m depth. Owing to the presence of volcanic underwater landscapes and reefs surrounding the island, many habitats are available to octocorals.

Methods

Octocoral specimens were collected and photographed at 34 dive localities by means of SCUBA down to depths < 30 m. A total of 160 vouchers were collected and subsampled. The subsamples were preserved in 96% ethanol for molecular analyses. The voucher specimens were preserved in 70% ethanol for further microscopic examination of the sclerites. All specimens have been deposited in the coelenterate collection of Naturalis Biodiversity Center (NBC), the Netherlands with catalogue numbers RMNH.COEL Photographs were taken using an Olympus® Stylus Tough TG-2 12.1 megapixel BSI CMOS sensor camera in an Olympus PT-053 Underwater Housing. For each sample at least three pictures were taken of 1) an overview of the colony 2) a close-up of the branch with the polyps extended and 3) a close-up of the branch with polyps retracted. The nomenclature of the species follows that of the World Register of Marine Species (WoRMS Editorial Board 2016). Each sampled octocoral was initially studied for sclerite composition by means of microscopy slides. Therefore a small fragment of the distal part of the specimen was dissolved in sodium hypochlorite (4% household bleach solution) to remove the coenchymal tissue and isolate the sclerites. These were rinsed with demineralised water (seven times) and were either air-dried or dried on a hot plate. Finally, slides were prepared by embedding the sclerites in Euparal, which allows visualisation with a light microscope.

Results

The number of octocoral genera recorded was comparable to previous expeditions to those from Curaçao. Based on photographs of specimens and sclerite examination 35 species belonging to 14 genera of six families were identified (Table 1). Species diversity is relatively poor and similar to that of Curaçao. The most common Caribbean species belong to two families, Plexauridae and Gorgoniidae, which is also the case for St. Eustatius. The variety of underwater landscapes of volcanic rock and stony corals that provided substrate is noteworthy. Several species found in St. Eustatius have not been recorded in Curaçao: *Iciligorgia schrammi*, *Carijoa riisei*, *Muriceopsis flavida*, and *Eunicea laxispica*. Gorgonian seafans that decreased in abundance at Curaçao are still common in St. Eustatius. *Gorgonia mariae*, which is quite rare in Curaçao, was frequently recorded in St. Eustatius.

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Table 1 Reef-dwelling octocorals (35 species) recorded in St. Eustatius (Subclass Octocorallia, Order Alcyonacea)

Suborder Calcaxonia

Family Ellisellidae Gray, 1859

Ellisella barbadensis (Duchassaing & Michelotti, 1864)
Ellisella elongata (Pallas, 1766)

Suborder Holaxonia Studer, 1887

Family Gorgoniidae Lamouroux, 1812

Antillogorgia acerosa (Pallas, 1766)
Antillogorgia americana (Gmelin, 1791)
Antillogorgia rigida (Bielschowsky, 1929)
Gorgonia flabellum Linnaeus, 1758
Gorgonia mariae Bayer, 1961
Gorgonia ventalina Linnaeus, 1758
Pterogorgia anceps (Pallas, 1766)
Pterogorgia citrina (Esper, 1792)
Pterogorgia guadalupensis Duchassaing & Michelin, 1846

Family Plexauridae Gray, 1859

Eunicea calyculata (Ellis & Solander, 1786)
Eunicea clavigera Bayer, 1961
Eunicea fusca Duchassaing & Michelotti, 1860
Eunicea knighti Bayer, 1961
Eunicea laciniata Duchassaing & Michelotti, 1860
Eunicea laxispica (Lamarck, 1815)
Eunicea mammosa Lamouroux, 1816
Eunicea succinea (Pallas, 1766)
Eunicea tourneforti Milne Edwards & Haime, 1857
Eunicea flexuosa (Lamouroux, 1821)
Muricea muricata (pallas, 1766)
Muricea pinnata Bayer, 1961
Muriceopsis flavida (Lamarck, 1815)
Plexaura homomalla (Esper, 1792)
Plexaurella dichotoma (Esper, 1791)
Plexaurella grisea Kunze, 1916
Plexaurella nutans (Duchassaing & Michelotti, 1860)
Pseudoplexaura flagellosa (Houttuyn, 1772)
Pseudoplexaura porosa (Houttuyn, 1772)
Pseudoplexaura wagenaari (Stiasny, 1941)

Suborder Scleraxonia Studer, 1887

Family Anthothelidae Broch, 1916

Erythropodium caribaeorum (Duchassaing & Michelotti, 1860)
Iciligorgia schrammi Duchassaing, 1870

Family Briareidae Gray, 1859

Briareum asbestinum (Pallas, 1766)

Suborder Stolonifera Thomson & Simpson, 1909

Family Clavulariidae Hickson, 1894

Carijoa riisei (Duchassaing & Michelotti, 1860)

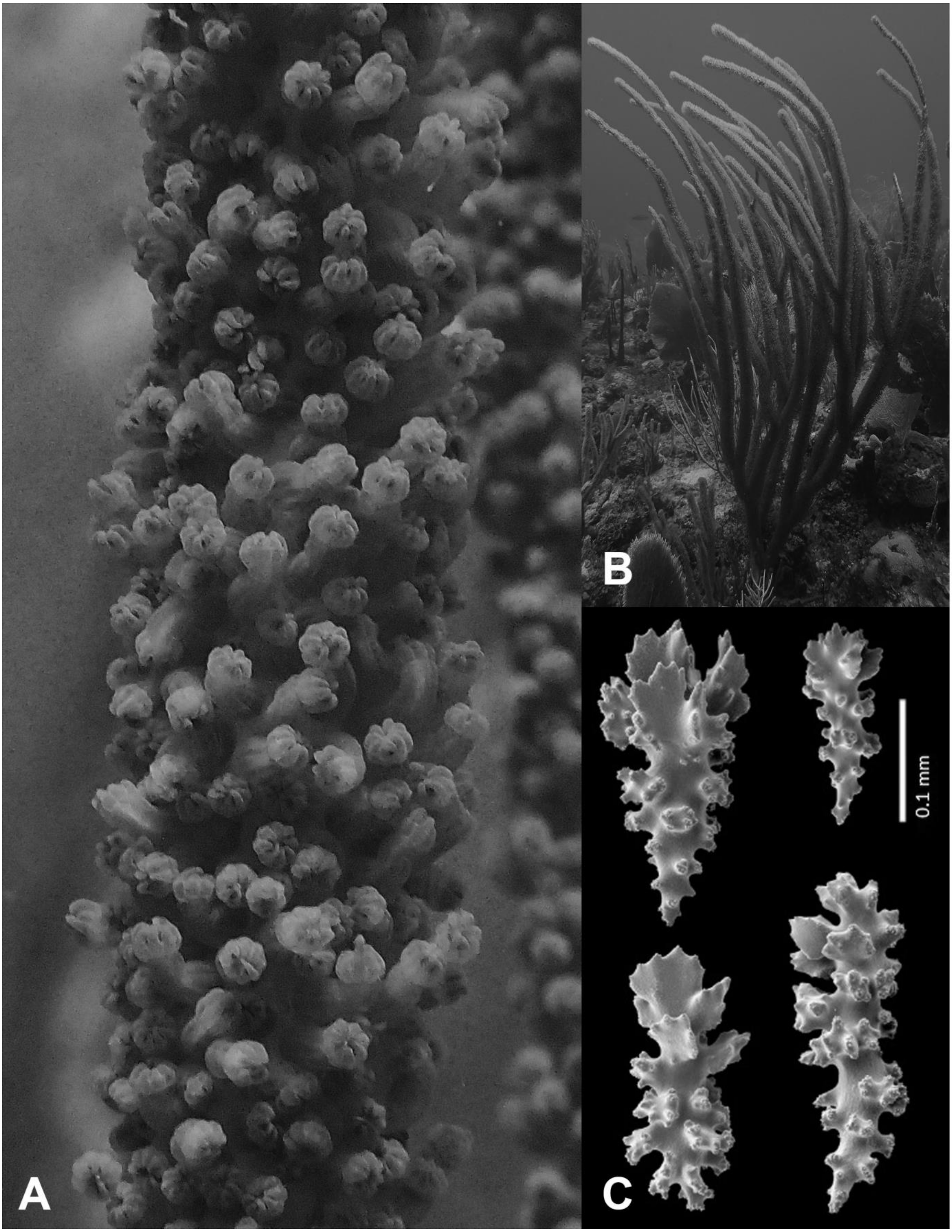

Fig 1. *Pseudoplexaura porosa.* **A** close-up of the polyps and **B** colony growth form, **C** so-called "clubs", sclerite type; characteristic for identification of the species, having the largest clubs within the genus and being laciniately sculptured.

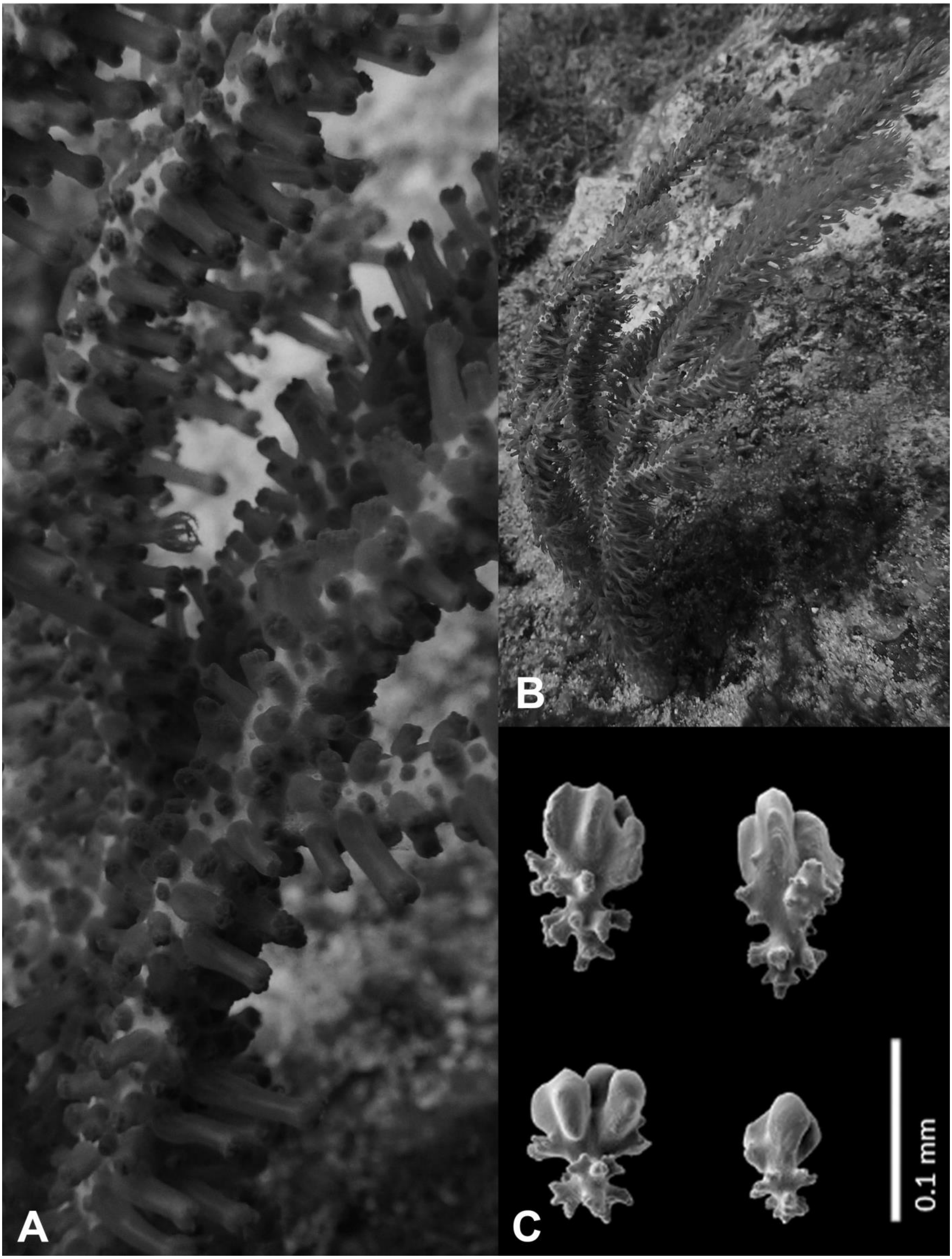

Fig. 2 *Pseudoplexaura flagellosa*. **A** close-up of the polyps and **B** colony growth form, **C** so-called "clubs", sclerite type; characteristic for identification of the species, having globose to foliated heads.

Fig. 3 *Pseudoplexaura wagenaari*. **A** close-up of the polyps and **B** colony growth form. **C** so-called “clubs”, sclerite type; characteristic for identification of the species, growth form with globose heads

Zoantharia of St. Eustatius

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Introduction

Research on the order Zoantharia (Cnidaria: Anthozoa: Hexacorallia) has a long history in the Caribbean Sea, with the first species, *Zoanthus sociatus*, described by Ellis & Solander (1768). Since then, the majority of worldwide zoantharian research has occurred in the Caribbean, and the fauna and species are generally thought to be well-known. However, over the past 20 years, molecular techniques have brought about a reconsideration of many marine species and their taxonomy, and the Zoantharia are no exception. Despite many species, genera, and family having been described recently, most discoveries have been from the Indo-Pacific, and thus a reconsideration of zoantharian species combined with faunal surveys in the Caribbean is timely. Additionally, recent Indo-Pacific work has shown that surveys in areas of coral reefs not normally examined (e.g. rubble zones, caves and cracks, sand) as well as at depths below the normal recreational range of SCUBA (> 30 m) harbor much unexamined diversity. During this survey around St. Eustatius, we focused on these areas as well as "normal" coral reef habitats (slopes, crests).

Materials and methods

A total of 177 Zoantharia specimens were collected from 19 locations by roving, via SCUBA or snorkeling. Zoantharians were observed on almost every dive and almost every site, and were usually abundant. Two suborders, 6 genera, and 14 species were observed and collected (Table 1). Specimens were photographed in situ, often with a CasMatch color card and ruler, and then collected. Specimens were preserved in 80-99% ethanol for further examination. The nomenclature of the species follows that by the World Register of Marine Species (WoRMS Editorial Board 2016).

Results and discussion

Surprisingly, the majority of collected specimens were from the suborder Macrocnemina, and not from the common genera *Zoanthus* and *Palythoa* in Brachycnemina. *Zoanthus* and *Palythoa* are generally common on shallow coral reefs, and may be the dominant benthos in both the Caribbean and Indo-Pacific. Only *P. caribaeorum* (Duchassaing de Fonbressin & Michelotti, 1860) was seen at more than three sites, and this species alone of Brachycnemina was common but never dominant (Fig. 1). The reason for the relative paucity of these two genera around St. Eustatius is unknown, but may be related to the lack of well-developed shallow reefs around the island, resulting in a relative lack of these species' favored habitats,. i.e. intertidal and shallow carbonate reefs.

The large majority of specimens (175/177) could be conclusively identified to species level from in situ images and gross external morphology (presence/absence of sand encrustation, tentacle numbers, size of oral disks, form of polyps, etc.), or via associations with specific species of sponges, etc. Only two specimens could not be identified, and both were preliminarily identified as belonging to *Palythoa*. The specimens may be *Palythoa* aff. *clavata* Duchassaing de Fonbressin, 1850 sensu Reimer et al. (2012), but molecular examinations will be needed to confirm this.

Interestingly, while we did not discover many potentially novel species, we did notice previously unreported associations between zoantharians and other fauna. Notably, small *Platypodiella spectabilis* (Herbst, 1794) crabs were seen in association with *Niphates digitalis* (Lamarck, 1814) sponges hosting *Umimayanthus parasiticus* (Duchassaing de Fonbressin & Michelotti, 1860) zoantharians (Garcia-Hernandez et al. 2015). Usually, this crab species is reported in association with *P. caribaeorum*. The reasons behind this previously unreported association are unknown, but it may also be linked to the general lack of *Palythoa* spp. around St. Eustatius as mentioned above.

Future work utilizing various DNA markers should help confirm and expand on these results, as well as shed light on the patterns of association of zooxanthellate species with *Symbiodinium*, for which patterns of association in the Caribbean remain largely unexamined (but see Kemp et al. 2006).

Table 1. Preliminary species list of the Order Zoantharia for St. Eustatius

Order Zoantharia Gray, 1832
Suborder Brachycnemina Haddon & Shackleton, 1891
Family Sphenopidae Hertwig, 1882
Palythoa caribaeorum (Duchassaing de Fonbressin & Michelotti, 1860)
Palythoa grandis (Verrill, 1900)
Palythoa variabilis (Duerden, 1898)
Palythoa sp.
Family Zoanthidae Rafinesque, 1815
Isaurus tuberculatus Gray, 1828
Zoanthus pulchellus (Duchassaing de Fonbressin & Michelotti, 1860)
Zoanthus sociatus (Ellis, 1768)
Zoanthus solanderi Lesueur, 1818
Suborder Macrocnemina Haddon & Shackleton, 1891
Family Hydrozoanthidae Sinniger, Reimer & Pawlowski, 2010
Hydrozoanthus antumbrosus (Swain, 2009)
Hydrozoanthus tunicans (Duerden, 1900)
Family Parazoanthidae Delage & Hérouard, 1901
Bergia catenularis Duchassaing de Fonbressin & Michelotti, 1860
Bergia puertoricense (West, 1979)
Parazoanthus swiftii (Duchassaing de Fonbressin & Michelotti, 1860)
Umimayanthus parasiticus (Duchassaing de Fonbressin & Michelotti, 1860)

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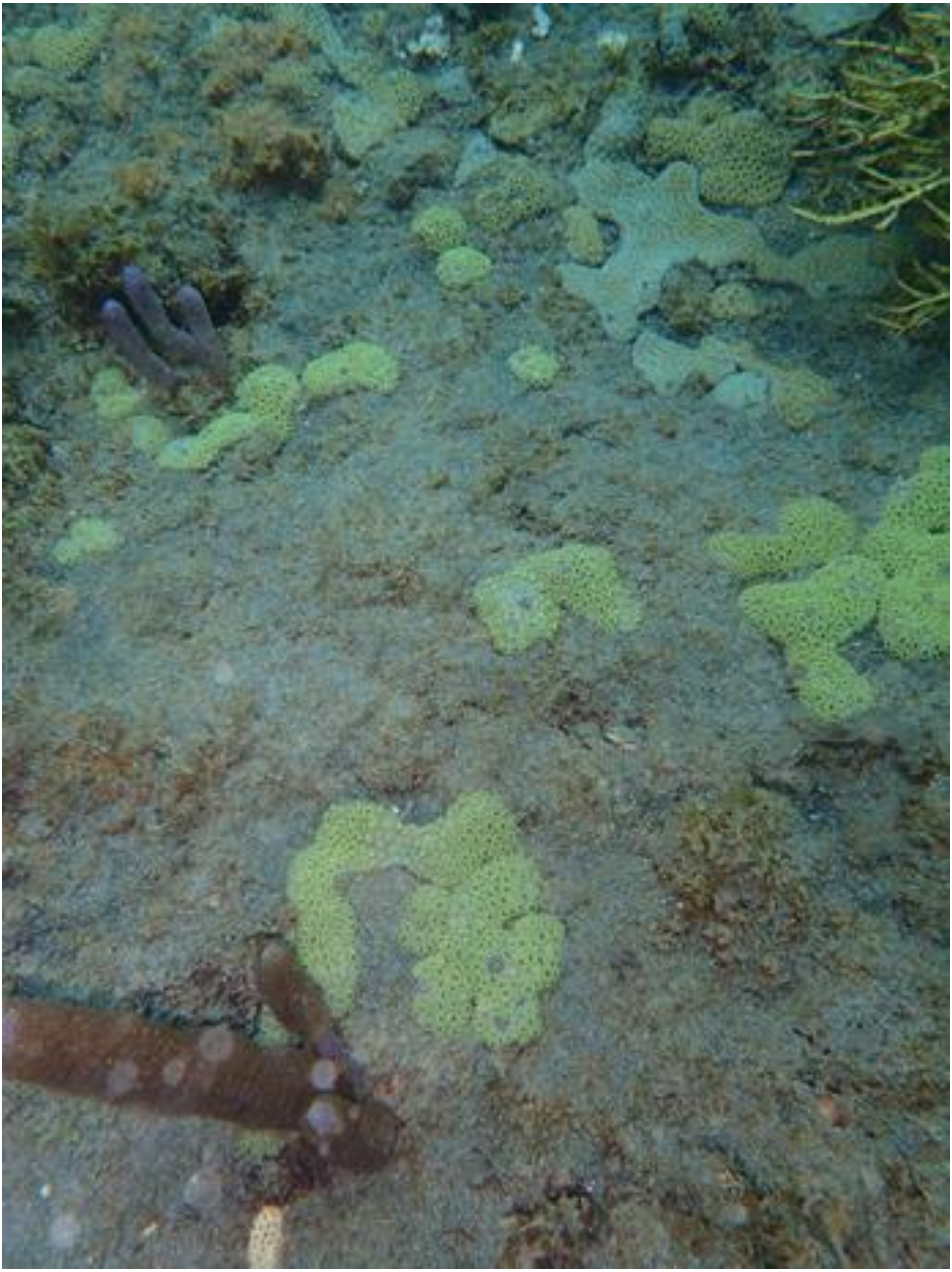
Fig. 1 *Palythoa caribaeorum* colonies on hard substrate at Twelve Guns, St. Eustatius (~3 m depth)

Hydroids associated with the coral reef fauna of St. Eustatius

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Introduction

The hydroids of the Caribbean Sea have been the subject of a restricted number of taxonomical studies. So far, sporadic, taxonomical and/or ecological studies, have been undertaken locally in various countries bordering the coasts of the Caribbean basin, such as Colombia, Panama, Belize, Cuba, Puerto Rico and the Virgin Islands. To date, there is no information available on the hydroid fauna of St. Eustatius (Dutch Caribbean), which lies in the eastern part of the Caribbean basin. In particular, there is little information about hydroids associated with other benthic invertebrates, such as sponges, bryozoans and octocorals, and no record yet of hydroids living in association with Caribbean scleractinian reef-building corals.

Methods

The field method used was the roving diver technique (presence / absence records per dive with ca. 60 min observation time, including photography and collecting of voucher specimens and DNA samples). All samples were carefully identified in the laboratory. In addition, for a more accurate identification of hydroids living in association with other organisms, measurements of the nematocysts were made using a dissecting microscope. Photos herein were taken with a Canon G11 camera mounted on a microscope.

Results

This is the first report on the hydroid fauna of the study area. A total of 18 species, belonging to seven families of Athecata (Table 1) and six families of Leptothecata (Table 2) were found. Regarding the athecate hydroids, the most important results are the discovery of 1) the hydroid *Zanclea* sp. found in association with the scleractinian coral *Orbicella faveolata* (Montano et al. 2016a), 2) the hydroid *Pteroclava krempfi* found in assocation with the octocoral *Antillogorgia* sp. (Montano et al. 2016b) and 3) several hydroids belonging to the genera *Sphaerocoryne* and *Heterocoryne* living in association with various sponge species. The list of stations and collected species collected is given below (Tables 1–2). The nomenclature follows that of the World Register of Marine Species (WoRMS Editorial Board 2016).

Table 1. Thecate hydroids (Order: Leptothecata) observed in St. Eustatius and the sites where they were collected

Family	Taxon	Sites (EUX)
Aglaopheniidae	*Macrorhynchia* sp.	05--14
Aglaopheniidae	*Aglaophenia* cf. *latecarinata* Allman, 1877	14--23--lynch beach
Campanulariidae	*Clytia gracilis* (Sars, 1850)	8
Haleciidae	*Nemalecium lighti* (Hargitt, 1924)	1--3--10
Halopterididae	*Antennella secundaria* (Gmelin, 1791)	2--6--9--16
Halopterididae	*Halopteris* sp.	5--11--21
Plumulariidae	*Dentitheca* cf. *dendritica* (Nutting, 1900)	12--15--17
Plumulariidae	*Plumularia* sp.	14-19
Sertulariidae	*Thyroscyphus* sp.	12

Table 2. Athecate hydroids (Order: Anthoathecata) observed in St. Eustatius, the sites where they were collected and the figure references

Family	Taxon	Sites (EUX)	Figures
Cladocorynidae	*Pteroclava krempfi* (Billard, 1919)	6--10--20	1A-B
Milleporidae	*Millepora alcicornis* Linnaeus, 1758	8--10-18	
Pennariidae	*Pennaria* sp.	4--10--12	
Tubulariidae	*Zyzzyzus warreni* Calder, 1988	5--14	
Tubulariidae	*Ralpharia gorgoniae* Petersen, 1990	8--20--25	3
Sphaerocorynidae	*Heterocoryne caribbensis* Wedler & Larson, 1986	1--4--5--26	1C-1D
Sphaerocorynidae	*Sphaerocoryne* cf. *bedoti* Pictet, 1893	8--11--16	1E
Stylasteridae	*Stylaster* cf. *roseus* (Pallas, 1776)	5--6--16--23	1F
Zancleidae	*Zanclea* sp.	9	2A-B-C-D

Main findings

Species of the genus *Zanclea* are known to form a strict relationship with organisms of different phyla. To date, scleractinian corals are known to count the highest number of species found in association with *Zanclea* hydroids (Montano et al. 2015). The finding of *Zanclea* hydroids living in association with Caribbean corals represents the first record of this kind of association for the whole Atlantic ocean. This contributes to enlarge the geographic range of the association. The polyps of the collected *Zanclea* sp. resemble morphologically *Z. sango* (Hirose and Hirose 2011). A newly released medusa was observed but its morphological features are not yet sufficiently known to distinguish it as a new species.

Pteroclava krempfi is reported from the waters around St. Eustatius for the first time. It was found to form a relationship with the octocoral *Antillogorgia* sp. It represents a new host record for the related hydroids. The medusa stage was not observed. The Caribbean specimens showed no morphological differences and the shape of their polyps was consistent with the original *P. krempfi* description. A multi-locus phylogeny reconstruction of the *P. krempfi* species complex based on both mitochondrial and nuclear loci revealed a new highly supported molecular lineage of all Caribbean specimens of *P. krempfi* associated with the family Gorgoniidae. This divergent molecular clade represents a distinct cryptic taxon within the *P. krempfi* species complex, in which the main interspecific difference consists of their host families.

Finally, several sponges were observed to host *Sphaerocoryne* cf. *bedoti* hydroids. To date, no molecular studies have been performed in order to examine the real diversity of *Sphaerocoryne*. Given the molecular diversity observed in other hydroids, it will be mandatory to understand if it is only one generalistic species or if more host specific species can exist. In addition it will be interesting to understand its phylogenetic relationship with the species *Heterocoryne caribbensis*.

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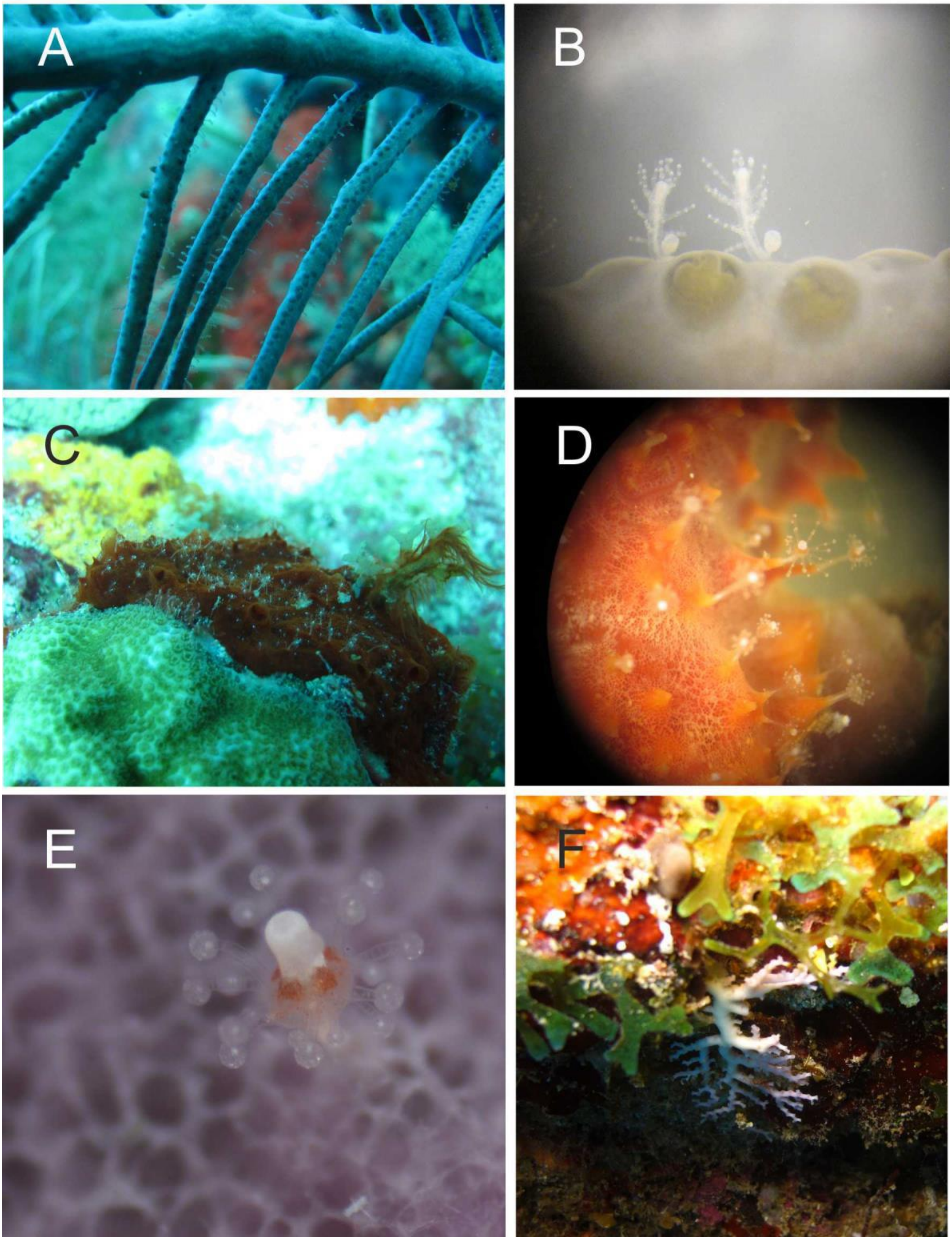

Fig. 1 **A** *Pteroclava krempfi* on *Antillogorgia* sp. **B** close-up of the polyp of *P. krempfi*. **C-D** *Heterocoryne caribbensis* living in association with an unidentified sponge. **E** *Sphaerocoryne* cf. *bedoti* found living on an unidentified sponge. **F** *Stylaster* cf. *roseus*.

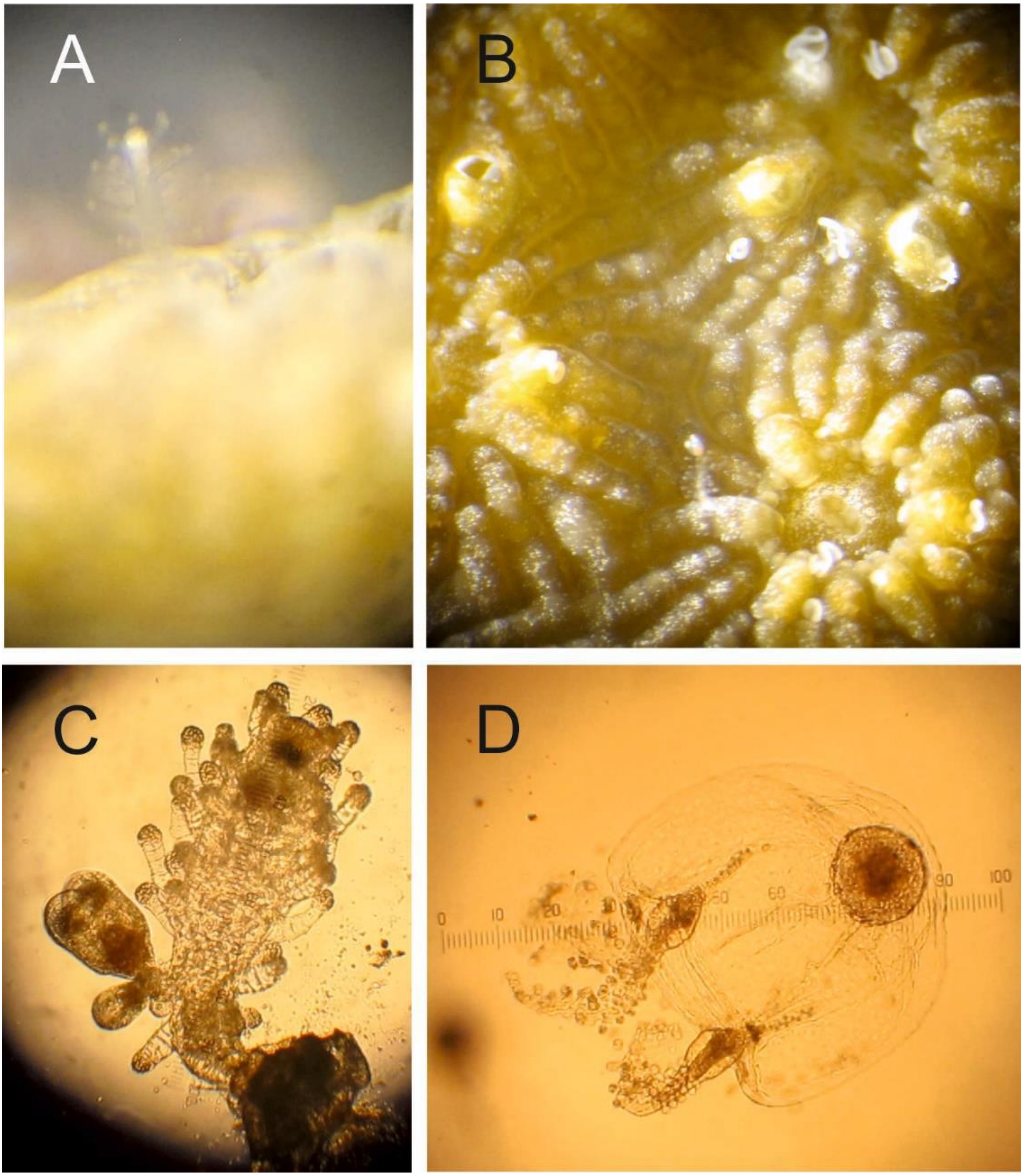

Fig. 2 A-B *Zanclea* sp. found in association with the reef-building coral *Orbicella faveolata*. **C** gonogastrozoide of *Zanclea* sp. **D** newly released medusa of *Zanclea* sp.

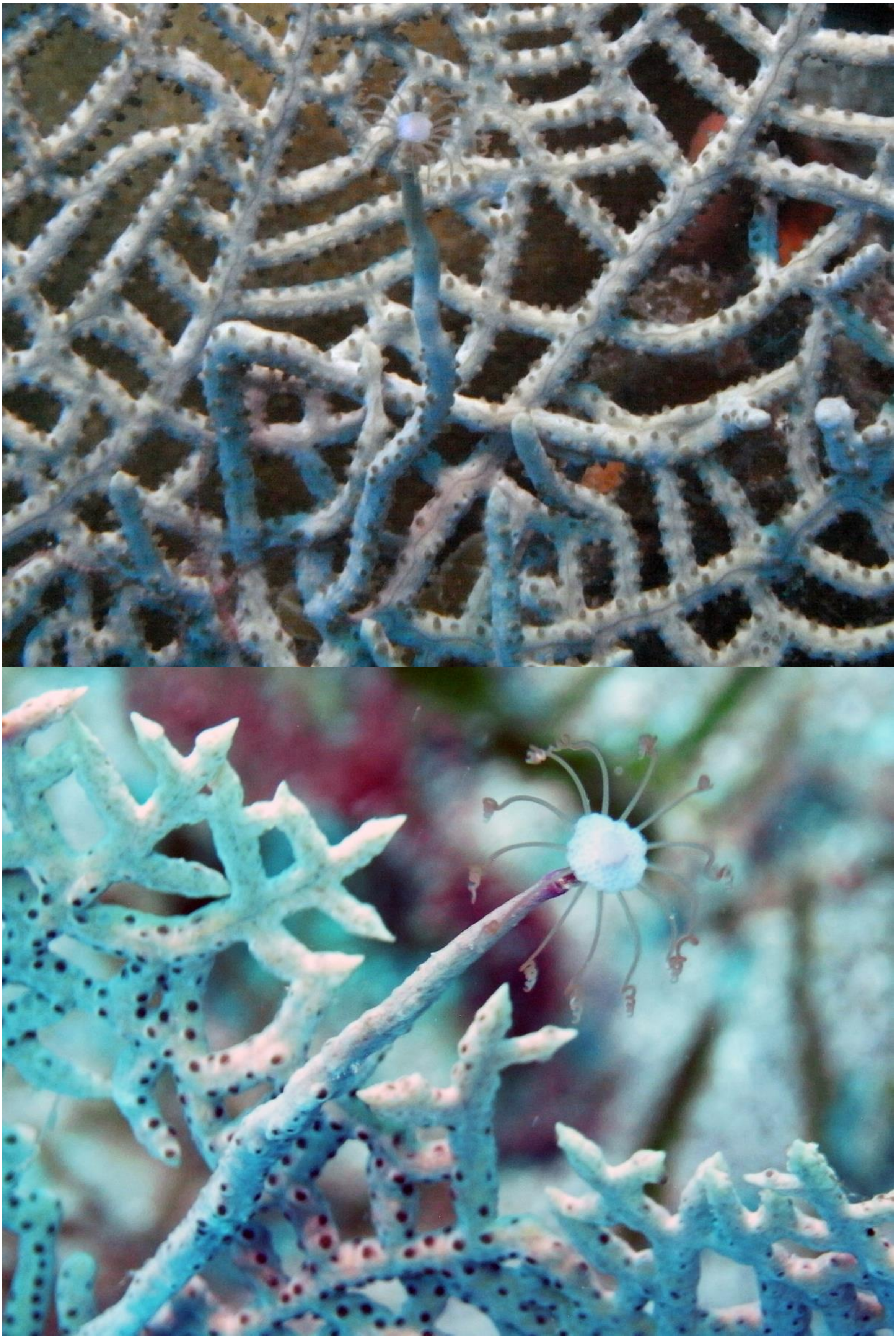

Fig. 3 The tubulariid *Ralpharia gorgoniae* on the gorgonian *Gorgonia ventalina* at Double Wreck, EUX 20 (photo: B.W. Hoeksema)

Various invertebrate taxa of St. Eustatius

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This report deals with Anthozoa (Actiniaria and Corallimorpharia), Hydrozoa, Decapoda and Polychaeta in the waters around St. Eustatius. No written reports are known on the occurrence of these various invertebrate taxa at this locality. On a greater Caribbean scale, none of the species recorded until now is particularly rare. The nomenclature of the species follows that of the World Register of Marine Species (WoRMS Editorial Board (2016).

Actiniaria (sea anemones)
Seven actinarian species were recorded, as well as specimens of an unknown, additional species not mentioned in the list. One observed intertidal species was impossible to collect or identify. The number of actiniarians is not particularly high. In a comparable survey effort at Bonaire 15 species were found (Faasse & van Moorsel, in prep.). Some zooxanthellate species, i.e. *Condylactis gigantea* and *Bartholomea annulata*, were relatively rare on Statia, which may be related to its paucity of shallow coral reefs. Ceriantharians, which belong to a different taxonomical group, were not recorded.

Table 1 Actiniaria recorded at St. Eustatius
Bartholomea annulata (Le Sueur, 1817)
Calliactis tricolor (Le Sueur, 1817)
Condylactis gigantea (Weinland, 1860)
Phymanthus crucifer (Le Sueur, 1817)
Lebrunia coralligens (Wilson, 1890)
Lebrunia neglecta Duchassaing & Michelotti, 1860
Telmatactis cricoides (Duchassaing, 1850)

Corallimorpharia
Two corallimorpharians were recorded, one of which may in fact consist of two species. As no nocturnal surveys were made, it is uncertain whether *Corynactis caribbaeorum* lives on Statia.

Table 2 Corallimorpharia recorded at St. Eustatius
Discosoma sp.
Ricordea florida Duchassaing & Michelotti, 1860

Hydrozoa
Only three hydrozoan species have yet been identified; the final list will contain some ten species.

Table 3 Hydrozoa recorded at St. Eustatius.
Plumularia floridana Nutting, 1900
Solanderia gracilis Duchassaing & Michelin, 1846 (Fig. 1)
Zyzzyzus warreni Calder, 1988 (Fig. 2)

Polychaeta
Only readily recognisable Polychaeta were recorded, nine species in all. No material was collected as most species recorded live in holes inside live corals. The list does not allow conclusions regarding the species richness of Statia.

Table 4 Polychaeta recorded on St. Eustatius
Anamobaea orstedii Krøyer, 1856
Bispira brunnea (Treadwell, 1917)
Hermodice carunculata (Pallas, 1766)
Notaulax occidentalis (Baird, 1865)
Pomatostegus stellatus (Abildgaard, 1789)
Sabellastarte magnifica (Shaw, 1800)
Spirobranchus giganteus (Pallas, 1766)
Spirobranchus tetraceros (Schmarda, 1861)
Terebellidae indet.

Decapoda

With 33 records, St. Eustatius is rich in decapods, while no night dives were made. Several additional species were collected, but not yet identified.

Table 5 Decapoda recorded at St. Eustatius
Acanthilia sp.
Alpheus armatus Rathbun, 1901
Ancylomenes pedersoni (Chace, 1958)
Brachycarpus biunguiculatus (Lucas, 1846)
Calcinus tibicen (Herbst, 1791)
Clibanarius tricolor (Gibbes, 1850)
Coenobita clypeatus (Fabricius, 1787)
Dardanus venosus (H. Milne Edwards, 1848)
Dissodactylus mellitae (Rathbun, 1900) (Fig.3)
Dissodactylus primitives Bouvier, 1917
Gecarcinus sp.
Gnathophylloides mineri Schmitt, 1933
Iridopagurus reticulates García-Gómez, 1983
Lysmata grabhami (Gordon, 1935)
Lysmata pederseni Rhyne & Lin, 2006
Mithrax sp.
Mithrax spinosissimus (Lamarck, 1818)
Munida pusilla Benedict, 1902 (Fig. 5)
Ocypode quadrata (Fabricius, 1787)
Paguristes cadenati Forest, 1954
Paguristes puncticeps Benedict, 1901
Panulirus argus (Latreille, 1804)
Panulirus guttatus (Latreille, 1804)
Pelia mutica (Gibbes, 1850)
Percnon gibbesi (H. Milne Edwards, 1853)
Periclimenes perryae Chace, 1942
Periclimenes yucatanicus (Ives, 1891)
Petrochirus diogenes (Linnaeus, 1758)
Platypodiella spectabilis (Herbst, 1794)
Porcellana sayana (Leach, 1820) (Fig. 4)
Stenopus hispidus (Olivier, 1811)
Stenopus scutellatus Rankin, 1898
Stenorhynchus seticornis (Herbst, 1788)
Thor cf. *amboinensis* (de Man, 1888)

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Fig. 1 Hydrozoan: *Solanderia gracilis*

Fig. 2. Hydrozoan: *Zyzzyzus warreni*

Fig. 3 Commensal crab *Dissodactylus melitae* on a sand dollar

Fig. 4 Spotted porcelain crab *Porcellana sayana*

Fig. 5 Common squat lobster *Munida pusilla*

Tunicates of St. Eustatius

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Introduction

Tunicates belong to the subphylum Tunicata in the phylum Chordata, which includes all animals with dorsal nerve cords and notocords. Some tunicates live as solitary individuals, but others become colonies, each unit being known as a zooid. They are marine filter feeders with a water-filled, sac-like body structure and two tubular openings, known as siphons, through which they draw in and expel water. Most adult tunicates are sessile as encrusting or stalked ascidians, which are permanently attached to rocks or other hard surfaces on the ocean floor; whereas others are salps, which swim in the pelagic zone of the sea as adults.

About 3000 described species of tunicates occur in the world's oceans (Appeltans et al. 2012), mostly living in shallow water. The most numerous group is the ascidians, and fewer than 100 species of these are found at depths greater than 200 m. They are found in a range of solid or translucent colours and may resemble seeds, grapes, peaches, barrels, or bottles.

One of the goals of the Statia Marine Expedition 2015, was to contribute to expanding the understanding of the tunicate fauna of the Dutch Caribbean island of St. Eustatius by a base line inventory. Another major goal of the investigation was to obtain DNA subsamples of soft tissue from live individuals of a number of tunicate species for molecular analysis and DNA barcoding. The tunicate fauna of St. Eustatius had been poorly investigated before the expedition. Rocha et al. (2005) reported on tunicates from some islands within 200 km range from St. Eustatius, two species from Saba (30 km) to 96 species from Guadeloupe (200 km). Cole (2012) reported on 32 species in collections from Tobago, which is located 700 km south of Statia.

Methods

As many species as possible were recorded and sampled from each field station. The voucher material consists of both formaline-preserved and alcohol-preserved material. This material will be housed in the reference collection of the Naturalis Biodiversity Center in Leiden. The nomenclature of the species is according to the World Register of Marine Species (WoRMS Editorial Board 2016).

Results

Twenty-three tunicate species were found, belonging to 10 families (Table 1). Even towards the end of the expedition, species were found that previously had not been recorded for the island (Fig. 1). This indicates that the marine tunicate fauna of St. Eustatius probably consists of more species than discovered during our 3-week expedition. The recorded species are listed in Table 2. Some identifications are not yet final.

Table 1. Total number of Tunicate taxa observed during the expedition by Class and Order

Class / Order	**Number of species**
Ascidiacea / Aplousobranchi	14
Ascidiacea / Phlebobranchia	4
Ascidiacea / Stolidobranchia	4
Thaliacea / Salpida	1

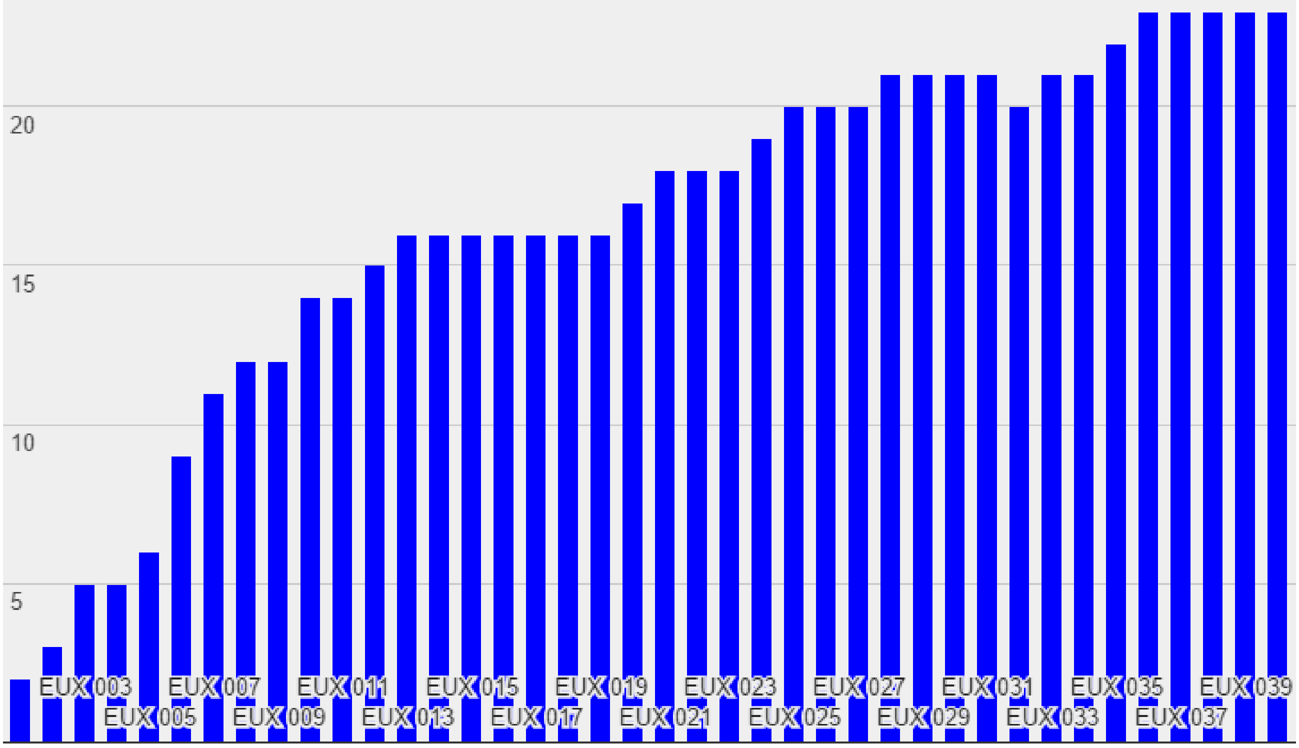

Fig. 1 Cumulative number of species found during the expedition per dive

Fig. 2 Encrusting social tunicate (*Symplegma* sp.) on Chien Tong Wreck

Table 2 Preliminary list of tunicates observed at St. Eustatius

CLASS **Ascidiacea**
ORDER **Aplousobranchia**
Clavelinidae
Clavelina cf. *dellavallei* (Zirpolo, 1825)
Clavelina cf. *picta* (Verrill, 1900)
Clavelina obesa Nishikawa & Tokioka, 1976
Clavelina puertosecensis Millar & Goodbody, 1974
Diazonidae
Rhopalaea abdominalis (Sluiter, 1898)
Didedemnidae
Aplidium cf. *undulatum* Monniot F. & Gaill, 1978
Didemnidae sp.1 (yellow white morph)
Didemnum conchyliatum (Sluiter, 1898)
Didemnum vanderhorsti Van Name, 1924
Trididemnum solidum (Van Name, 1902)
Holozoidae
Distaplia bermudensis Van Name, 1902
Distaplia corolla Monniot F., 1974
Distaplia sp. 1
Polycitoridae
Eudistoma sp. 1 (red morphotype)
Eudistoma sp. 2 (white morphotype)
ORDER **Phlebobranchia**
Ascidiidae
Ascidia sp. 1
Ascidiella cf. *scabra* (Müller, 1776)
Perophoridae
Ecteinascidia turbinate Herdman, 1880
ORDER **Stolidobranchia**
Styelidae
Polycarpa spongiabilis Traustedt, 1883
Styela cf. *plicata* (Lesueur, 1823)
Styelidae (red - white morphotype)
Symplegma viride Herdman, 1886
CLASS **Thaliacea**
ORDER **Salpida**
Salpidae
Salpa cf. *maxima* Forskål, 1775

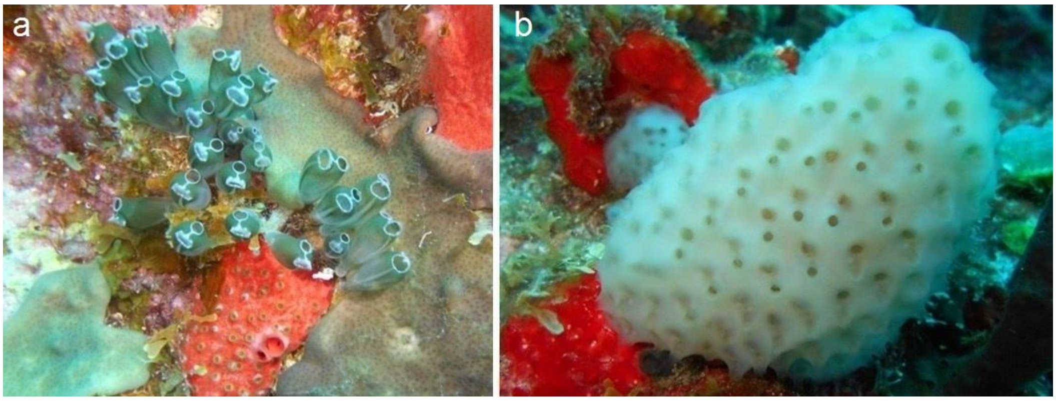

Fig. 3 Ascidians at Barracuda Reef (EUX 036): **a** *Clavelina peurtosecensis*; **b** *Eudistoma* sp. white morphotype

Conclusions

The expedition recorded at least 23 tunicate species for the fauna of St. Eustatius, 10 of which could be identified with certainty at species level. This is for the first time that such an inventory was made for this island. These numbers may increase since the list is not complete yet. On the nearby Island of Guadeloupe (200 km away) 96 species were found and it is expected that several of these also occur on St. Eustatius. Once comparisons are made of species lists from individual marine field stations, these will yield valuable information on the faunal distribution within the shallow-water habitats surrounding St. Eustatius, and then these areas can be monitored over time based on the present baseline. The results of the DNA analysis will be available in 2016.

Acknowledgements The author wants to thank Godfried van Moorsel, Frank Stokvis, Bert Hoeksema and Luna van der Loos who all delivered tunicates and underwater photographs.

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Links

Information on citizen science project in the Dutch Caribbean: http://www.anemoon.org/projecten/onderwater-moo-bes/nederlandse-cariben

Species information of the species found on St. Eustatius:
http://www.anemoon.org/flora-en-fauna/soorteninformatie/categoryid/2

Dive sites St. Eustatius:
http://www.scubaqua.com/8ulfjh-dive-sites.html

Vroege vogels:
http://vroegevogels.vara.nl/nieuws/expeditie-st-eustatius

Symbiotic copepods associated with invertebrates at St. Eustatius

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Introduction

Symbiotic copepods are a diverse group of crustaceans associated with invertebrates of various taxa including corals, sponges and echinoderms (Humes 1985, 1994). Among nearly 14 10^3 species of described copepods (ca 35% of all species) are found associated with other animals and only about 1% of symbiotic copepods associated with invertebrate hosts have been described so far (Humes 1994). Symbiotic copepods associated with scleractinian corals of the Caribbean Sea are represented by a diverse and highly endemic fauna that differs from that of the Indo-Pacific (Stock 1973, 1975, 1977, 1987, 1988; Herriott and Immermann 1979). Caribbean copepods associated with octocorals, sponges and echinoderms are poorly studied (Stock 1973, Grygier 1980), whereas those associated with corals, sponges and echinoderms of St. Eustatius had not been investigated at all.

The research goal was to collect symbiotic copepods from most scleractinian species and to inspect common species of octocorals, sponges and echinoderms for the presence of symbiotic copepods in order to study the cryptic diversity and host specificity of symbiotic copepods by molecular and morphological methods.

Methods

The invertebrate hosts (mainly corals, sponges) were collected during 38 SCUBA dives at depths down to 40 m by V Ivanenko with Bert Hoeksema. The invertebrate hosts were photographed, collected and isolated in plastic bags underwater. In the laboratory, alcohol was added to the bags (adjusting solution 10%), and the hosts were kept in the solution for at least 20–30 min. Then the symbionts were shaken and the residue with anaesthetized copepods was passed through a fine sieve (mesh size 60 µm). The invertebrates were also dissected and examined for presence of copepods living in galls or polyps. Symbiotic copepods and pieces of each host were fixed in 96% alcohol and stored in -20 °C for morphological and molecular studies. Subsamples of hosts were fixed in 96% alcohol for morphological and molecular studies as well. Scleractinian hosts were identified by Bert Hoeksema (see Hoeksema and Van Moorsel 2016; nomenclature according to the World Register of Marine Species (WoRMS Editorial Board 2016). Coral skeletons were bleached, dried and photographed.

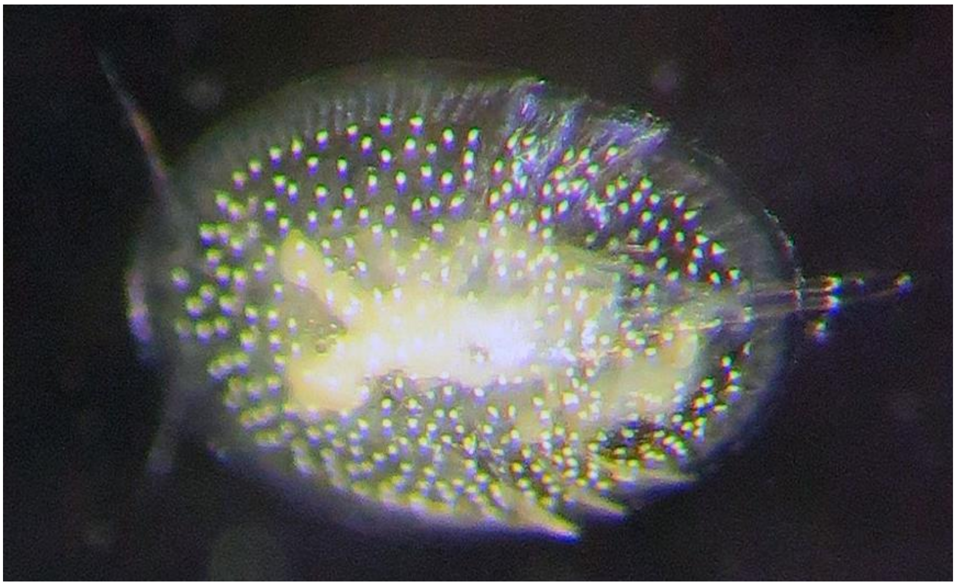

Fig. 1 Dorsal view of a copepod (Siphonostomatoida: Entomolepididae Brady, 1899) found associated with a scleractinian coral, *Manicina areolata* (sample Statia15-16)

Results

Diverse and abundant copepods representing different orders from 38 sites have been collected and sorted for study by molecular and morphological methods; they were associated with 26 species of scleractinian corals (57 samples, Table 1), octocorals (13 samples mainly representing *Gorgonia ventalina* from different localities and depths), sponges (23 samples, including the Giant barrel sponge *Xestospongia muta*), echinoderms (six samples including one echinoid, three holothurians and two ophiuroids). This survey is the most complete survey of symbiotic copepod associated with scleractinians of the Caribbean Sea so far. The copepods associated with the scleractinians in the samples are represented by diverse asterocherid-like copepods including those described before and a number of previously unknown species and hosts. The tentatively identified and previously found symbiotic copepods associated with scleractinians are siphonostomatoid asterocherids described earlier from Curaçao: *Peltomyzon rostratum* Stock, 1975 found on *Montastraea cavernosa* and *Hermacheres diploriae* Stock, 1975 found on *Pseudodiploria clivosa* and *P. strigosa*. The collection of copepods associated with sponges and echinoderms includes many copepods represented by poecilostomatoids, siphonostomatoids, and harpactocoids. This is essential for studies on the cryptic diversity, host specificity, host switching and phylogeny of symbiotic copepods of the Caribbean Sea.

During a survey of diseases of common invertebrates, new endoparasitic lamippid copepods were found that induce multiple purple spots on colonies of the common gorgonian *Gorgonia ventalina*. These spots caused by copepods are remarkably similar to those of the multifocal purple spots syndrome of *G. ventalina* reported from several Caribbean localities since 2006 (Burge at al. 2012). A report on this finding has been published recently (Ivanenko et al. 2015).

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Table 1 Scleractinian hosts of copepods (Siphonostomatoida) collected at St. Eustatius (June 2015)

Host coral	**Sample**	**Sampling date**
Agaricia agaricites	Statia15-19	07.06.2015
	Statia15-166	24.06.2015
Agaricia fragilis	Statia15-111	12.06.2015
Agaricia lamarcki	Statia15-39	08.06.2015
Dendrogyra cylindrus	Statia15-87	10.06.2015
Dichocoenia stokesii	Statia15-123	16.06.2015
	Statia15-158	23.06.2015
Eusmilia fastigiata	Statia15-15	07.06.2015
Isophyllia rigida	Statia15-108	15.06.2015
	Statia15-124	16.06.2015
Isophyllia sinuosa	Statia15-156	23.06.2015
Madracis auretenra	Statia15-56	12.06.2015
	Statia15-127	16.06.2015
Manicina areolata	Statia15-16	09.06.2015
Meandrina danae	Statia15-2	07.06.2015
Meandrina meandrites	Statia15-11	07.06.2015
	Statia15-51	08.06.2015
	Statia15-71	09.06.2015
	Statia15-83	10.06.2015
	Statia15-122	16.06.2015
	Statia15-159	23.06.2015
Montastraea cavernosa	Statia15-36	10.06.2015
	Statia15-40	11.06.2015
	Statia15-52	11.06.2015
	Statia15-115	12.06.2015
	Statia15-84	14.06.2015
	Statia15-155	22.06.2015
	Statia15-160	23.06.2015
	Statia15-167	25.06.2015
Mussa angulosa	Statia15-3	07.06.2015
	Statia15-133	17.06.2015
Mycetophyllia aliciae	Statia15-126	16.06.2015
	Statia15-165	24.06.2015
Orbicella faveolata	Statia15-169?	26.06.2015
Orbicella franksi	Statia15-168	25.06.2015
Porites astreoides	Statia15-103	12.06.2015
	Statia15-144	19.06.2015
	Statia15-147	20.06.2015
	Statia15-151	21.06.2015
	Statia15-152	21.06.2015
	Statia15-161	23.06.2015
Porites divaricata	Statia15-7	07.06.2015
	Statia15-104	15.06.2015

Porites furcata	Statia15-32	10.06.2015
Porites sp	Statia15-150	20.06.2015
Pseudodiploria clivosa	Statia15-72	13.06.2015
Pseudodiploria strigosa	Statia15-43	08.06.2015
	Statia15-67	09.06.2015
	Statia15-68	13.06.2015
	Statia15-80	14.06.2015
	Statia15-149	20.06.2015
Siderastrea siderea	Statia15-47	08.06.2015
	Statia15-148	20.06.2015
	Statia15-154	22.06.2015
Solenastrea bournoni	Statia15-137	17.06.2015
Stephanocoenia intersepta	Statia15-125	16.06.2015
Tubastraea coccinea	Statia15-27	08.06.2015

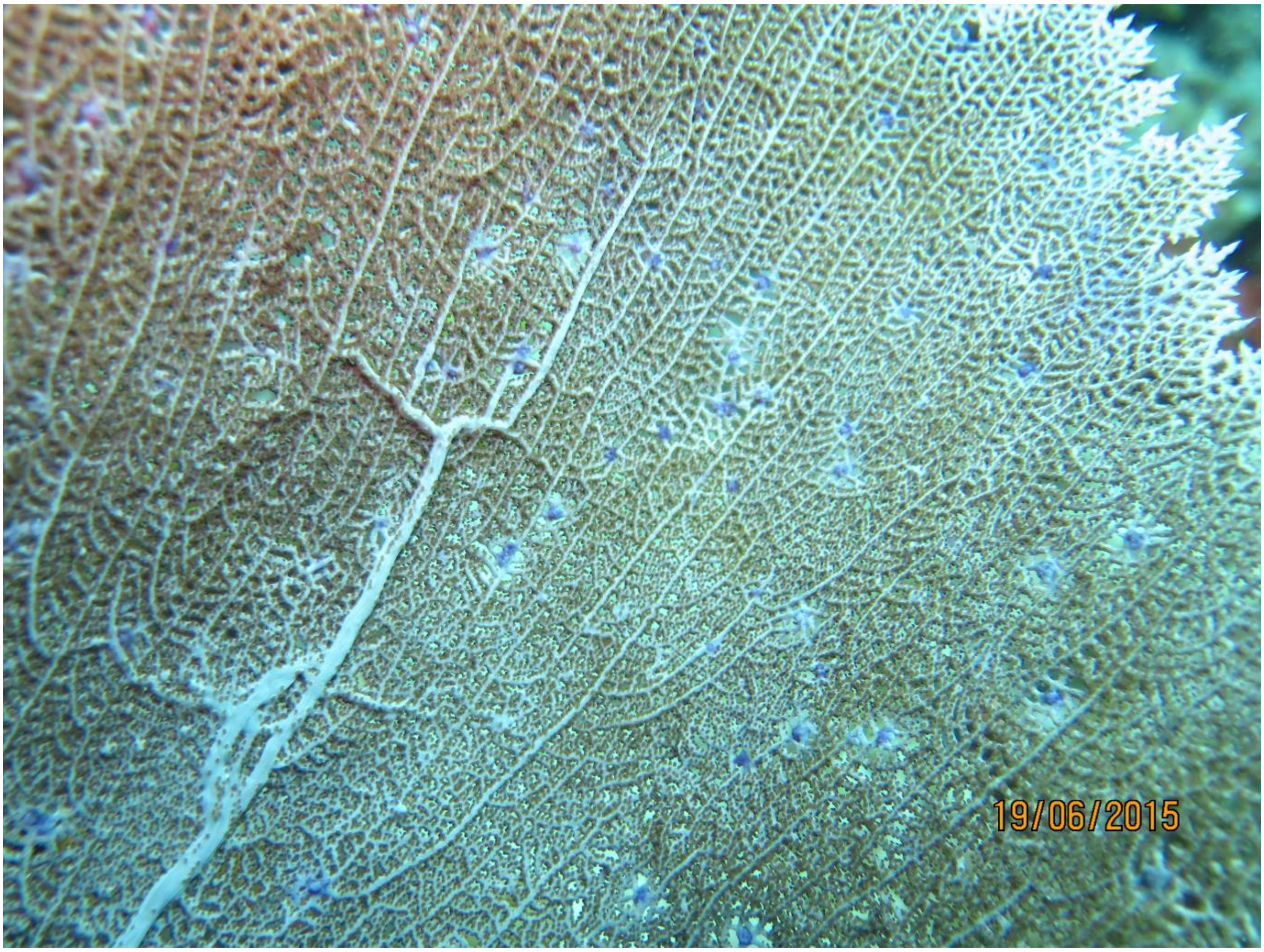

Fig. 2 *Gorgonia ventalina* with multiple purple spots caused by a parasitic copepod, *Sphaerippe* sp. (depth 7 m)

Fig. 3 Habitus of female *Sphaerippe* sp., ventral view, SEM.

Amphipod crustaceans of St. Eustatius

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Introduction

St. Eustatius, or Statia, is an elongated island of 21 km^2. It is situated along the northwest axis of the northern Lesser Antilles and measures 8 km by 3.5 km and comprises two morphologically distinct units. The north-west end was built from a cluster of five coalesced older volcanoes and lava flows and domes and their pyroclastic aprons of block and ash deposits. These are best seen in the island's sea cliffs (Smith et al. 1980). At the extreme south end of the island and standing out of the flanks of the Quill is a tilted wall and ridge of shallow marine limestone known as the Sugar Loaf - White Wall, running 1.2 km east to west with stratification dipping around 40 degrees seawards. This is believed to be part of the limestone cap of the submarine platform uplifted by the emplacement of a dome. Similar structures exist at Brimstone Hill on St. Kitts. On Statia, unlike the neighboring island of Saba, there are coarse-grained plutonic blocks of igneous cumulates (both andesite and basaltic components) of the type found on the floors of magma chambers. Thus the Quill is underlain by a magma chamber in which crystal fractionation occurs to produce a wide range of lava compositions. This unique setting is believed to have contributed to Statia's diversity of non-carbonaceous sediments in its shallow marine environments.

During the 2015 expedition, the significant sediment contribution of volcanic origin is in contrast to typical reef sediments, which are dominated by poorly sorted calcium carbonate components generally consisting of a large admixture from calcareous algae and foraminifera. Statia's sediments are generally dominated by non calcium carbonate particles from volcanic weathering, characteristically angular and well sorted and winnowed.

While extensive scleractinian coral platforms are lacking in Statia, there are well developed and extensive sponge, ascidian, octocoral, and rubble and volcanic block communities. A first impression in observing the diversity of underwater habitats is that there is little significant human impact in the marine system other than the coastal oil storage site, sunken wrecks, and habitation dating back to the Dutch colonial period. The island remains minimally impacted and this is reflected in the rich marine habitats surrounding the island.

Amphipods are free-living peracarid crustaceans that lack a free-living larval stage and thus more accurately reflect historical evolutionary dispersion scenarios. They are the dominant mesoscale (2–5 mm) taxonomic component of tropical marine ecosystems and serve as important prey for many fish species and are important converters of inorganic matter. They exhibit a variety of life styles including tube builders, nestlers, inquilines (commensals with other invertebrates), epifaunal, epibenthic, infaunal, fouling, cryptic, interstitial, and rubble dwellers.

Methods

Due to the high numbers of potential amphipod species that could be encountered, the author decided to concentrate on the cryptic families of amphipods for the molecular studies, as their distribution would be theoretically more restricted than amphipods that could raft on algae or other epibenthic habitats. Therefore efforts were directed at commensal amphipods in sponges, ascidians, octocoral associates, and epibenthic habitats. The author and Marco Faasse also collected algal associates, fouling communities, and habitats encountered in dives. Species identifications followed the nomenaclature according to the World Register of Marine Species (WoRMS Editorial Board 2016).

Results

Sampling efforts yielded a picture of the Statia amphipod diversity including both Caribbean basin regional endemics. Several new species of *Leucothoe* were recorded, as were range extensions for a number of extant species in a variety of families. A remarkable epibenthic community of two amphipod species, *Photis trapherus,* Thomas and Barnard, 1990 (Fig. 1a), and *Gitana dominica* Thomas and Barnard, 1991, were observed in vast numbers in shallow, well sorted volcanic sediments (Fig. 1b). This association extended continually along the bottom of certain habitats. A similar situation was reported for *G. dominica* from volcanic sediments from Dominica (Thomas 1990). Both species exhibited cryptic color patterns matching the sediment particles.

Fig. 1 a *Photis trapherus,* adult male; **b** *Photis* / *Gitana* epifaunal community

Another notable record was the discovery of *Anamixis hanseni* Stebbing, 1897 which has never been documented since its original description from the "West Indies". This is a significant record as the family Leucothoidae has been well documented by Thomas and coworkers in the Caribbean and may possibly be a regional endemic to the northern Lesser Antillean Islands. Both juvenile leucomorph and adult hypermale anamorph forms were collected and plated for molecular analysis.

Additionally, a number of new amphipod-sponge hosts were documented, thanks to the help of Jaaziel Garcia who provided sponge identifications (García-Hernández et al. 2016). See Table 1 for details of sponge associated amphipods. Because few host specific records for sponge dwelling amphipods exist (Thomas and Klebba 2006, 2007) these findings are of particular interest.

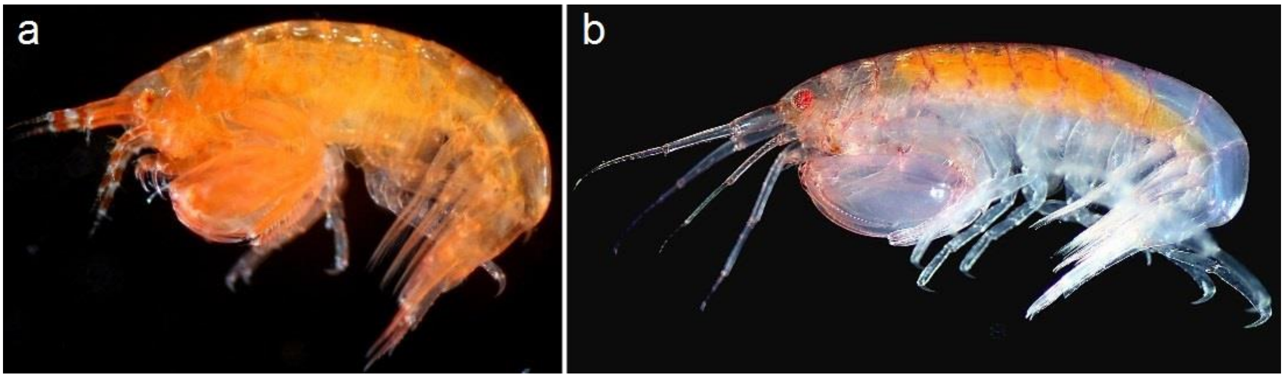

Fig. 2 a *Leucothoe* n. sp. 2, **b** *Leucothoe hortapugae*


Fig. 3 *Leucothoe hortapugae* on *Callyspongia falax*

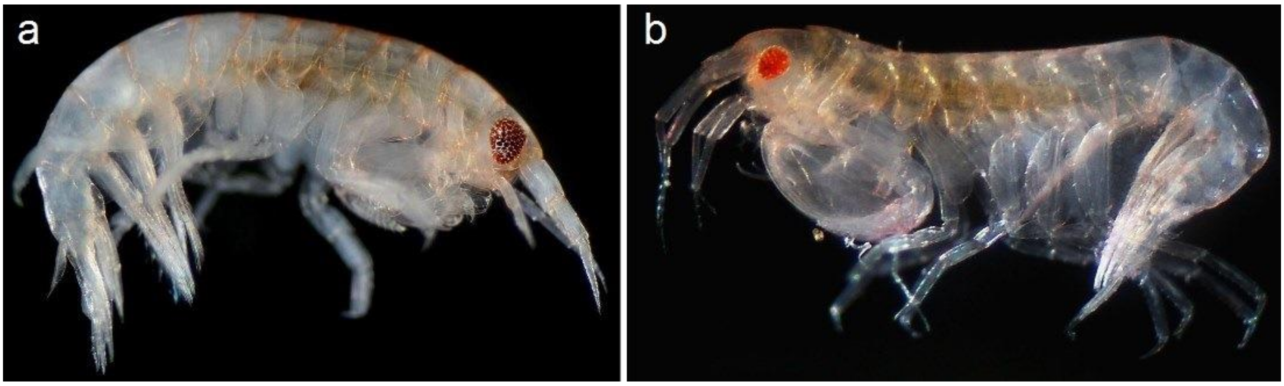

Fig. 4 a *Leucothoe* n. sp. 1, **b** *Leucothoe* n. sp. 3

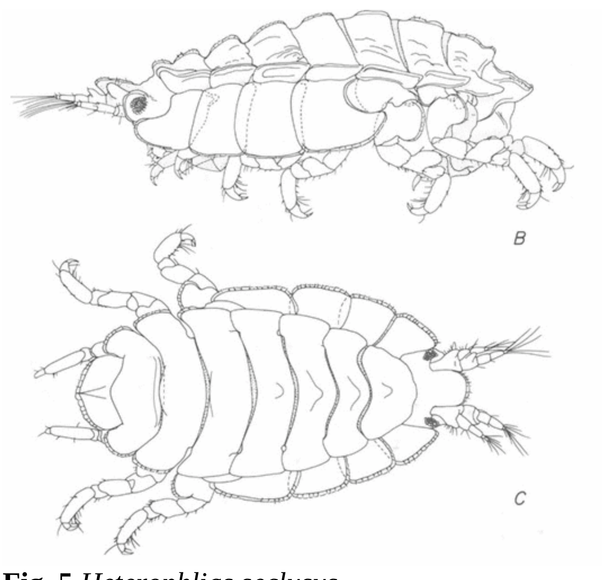

Fig. 5 *Heterophlias seclusus*

Summary of findings

Algal associates:

Members of the Ampithoidae (*Ampithoe* and *Cymadusa*; Fig.7), are abundant algal associates and consumers. One species, *Pseudampithoides incurvaria* (pictured) constructs a "domicile" with using the toxic alga *Dictyota* as chemical deterrent to predators. This component was abundant at all sites and locations sampled.

Cryptic and inquilines (commensals with other invertebrates):

At least four undescribed species of *Leucothoe* (Figs. 2-4) were documented in addition to range extensions for several other leucothoid taxa.

Heterophlias seclusus an unusual armored amphipod found in cryptic habitats.

Epibenthic:

Most notable was the discovery of large numbers of an epibenthic community of *Gitana* / *Photis* (Fig. 1) in shallow volcanic rich sediments. This unusal community association is the subject of a manuscript in preparation by the author

Also associated with this community are the Megaluropidae, where two genera were recorded: *Resupinus,* represented by a new species with spinose telson, (Fig. 6) and *Gibberosus*.

Infaunal:

Taxa encountered were members of Platyischnopidae (*Eudevanopus*) and Oedicerotidae (*Synchelidium*).

Interstitial:

Netamelita sp. from fine calcareous sediments. In other Caribbean reef systems this genus is found in poorly sorted calcareous muds at depths from 20-30 m. *Microcharon quilli* n. sp. (in press), a new interstitial isopod. *Microcharon* is known mostly from subterranean freshwater worldwide (70 species) and has only four fully marine species of which this one is the 5th

Tube builders/ fouling communities:

While not a focus of sampling effort, tube builders were frequently found on mooring lines associated with hydroids and included *Cymadusa filosa*, *Ampithoe ?ramondi*, *Erichthonius brasiliensis*, *Podocerus brasiliensis*, *Amphilochu*s sp., and *Stenothoe ? valida*.

Nestlers:

This would include primarily algal nestlers who were sampled only incidentally by Marco Faasse and included *Anamixis vanga*, *A. cavitura*, and the Antillean endemic *A, hanseni.*

A more complete sampling of algal communities would surely reveal a number of amphipod and other taxa.

Epifaunal:

Habitats would include pilings, sea walls, and floating structures. *Elasmopus* spp. among other taxa form distinct marine communities here but such habitats were not sampling focus.

Rubble dwellers:

The few sites sampled for rubble yielded species of *Seba*, *Liljeborgia*, *Heterophlias seclusus*, a variety of gammarids (*Elasmopus*, *Maera*, and *Melita).* These gammarids are mesograzers that feed on unicellular "turf" algae and are often numerous on rubble samples as they are associated with the algal turfs covering the sunlit cryptic surfaces and crevices of rubble that the normal compliment of macro grazing fishes (scarids, acanthurids, pomacentrids) cannot access.

Future work

If future efforts are made to collect in Statia the PI suggests more extensive surveys of infaunal and epifaunal groups. Also a focus on sampling in intertidal, algal, rubble, interstitial, wells, seeps, groundwater, and caves would surely reveal a number of new taxonomic discoveries.

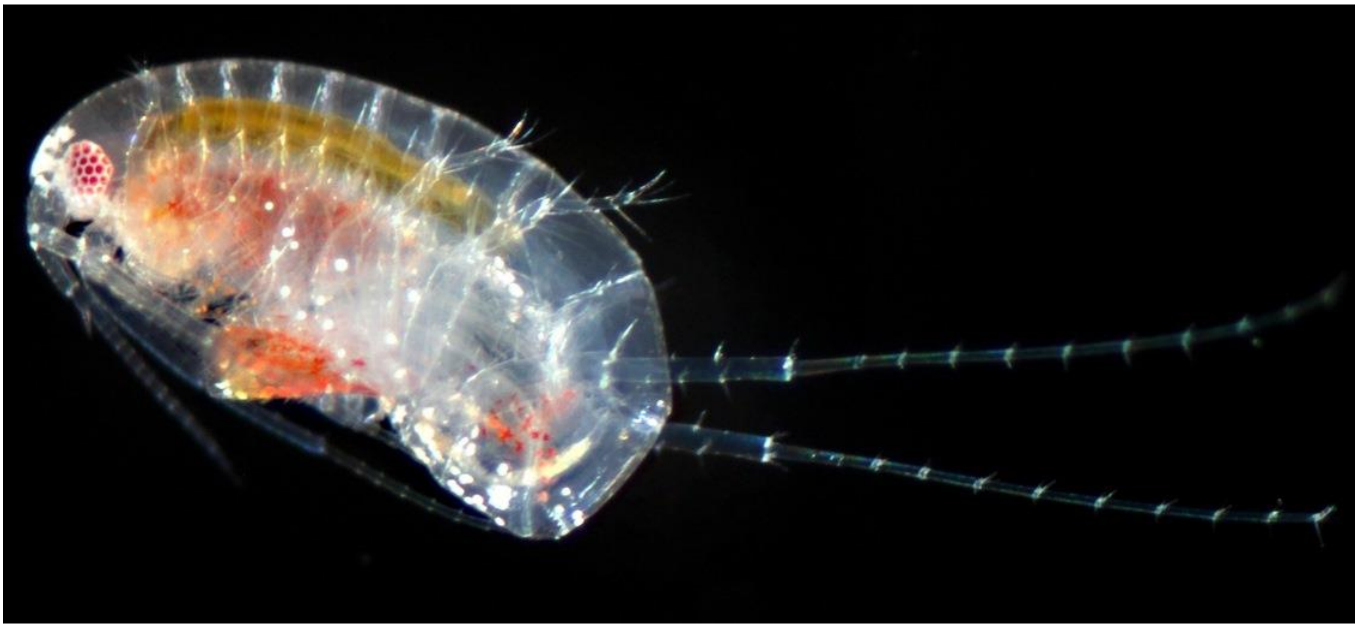

Fig. 6 *Resupinus* n.sp.

Fig. 7 The amphotoid *Cymadus filosa*

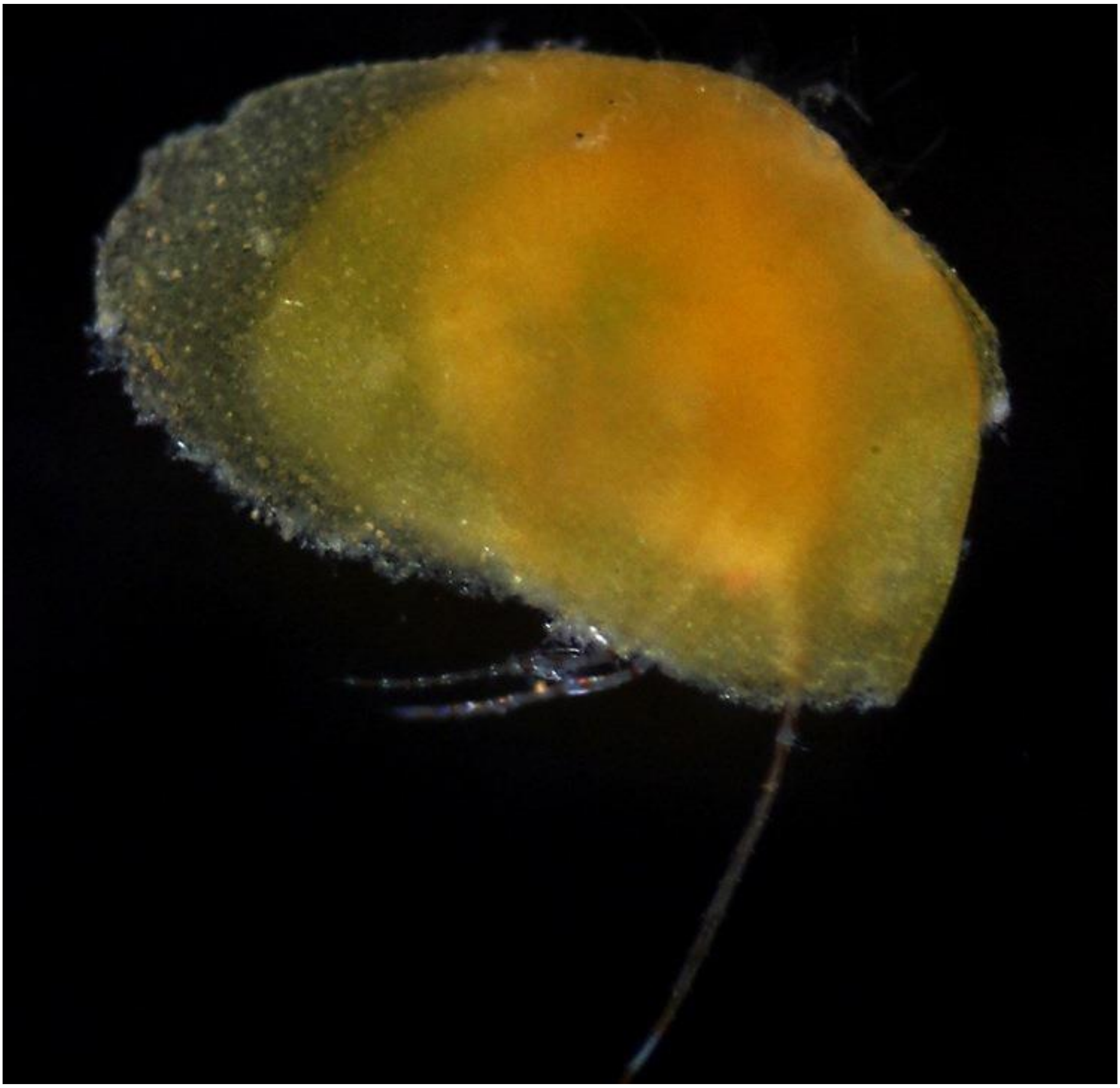

Fig. 8 *Pseudoampithoides incurvaria* in *Dictyota*

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Marine interstitial crustaceans of St. Eustatius

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Interstitial aquatic crustaceans are present in the environmental range that stretches from deep sea sediments upward to shallow reef debris, and further upshore to freshwater riverbeds. The location and depth below the uppermost layer of grains determines the fauna and its evolutionary history. On St. Eustatius the presence of almost any type of groundwater crustacean, offshore and on the island, is unknown and as such the island forms an interesting bridge between the relatively well-explored areas of Haiti in the north and the Dutch Leeward Antilles in the southern part of the Caribbean. Scuba diving for two hours in a day during three weeks allowed for probing several spots on the southwest side of the island. A search for the right type of coarse sand between the submerged lava ridges was done until a depth of approximately 20 m. First results are the presence of blind microparasellid isopods and semi-oculate melitid amphipods, specialised for a life just below the sandy bottom surface.

The seafloor and also the shallow marine interstitial are habitats that were and are colonized by pre-adapted benthic invertebrates seeking refuge from predation. Especially islands are reserves of more or less isolated pieces of seafloor that stick out of a landscape of uniformity. This makes it probable that offshoots of a general, deeper seafloor fauna evolved in the shallow waters surrounding islands. Specimen identification and previous knowledge on species community assemblages in coral sands will lead to more information on the Statia offshore fauna.

Fig. 1 *Netamelita* sp. A semi-oculate amphipod living in the top layer of coarse and well-aerated coral debris of Castle Rock reef, St. Eustatius (photo: J.D. Thomas)

Table 1 **L**ist of stations that held interstitial peracarid crustaceans

Dive site	**Depth range**	**Topography**	**Taxa**
Princess Corner	13–20 m	Reef	Hadziidae (amphipods), Microparasellidae (isopods)
Five Fingers North	14–20 m	Patch reef	Microparasellidae (isopods)
Chien Tong	14–23 m	Wreck	*Netamelita sp.* (amphipods), Microparasellidae (isopods)
Maxima's Reef	20–26 m	Reef	Hadziidae (amphipods), Microparasellidae (isopods)
Northman	8–20 m	Patch reef / boulders	*Stenobermuda sp.* (isopod)
Lost Anchors	20–24 m	Reef	Microparasellidae (isopods)
The Ledges	14–20 m	Reef	Hadziidae (amphipods), Microparasellidae (isopods)
Mushroom Garden	14–18 m	Patch reef	Hadziidae (amphipods)
Twin Sisters	14–20 m	Reef	*Microcharon* (isopod)
Castle Rock	15–22 m	Reef	*Netamelita sp., Idunella sp.* (amphipods)

Marine fishes of St. Eustatius

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Introduction

During the course of the expedition, 37 sampling stations were surveyed for fish species using the roving diver method. On August 22nd, an additional survey dive was carried out. A total of 206 species were observed during 37 hours of survey time. For the species list (Table 1) the binomial nomenclature is taken from the World Register of Marine Species (WoRMS Editorial Board 2016). Maximum and minimum observed species richness per site was 98 and 36, respectively (mean = 70; Fig. 1). Five species (*Halichoeres garnoti, Rhinesomus triqueter, Thalassoma bifasciatum, Acanthurus tractus* and *Stegastes partitus*) were found at all sites, 38 species were only observed at a single location, a further 14 were only observed at two sampling stations. During the expedition a Cuban chimaera (*Chimaera cubana*) was landed by a fisherman, which was kept as a voucher specimen. The individual was caught whilst bottom fishing at a depth of 200–300 m.

A further 75 species have been recorded in other publications, museum collections, and through personal observations, photographic evidence and fisheries data. Metzelaar (1919) recorded 84 species collected from St. Eustatius by various collectors in the early 1900's. In 1937 the Smithsonian-Hartford West Indies Expedition collected six species from St. Eustatius by trawling, four of which have not been recorded since. In 1967 and 1969 the R/V Oregon II collected a further 37 species utilizing deep-water (600–1500 m) bottom trawls. Van Kuijk (2014) recorded a total of 83 species using stereo-baited remote underwater video (sBRUV), and a further three elasmobranches were reported by Van Beek et al. (2012). An additional 26 species have been recorded in fisheries catch data, or from personal observation and photographic evidence. Accounting for duplicates between sources, this brings the total number of marine fish species at St. Eustatius to 307.

The number of shorefishes (those collected at < 100 m depth, n=273) identified at St. Eustatius resembles that of the similarly sized Mona Passage islands, Puerto Rico (n=261; Dennis et al. 2005) and Buck Island Reef National Monument (n=262; Smith-Vaniz et al. 2006). Williams et al. (2010) identified a total of 270 species on Saba bank, in close proximity to St. Eustatius but only 132 (49%) of these were observed during visual surveys. Relying solely on visual and fisheries data usually results in cryptic species being underrepresented. The use of rotenone during the Saba bank study yielded an additional 84 species that were not observed during visual surveys. As such, the observed species richness observed during the present study is expected to be an underestimate. A follow-up study on St. Eustatius using ichthyocide collections may provide a more reliable number.

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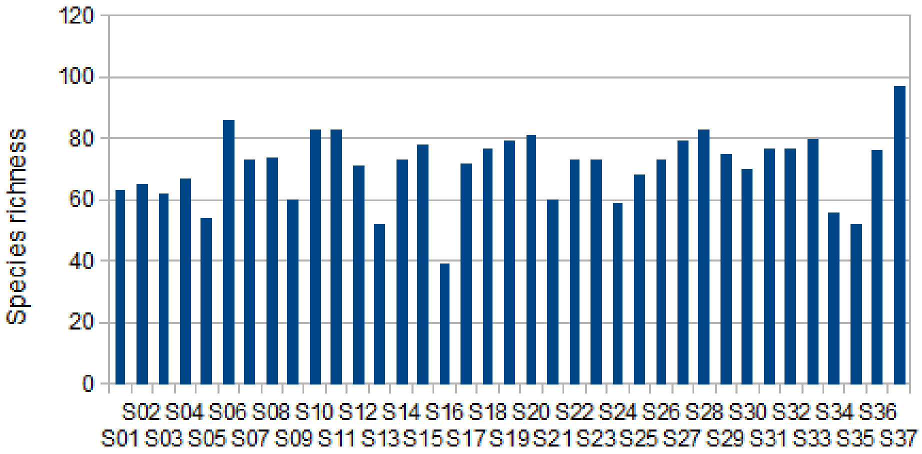

Fig. 1 Observed species richness at each sampling station

Fig. 2 *Paradiplogrammus bairdi*

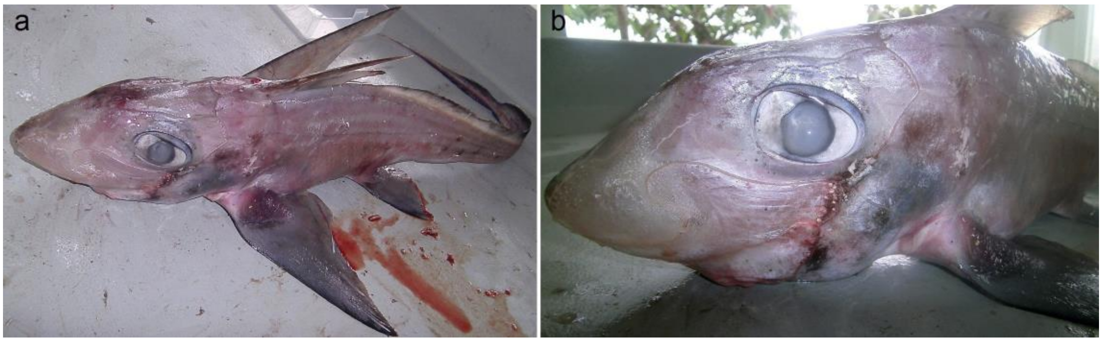

Fig. 3 *Chimera cubana*. **a** Complete animal. **b** Close-up of head

Fig. 4 *Emblemariopsis occidentalis*

Fig. 5 *Risor ruber*

<u>**Table 1.** A complete list of marine fish species recorded on St. Eustatius</u>

Family / species	Common name
Acanthuridae	**Surgeonfishes**
Acanthurus tractus Poey, 1860	Ocean surgeonfish
Acanthurus chirurgus (Bloch, 1787)	Doctorfish
Acanthurus coeruleus Bloch & Schneider, 1801	Blue Tang

Acropomatidae	**Lanternbellies**
Synagrops bellus (Goode & Bean, 1896)	Blackmouth bass
Anacanthobatidae	**Legskates**
Cruriraja rugosa Bigelow & Schroeder, 1958	Rough legskate
Antennaridae	**Frogfishes**
Antennarius multiocellatus (Valenciennes, 1837)	Longlure frogfish
Histrio histrio (Linnaeus, 1758)	Sargassum frogfish
Apogonidae	**Cardinalfishes**
Apogon affinis (Poey, 1875)	Bigtooth cardinalfish
Apogon aurolineatus (Mowbray, 1927)	Bridle cardinalfish
Apogon maculatus (Poey, 1860)	Flamefish
Apogon quadrisquamatus Longley, 1934	Sawcheek cardinalfish
Apogon townsendi (Breder, 1927)	Belted cardinalfish
Astrapogon stellatus (Cope, 1867)	Conch fish
Phaeoptyx pigmentaria (Poey, 1860)	Dusky cardinalfish
Argentinidae	**Argentines**
Argentina stewarti Cohen & Atsaides, 1969	N/A
Atherinidae	**Old-world silversides**
Hypoatherina harringtonensis (Goode, 1877)	Reef silverside
Aulostomidae	**Trumpetfishes**
Aulostomus maculatus Valenciennes, 1841	Trumpetfish
Balistidae	**Triggerfishes**
Balistes capriscus Gmelin, 1789	Gray triggerfish
Balistes vetula Linnaeus, 1758	Queen triggerfish
Canthidermis sufflamen (Mitchill, 1815)	Ocean triggerfish
Melichthys niger (Bloch, 1786)	Black durgon
Belonidae	**Needlefishes**
Platybelone argalus (Lesueur, 1821)	Keeltail needlefish
Blennidae	**Combtooth blennies**
Entomacrodus nigricans Gill, 1859	Pearl blenny
Hypsoblennius exstochilus Böhlke, 1959	Longhorn blenny
Ophioblennius macclurei (Silvester, 1915)	Redlip blenny
Parablennius marmoreus (Poey, 1876)	Seaweed blenny
Bothidae	**Lefteye flounders**
Bothus lunatus (Linnaeus, 1758)	Peacock flounder
Bothus ocellatus (Agassiz, 1831)	Eyed flounder
Chascanopsetta lugubris Alcock, 1894	Pelican flounder
Syacium micrurum Ranzani, 1842	Channel flounder
Callionymidae	**Dragonets**
Paradiplogrammus bairdi Jordan, 1887	Lancer dragonet
Carangidae	**Jacks**
Alectis ciliaris (Bloch, 1787)	African pompano
Caranx bartholomaei (Cuvier, 1833)	Yellow jack
Caranx crysos (Mitchill, 1815)	Blue Runner
Caranx hippos (Linnaeus, 1766)	Crevalle jack
Caranx latus Agassiz, 1831	Horse eye jack
Caranx lugubris Poey, 1860	Black jack
Caranx ruber (Bloch, 1793)	Bar jack
Decapterus macarellus (Cuvier, 1833)	Mackerel scad
Decapterus punctatus (Cuvier, 1829)	Round scad
Elagatis bipinnulata (Quoy & Gaimard, 1825)	Rainbow runner
Hemiramphus brasiliensis (Linnaeus, 1758)	Ballyhoo
Selar crumenophthalmus (Bloch, 1793)	Big eye scad
Seriola rivoliana Valenciennes, 1833	Almaco jack
Trachinotus falcatus (Linnaeus, 1758)	Permit
Trachinotus goodei Jordan & Evermann, 1896	Palometa
Tylosurus crocodilus (Péron & Lesueur, 1821)	Houndfish

Carcharhindae	**Requiem sharks**
Carcharhinus limbatus (Müller & Henle, 1839)	Blacktip reef shark
Carcharhinus leucas (Müller & Henle, 1839)	Bull shark
Carcharhinus perezii (Poey, 1876)	Caribbean reef shark
Galeocerdo cuvier (Péron & Lesueur, 1822)	Tiger shark
Negaprion brevirostris (Poey, 1868)	Lemon shark
Centrophoridae	**Gulper sharks**
Centrophorus granulosus (Bloch & Schneider, 1801)	Gulper shark
Chaenopsidae	**Pike blennies**
Chaenopsis limbaughi Robins & Randall, 1965	Yellowface pike blenny
Emblemaria pandionis Evermann & Marsh, 1900	Sailfin blenny
Chaetodontidae	**Butterflyfishes**
Chaetodon aculeatus (Poey, 1860)	Longsnout butterfly
Chaetodon capistratus Linnaeus, 1758	Four-eye butterflyfish
Chaetodon ocellatus Bloch, 1787	Spotfin butterflyfish
Chaetodon sedentarius Poey, 1860	Reef butterflyfish
Chaetodon striatus Linnaeus, 1758	Banded butterflyfish
Chaunacidae	**Sea toads**
Chaunax suttkusi Caruso, 1989	N/A
Chimaeridae	**Chimaeras**
Chimaera cubana Howell Rivero, 1936	Cuban chimaera
Hydrolagus alberti Bigelow & Schroedecirrr, 1951	Gulf chimaera
Chlopsidae	**False morays**
Chilorhinus suensonii Lütken, 1852	Seagrass eel
Chlorophthalmidae	**Greeneyes**
Chlorophthalmus agassizi Bonaparte, 1840	Shortnose greeneye
Parasudis truculenta (Goode & Bean, 1896)	Longnose greeneye
Cirrhitidae	**Hawkfishes**
Amblycirrhitus pinos (Mowbray, 1927)	Redspotted hawkfish
Clupeidae	**Herrings**
Harengula clupeola (Cuvier, 1829)	False pilchard
Harengula humeralis (Cuvier, 1829)	Redear sardine
Jenkinsia lamprotaenia (Gosse, 1851)	Dwarf herring
Opisthonema oglinum (Lesueur, 1818)	Atlantic thread herring
Sardinella aurita Valenciennes, 1847	Round sardinella
Congridae	**Conger eels**
Heteroconger longissimus Günther, 1870	Brown garden eel
Xenomystax bidentatus (Reid, 1940)	N/A
Cynoglossidae	**Toungefishes**
Symphurus marginatus (Goode & Bean, 1886)	Margined toungefish
Dactylopteridae	**Flying gurnards**
Dactylopterus volitans (Linnaeus, 1758)	Flying gurnard
Dasyitidae	**Whiptail stingrays**
Dasyatis americana Hildebrand & Schroeder, 1928	Southern stingray
Diodontidae	**Porcupinefishes**
Chilomycterus antillarum Jordan & Rutter, 1897	Web burrfish
Diodon holocanthus Linnaeus, 1758	Balloonfish
Diodon hystrix Linnaeus, 1758	Porcupinefish
Diretmidae	**Spinyfins**
Diretmus argenteus Johnson, 1864	Silver spinyfin
Echeneidae	**Remoras**
Echeneis naucrates Linnaeus, 1758	Sharksucker
Remora remora (Linnaeus, 1758)	Remora
Ephippidae	**Spadefishes**
Chaetodipterus faber (Broussonet, 1782)	Atlantic spadefish

Etmopteridae	**Lanternsharks**
Etmopterus hillianus (Poey, 1861)	Caribbean lanternshark
Etmopterus robinsi Schofield & Burgess, 1997	West Indian lanternshark
Fistulariidae	**Cornetfishes**
Fistularia tabacaria Linnaeus, 1758	Bluespotted cornetfish
Gerreidae	**Mojarras**
Eucinostomus jonesii (Günther, 1879)	Slender mojarra
Gerres cinereus (Walbaum, 1792)	Yellowfin mojarra
Ulaema lefroyi (Goode, 1874)	Mottled mojarra
Ginglystomatidae	**Nurse sharks**
Ginglymostoma cirratum (Bonnaterre, 1788)	Nurse shark
Gobiidae	**Gobies**
Coryphopterus dicrus Böhlke & Robins, 1960	Colon goby
Coryphopterus eidolon Böhlke & Robins, 1960	Pallid goby
Coryphopterus glaucofraenum Gill, 1863	Bridled goby
Coryphopterus hyalinus Böhlke & Robins, 1962	Glass goby
Coryphopterus lipernes Böhlke & Robins, 1962	Peppermint goby
Coryphopterus personatus (Jordan & Thompson, 1905)	Masked goby
Coryphopterus thrix Böhlke & Robins, 1960	Bartail goby
Coryphopterus tortugae (Jordan, 1904)	Sand goby
Gnatholepis thompsoni Jordan, 1904	Goldspot goby
Gobiosoma chancei (Beebe & Hollister, 1933)	Shortstripe goby
Gobiosoma dilepis (Robins & Böhlke, 1964)	Orangeside goby
Gobiosoma evelynae (Böhlke & Robins, 1968)	Sharknose goby
Nes longus (Nichols, 1914)	Orange-spotted goby
Priolepis hipoliti (Metzelaar, 1922)	Rusty goby
Risor ruber (Rosén, 1911)	Tusked goby
Grammatidae	**Basslets**
Gramma loreto Poey, 1868	Royal Gramma
Grammicolepididae	**Tinselfishes**
Grammicolepis brachiusculus Poey, 1873	Thorny tinselfish
Haemulidae	**Grunts**
Anisotremus surinamensis (Bloch, 1791)	Black margate
Haemulon album Cuvier, 1830	White margate
Haemulon aurolineatum Cuvier, 1830	Tomtate
Haemulon carbonarium Poey, 1860	Caesar grunt
Haemulon chrysargyreum Günther, 1859	Smallmouth grunt
Haemulon flavolineatum (Desmarest, 1823)	French grunt
Haemulon macrostomum Günther, 1859	Spanish grunt
Haemulon melanurum (Linnaeus, 1758)	Cottonwick
Haemulon parra (Desmarest, 1823)	Sailors choice
Haemulon plumieri (Lacepède, 1801)	White grunt
Haemulon sciurus (Shaw, 1803)	Bluestriped Grunt
Haemulon striatum (Linnaeus, 1758)	Striped Grunt
Haemulon vittata (Poey, 1861)	Boga
Halosauridae	**Halosaurs**
Halosaurus ovenii Johnson, 1864	Oven's halosaur
Holocentridae	**Squirrelfishes**
Holocentrus adscensionis (Osbeck, 1765)	Squirrelfish
Holocentrus rufus (Walbaum, 1792)	Longspine squirrel
Myripristis jacobus Cuvier, 1829	Blackbar soldierfish
Neoniphon marianus (Cuvier, 1829)	Longjaw squirrel
Sargocentron coruscum (Poey, 1860)	Reef squirrelfish
Sargocentron vexillarium (Poey, 1860)	Dusky squirrelfish
Istiophoridae	**Marlins**
Istiophorus platypterus (Shaw, 1792)	Sailfish
Makaira nigricans Lacepède, 1802	Blue marlin

Kyphosidae	**Chubs**
Kyphosus cinerascens (Forsskål, 1775)	Blue sea chub
Kyphosus sectatrix (Linnaeus, 1758)	Bermuda chub
Kyphosus vaigiensis (Quoy & Gaimard, 1825)	Yellow chub
Labridae	**Wrasses**
Bodianus rufus (Linnaeus, 1758)	Spanish hogfish
Clepticus parrae (Bloch & Schneider, 1801)	Creole wrasse
Halichoeres bivittatus (Bloch, 1791)	Slippery dick
Halichoeres cyanocephalus (Bloch, 1791)	Yellowcheek wrasse
Halichoeres garnoti (Valenciennes, 1839)	Yellowhead wrasse
Halichoeres maculipinna (Müller & Troschel, 1848)	Clown wrasse
Halichoeres pictus (Poey, 1860)	Rainbow wrasse
Halichoeres poeyi (Steindachner, 1867)	Blackear wrasse
Halichoeres radiatus (Linnaeus, 1758)	Puddingwife
Thalassoma bifasciatum (Bloch, 1791)	Bluehead wrasse
Xyrichtys martinicensis Valenciennes, 1840	Rosy razorfish
Xyrichtys novacula (Linnaeus, 1758)	Pearly razorfish
Xyrichtys splendens Castelnau, 1855	Green razorfish
Labrisomidae	**Labrosomid blennies**
Acanthemblemaria aspera (Longley, 1927)	Roughhead blenny
Acanthemblemaria maria Böhlke, 1961	Secretary blenny
Acanthemblemaria spinosa Metzelaar, 1919	Spinyhead blenny
Emblemariopsis occidentalis Stephens, 1970	Redspine blenny
Labrisomus nuchipinnis (Quoy & Gaimard, 1824)	Hairy blenny
Malacoctenus aurolineatus Smith, 1957	Goldline blenny
Malacoctenus boehlkei Springer, 1959	Diamond blenny
Malacoctenus triangulatus Springer, 1959	Saddled blenny
Lobotidae	**Tripletails**
Lobotes surinamensis (Bloch, 1790)	Atlantic tripletail
Lutjanidae	**Snappers**
Apsilus dentatus Guichenot, 1853 `	Black snapper
Etelis oculatus (Valenciennes, 1828)	Queen Snapper
Lutjanus analis (Cuvier, 1828)	Mutton snapper
Lutjanus apodus (Walbaum, 1892)	Schoolmaster
Lutjanus buccanella (Cuvier, 1828)	Blackfin snapper
Lutjanus campechanus (Poey, 1860)	Red snapper
Lutjanus cyanopterus (Cuvier, 1828)	Cubera snapper
Lutjanus griseus (Linnaeus, 1758)	Grey snapper
Lutjanus jocu (Bloch & Schneider, 1801)	Dog snapper
Lutjanus mahogoni (Cuvier, 1828)	Mahogany snapper
Lutjanus synagris (Linnaeus, 1758)	Lane snapper\
Lutjanus vivanus (Cuvier, 1828)	Silk snapper
Ocyurus chrysurus (Bloch, 1791)	Yellowtail snapper
Lophiidae	**Goosefishes**
Lophiodes monodi (Le Danois, 1971)	N/A
Macrouridae	**Grenadiers**
Gadomus arcuatus (Goode & Bean, 1886)	Doublethread grenadier
Gadomus dispar (Vaillant, 1888)	Longbeard grenadier
Hymenocephalus aterrimus Gilbert, 1905	Blackest whiptail
Hymenocephalus billsam Marshall & Iwamoto, 1973	N/A
Malacocephalus laevis (Lowe, 1843)	Armed grenadier
Nezumia aequalis (Günther, 1878)	Common Atlantic grenadier
Ventrifossa macropogon Marshall, 1973	Longbeard grenadier
Malacanthidae	**Tilefishes**
Malacanthus plumieri (Bloch, 1786)	Sand tilefish
Megalopidae	**Tarpons**
Megalops atlanticus Valenciennes, 1847	Tarpon

Merlucciidae	**Merluccid hakes**
Steindachneria argentea Goode & Bean, 1896	Luminous hake
Microdesmidae	**Dartfishes**
Ptereleotris helenae (Randall,1968)	Hovering dartfish
Monacathidae	**Filefishes**
Aluterus scriptus (Osbeck, 1765)	Scrawled filefish
Cantherhines macrocerus (Hollard, 1854)	White spotted filefish
Cantherhines pullus (Ranzani, 1842)	Orangespotted filefish
Monacanthus ciliatus (Mitchill, 1818)	Fringed filefish
Monacanthus tuckeri Bean, 1906	Slender filefish
Stephanolepis setifer (Bennett, 1831)	Pygmy filefish
Mugilidae	**Mullets**
Mugil curema Valenciennes, 1836	White mullet
Mullidae	**Goatfishes**
Mulloidichthys martinicus (Cuvier, 1829)	Yellow goatfish
Pseudupeneus maculatus (Bloch, 1793)	Spotted goatfish
Muraenidae	**Moray eels**
Echidna catenata (Bloch, 1795)	Chain moray
Gymnothorax funebris Ranzani, 1839	Green moray
Gymnothorax miliaris (Kaup, 1856)	Goldentail moray
Gymnothorax moringa (Cuvier, 1829)	Spotted moray
Gymnothorax vicinus (Castelnau, 1855)	Purplemouth moray
Myliobatidae	**Eagle rays**
Aetobatus narinari (Euphrasen, 1790)	Spotted eagle ray
Narcinidae	**Numbfishes**
Narcine bancroftii (Griffith & Smith, 1834)	Lesser electric ray
Ogcocephalidae	**Batfishes**
Dibranchus atlanticus Peters, 1876	Atlantic batfish
Ophichthidae	**Snake eels**
Myrichthys breviceps (Richardson, 1848)	Sharptail eel
Ophichthus ophis (Linnaeus, 1758)	Spotted snake eel
Ophidiidae	**Cusk eels**
Neobythites elongatus Nielsen & Retzer, 1994	N/A
Opistognathidae	**Jawfishes**
Opistognathus aurifrons (Jordan & Thompson, 1905)	Yellowhead jawfish
Opistognathus macrognathus Poey, 1860	Banded jawfish
Ostraciidae	**Trunkfishes**
Acanthostracion polygonius Poey, 1876	Honeycomb cowfish
Acanthostracion quadricornis (Linnaeus, 1758)	Scrawled cowfish
Lactophrys bicaudalis (Linnaeus, 1758)	Spotted trunkfish
Lactophrys trigonus (Linnaeus, 1758)	Trunkfish
Rhinesomus triqueter (Linnaeus, 1758)	Smooth trunkfish
Paralichthyidae	**Sand flounders**
Citharichthys cornutus (Günther, 1880)	Horned whiff
Parazenidae	**Dories**
Cyttopsis rosea (Lowe, 1843)	Rosy dory
Pempheridae	**Sweepers**
Pempheris schomburgkii Muller & Troschel, 1848	Glassy sweeper
Pentanchidae	**Catsharks**
Apristurus canutus Springer & Heemstra, 1979	Hoary catshark
Galeus antillensis Springer, 1979	Antilles catshark
Percophidae	**Duckbills**
Bembrops ocellatus Thompson & Suttkus, 1998	Ocellate duckbill
Bembrops quadrisella Thompson & Suttkus, 1998	Saddleback duckbill
Peristediidae	**Armored searobins**
Peristedion truncatum (Günther, 1880)	Black armored searobin

Polymixiidae	**Beardfishes**
Polymixia lowei Günther, 1859	Beardfish
Pomacanthidae	**Angelfishes**
Centropyge argi Woods & Kanazawa, 1951	Pygmy Angelfish
Holacanthus ciliaris (Linnaeus, 1758)	Queen angelfish
Holacanthus tricolor (Bloch, 1795)	Rock beauty
Pomacanthus arcuatus (Linnaeus, 1758)	Gray angelfish
Pomacanthus paru (Bloch, 1787)	French angelfish
Pomacentridae	**Damselfishes**
Abudefduf saxatilis (Linnaeus, 1758)	Sergeant major
Abudefduf taurus (Müller & Troschel, 1848)	Night sergeant
Chromis cyanea (Poey, 1860)	Blue Chromis
Chromis insolata (Cuvier, 1830)	Sunshine fish
Chromis multilineata (Guichenot, 1853)	Brown Chromis
Microspathodon chrysurus (Cuvier, 1830)	Yellowtail damselfish
Stegastes adustus (Troschel, 1865)	Dusky damselfish
Stegastes diencaeus (Jordan & Rutter, 1897)	Longfin damselfish
Stegastes leucostictus (Müller & Troschel, 1848)	Beaugregory
Stegastes partitus (Poey, 1868)	Bicolor damselfish
Stegastes planifrons (Cuvier, 1830)	Three spot damselfish
Stegastes xanthurus (Poey, 1860)	Cocoa damselfish
Priacanthidae	**Bigeyes**
Heteropriacanthus cruentatus (Lacepède, 1801)	Glasseye snapper
Priacanthus arenatus Cuvier, 1829	Atlantic Bigeye
Rhincodontidae	**Whale sharks**
Rhincodon typus Smith, 1828	Whale shark
Scaridae	**Parrotfishes**
Cryptotomus roseus Cope, 1871	Bluelip parrotfish
Scarus coeruleus (Edwards, 1771)	Blue Parrotfish
Scarus guacamaia Cuvier, 1829	Rainbow parrotfish
Scarus iseri (Bloch, 1789)	Striped parrotfish
Scarus taeniopterus Lesson, 1829	Princess parrotfish
Scarus vetula Bloch & Schneider, 1801	Queen parrotfish
Sparisoma atomarium (Poey, 1861)	Greenblotch parrotfish
Sparisoma aurofrenatum (Valenciennes, 1840)	Redband parrotfish
Sparisoma chrysopterum (Bloch & Schneider, 1801)	Redtail parrotfish
Sparisoma radians (Valenciennes, 1840)	Bucktooth parrotfish
Sparisoma rubripinne (Valenciennes, 1840)	Redfin parrotfish
Sparisoma viride (Bonnaterre, 1788)	Stoplight parrotfish
Sciaenidae	**Drums**
Equetus lanceolatus (Linnaeus, 1758)	Jackknife fish
Equetus punctatus (Bloch & Schneider, 1801)	Spotted drum
Pareques acuminatus (Bloch & Schneider, 1801)	High-hat
Umbrina coroides Cuvier, 1830	Sand drum
Scombridae	**Tunas and mackerels**
Acanthocybium solandri (Cuvier, 1832)	Wahoo
Euthynnus alletteratus (Rafinesque, 1810)	Little tunny
Katsuwonus pelamis (Linnaeus, 1758)	Skipjack tuna
Scomberomorus cavalla (Cuvier, 1829)	King mackerel
Scomberomorus regalis (Bloch, 1793)	Cero
Thunnus atlanticus (Lesson, 1830)	Blackfin tuna
Scorpaenidae	**Scorpionfishes**
Pterois miles (Bennett, 1828)	Devil firefish
Pterois volitans (Linnaeus, 1758)	Red lionfish
Scorpaena plumieri Bloch, 1789	Spotted scorpionfish
Setarches guentheri Johnson, 1862	Deepwater scorpionfish

Serranidae	**Groupers**
Alphestes afer (Bloch, 1793)	Mutton Hamlet
Cephalopholis cruentata (Lacepède, 1802)	Graysby
Cephalopholis fulva (Linnaeus, 1758)	Coney
Epinephelus adscensionis (Osbeck, 1765)	Rock hind
Epinephelus guttatus (Linnaeus, 1758)	Red hind
Epinephelus striatus (Bloch, 1792)	Nassua grouper
Hypoplectrus chlorurus (Cuvier, 1828)	Yellowtail Hamlet
Hypoplectrus guttavarius (Poey, 1852)	Shy hamlet
Hypoplectrus nigricans (Poey, 1852)	Black Hamlet
Hypoplectrus puella (Cuvier, 1828)	Barred Hamlet
Hypoplectrus unicolor (Walbaum, 1792)	Butter hamlet
Liopropoma rubre Poey, 1861	Peppermint bass
Mycteroperca interstitialis (Poey, 1860)	Yellowmouth grouper
Mycteroperca tigris (Valenciennes, 1833)	Tiger grouper
Mycteroperca venenosa (Linnaeus, 1758)	Yellowfin grouper
Paranthias furcifer (Valenciennes, 1828)	Atlantic Creolefish
Rypticus bistrispinus (Mitchill, 1818)	Freckled soapfish
Rypticus saponaceus (Bloch & Schneider, 1801)	Greater soapfish
Serranus baldwini (Evermann & Marsh, 1899)	Lantern Bass
Serranus flaviventris (Cuvier, 1829)	Twinspot bass
Serranus phoebe Poey, 1851	Tattler
Serranus tabacarius (Cuvier, 1829)	Tobaccofish
Serranus tigrinus (Bloch, 1790)	Harlequin bass
Serranus tortugarum Longley, 1935	Chalk bass
Sparidae	**Porgies**
Calamus bajonado (Bloch & Schneider, 1801)	Jolthead porgy
Calamus calamus (Valenciennes, 1830)	Saucereye porgy
Calamus pennatula Guichenot, 1868	Pluma porgy
Sphyraenidae	**Barracudas**
Sphyraena barracuda (Edwards, 1771)	Great barracuda
Sphyraena borealis DeKay, 1842	Northern sennet
Sphyrnidae	**Hammerhead sharks**
Sphyrna mokarran (Rüppell, 1837)	Great hammerhead
Squalidae	**Dogfishes**
Squalus mitsukurii Jordan & Snyder, 1903	Shortspine spurdog
Syngnathidae	**Seahorses and pipefishes**
Bryx dunckeri (Metzelaar, 1919)	Snub-nosed pipefish
Cosmocampus albirostris (Kaup, 1856)	Whitenose pipefish
Hippocampus reidi Ginsburg, 1933	Longsnout sea horse
Synodontidae	**Lizardfishes**
Synodus foetens (Linnaeus, 1766)	Inshore lizardfish
Synodus intermedius (Spix & Agassiz, 1829)	Sand diver
Synodus synodus (Linnaeus, 1758)	Red lizardfish
Trachinocephalus myops (Forster, 1801)	Snakefish
Tetraodontidae	**Pufferfishes**
Canthigaster rostrata (Bloch, 1786)	Sharpnose pufferfish
Sphoeroides nephelus (Goode & Bean, 1882)	Southern pufferfish
Sphoeroides spengleri (Bloch, 1785)	Bandtail pufferfish
Trachichthyidae	**Roughies**
Hoplostethus occidentalis Woods, 1973	Western roughy
Triacanthodidae	**Spikefishes**
Hollardia hollardi Poey, 1861	Reticulate spikefish
Tripterygiidae	**Triplefins**
Enneanectes jordani (Evermann & Marsh, 1899)	Mimic triplefin
Enneanectes pectoralis (Fowler, 1941)	Redeye triplefin

Molluscs of St. Eustatius

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Introduction

Molluscs are one of the largest phyla in the animal kingdom. They make up a large part of marine faunas worldwide (Appeltans et al. 2012), and have a considerable presence on land and in freshwater. During the Statia Marine Expedition 2015, we hoped to contribute significantly to expanding the understanding of the molluscan fauna of the Dutch Caribbean island of St. Eustatius. The main goal of the present research was to produce an inventory of the fauna, with the primary emphasis being marine molluscs. Another major goal of the investigation was obtaining DNA subsamples of soft tissue from live individuals of a number of marine mollusc species. This will enable subsequent molecular analysis and DNA barcoding.

The malacofauna of St. Eustatius had been investigated to some extent before the 2015 expedition. Coomans (1958) listed 40 marine gastropods and Kaas (1972) reported on eight polyplacophorans based on material collected by Wagenaar Hummelinck in 1949 (Wagenaar Hummelinck 1977). Hewitt (2015) recorded 183 marine mollusc species based on her own collections and those of others from 2000 to 2011. In addition, 15 species of terrestrial gastropods were reported by Vernhout (1914), Haas (1960, 1962), Hovestadt (1980), and Van der Valk (1987).

In the 2015 survey, we attempted to find as many mollusc species as possible from each field station. The voucher material (marine and non-marine) consists of dry specimens (shells) and alcohol-preserved material. This material will be deposited in the reference collection of Naturalis Biodiversity Center in Leiden.

Materials and methods

Marine molluscs. Three expedition members made up a shore team: two citizen-scientist malacologists (the authors of this report) and one algologist. The malacologists focused on finding marine molluscs or their shells within the littoral zone. However, St. Eustatius is a volcanic island, and much of the rocky coastline is inaccessible from land where it consists of high cliffs. Other parts of the coastline consist of beaches made of black volcanic sand. In all, 19 field trips were made to the coastline at 15 localities (shore stations EUX 101–119). These sites were located on nearly every accessible stretch of shore, and included four out of the five field stations visited by Wagenaar Hummelinck in 1949 and 1963 (Wagenaar Hummelinck 1977). No timely permission was obtained to visit Tumble Down Dick Bay, where the oil pipeline of the Nustar Energy L.P. Company comes ashore.

At each coastal field station live animals were sampled from rocks and water depths of up to 50 cm. Empty shells were collected from beach drift. Wherever possible, rocks were turned over to find molluscs living underneath them. Live molluscs were found in the littoral zone and also in the supralittoral zone (never submerged but influenced by wave splash and salt spray). At two sheltered localities live molluscs were collected by snorkelling.

Individuals of some species were photographed in situ or in the laboratory. Empty shells were stored dry; a few shells containing dead material were stored in alcohol. Live-collected specimens were stored in alcohol and a number of these were subsampled for DNA studies.

For the species lists (Tables 1–2) the binomial nomenclature is taken from the World Register of Marine Species (WoRMS Editorial Board 2015) and MolluscaBase (2016); the taxonomic sequences of families follow those of Bouchet et al. (2005) for gastropods and of Bouchet et al. (2010) for bivalves, updated by MolluscaBase (2016).

Fig. 1 Atlantic coast, general view north of Corre Corre Bay

Fig. 2 Searching beach drift at Lynch Beach (shore station EUX 105)

Fig. 3 Shells from Twin Sisters (diving station EUX 032)

The other expedition members were scuba-diving scientists who worked in the subtidal zone, mainly up to a depth of 30 m (field stations EUX 001–040). Mollusc material collected by them during dives included live animals and empty shells. Occasionally they took underwater photographs, mostly of live molluscs. In addition, during laboratory investigations of material collected underwater, small molluscs were discovered in sediment, algae, and in one case on a sea cucumber. Since many molluscs in the sublittoral zone seldom or never wash ashore, the contributions of the dive team added substantially to the species list of marine molluscs.

Land molluscs. Land molluscs data was collected from 10 terrestrial stations (EUX 200–210). Large species were located via inspection. For smaller species, samples of leaf litter and soil were dried, sieved and sorted. Some gardens in the town of Oranjestad were inspected for large species, and residents were questioned about the presence of snails or slugs.

Freshwater molluscs. The expedition took place during an extended period of severe drought. No natural freshwater habitat was available: no water in any ravines or gullies was observed. A bucket pulled up from a well with ground water near Venus Bay (EUX 111) did not contain any molluscs. An empty shell of a freshwater gastropod was found in an artificial pond which had completely dried out (EUX 200).

DNA. For molecular studies, tissue subsamples were taken from 128 live specimens of 55 species, of which 52 are marine and three are terrestrial. The overall total of 128 includes 30 subsamples taken by other expedition members. All subsampled specimens were photographed and stored in alcohol. The results of the DNA analysis (using the mitochondrial gene cytochrome c oxidase 1, aka CO1) will be published through the international DNA barcode database BOLD, available online at (http://www.boldsystems.org/).

Results

Marine molluscs. A total of 309 marine species, belonging to 99 families, was recorded (Table 1). Of these, nearly 50% (147 species) had not previously been reported for St. Eustatius. Fig. 4 shows our totals for each molluscan class, and the number of those that were new records for the island. Out of the overall total of 309 species, 99 were found as living animals, and another 47 were found as empty shells in very fresh condition. Even just before the end of the expedition, marine species that had previously not been recorded for the island were found on a daily basis (Fig. 5). This implies that the marine mollusc fauna of St. Eustatius may consists of many more species than discovered during the three-week expedition. Table 1 contains a list of the marine mollusc species found during the expedition. Some identifications require a considerable amount of research, such as those of the micromolluscs, and are not yet final or complete. Newly recorded species are marked with an asterisk.

Land and freshwater molluscs. The survey of non-marine molluscs was limited in scope, both by the fact that the main focus of the present study was marine molluscs, and by the extreme drought encountered during the expedition.

Previously, the land snails of St. Eustatius were investigated by Vernhout (1914), who published a list of six species from the island. Haas (1960, 1962), in overviews of the families Vertiginidae, Subulinidae, and Oleacinidae from the Caribbean, reported eight species from Statia. Breure (1974) reported three species of Bulimulidae in his overview of that family. Hovestadt (1980) published a list of 13 species, based on the literature and his own observations. Van der Valk (1987) published a list of 15 fossil and Holocene land molluscs that were found during archeological excavations on St. Eustatius. His list included 15 species and some additional taxa which were not identified to species level. In total, 15 species of land snails have previously been reported from the island, none of which were endemic.

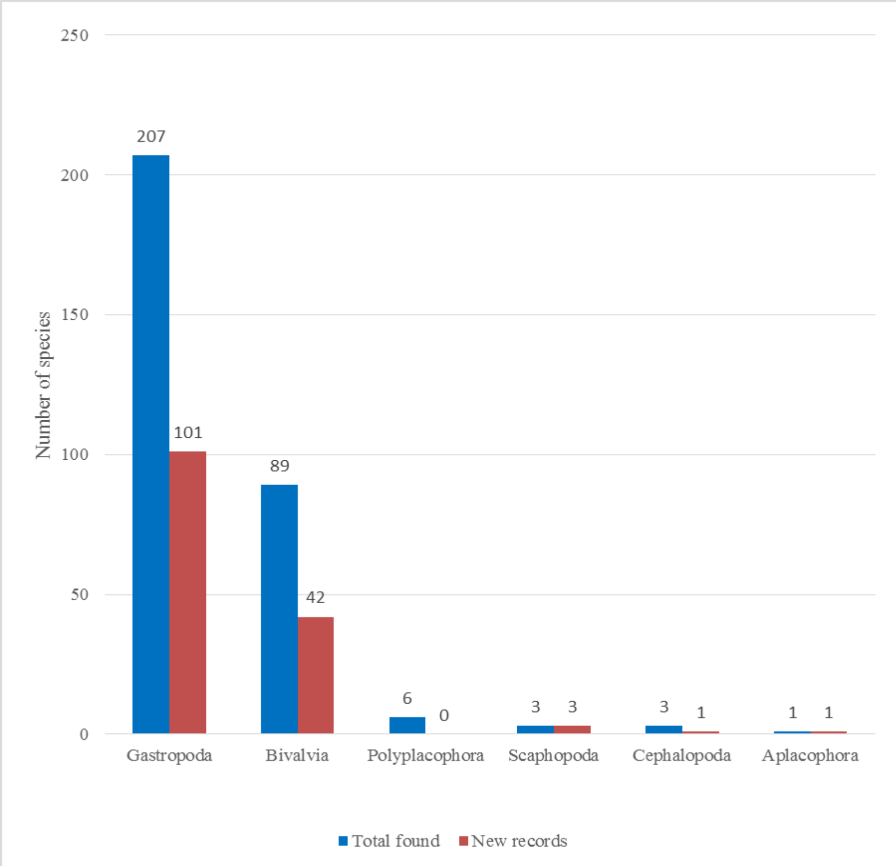

Fig. 4 Total number of mollusc species (by class) and the number of new records for St. Eustatius

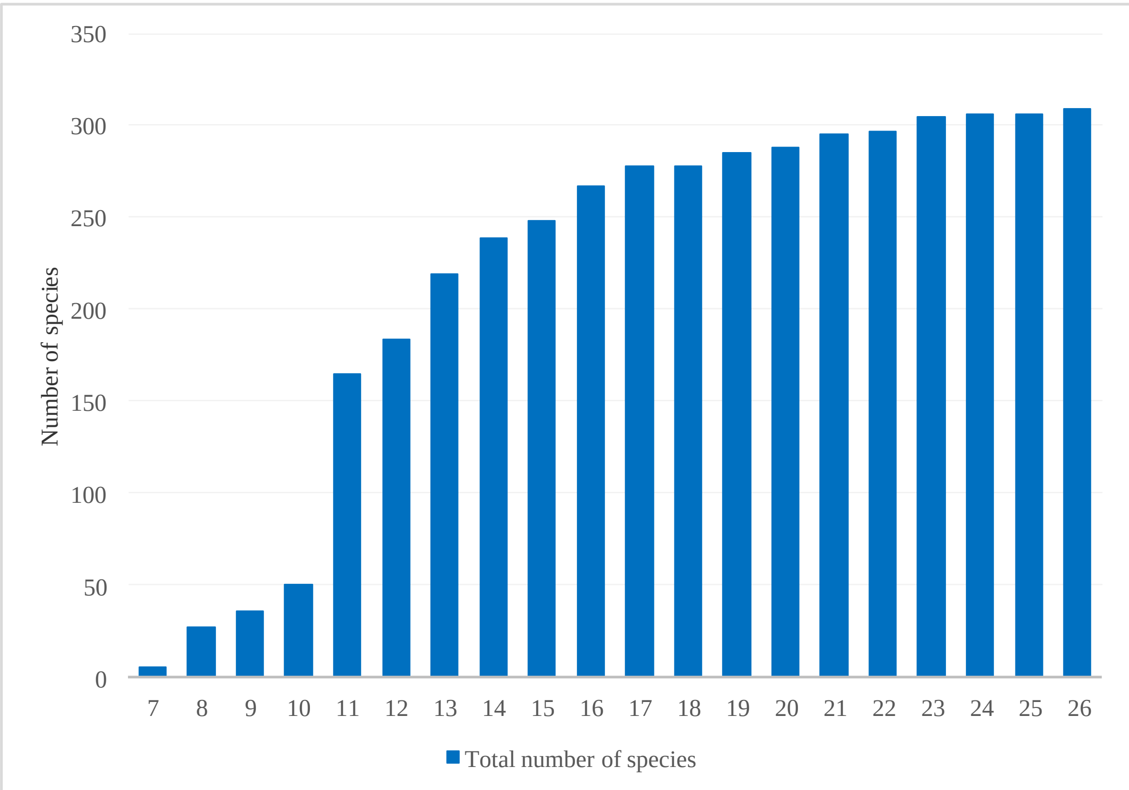

Fig. 5 Cumulative number of species found per survey day, numbered by date in the month of June 2015

Fig. 6 Gastropoda. **a**Three species of littorinids: *Echinolittorina zicac* (four, large, pale), *Echinolittorina tuberculata* (with nodules: one juvenile on the upper right and one very small juvenile on the lower left) and *Echinolittorina angustior* (the majority) on a rock at the north end of Oranje Bay (EUX 106);
b *Nerita versicolor* at Oranjestad Bay (shore station EUX 116); **c** *Nerita tessellata* and *Echinolittorina meleagris* at Oranjestad Bay (EUX 106)

During the present expedition, 22 land snail species were observed (Table 2). Seven of these represented new records for St. Eustatius (Table 2). Twenty species are also known from other Caribbean islands, but this is uncertain for the two species that could not yet be identified to the species level.

No previous records of freshwater molluscs are known from St. Eustatius. The field station list of Wagenaar Hummelinck (1981) contains several freshwater localities on Statia, but the mollusc results of these stations – if any - are not published. Even in years with normal amounts of rainfall, most of the island is dry, and much of its surface area consists of steep slopes. Although water runs through numerous ravines after rainstorms, there are very few naturally formed freshwater habitats that hold water during the whole year. During the expedition one aquatic mollusc species was found in a dried-out artificial pond in the Botanical Garden. During future surveys, it would be interesting to investigate the private water cisterns on the island, which was not done in the present study.

Two species of land snail previously been reported from St. Eustatius were not found during the expedition. *Bulimulus guadaloupensis* (Brugière, 1789) was reported by Breure (1974) and Hovestadt (1980). *Lacteoluna selenina* (Gould, 1848) was reported by Hovestadt (1980). Because fieldwork on land molluscs was not a priority, it is uncertain whether these species still live on the island or not.

Conclusions

For marine molluscs, the expedition succeeded in adding at least 147 additional taxa to the known fauna of St. Eustatius. This is an increase of nearly 80%. However, the total number of marine taxa will further increase, since the species list of the expedition is not complete yet. Numerous rare species were encountered and range extensions for several of the more uncommon Caribbean species were recorded. The number of records for taxa that were underrepresented in previous lists (Coomans 1958; Hewitt 2015) — shell-less species, minute species, and subtidal species (< 40 m deep) — was increased by more than 80%. When comparisons are made of the species lists from individual marine field stations, these may yield valuable information on the species diversity across the shallow-water habitats surrounding St. Eustatius, and using the present baseline, these areas can now be monitored for changes over time.

For non-marine molluscs, eight species were added to the presently known fauna of the island. This represents a > 50% increase in the number known to live on St. Eustatius.

The results of the DNA analysis will be made available when ready. The authors are currently working on publications which will include more detailed results on both marine and non-marine molluscs. Because of the relative ease with which new species records were added, right up to the end of the expedition, we believe that both the marine and non-marine mollusc faunal lists for St. Eustatius can be expanded further. It is our hope that future investigations will be carried out.

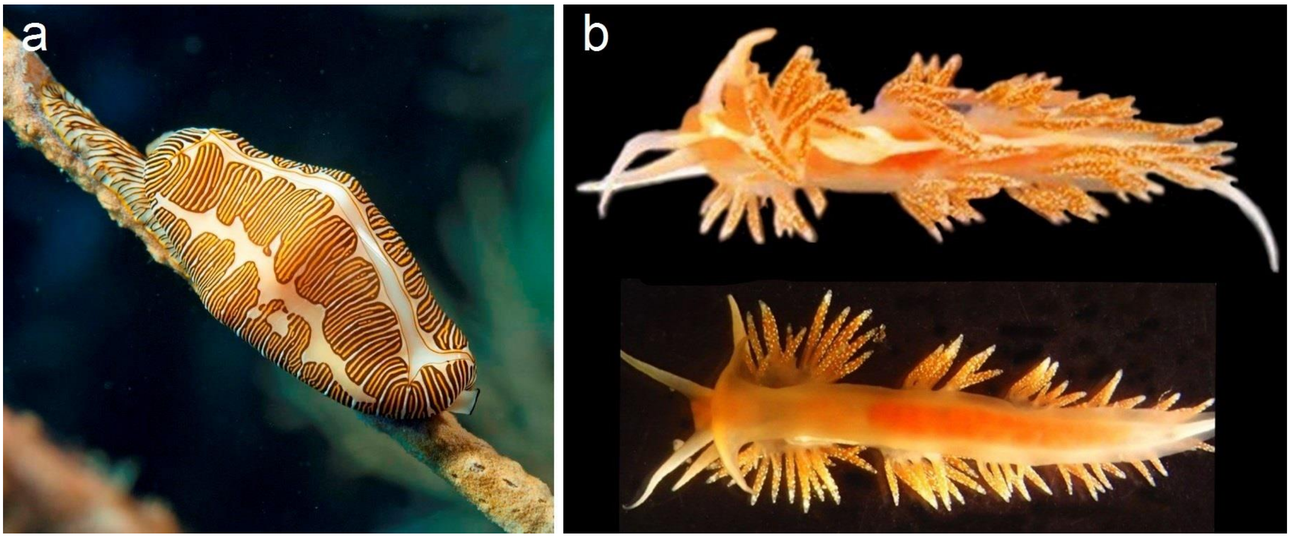

Fig. 7 Gastropoda. **a** *Cyphoma signatum* at Blairs Reef (EUX 019; photo: M. Haarsma); **b** *Flabellina verta* at North end of Oranje Bay (EUX 013; photographs: L.M. van der Loos and S. van Leeuwen, images arranged by A. DuPont)

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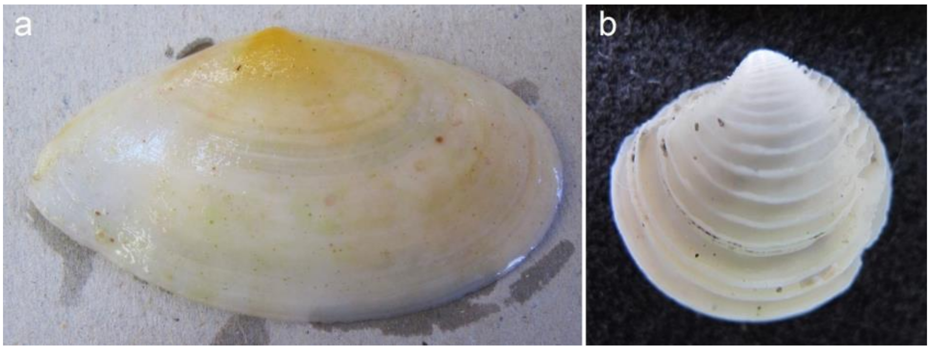


Fig. 8 Bivalvia. **a** Left valve of *Laciolina magna* from Twin Sisters (EUX 032); **b** Left valve of *Pleurolucina hendersoni* from The Blocks (EUX 015, max 17 m depth)

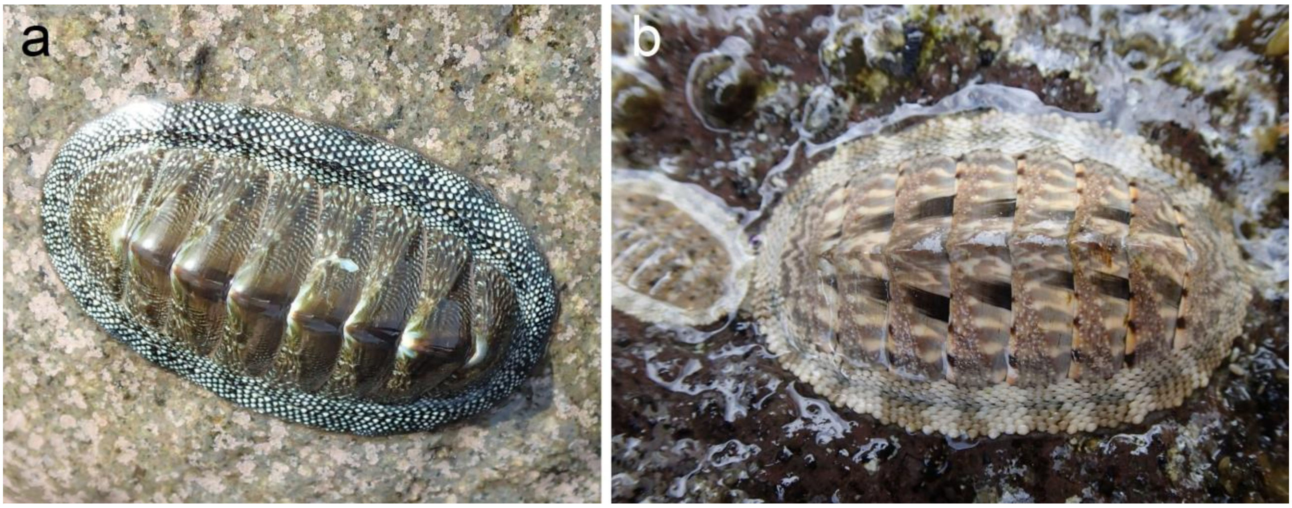


Fig. 9 Polyplacophora. **a** *Chiton tuberculatus* at Oranjestad Bay (EUX 106); **b** *Chiton squamosus* at Zeelandia Bay (EUX 108)

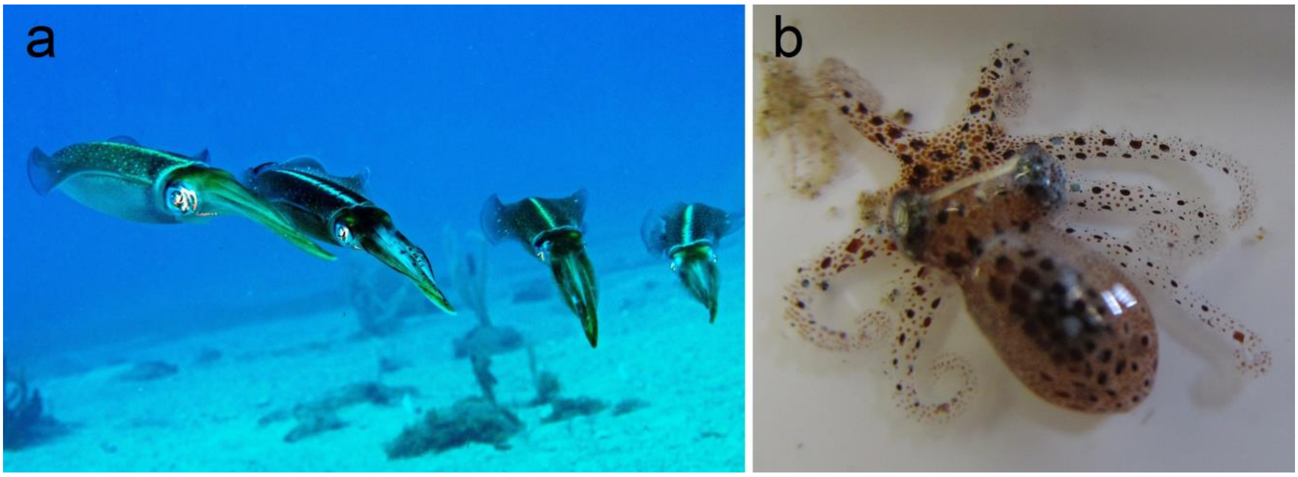


Fig. 10 Cephalopoda. **a** *Sepioteuthis sepioidea* at Triple wreck (EUX 002; photo: M. Haarsma); **b** Juvenile *Octopus* sp. from Twin Sisters (EUX 032)

Fig. 11 *Helicina fasciata* on a tree (EUX 208)

Fig 12. Queen conch shells (EUX 116)

Table 1 Preliminary list of marine molluscs observed during the Statia Marine Biodiversity Expedition, 2015.
* = new record for St. Eustatius

CLASS Gastropoda

SUBCLASS Patellogastropoda

Eoacmaeidae

Eoacmaea pustulata (Helbling, 1779)

Lottiidae

Lottia albicosta (C.B. Adams, 1845)
Lottia antillarum G.B. Sowerby I, 1834
Lottia cubensis (Reeve, 1855)

SUBCLASS Vetigastropoda

Fissurellidae

Diodora arcuata (G.B. Sowerby II, 1862)
Diodora listeri (d'Orbigny, 1847)
* *Diodora variegata* (G.B. Sowerby II, 1862)
Diodora viridula (Lamarck, 1822)
Fissurella angusta (Gmelin, 1791)
Fissurella barbouri Pérez Farfante, 1943
Fissurella nimbosa (Linnaeus, 1758)
Fissurella nodosa (Born, 1778)
Fissurella punctata Pérez Farfante, 1943
Fissurella rosea (Gmelin, 1791)
Hemimarginula dentigera (Heilprin, 1889)
* *Hemimarginula pumila* (A. Adams, 1852)
Hemitoma octoradiata (Gmelin, 1791)
* *Lucapina philippiana* (Finlay, 1930)
* *Lucapina suffusa* (Reeve, 1850)

Tegulidae

Cittarium pica (Linnaeus, 1758)
Tegula excavata (Lamarck, 1822)
* *Tegula fasciata* (Born, 1778)
Tegula hotessieriana (d'Orbigny, 1842)
Tegula lividomaculata (C.B. Adams, 1845)

*** Trochidae**

* *Synaptocochlea picta* (d'Orbigny, 1847)

*** Areneidae**

* *Arene tricarinata* (Stearns, 1872)
* *Arene venustula* Aguayo & Rehder, 1936

Calliostomatidae

Calliostoma jujubinum (Gmelin, 1791)

Turbinidae

* *Turbo canaliculatus* (Hermann, 1781)
Lithopoma caelatum (Gmelin, 1791)
* *Lithopoma phoebium* (Röding, 1798)
Lithopoma tectum (Lightfoot, 1786)
Lithopoma tuber (Linnaeus, 1758)

Phasianellidae

* *Eulithidium adamsi* (Philippi, 1853)
* *Eulithidium affine* (C.B. Adams, 1850)
* *Eulithidium bellum* (M. Smith, 1937)
* *Eulithidium thalassicola* (Robertson, 1958)

SUBCLASS Neritimorpha

ORDER Cycloneritimorpha

Neritidae

Nerita peloronta Linnaeus, 1758
Nerita tessellata Gmelin, 1791
Nerita versicolor Gmelin, 1791
Smaragdia viridis (Linnaeus, 1758)

SUBCLASS Caenogastropoda

ORDER Incertae sedis 1

Cerithiidae

* *Bittiolium varium* (Pfeiffer, 1840)
Cerithium cf eburneum Bruguière, 1792
Cerithium litteratum (Born, 1778)

Modulidae

Modulus modulus (Linnaeus, 1758)

Planaxidae

Angiola lineata (da Costa, 1778)
* *Fossarus ambiguus* (Linnaeus, 1758)
Supplanaxis nucleus (Bruguière, 1789)

Turritellidae

Turritella exoleta (Linnaeus, 1758)

ORDER Littorinimorpha

Cypraeidae

Erosaria acicularis (Gmelin, 1791)
Luria cinerea (Gmelin, 1791)
Macrocypraea zebra (Linnaeus, 1758)

Ovulidae

* *Cymbovula acicularis* (Lamarck, 1811)
Cyphoma gibbosum (Linnaeus, 1758)
* *Cyphoma mcgintyi* Pilsbry, 1939
Cyphoma signatum Pilsbry & McGinty, 1939

Littorinidae

Cenchritis muricatus (Linnaeus, 1758)
Echinolittorina angustior (Mörch, 1876)
Echinolittorina meleagris (Potiez & Michaud, 1838)
* *Echinolittorina mespillum* (Muhlfeld, 1824)
Echinolittorina tuberculata (Menke, 1828)
Echinolittorina zicac (Gmelin, 1791)

Naticidae

Naticarius canrena (Linnaeus, 1758)
* *Polynices hepaticus* (Röding, 1798)
Polinices lacteus (Guilding, 1834)
* *Sinum perspectivum* (Say, 1831)
Stigmaulax sulcatus (Born, 1778)

* **Rissoidae**
  * Rissoidae sp. A
  * Rissoidae sp. B
Rissoinidae
  * *Phosinella pulchra* (C.B. Adams, 1850)
  Rissoina sp.
  * *Zebina browniana* (d'Orbigny, 1842)
  Zebina sp.
  Rissoinidae spp.
*** Caecidae**
  * *Caecum* cf. *donmoorei* Mitchell-Tapping, 1979
  * *Caecum regulare* Carpenter, 1858
  * *Meioceras cornucopiae* Carpenter, 1858
Strombidae
  Lobatus costatus (Gmelin, 1791)
  Lobatus gallus (Linnaeus, 1758)
  Lobatus gigas (Linnaeus, 1758)
  Lobatus raninus (Gmelin, 1791)
  Strombus pugilis Linnaeus, 1758
Tonnidae
  * *Tonna galea* (Linnaeus, 1758)
  Tonna pennata (Mörch, 1853)
Bursidae
  Bursa rhodostoma (G.B. Sowerby II, 1835)
Ranellidae
  Charonia variegata (Lamarck, 1816)
  Monoplex aquatilis (Reeve, 1844)
  * *Monoplex nicobaricus* (Röding, 1798)
  Monoplex pilearis (Linnaeus, 1758)
  * *Septa occidentalis* (Mörch, 1877)
  * *Turritriton labiosus* (Wood, 1828)
Cassidae
  Cassis flammea (Linnaeus, 1758)
  Cassis tuberosa (Linnaeus, 1758)
  Cypraecassis testiculus (Linnaeus, 1758)
*** Vanikoridae**
  * Vanikoridae sp.
Hipponicidae
  Cheilea equestris (Linnaeus, 1758)
  Hipponix antiquatus (Linnaeus, 1767)
  Hipponix incurvus (Gmelin, 1791)
  Hipponix subrufus (Lamarck, 1822)
Triviidae
  * *Dolichupis leucosphaera* (Schilder, 1931)
  Niveria quadripunctata (J.E. Gray, 1827)
  Niveria suffusa (J.E. Gray, 1827)
  Pusula pediculus (Linnaeus, 1758)
Vermetidae
  Dendropoma corrodens (d’Orbigny, 1841)
  * *?Petaloconchus* sp.
  Thylacodes decussatus (Gmelin, 1791)

Thylacodes riisei Mörch, 1862
Vermetidae spp.

*** Eulimidae**

* *Parvioris* sp. B (Redfern 2013: photo 333B, p. 119)

ORDER Incertae sedis 2

Epitoniidae

* *Cycloscala echinaticosta* (d'Orbigny, 1842)

*** Triphoridae**

* Triphoridae sp. A
* Triphoridae sp. B
* Triphoridae sp. C
* Triphoridae sp. D

*** Cerithiopsidae**

* Cerithiopsidae sp.
* *Seila* sp.

ORDER Neogastropoda

Buccinidae

* *Bailya parva* (C.B. Adams, 1850)
* *Engina turbinella* (Kiener, 1836)
Gemophos auritulus (Link, 1807)
Gemophos tinctus (Conrad, 1846)
Pisania pusio (Linnaeus, 1758)

Colubrariidae

* *Colubraria testacea* (Mörch, 1854)

Columbellidae

* *Astyris lunata* (Say, 1826)
Columbella mercatoria (Linnaeus, 1758)
* *Columbellopsis nycteis* (Duclos, 1846)
* *Conella ovulata* (Lamarck, 1822)
Mitrella ocellata (Gmelin, 1791)
Nitidella nitida (Lamarck, 1822)
* *Rhombinella laevigata* (Linnaeus, 1758)
* *Steironepion moniliferum* (G.B. Sowerby I, 1844)
Zafrona pulchella (Blainville, 1829)

Fasciolariidae

Leucozonia nassa (Gmelin, 1791)
Leucozonia ocellata (Gmelin, 1791)
Polygona infundibulum (Gmelin, 1791)

Nassariidae

* *Nassarius* cf. *antillarum* (d'Orbigny, 1847)

Muricidae

Coralliophila erosa (Röding, 1798)
* *Coralliophila galea* (Dillwyn, 1823)
* *Dermomurex* cf. *alabastrum* (A. Adams, 1864)
* *Favartia cellulosa* (Conrad, 1846)
* *Morula nodulosa* (C.B. Adams, 1845)
* *Muricopsis rosea* (Reeve, 1846)
* *Phyllonotus pomum* (Gmelin, 1791)
Plicopurpura patula (Linnaeus, 1758)
Stramonita rustica (Lamarck, 1822)
Vasula deltoidea (Lamarck, 1822)

Costellariidae
* *Vexillum dermestinum* (Lamarck, 1811)
* *Vexillum laterculatum* (Sowerby II, 1874)

Harpidae
Morum oniscus (Linnaeus, 1767)

Cystiscidae
* *Gibberula* sp.
* *Persicula pulcherrima* (Gaskoin, 1849)

Marginellidae
* *Eratoidea hematita* (Kiener, 1834)
* *Granulina ovuliformis* (d'Orbigny, 1842)
* *Granulina* sp.
Volvarina cf. *avena* (Kiener, 1834)
Volvarina cf. *ardovinii* Cossignani, 1997

Mitridae
Mitra barbadensis (Gmelin, 1791)
Mitra nodulosa (Gmelin, 1791)

Turbinellidae
Vasum globulus (Lamarck, 1816)

Olividae
Americoliva reticularis (Lamarck, 1811)
Oliva scripta Lamarck, 1811

Olivellidae
* *Olivella exilis* (Marrat, 1871)
* *Olivella acteocina* Olsson, 1956

Conidae
* *Conasprella mindana* (Hwass in Bruguière, 1792)
Conus daucus Hwass in Bruguière, 1792
* *Conus ermineus* Born, 1778
Conus mus Hwass in Bruguière, 1792
Conus regius Gmelin, 1791
Conus spurius Gmelin, 1791

Drillidae
* *Decoradrillia pulchella* (Reeve, 1845)

Horaiclavidae
* *Buchema* sp.

Mangeliidae
* *Brachycythara* sp.
* *Tenaturris* sp.

Pseudomelatomidae
* *Pilsbryspira* sp.

Terebridae
* *Hastula hastata* (Gmelin, 1791)
Impages cinerea (Born, 1778)

*** Cancellariidae**
* *Bivetopsia rugosa* (Lamarck, 1822)

SUBCLASS **Heterobranchia**

Architectonicidae
* *Heliacus cylindricus* (Gmelin, 1791)

*** Pyramidellidae**
* *Pseudoscilla babylonia* (C.B. Adams, 1845)

* *Pyramidella dolabrata* (Linnaeus, 1758)
* *Pyramidellidae* sp. A
* *Pyramidellidae* sp. B

INFRACLASS Opisthobranchia

ORDER Cephalaspidea

Bullidae

Bulla occidentalis A. Adams, 1850

*** Haminoeidae**

* *Atys caribaeus* (d'Orbigny, 1841)
* *Haminoea* sp.

*** Gastropteridae**

* *Gastropteron* sp.

*** Retusidae**

* Retusidae sp. A
* Retusidae sp. B

ORDER Runcinacea

*** Runcinidae**

* *Runcina* sp.

ORDER Thecosomata

*** Cavoliniidae**

* *Diacavolinia* cf. *deblainvillei* van der Spoel, Bleeker & Kobayasi, 1993
* *Diacavolinia deshayesi* van der Spoel, Bleeker & Kobayasi, 1993

ORDER Anaspidea

*** Aplysiidae**

* *Petalifera ramosa* Baba, 1959

ORDER Sacoglossa

Plakobranchidae

Elysia crispata Mörch, 1863

* *Elysia marcusi* (Ev. Marcus, 1972)
* *Elysia ornata* (Swainson, 1840)

ORDER Nudibranchia

*** Chromodorididae**

* *Doriprismatica sedna* (Ev. Marcus & Er. Marcus, 1967)
* *Felimida clenchi (*Russell, 1935)

*** Dotidae**

* *Doto* sp. A on algae
* *Doto* sp. B on rock

*** Tethydidae**

* *Melibe arianeae* Espinoza, Dupont & Valdés, 2013

*** Flabellinidae**

* *Flabellina verta* (Ev. Marcus, 1970)

*** Tergipedidae**

* *Cuthona barbadiana* Edmunds & Just, 1983

*** Facelinidae**

* *Learchis evelinae* Edmunds & Just, 1983

*** Aeolidiidae**

* *Berghia creutzbergi* Er. Marcus & Ev. Marcus, 1970

SUBCLASS Heterobranchia

INFRACLASS Pulmonata

Ellobiidae

Melampus coffea (Linnaeus, 1758)
Melampus monile (Bruguière, 1789)
* *Microtralia ovulum* (Pfeiffer, 1840)
Tralia ovula (Bruguière, 1789)

CLASS Bivalvia

SUBCLASS Pteriomorphia

ORDER Mytilida

Mytilidae

Brachidontes exustus (Linnaeus, 1758)
Modiolus americanus (Leach, 1815)

ORDER Arcida

Arcidae

Acar domingensis (Lamarck, 1819)
Anadara hemidesmos (Philippi, 1845)
Anadara notabilis (Röding, 1798)
Arca imbricata Bruguière, 1789
Arca zebra (Swainson, 1833)
Barbatia cancellaria (Lamarck, 1819)
Barbatia candida (Helbling, 1779)
Fugleria tenera (C.B. Adams, 1845)

Glycymerididae

Glycymeris decussata (Linnaeus, 1758)
Glycymeris undata (Linnaeus, 1758)
Tucetona pectinata (Gmelin, 1791)
* *Tucetona* sp.

Noetiidae

Arcopsis adamsi (Dall, 1886)

*** Philobryidae**

* Philobryidae sp.

ORDER Ostreida

Pteriidae

Isognomon bicolor (C.B. Adams, 1845)
Isognomon radiatus (Anton, 1838)
Pteria colymbus (Röding, 1798)

*** Malleidae**

* *Malleus candeanus* (d'Orbigny, 1853)

Pinnidae

Pinna carnea Gmelin, 1791

Ostreidae

Dendostrea frons (Linnaeus, 1758)
* *Ostrea equestris* Say, 1834

Gryphaeidae

Hyotissa mcgintyi (Harry, 1985)

ORDER Pectinida

*** Anomiidae**

* *Pododesmus* sp.

Pectinidae

* *Antillipecten antillarum* (Récluz, 1853)
* *Argopecten nucleus* (Born 1778)
* *Caribachlamys mildredi* (Bayer, 1941)
Caribachlamys ornata (Lamarck, 1819)
* *Caribachlamys pellucens* (Linnaeus, 1758)
Caribachlamys cf sentis (Reeve, 1853)
* *Euvola ziczac* (Linnaeus, 1758)
* *Laevichlamys multisquamata* (Dunker, 1864)

Spondylidae

Spondylus tenuis Schreibers, 1793

Plicatulidae

Plicatula gibbosa Lamarck, 1801

ORDER Limida

Limidae

Ctenoides mitis (Lamarck, 1807)
Ctenoides scaber (Born, 1778)
Lima caribaea d'Orbigny, 1853
* *Limaria pellucida* (C.B. Adams, 1848)
* *Limatula* sp.

SUBCLASS Heterodonta

INFRACLASS Euheterodonta

ORDER Lucinida

Lucinidae

Cavilinga blanda (Dall in Dall & Simpson 1901)
* *Clathrolucina costata* (d'Orbigny, 1846)
Codakia orbicularis (Linnaeus, 1758)
Ctena orbiculata (Montagu, 1808)
* *Divalinga dentata* (Wood, 1815)
* *Divalinga quadrisulcata* (d'Orbigny, 1846)
Lucina pensylvanica (Linnaeus, 1758)
* *Parvilucina crenella* (Dall, 1901)
* *Pleurolucina hendersoni* Britton, 1972

ORDER Carditida

*** Crassatellidae**

* *Crassinella lunulata* (Conrad, 1834)

Cardiidae

Acrosterigma magnum (Linnaeus, 1758)
* *Americardia guppyi* (Thiele, 1910)
* *Americardia media* (Linnaeus, 1758)
Laevicardium serratum (Linnaeus, 1758)
* *Papyridea semisulcata* (J.E. Gray, 1825)
Papyridea soleniformis (Bruguière, 1789)
* *Trachycardium egmontianum* (Shuttleworth, 1856)
* *Trachycardium isocardia* (Linnaeus, 1758)

SUPERORDER Imparidentia

Chamidae

Chama congregata Conrad, 1833
Chama florida Lamarck, 1819
* *Chama macerophylla* Gmelin, 1791
Chama sarda Reeve, 1847

Chama sinuosa Broderip, 1835
Pseudochama cristella (Lamarck, 1819)
*** Galeommatidae**
* *Divariscintilla* sp.
*** Montacutidae**
* *Planktomya henseni* Simroth, 1896
ORDER Cardiida
Tellinidae
Arcopagia fausta (Pulteney, 1799)
* *Laciolina magna* Spengler, 1798
* *Strigilla mirabilis* (Philippi, 1841)
* *Tellina gouldii* Hanley, 1846
* *Tellina radiata* Linnaeus, 1758
* *Tellinella listeri* Röding, 1798
* Tellinidae spp.
*** Psammobiidae**
* *Gari circe* (Mörch, 1876)
Semelidae
* *Cumingia lamellosa* G.B. Sowerby I, 1833
Ervilia sp.
* *Semele bellastriata* (Conrad, 1837)
Semele proficua (Pulteney, 1799)
ORDER Venerida
Veneridae
Callista maculata (Linnaeus, 1758)
* *Chione cancellata* (Linnaeus, 1767)
Chioneryx pygmaea (Lamarck, 1818)
* *Globivenus rigida* (Dillwyn 1817)
* *Gouldia cerina* (C.B. Adams, 1845)
Lirophora paphia (Linnaeus, 1767)
Petricola lapicida (Gmelin, 1791)
Tivela trigonella (Lamarck, 1818)
* *Transennella gerrardi* Abbott, 1958
* *Transennella* sp.
ORDER Myida
*** Corbulidae**
* Corbulidae sp.

CLASS Polyplacophora
SUBCLASS Neoloricata
ORDER Chitonida
SUBORDER Chitonina
Callistoplacidae
Ceratozona squalida (C.B. Adams, 1845)
Chitonidae
Acanthopleura granulata (Gmelin, 1791)
Chiton marmoratus Gmelin, 1791
Chiton squamosus Linnaeus, 1764
Chiton tuberculatus Linnaeus, 1758
Ischnochitonidae
Ischochitonidae sp.

CLASS * Scaphopoda
ORDER Dentaliida
*** Dentaliidae**
* Dentaliidae sp.
* ? *Graptacme* sp.
ORDER Gadilida
*** Gadilidae**
* *Polyschides* sp.

CLASS Cephalopoda
SUBCLASS Coleoidea
ORDER Myopsida
Loliginidae
Sepioteuthis sepioidea (Blainville, 1823)
ORDER Octopoda
Octopodidae
Octopus vulgaris Cuvier, 1797
ORDER Spirulida
Spirulidae
Spirula spirula (Linnaeus, 1758)

CLASS * Aplacophora
? Family
* "aplacophoran" sp.

Table 2 Preliminary list of non-marine molluscs observed during the Statia Marine Biodiversity Expedition, 2015. * = new record for St. Eustatius.

Terrestrial

CLASS Gastropoda
SUBCLASS Neritimorpha
ORDER Cycloneritimorpha
Helicinidae
Helicina fasciata Lamarck, 1822
* *Lucidella plicatula* (Pfeiffer, 1848)
SUBCLASS Heterobranchia
INFRACLASS Pulmonata
*** Ferrussaciidae**
* *Karolus consobrinus* (d'Orbigny, 1841)
ORDER Stylommatophora
*** Achatinidae**
* *Achatina fulica* (Ferussac, 1821)
Subulinidae
Allopeas gracile (Hutton, 1834)
Allopeas micra (d'Orbigny, 1835)
Beckianum beckianum (Pfeiffer, 1846)
Obeliscus swiftianus (Pfeiffer, 1852)
Opeas pumilum (Pfeiffer, 1840)
Subulina octona (Bruguiere, 1789)

SUBORDER Orthurethra

Pupillidae

Pupoides albilabris (C.B. Adams, 1841)

Vertiginidae

Gastrocopta barbadensis (Pfeiffer, 1853)

Gastrocopta servilis (Gould, 1843)

* *Pupisoma dioscoricola* (C.B. Adams, 1845)

Pupisoma macneillii (Clapp, 1918)

SUBORDER Sigmurethra

*** Euconulidae**

* *Guppya gundlachi* (Pfeiffer, 1839)

*** Gastrodontidae**

* *Zonitoides arboreus* (Say, 1817)

Orthalicidae

Bulimulus diaphanus fraterculus (Potiez & Michaud, 1835)

Drymaeus virgulatus (Ferussac, 1822)

Oxychilidae

Oxychilidae sp.

Sagdidae

Hojeda spec

* *Hyalosagda subaquila* (Shuttleworth, 1854)

Aquatic

CLASS Gastropoda

SUBCLASS Heterobranchia

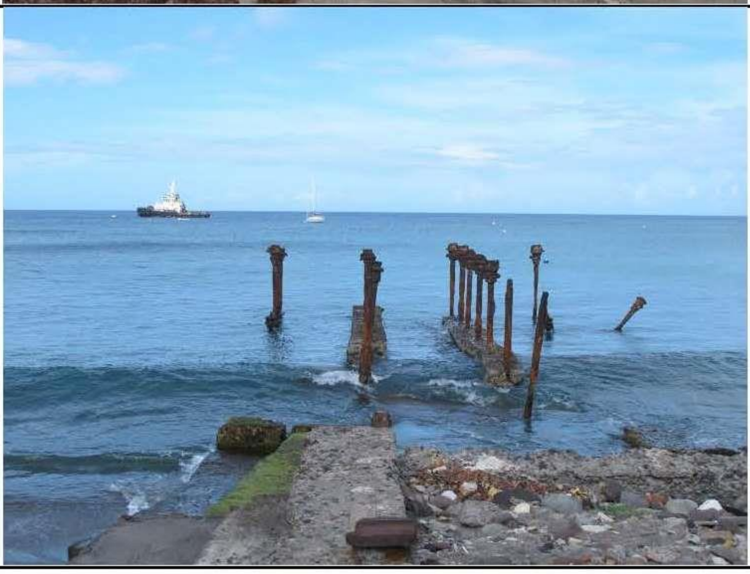
INFRACLASS Pulmonata

ORDER Hygrophila

*** Planorbidae**

* *Helisoma duryi* (Wetherby, 1879)

Table 3 Coastal localities mollusc surveys

EUX 101 -- Zeelandia Bay, Atlantic side, 7 June. Long exposed sand beach. The mollusc team had not arrived yet; the rest of the expedition team found no mollusc material on this date.	
EUX 102 -- Lynch Beach, Atlantic side, 8 June. First visit. Rock cobble beach with one dynamic sandy area, protected by a rock reef. Living molluscs on the rocks, small shells in the sandy area.	
EUX 103 -- Old Pier, Oranje Bay, Caribbean side, 10 June. The remains of the old town pier with concrete walls below the water surface. Sand beach. Living molluscs on the concrete structures, and empty shells on the sand.	

EUX 104 – Gallows Bay near Crooks Castle ruins, Caribbean side, 11 June. A small sand beach on rocky coast right next to a ravine, just south of the "castle" ruins. Living molluscs on the rocks, and many small empty shells on the sand.	
EUX 105 -- Lynch Beach, Atlantic side, 13 June. Rock cobble beach, partly protected by a rock reef. On this second visit there were three small sandy areas instead of one large one.	
EUX 106 -- Groyne, small jetty in Oranjestad Bay, Caribbean side, 14 June. Rocks and small sandy areas. The stone jetty is visible on the right of this image. Living molluscs on the rocks of the jetty and on rocks along the shore, empty shells on the sand.	

EUX 107 -- Corre Corre Bay, Atlantic side, 15 June. Rocks in sheltered bay (rock reef visible near the horizon at the left side of the photo). Living molluscs on the rocks and empty shells on the rocky beach.	
EUX 108 -- Zeelandia Bay, Atlantic side, 16 June. First visit by the mollusc team. Long sand beach with *Sargassum.* Living molluscs on rocks at the north end. Shells on sand above high tide level. Shells of terrestrial species found washed out onto the beach from a gully (just left of this photo).	
EUX 109 -- "Baby Beach", Oranje Bay, Caribbean side, 16 June. A small sheltered sand beach immediately north of the port jetty, with a concrete boat-launching ramp. Used as a safe-swimming area. Many small shells on the sand.	

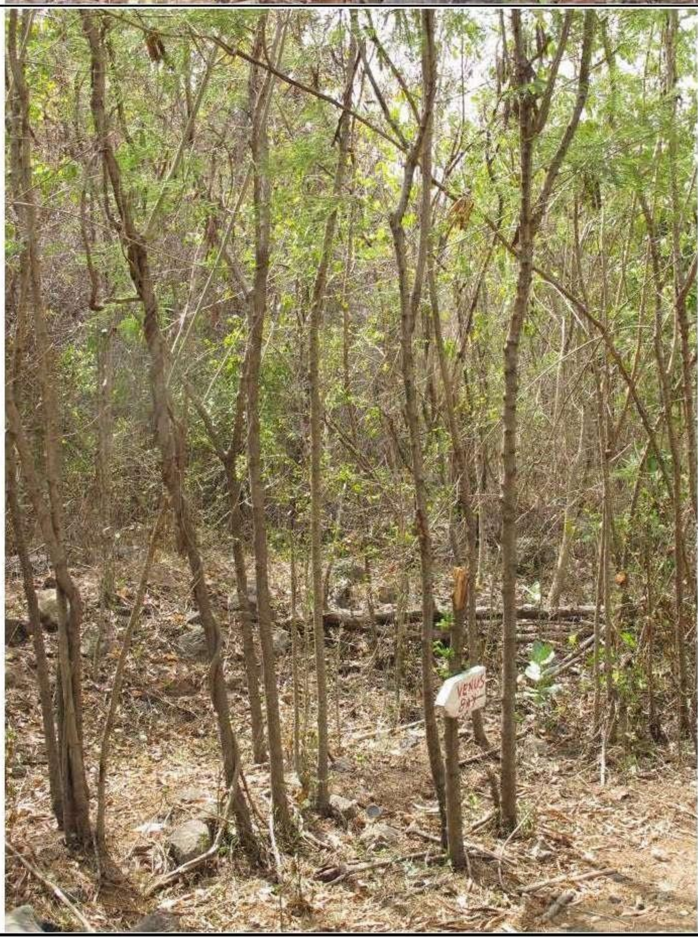
EUX 110 -- Gallows Bay, near Crooks Castle ruins at both sides, Caribbean side, 16 June. Gravel and rocks beach. All of the coastline from the access point south of the port to past the ruins, including the small sand beach just south of the "castle" ruins. Many shells between rocks and on gravel.	
EUX 111 -- Venus Bay, Atlantic side, June 19. Rock and boulder beach. Live molluscs on rocks and some shells between the boulders.	
EUX 112 -- Lynch Beach, Atlantic side, 20 June. Third visit. Rock cobble beach with one dynamic sandy area, protected by a rock reef. On this day, the sand was back in just one area, as was the case on the first visit. Small shells in the sand.	

EUX 113 -- North end of Oranje Bay, Caribbean side, 21 June. Sand beach with rocks and ruins. Living molluscs on the ruins and empty shells on the sand.	
EUX 114 -- Billy's Gut, Caribbean side, 21 June. Sand beach with rocks and ruins. Living molluscs on the ruins and empty shells on the sand.	
EUX 115 -- Platform in Billy's Gut, Caribbean side, 21 June. Platform area in the mouth of the gully, with old shells in sand, perhaps as kitchen deposits. The arrow shows the platform.	

EUX 116 -- Fishermen & boat pier, Caribbean side, 21 June. Concrete pier and rocky coast where conch shells are dumped by fishers. Living molluscs on the boat pier**.**	
A closer view of the shell dump.	
EUX 117 -- South of Corre Corre Bay, Atlantic side, 23 June. Rocks in high littoral zone, rough waves. Living molluscs on the rocks and empty shells on the rock beach.	

EUX 118 -- Jenkins Bay, Caribbean side, 24 June. A steep beach of large round boulders. In 1949, Wagenaar Hummelinck was able to reach this bay on foot. We swam from a boat to shore. Living molluscs on the boulders and in a very small tidal rock pool.	
EUX 119 -- Lynch Beach, Atlantic side, 25 June. Fourth visit. Rock cobble beach with only one dynamic sandy area, less sand than during the first and third visits. This shows the location of the rock reef in shallow water where the waves break, allowing sand to accumulate on shore.	

Table 4 Non-marine localities mollusc surveys

EUX 200 -- Botanical Garden, 15 June. In a dried-out ornamental pond. Altitude: 75 m.	**EUX 201 -- Toby's Gut**, 17 June. A gully in the forest north of the road, with some bromeliads on the trees. Altitude: 100 m
EUX 202 -- Boven National Park, north slope, 19 June. Under large trees on the way to Venus Bay, northern slope. Altitude: 100 m.	
EUX 203 -- Boven National Park, 19 June. A small wood of *Leucaena* trees along the path to Venus Bay. Altitude: 75 m.	

EUX 204 -- Boven National Park entrance. 19 June. Dry shrubs, spiny Acacia trees and rocks. Altitude: 50 m.	
EUX 205 -- The Quill southwestern slope, 20 June. Beside the path through the forest between entrance and viewpoint. Altitude: 150-325 m.	
EUX 206 -- The Quill, west slope, 20 June. Beside path through forest between viewpoint and crater rim. Altitude: 325-400 m.	

	
EUX 207 -- The Quill, **crater bottom.** 20 June. Rainforest with large trees, rocks and Giant Philodendron, *Philodendron giganteum.* Altitude: 300 m.	

<table>
<tr><td></td><td></td></tr>
<tr><td>EUX 208 -- The Quill, southsouthwestern slope, 20 June. Deciduous forest beside trail around the Quill.
Altitude: 300-350 m.</td><td>
</td></tr>
<tr><td>EUX 209 -- The Quill, above White Wall, 20 June. Deciduous forest beside trail around the Quill, with some calcareous outcrops.
Altitude: 250-350 m.</td><td>EUX 210 -- Oranjestad, James S. Rhoda Road, 25 June. Garden with ornamental plants.
Altitude: 50 m.</td></tr>
</table>

Marine (meta) barcoding of St. Eustatius

Arjen G.C.L. Speksnijder [1], Frank R. Stokvis [1]

[1]Naturalis Biodiversity Center, P.O. Box 9517, 2300 RA Leiden, The Netherlands

Introduction

The aim of the Dutch barcoding project is to assess the Dutch biodiversity and to create a collection of fully identified specimens that is backed up by DNA analysis and high resolution photography. The DNA analysis consist of barcoding and phylogenetic analysis of representative genes to support taxonomic classification. Up to now, a DNA collection of 80.000 specimens has been established and more than 20.000 species have been barcoded (Beentjes et al. 2015). The aim is to contribute to the worldwide genetic database for biodiversity (www.boldsystems.org). This Barcoding of Life Database (BOLD) currently consists of around 4.6 million animal sequences, representing over 170.000 species. The BOLD database functions as a repository for (newly) described species connected to DNA barcodes. The database is suitable for (environmental) DNA approaches to monitor biodiversity at different trophic levels.

To develop our knowledge about Dutch biodiversity in the overseas territories, we performed a barcoding project embedded in the baseline biodiversity surveys of St. Eustatius. Tissue samples were collected and DNA was isolated for molecular analyses. Barcode sequences were determined from selected specimens for a DNA sequence reference database of the biodiversity of the island. This will be the groundwork for a DNA monitoring tool, which can be applied to environmental impact studies. Protocols for collecting were already well developed for the European Netherlands (www.science.naturalis.nl/en/labs-services/services/dna-barcoding-lab/) but were adapted to the Caribbean Netherlands by direct involvement of researchers for collection, subsampling and taxonomic classification.

Metabarcoding of environmental DNA enables us to detect “hidden” biodiversity and cryptic species(Leray et al. 2014). We want to target total macro fauna community in sediment and water column at St. Eustatius and implementing the specimen barcoding data in an identification pipeline.

Macro fauna including corals can carry a core microbiome which is shared amongst them (Yang et al. 2013). This enables us to use the microbial composition as a support for taxonomical classification of cryptic species, but also as an indication of the ecological function of the host. Thus, targeted sampling of marine macro fauna species for microbial community analysis was performed.

Methods

All marine specimens were kept on ice directly after field sampling to prevent DNA degradation. Specimens were transferred to an air conditioned laboratory and subsampled the same day. The laboratory was equipped with tools for a minimal cross-contamination workflow. Zoological subsamples were transferred to tubes filled with 96% ethanol, botanical subsamples to tubes with silica gel. The remaining voucher specimens were preserved where possible. One or more photographs were taken of each specimen. Collection registration code, taxon, identifier, collector, collection date, country, location, area and coordinates were recorded for each specimen. DNA extraction and barcode sequencing was performed at the Naturalis DNA Barcoding Facility. Results were submitted to the BOLD database.

Water column and sediment samples were taken at each site for eDNA analysis of macro fauna. DNA was extracted from water filters and sediment samples. Whole community analyses of samples were performed by amplification of a 350 bp fragment of the cytochrome c oxidase subunit I gene (COI), using generic primers and subsequent next generation sequencing (Speksnijder et al.

2015). Sequences were matched against the BOLD database with the basic local alignment search tool (BLAST).

Sampling for microbial interaction was performed by sub-sampling from a number of copepod species. Microbial analysis was performed by rRNA barcoding. Whole bacterial community analyses of samples were performed by amplification of the 16S rRNA gene using generic primers and subsequent next generation sequencing. Sequence matching was performed against the Genbank database with BLAST.

Results

Table 1 Overview of collected specimens subsampled for barcoding

Group	Number of subsamples	Marker	Number of generated barcodes
Algae (red, brown, green)	424	UPA	211
		LSU	53
		LSU Y	138
		COI	72
		TufA	32
		rbcl	6
		matK	5
Octocorallia (soft corals)	190	COI	152
		ND6	146
		MSH	142
		28S	152
Mollusca (molluscs)	130	COI	99
Scleractinia (stony corals)	103	COI	54
Porifera (sponges)	95	not determined	0
Crustacea (crustaceans)	78	COI	48
Hydrozoa (hydroids)	66	COI	35
Tunicata (sea squirts)	43	COI	28
Zoantharia (encrusting anemones)	36	COI	31
Pisces (fish)	31	COI	29
Echinodermata (Echinoderms)	25	COI	2
Annelida (worms)	9	COI	4
Bryozoa (moss animals)	1	COI	0

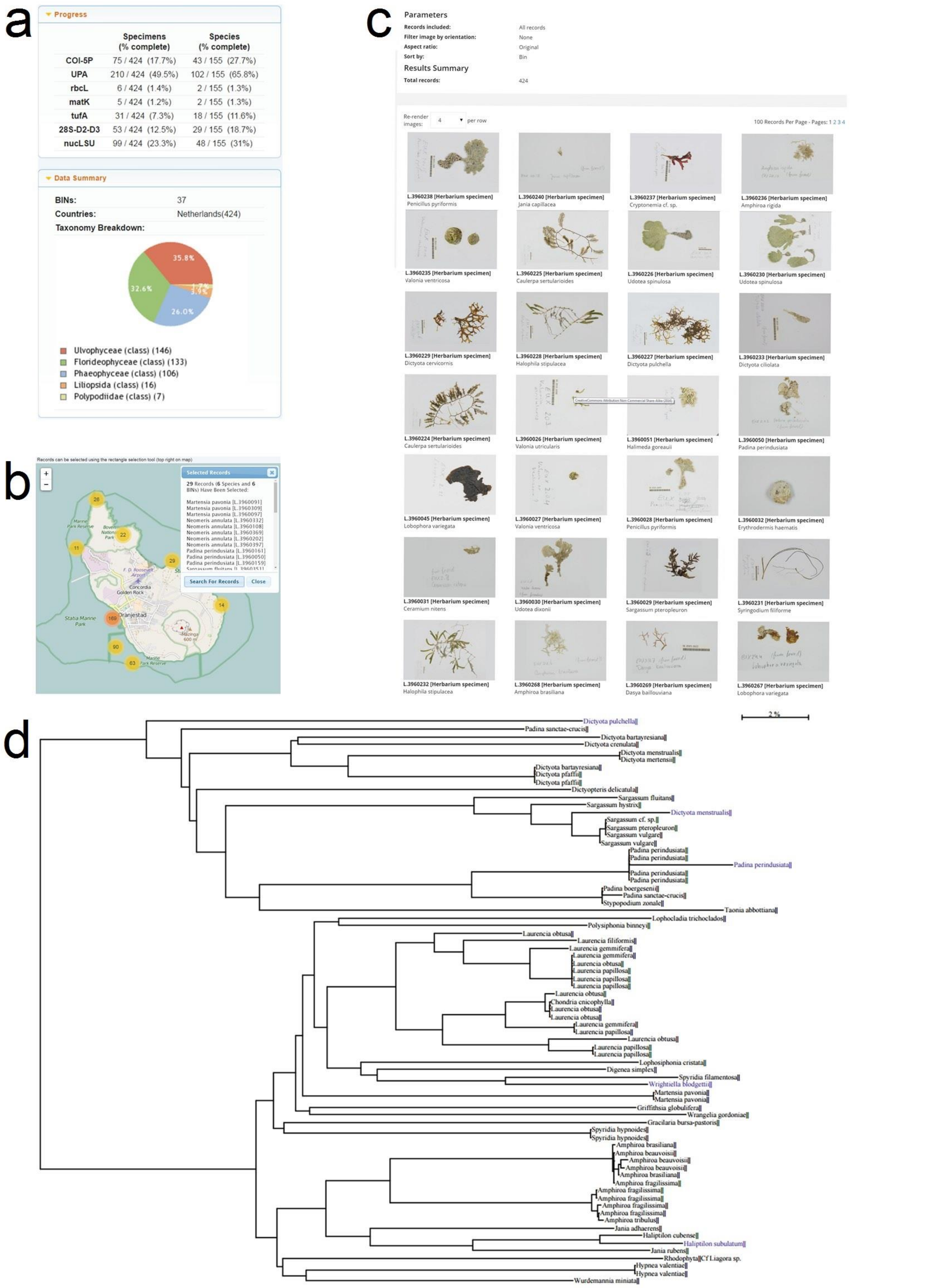


Fig. 1 Examples of interactive BOLD overviews of collected algae (coll. L.M. van der Loos). **a** Project overview. **b** Distribution map of specimens **c** Overview of voucher images. **d** Taxon tree based on the CO1 barcode.

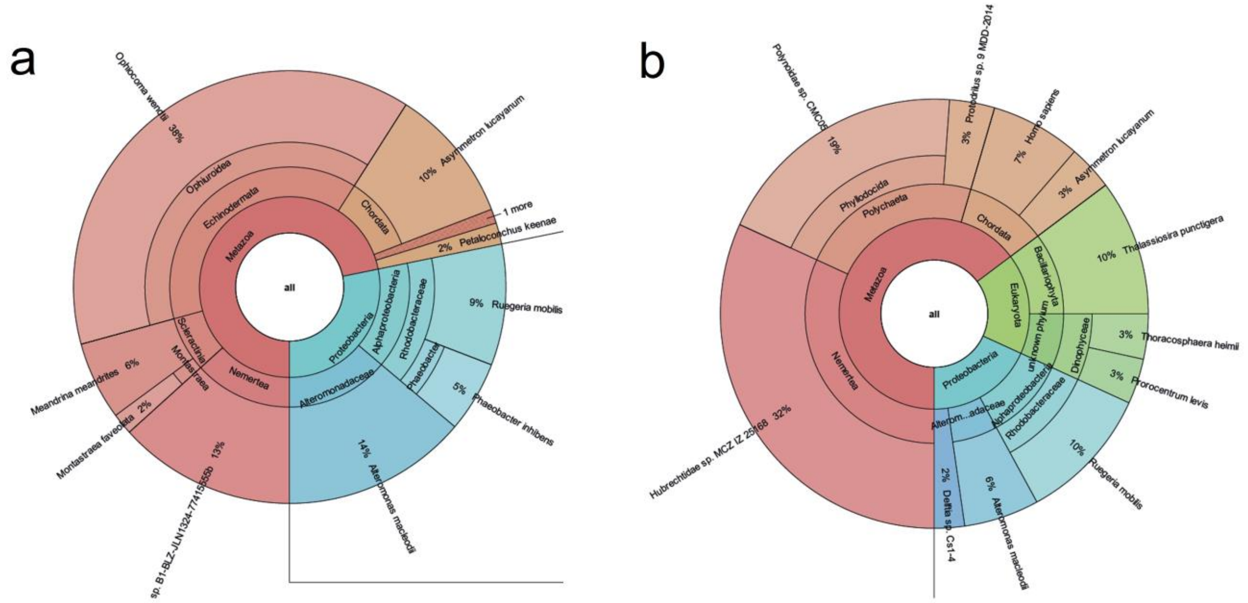


Fig. 2 Community composition of sediment samples taken from two dive sites (coll. R. Vonk) as determined by CO1 metabarcoding. **a** Sta. EUX 28. **b** Sta. EUX32.

Table 2 Non-exhaustive cumulative list of species hits by CO1 metabarcoding of sediment samples.

Kingdom	Phylum	Class	Order	Family	Species
Eukaryota	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira punctigera*
Eukaryota	Bacillariophyta	Bacillariophyceae	Bacillariales	Bacillariaceae	*Cylindrotheca closterium*
Eukaryota	unknown	Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia pacifica*
Eukaryota	Phaeophyceae	unknown class	Dictyotales	Dictyotaceae	*Lobophora littlerorum*
Eukaryota	Phaeophyceae	unknown class	Fucales	Sargassaceae	Sargassum vachellianum
Eukaryota	unknown	Florideophyceae	Gigartinales	Hypneaceae	*Hypnea stellulifera*
Metazoa	Echinodermata	Ophiuroidea	Ophiurida	Ophiocomidae	*Ophiocoma wendtii*
Metazoa	Chordata	Mammalia	Primates	Hominidae	*Homo sapiens*
Metazoa	Chordata	Actinopteri	Labriformes	Labridae	*Scarus taeniopterus*
Metazoa	Arthropoda	Malacostraca	Decapoda	Paguridae	*Pagurus prideaux*
Metazoa	Chordata	unknown class	unknown order	Branchiostomidae	*Asymmetron lucayanum*
Metazoa	Nemertea	Palaeonemertea	unknown order	Hubrechtidae	Hubrechtidae sp.
Metazoa	Cnidaria	Anthozoa	Scleractinia	Meandrinidae	*Meandrina meandrites*
Metazoa	Nemertea	Enopla	Monostilifera	Tetrastemmatidae	*Tetrastemma* sp.
Metazoa	Annelida	Polychaeta	Phyllodocida	Hesionidae	*Neogyptis fauchaldi*
Metazoa	Annelida	Polychaeta	Phyllodocida	Polynoidae	Polynoidae sp. CMC05
Metazoa	Cnidaria	Anthozoa	Scleractinia	Merulinidae	*Orbicella faveolata*

Conclusions

During the expedition the Dutch DNA barcoding program was implemented into a tropical marine expedition involving staff researchers and citizen scientists. New barcodes of identified species were added to the BOLD database (Table 1). The barcode data can help to identify cryptic or unknown species and describe new species. Macro fauna community profiling will be possible from collected sediment and water column samples. This implies a great potential for monitoring programs and food web analysis, although the preservation of the samples was not optimal and not all of them were successfully analyzed. We were able to profile microbial communities from copepod samples after preparation and DNA isolation by a copepod specialist (Fig. 3). This will give us more insight in ecological function and taxonomy of this diverse macro fauna group.

Future work

We will continue our barcoding program in future research projects at St. Eustatius and contribute to a dedicated DNA-based reference library which will support taxonomic and ecological research at the island. Optimization of our eDNA detection techniques in aquatic environments will take place trough a PhD program and will improve our knowledge about interactions between communities. An environmental impact study is proposed in transitional and nature conservation areas. An eDNA sample strategy can target marine sediments and the water column. DNA based biodiversity assessments can also be set up for human impact studies on fragile islands and coastal waters in general.

Acknowledgements The Dutch Barcoding Program is made possible with the Fund for Economic Structure Reinforcement (FES). DNA barcodes will be obtained and added to the public database The authors want to thank all expedition members for their efforts in collecting, photography, identification and subsampling.

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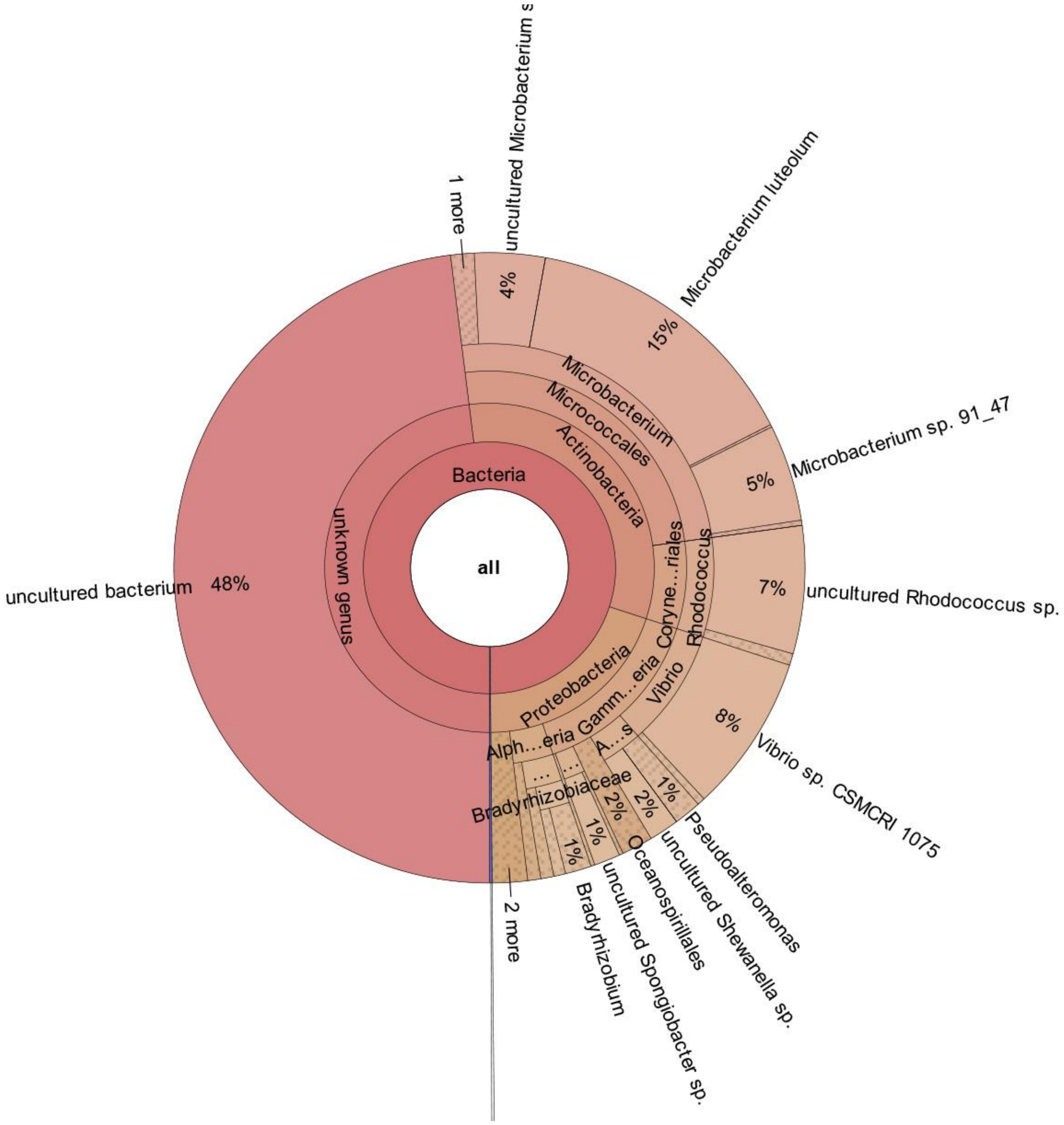

Fig. 3 Microbial composition of a lamippid copepod from *Gorgonia ventalina*, gall tissue (coll. V.N. Ivanenko).

Publications and reports Statia Marine Biodiversity Expedition 2015

Published / online

Garcia-Hernandez JE, Reimer JD, Hoeksema BW (2016) Sponges hosting the Zoantharia-associated crab *Platypodiella spectabilis* at St. Eustatius, Dutch Caribbean. Coral Reefs 35:209. Doi: 10.1007/s00338-015-1361-4

Garcia-Hernandez JE, Van Moorsel GWNM, Hoeksema BW (2016) Lettuce corals overgrowing tube sponges at St. Eustatius, Dutch Caribbean. Marine Biodiversity. Doi: 10.1007/s12526-016-0467-4

Hoeksema BW (2015) Met Naturalis in zee: Statia Marine Biodiversity Expedition 2015. Onderwatersport 47 (7):42-45

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Ivanenko VN, Nikitin MA, Hoeksema BW (2015) Multiple purple spots in the Caribbean sea fan *Gorgonia ventalina* caused by parasitic copepods at St. Eustatius, Dutch Caribbean. Marine Biodiversity. Doi: 10.1007/s12526-015-0428-3

Montano S, Galli P, Hoeksema BW (2016) First record from the Atlantic: a *Zanclea*-scleractinian association at St. Eustatius, Dutch Caribbean. Marine Biodiversity. Doi: 10.1007/s12526-015-0432-7

Montano S, Maggioni D, Galli P, Hoeksema BW (2016) A cryptic species in the *Pteroclava krempfi* species complex (Hydrozoa, Cladocorynidae) revealed in the Caribbean. Marine Biodiversity. Doi: 10.1007/s12526-016-0555-5

Van der Loos LM (2016) Macroalgal communities around the tropical island of St Eustatius - Combining ecology with phylogenetics. MSc thesis, University of Groningen.

Van der Loos LM, Prud'homme van Reine WF (2016) First Atlantic record of the green alga *Parvocaulis exiguus* from St. Eustatius, Dutch Caribbean. Marine Biodiversity. Doi: 10.1007/s12526-016-0494-1

Accepted

Davies MR, Piontek S (2016) The fishes of St. Eustatius. Marine Biodiversity.

Hewitt SJ, van Leeuwen S, Schrieken N (2016) New information on *Pleurolucina hendersoni* (Britton, 1972) (Bivalvia, Lucinidae) from the Dutch island of St. Eustatius, West Indies. Basteria.

Vonk R, Lau YW (2016) *Microcharon quilli*, a new asellote isopod crustacean from interstitial spaces in shallow coralline sands off St. Eustatius, Caribbean Netherlands. Marine Biodiversity.

Submitted

Hoeksema BW, van Beusekom M, ten Hove HA, Ivanenko VN, van der Meij SET, van Moorsel GWNM (subm.) *Helioseris cucullata* as a host coral at St. Eustatius, Dutch Caribbean. Marine Biodiversity.

Van der Loos LM, Prud'homme van Reine WF, Speksnijder A, Stokvis FR, Hoeksema BW (subm.) Beta diversity of macroalgal communities around St. Eustatius, Dutch Caribbean. Marine Biodiversity.

Participating organisations

Naturalis Biodiversity Center

https://science.naturalis.nl/en/research/systematic-research/marine-zoology/
https://www.facebook.com/zeeteam.naturalis

Stichting ANEMOON

http://www.anemoon.org/
https://www.facebook.com/groups/StAnemoonMOO/

CNSI
CARIBBEAN NETHERLANDS SCIENCE INSTITUTE

http://www.cnsi.nl/
https://www.facebook.com/pages/Caribbean-Netherlands-Science-Institute-at-St-Eustatius-CNSI/381662415272901

St. Eustatius National Parks

STENAPA
http://www.statiapark.org/
https://www.facebook.com/pages/Stenapa-St-Eustatius/203334299688441

SCUBAQUA
Dive Center St. Eustatius

http://www.scubaqua.com/
https://www.facebook.com/pages/Scubaqua-Dive-Centre

Appendix: Expedition blog Naturalis

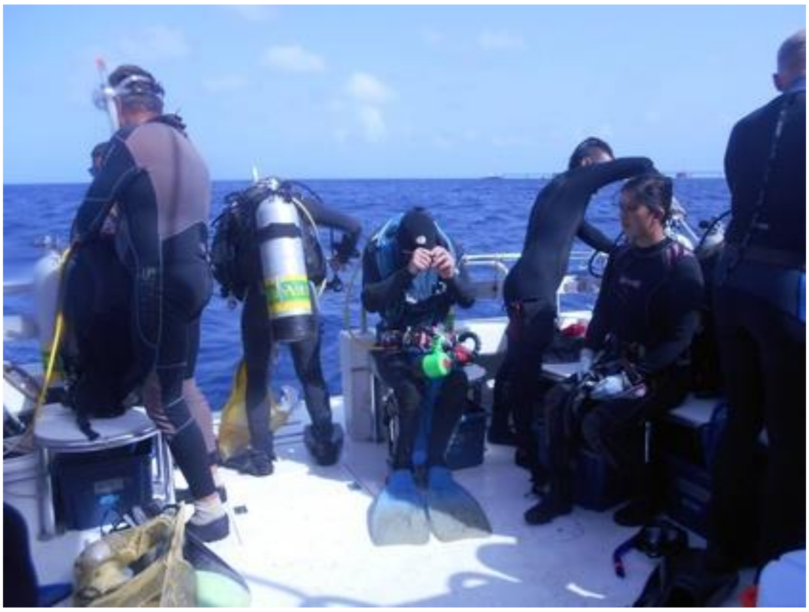
http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/statia-marine-expedition-2015-start/

Statia Marine Expedition 2015: the start

Posted on 17-06-2015 by Bert Hoeksema
St. Eustatius, affectionately called “Statia”, is a volcanic island in the northern Windward Group of the Lesser Antilles Islands in the Caribbean. Since 10 October 2010, Statia is a Dutch municipality in the Caribbean Netherlands. It is part of the Dutch Caribbean, which was previously known as the Netherlands Antilles. (Bert Hoeksema)

The marine fauna and flora of St. Eustatius is poorly investigated. There is some information available from old studies. For instance, the Dutch naturalist Dr. Wagenaar Hummelinck published data on four collection stations where he sampled marine specimens in 1949 besides some fresh and brackish water habitats on Statia.

Naturalis Biodiversity Center was involved in the organization of an expedition to the neighbouring Saba Bank in 1972, which included two sampling stations at the west coast of St. Eustatius. Samples have been deposited in the Naturalis research collections, where they are available for further research.



(Photo: Niels Schrieken)

Because a baseline study of Statia’s marine fauna and flora is needed, Naturalis Biodiversity Center is organizing a marine expedition to St. Eustatius in collaboration with ‘Anemoon Foundation’. The Caribbean Netherlands Science Institute (CNSI) acts as host by offering laboratory space and lodging at Statia. The St. Eustatius National Parks Foundation (STENAPA) is the local counterpart. The results will be made publicly available for local conservation efforts through scientific reports and publications, websites, and exhibits. Scubaqua is the local dive center assisting in diving logistics.

The goals of the expedition are to examine the composition and distribution patterns of species in order to investigate (a) marine species that are widely spread or locally distributed, (b) the variation in species diversity (species richness) among various localities, (c) the marine benthic diversity of Statia in comparison with other areas in the Caribbean, (d) whether a baseline can be established for studies concerning changes over time, (e) whether species can be discovered that are new to science, (f) the distribution of keystone taxa important for conservation (endangered species, invasive species). Photographic documentation and a reference collection will support the establishment of the baseline. DNA samples will be taken for molecular analyses and DNA bar coding.

In the near future the participants will contribute more pages to this blog, each one dedicated to their own specialty or task.


CNSI building

Participants

Naturalis Biodiversity Center

1. Dr. Bert W. Hoeksema (stony corals and associated fauna)
2. Dr. Ronald Vonk (interstitial bottom fauna)
3. Dr. Arjen Speksnijder (molecular biodiversity bottom fauna)
4. Frank Stokvis, MSc (technician molecular analyses)
5. Mr. Koos van Egmond (collection technician)
6. Ms. Yee Wah Lau, MSc (student UL, octocorals)
7. Ms. Luna van der Loos (student RUG, marine algae) – also member of Anemoon team
8. Dr. Willem Prud'homme van Reine (marine algae) non-SCUBA

STENAPA

1. Ms. Jessica Berkel (Park manager)
2. Mr. Matt Davies (Park ranger)

Anemoon Foundation

1. Mr. Niels Schrieken, MSc (coordinator Anemoon; ascidians, sponges)
2. Dr. Godfried van Moorsel (scleractinians, fishes)
3. Mr. Marco Faasse, MSc (hydrozoans, bryozoans)
4. Ms. Marion Haarsma (molluscs, general marine fauna)
5. Ms. Sylvia van Leeuwen (littoral fauna and flora)
6. Ms. Susan Hewitt (littoral fauna and flora)
7. Mr. Steve Piontek (fish)

Foreign specialists

1. Prof. Jim Thomas, Nova Southeastern University, Fort Lauderdale, USA (amphipods)
2. Dr. Slava Ivanenko, Moscow State University, Russia (coral-associated copepods)
3. Dr. Simone Montano, University of Milano-Bicocca, Milano, Italy (hydrozoans)
4. Dr. James Reimer, University of the Ryukyus, Okinawa, Japan (zoantharians)
5. Mr. Jaaziel E. Garcia-Hernandez, University of Puerto Rico (sponges).

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/finding-great-tellin-sint-eustatius/

Finding the Great Tellin at Sint Eustatius

Posted on 18-06-2015 by Susan J. Hewitt

An interesting find of a very large tellin adds to the list of species known from Sint Eustatius. (Susan J. Hewitt)

Every day, underwater, the scuba divers of the Statia Marine 2015 Expedition are finding and photographing live organisms, as well as taking them back to the lab at the Caribbean Netherlands Science Institute for DNA subsampling. The divers are also picking up dead empty mollusc shells. With all this material coming in to the lab for identification, each day we are able to add several more species to the list of marine molluscs of Statia (previously 182 species).

On Sunday June 13th during the second dive of the day at "The Blocks", in a depth of 17 m, Marion Haarsma spotted a large (100 mm) and unusual-looking valve (one half of the shell) of a bivalve.

Niels Schrieken gave the valve to the malacologists on the team (Susan J. Hewitt and Sylvia van Leeuwen) to identify. They were surprised; it is a valve of the Great Tellin, *Laciolina magna*, the largest tellin in the western Atlantic Ocean, and rather a rare species.

The shell of the Great Tellin is semi-translucent, thin but strong. Typically the shell of this species is cream in color; in other individuals it can be tinged with pink or yellow, but never in a pattern of rays. Although the shell is large and showy, and therefore not easy to overlook, the species is not known from many localities in its range, which includes Bermuda, North Carolina and Florida in the US, the Gulf of Mexico, Colombia and the Greater and Lesser Antilles, including Saba. Thanks to Marion for finding this valve, which makes an interesting addition to the list for Statia!

Laciolina magna

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/mission-naturalis-barcoding-program-within-marine-expedition-statia/

Mission of the Naturalis barcoding program within the marine expedition at Statia

Posted on 22-06-2015 by Arjen Speksnijder, Head Laboratories O&O

We are on a three week expedition on St. Eustatius. This sound great and exciting, which it is, but why are we doing this? What do we do with the species we find? (Arjen Speksnijder)

Barcoding Statia

To enrich our knowledge about Dutch biodiversity in the overseas territories we perform a barcoding project embedded in the baseline biodiversity measurements on the Island of Sint Eustatius. A DNA and a tissue collection is set up for future DNA analysis. Barcode sequences are determined from selected species to make a DNA based reference database of the biodiversity of the island (S-BOLD). This reference library can be used for future monitoring.

Below water we collect marine invertebrates. DNA will be extracted from the collected samples for long-term preservation and, if possible, also tissue will be stored. The aim is to acquire as many DNA samples as possible for future research whilst the more costly process of barcoding can be performed on fewer samples answering the current questions.

eDNA sampling for metabarcode analysis

Modern techniques like metabarcoding of CO1, ITS and matK of environmental DNA by next generation sequencing enables us to analyze total biodiversity in a given dimension and time point. Meta-analysis of eDNA data enables us to relate diversity, interactions and community changes through different dimensions and time. At Statia we will assess below-surface biodiversity. These biodiversity assessments can be set up for human

impact studies on fragile islands and coastal waters in general. The main scientific question lies in the discovery of new species and interactions between communities. Marine sediments are sampled with cores and in the water column by filtration. In addition, filter-feeding invertebrates that attract eDNA are collected.

Fieldwork

My program of the day is making 2 dives in the morning in which water and sediment samples are taken. Like most divers, I monitor the environment, take pictures and maintain a presence-absence list of a selection of species. Filtration of water samples for eDNA analysis are done on the boat. Upon arrival we have lunch and after which we return to the lab for further processing and preservation of the samples. I also assist in subasampling of collected species. After dinner I do administration of the samples, photographs, presence absence list and regular work email. Furthermore I support people in their administration for the subsampling. From each subsampled voucher we have an *insitu* photo or a lab photo plus environmental data. To arrange this for 20 people requires some tight organisation. We get up at 6 am and the dive briefing starts at 8 am. I hit the bed at 23 pm when some other people are still working in the lab. This field trip is a very inspiring experience and also a complex enterprise. But for the barcoding program and eDNA analysis we think we have a optimal protocol put in place during this expedition. We thank our expedition members for their support.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/fingerprint-flamingo-tongue-found-sint-eustatius/

Fingerprint flamingo tongue found at Sint Eustatius

Posted on 23-06-2015 by Sylvia van Leeuwen

The fun of participating in a marine expedition is that divers show their surprising discoveries each day. In this way non-divers can enjoy as well. (Sylvia van Leeuwen)

Yesterday (June 18, 2015), Yee Wah Lau found a beautiful Fingerprint flamingo tongue. This rare snail species, *Cyphoma signatum*, differs from the common flamingo tongue, *Cyphoma gibbosa*, by a different colour pattern of the mantle that usually covers the shell. It does not show the orange spots on the mantle of the latter species, but thin black, white and orange lines that remind of fingerprints. The snail was spotted on one of its prey species, the octocoral *Plexaurella nutans (see photo by Yee Wah Lau).* The photograph shows where the coral was eaten by the snail. Coral lovers may not be pleased to see the coral being predated on by the snail but this is a natural process in a healthy ecosystem. In nature 'to eat or be eaten' is a normal phenomenon, including coral reefs.

Photo: Lee Wah Lau

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/zoantharia-statia/

Zoantharia at Statia

Posted on 24-06-2015 by James Davis Reimer
Not only experts from Naturalis and Stichting ANEMOON join the expedition to St. Eustatius. Also external experts are participating. One of the people is James Davis Reimer. He is expert on zoantharians, these are an order of cnidarians commonly found in coral reefs. (James Davis Reimer)

I lead a group of students and post-doctoral fellows at the University of the Ryukyus in Okinawa, Japan (www.miseryukyu.com). Our group is working on understanding the diversity of a variety of understudied marine invertebrate taxa, as well as the ecological impacts of coastal development on marine biodiversity.

Personally, my first research love is the order Zoantharia, an order of cnidarians most closely related to hard corals and sea anemones. This is my first extended field work in the Caribbean, and I am really enjoying familiarizing myself with the various Zoantharia species. I have been truly surprised by the beauty and diversity of the reefs of Statia, as well as the abundance of Zoantharia. In particular, the sponge-associated parazoanthids are fascinating to me, as the associations are similar yet so different from the more cryptic and tiny parazoanthids of the Indo-Pacific.

I have also really enjoyed examining the zooxanthellate species of Zoanthus and Palythoa, most of which have counterpart species in the Indo-Pacific. It is very interesting to me how these counterpart pairs still have very similar morphology and ecology, and I believe we can learn more about the evolution and divergence of shallow water benthos in the Atlantic and Indo-Pacific from them.

Image: *Zoanthus solanderi* from the east coast of St. Eustatius.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/expedition-experience-squbaqua/

The expedition experience by Scubaqua

Posted on 25-06-2015 by Scubaqua team

Naturalis and stichting Anemoon have organised the Statia Marine 2015 Expedition and we were happy to host them for the last three weeks (Mike Harterink)

Not our usual group of divers. Not an usual group in general. Besides a full boat of nitrox tanks and dive equipment, it was stacked with coolers (for samples, not rum), camera’s, hammers, chisels and all kind of bags and tubes for their samples. We also figured out quickly that there was no chance this group would follow the guides on our tours. Instead the dive plan was more something like “make sure you see the boat and do your thing”. We learned quickly that we should not point out a juvenile Queen Angel to the seaweed expert. Same for showing a nudibranch to the coral expert and so on. Our Latin (normaly only covers veni vidi vici) improved by the day and we learned about the most tiny creatures only to been seen through a microscope. All bits and pieces together complete the whole picture puzzle of our unique island. Most important thing we discovered the last three weeks was the passion of this group of scientists, we hoped we showed them ours as well!

The Scubaqua team

SCUBAQUA
Dive Center St. Eustatius

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/seagrass-fields-statia/

Seagrass fields on Statia

Posted on 25-06-2015 by Luna van der Loos
Although coral reefs are important ecosystems with high biodiversity, seagrass fields are also vital habitats. (Luna van der Loos)

Worm eggs, attached to the invasive *Halophila stipulacea*

The submerged plants form dense beds in sandy areas, often in proximity to coral reefs, but seldom consist of seagrass alone. Their complex structures provide shelter and nursery areas to many fish and invertebrate species, such as crustaceans, gastropods and echinoderms. In addition, the rhizomes of seagrass form networks that provide protection to predators for the infauna that inhabit the sediment beneath seagrass fields. The seagrass beds also harbour different species of macroalgae, such as *Caulerpa species* that grow with their stolons in the sediment, and many epiphytes, such as *Dictyota species*. Also sponges, bryozoans and other benthic organisms can be found as epiphytes on seagrass species. The macroalgal epiphytes can greatly add to the primary production of the seagrass fields and increase the complexity of food web dynamics.

During the Statia marine expedition 2015, we have had the pleasure among others to explore the biodiversity within the seagrass fields. Before the start of the expedition, the native *Halophila decipiens* and *Syringodium filiforme* were known to occur around St Eustatius. In addition the invasive species *Halophila stipulacea* has been reported. This species originally occurs in the Pacific and the Red Sea and became established in the Meditarranean after the opening of the Suez Canal. In 2002, it was introduced in the Caribbean area.

After 33 dives during the expedition, only seagrass fields dominated by *H. stipulacea* and sparse presence of *S. filiforme* have been found. This can have several consequences for the native seagrasses and biodiversity. The introduced species might compete with the native species, resulting in a decline and perhaps even extirpation of the native seagrasses. However, *Halophila stipulacea* might also provide habitat, thereby adding to the biodiversity. We have noticed the presence of many macroalgae, crustaceans, echinoderms, worms, epiphytes and gastropods in the invasive seagrass beds. How the biodiversity of *H. stipulacea* fields differs from the biodiversity within native seagrass beds remains to be seen.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/st-eustatius-coastal-subsoil-waters/

St. Eustatius coastal subsoil waters

Posted on 26-06-2015 by Ronald Vonk
On this expedition I study marine groundwater crustaceans. (Ronald Vonk)

In the range that stretches from deepsea sediments upward to shallow reef debris, and further upward to freshwater riverbeds, the location of these small animals determines species and history. On St. Eustatius the presence of almost any type of groundwater crustacean, offshore and on the island, is unknown and as such the island forms an interesting bridge between the relatively well explored areas of Haiti and the Dutch Leeward Antilles. Scuba diving for two hours in a day during 3 weeks allows for probing several spots on the southwest side of the island. Searching for the right type of coarse sand between the submerged lava ridges is done until approximately 20 meters depth. First results are the presence of blind Microparasellid isopods and semi-oculate Melitid amphipods, specialised for a life just below the sandy bottom surface.

The seafloor and also the shallow marine interstitial are habitats that were colonized at one point in time by pre-adapted benthic invertebrates seeking refuge from predation. Especially islands are reservates of more or less isolated pieces of seafloor that stick out of a landscape of uniformity. This makes it probable that offshoots of a general, more deeper seafloor fauna evolved in the shallow waters surrounding it.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/new-species-amphipods-statia/

New species of amphipods from Statia

Posted on 29-06-2015 by Jim Thomas

I, James Thomas study amphipod crustaceans from coral reef habitats. (Jim Thomas)

My specialty is the Leucothoidae, a cryptic group of amphipods that live inside sessile invertebrates such as sponges and tunicates. Amphipods lack a larval stage and the commensal lifestyle of leucothoids further restricts their ability to disperse thus making them excellent measures of comparative diversity between reef systems. While focusing on this cryptic group of amphipods on the Naturalis expedition, my colleagues and I are also exploring wider reef habitats such as algae, sediment-dwellers, and fouling communities among others. A benefit of the camaraderie of the Statia expedition is the cross fertilization of information and expertise by the participants. For example, Jaaziel (sponges), Niels (tunicates), Marco (bryozoans), Ronald (interstitial fauna) among others have provided amphipods from their dives. Typically on a dive amphipods are coaxed out of particular species of sponge or tunicate and captured in a specialized squirt bottle to be examined and photographed later in the lab. Not all sponges and tunicates house these amphipods, and many species of amphipods prefer particular species of sponges. Thus it is a challenge to make comparative collections of the rich undersea reef communities of Statia.

Why collect these small (2-5mm) crustaceans? The preliminary results from Statia have already yielded at least four new species and increased distribution records for others. The sand-dwelling amphipod fauna is especially rich on Statia reefs, most likely due to the particular make up of reef sediments that incorporate remains of volcanic materials. While Statia lacks the calmer back reef and mangrove environments typical of other Caribbean islands with fringing reefs, Statia's fauna is rich and diverse, yielding unusual new species of cryptic amphipods that are likely limited to a few nearby islands.

As we compare the amphipod biodiversity from Statia to other Caribbean coral reef systems there is likely to be an endemic component of cryptic amphipods that have evolved in the particular conditions found in the Lesser Antillean arc. Much of the Statia undersea environment has been determined by its geological past. Volcanic eruptions, lava flows, and explosive ejecta have combined to produce a rich heterogeneous environment on which the reef system has developed.

It has been an enriching experience to work with a rich cross section of scientists. The Naturalis Statia expedition has proved a success. Few islands have been the focus of such concentrated scientific expertise and attention. Now the work of sorting through the data and specimens begins. Thanks are due the expedition organizers, Bert Hoeksema and Niels Schrieken, for their untiring efforts and organizational support, along with all the participants who have made this a memorable scientific effort.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/getting-most-out-expedition/

Getting the most out of the expedition

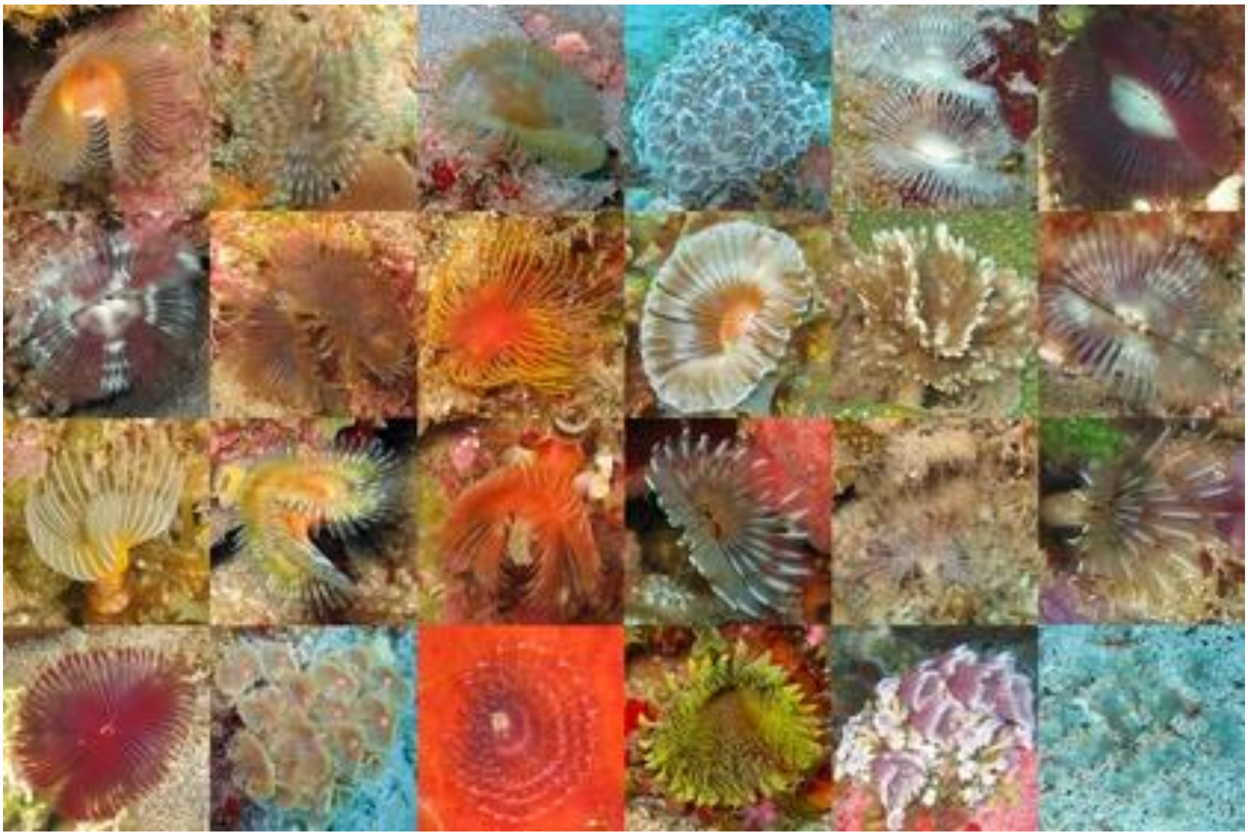
Posted on 29-06-2015 by Frank Stokvis

Instead of bringing the samples to the lab, this time the lab is joining the expedition! (Frank Stokvis)

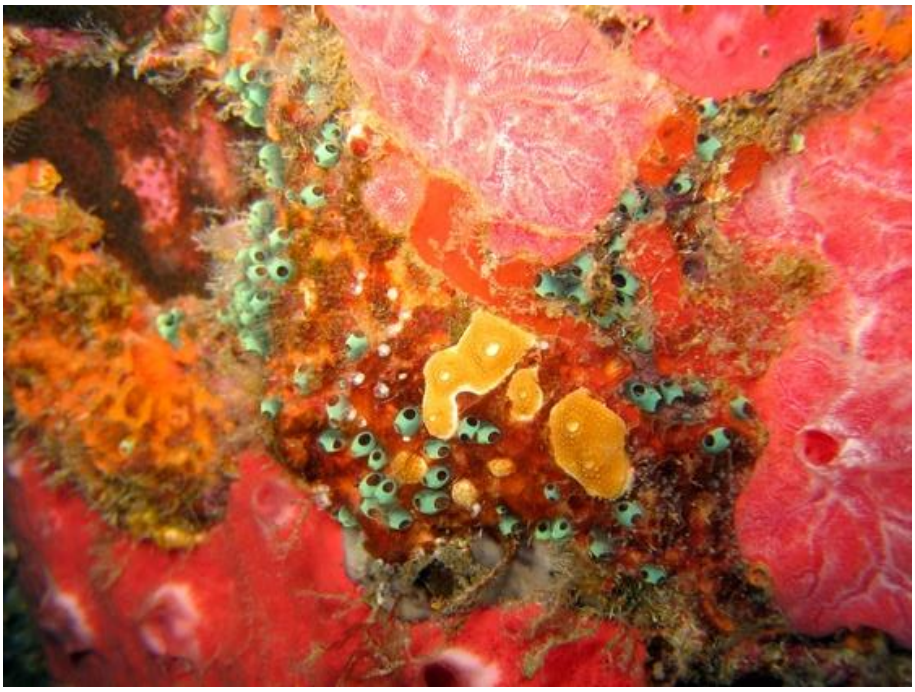
To realize our goal of building up a molecular reference library of the Dutch Caribbean, we are making sure the quality of the DNA from the collected samples is optimized on the spot and the collection data is recorded properly.

This process already starts under water with taking in situ pictures of the specimens. On the boat we immediately cool them to prevent degradation of the DNA. The same day, subsamples (small pieces of the specimens) are preserved in 96% alcohol. We will start extracting DNA from these subsamples within the next few months and sequence their DNA barcodes.

Together with Arjen Speksnijder I coordinate the DNA barcoding in Sint Eustatius. My job here is to support the expedition members with the collection and subsampling of specimens and the registration of the data by providing the necessary equipment, chemicals and datasheets. The results so far are very good! 17 micro plates, each with 95 subsamples, are being filled up nicely by the enthusiastic crew. The groups they are working on are Octocorallia, Porifera, Echinoderata, Scleractinia, Hydrozoa, Decapoda, Tunicata, Annelida, Amphipoda, Zoantharia, Algae, Copepoda and Pisces



My tasks under water are to monitor the presence/absence of calcareous tube worms, recognizable by their colourful fan. Besides scoring tube worms, I keep an eye out for unscored/new species for Sint Eustatius in certain groups. A spot underneath an overhang for example, contained at least 4 species of tunicate, some of which might even be new to science.



http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/symbiotic-crustacean-copepods-invertebrates/

Symbiotic crustacean copepods from invertebrates

Posted on 30-06-2015 by Viatcheslav N. Ivanenko

Symbiotic Copepoda form a diverse group of small crustaceans (typically with body length from 0.5 to 2 mm), which are associated with many taxa of invertebrates including scleractinian corals. (Viatcheslav N. Ivanenko)

More than 340 species of copepods representing different families and orders have been described from scleractinian corals. Most of the known copepods were found by washings of corals and only some species were reported from galls or polyps. The relationship between these copepods and their scleractinian hosts is still poorly known. Some of the symbiotic copepods can probably affect stressed corals as well as transmit diseases (viral, bacterial etc.). Knowledge of copepods associated with scleractinians of the Caribbean region is mainly known from several papers dealing with taxonomy and ecology of copepods from Curacao and the Virgin Islands. The copepods associated with scleractinians and other invertebrates of Statia had not not investigated before our field trip (June 2015).

Dorsal view of an enigmatic crustacean copepod (Siphonostomatoida) found associated with a scleractinian coral of Statia, June 2015.

During the expedition more than 150 colonies of diverse species of scleractinian corals plus representative of different sponges and echinoderms were inspected for symbionts applying microscopy. Various unknown but also rare symbiotic copepods from about 70 colonies of scleractinian corals and about 40 specimens of other invertebrate hosts were collected. The diversity, host specificity and phylogeny of the copepods will be investigated by applying molecular and morphological methods.

Close-up photograph of *Montastraea cavernosa*, the scleractinian coral hosting copepods, depth 18 m. Statia, June 2015.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/octocorals-and-its-hidden-inhabitant/

Octocorals and its hidden inhabitant

Posted on 30-06-2015 by Yee Wah Lau

My focus is directed to soft corals (Octocorallia), more commonly called gorgonians, which are conspicuous members of marine communities that have received (too) little attention.

The phylogenetic relationships of Caribbean octocorals remain unresolved and molecular research has questioned the classical systematics based on morphological characteristics. I aim to find more insights in the phylogenetic reconstruction of this diverse group, by combining both molecular and morphological information. The Statia Marine expedition 2015 could provide more answers and its exiting to see the octocoral diversity and marine life that Statia harbours.

While examining soft coral species, a small beauty always manages to surprise me during my dives. Truly a master of disguise, the Slender Filefish (*Monacanthus tuckeri*) hides between the branches of octocorals. Changing its colour and patterns to blend in with its surroundings, roaming from one soft coral to the other, this little fish even uses the bristles on its body **to enhance its camouflage**. I believe there is much more to be discovered about both evolutionary relationships within octocorals and associated ocean critters.

Monacanthus tuckeri in between the branches of *Antillogorgia sp*. (left) and *Muricea sp* (right) http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/stony-corals-statia/

Stony corals of Statia

Posted on 30-06-2015 by Godfried van Moorsel

In 1978-1980 I dove on a daily basis at the coral reefs of the Caribbean leeward islands Bonaire and Curaçao for a PhD study on reproduction, settlement and growth of stony corals (Scleractinia).

Ever since I have been working as a marine biologist (2001-present at Ecosub for research and consultancy) and kept my interest in coral reef ecology. This Naturalis/ANEMOON expedition to windward Sint Eustatius (Statia) is a nice opportunity for me to compare its reefs with the leeward islands.

Stony corals make up the framework of coral reefs. Even after corals die off, their skeletons add to habitat complexity and as such they are important for biodiversity. This is especially true in fringing reefs such as in the leeward islands. Around volcanic Statia, hard substrates for stony corals predominantly consist of lava flows. Also wrecks offer a favourable surface for settlement. The largest coral species grow to a maximum of 1 m diameter, which somewhat less than compared to the leeward islands. However, the coral diversity around Statia is high and we hardly found any bleached specimens or coral diseases. This suggests a favourable condition compared to many other reefs in the Caribbean. On the other hand, on many dive locations algal cover is high (compared to previous decades) and corals are often struggling to outcompete algae.

Isophyllia sinuosa

Opistognathus aurifrons

We encountered several species not found at the leeward islands, such as Fragile saucer coral (*Agaricia fragilis*), Smooth star coral (*Solenastrea bournoni*) and Sinuous cactus coral (*Isophyllia sinuosa*). Together with Bert Hoeksema of Naturalis we try to score the full spectrum of stony-coral species at 37 locations at Statia. This results in a list of species with frequency of occurrence as well as distribution maps for the reefs of Statia. Also I am involved registering reef life by underwater photography.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/sponges-statia/

Sponges from Statia

Posted on 01-07-2015 by Jaaziel E. García-Hernández

My name is Jaaziel E. García-Hernández, I am a Master's student and scientific diver at the University of Puerto Rico – Mayagüez (UPRM). Here at UPRM, I am currently working on several research projects involving marine sponges under advisers Dr. Monica Alfaro and Dr. Nikolaos Schizas (http://cima.uprm.edu/~n_schizas/).

I personally think that sponges (Phylum: Porifera) are one of the most interesting and enigmatic animals (not plants) on our planet. They are more than just water pumping/filtering machines. Their internal structure is composed of hundreds if not thousands of chambers and canals which serve as an ideal habitat for an array of microorganisms.

Perhaps my favorite picture of this Expedition is of this Gaudy Clown Crab (*Platypodiella spectabilis*) who created a burrow on this particular sponge (Niphates digitalis). A perfect example of how sponges serve as habitat for different species of animals. If you look closely, you can also see that there is a species of zoanthid who also uses the sponge as a host (see Dr. James Reimer's blog post on Statia's Zoanthids).

Gaudy Clown Crab (*Platypodiella spectabilis*)

Unfortunately, in the past, marine sponges have been ignored in most major expeditions and reef surveys. Thus my main job during this expedition, along with Naturalis Biodiversity Center's Sponge Taxonomists Dr. Nicole de Voogd and Dr. Rob van Soest is to survey, collect and catalog Statia's marine sponge fauna. Our data will be used as a baseline reference for future studies of the island and across the Caribbean region. Like any expedition, final results will take months to complete, none the less, I am extremely excited about a dozen or so specimens we've sampled from Statia, including range extension of certain species, along with possibly new species.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/bryozoans-and-hydrozoans-st-eustatius/

Bryozoans and hydrozoans of St. Eustatius

Posted on 01-07-2015 by Marco Faasse

Corals and fish belong to the most eyecatching representants of biodiversity on reefs. (Marco Faasse)

The contribution of other organisms to diversity should however not be underestimated. Bryozoans and hydrozoans belong to the most secretive of sessile fauna, yet they contribute significantly to the species richness of the reef community. Many species host associated organisms seeking protection, holdfasts or food. For instance, one small fertile *Eudendrium* colony was host to many associated stenothoid amphipods and a predatory nudibranch. Nudibranchs in particular may depend on the occurrence of certain hydrozoans.

Habitat diversity is a key factor to species numbers. Algae such as *Halimeda*, sponges, coral rubble, shaded overhangs and wrecks all house a different bryozoan and hydrozoan fauna. In a Caribbean context, the bryozoans and hydrozoans of St. Eustatius exhibit a fairly high diversity. Previously, virtually nothing was known of this fauna on Statia. It was a pleasure to contribute to the knowledge of this part of marine biodiversity of St. Eustatius.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/hunting-zanclea-and-other-coral-associated-hydroids/

Hunting for Zanclea and other coral-associated hydroids

Posted on 01-07-2015 by Simone Montano

Little is known about the symbiosis between corals and hydrozoans. (Simone Montano)

The latter belong to the genus *Zanclea.* They have been discovered to form strict relationships with numerous scleractinian species in the Indo-Pacific and appear to be more widespread in coral communities than previously known. They are 1 mm long and barely visible with the naked eye. In total 33 host corals have been known so far, and ten of these (all mushroom coral species) were only discovered in 2014 in the Republic of the Maldives. So far none were known from the Atlantic. However, during the Statia Marine Expedition, tiny *Zanclea* hydroids were discovered for the first time on Caribbean reef corals.

Pteroclava hydroids living in association with soft corals and *Sphaerocoryne* hydroids living in association with sponges seem to show similar patterns. However for most of them the information about distribution, host range and prevalence in the coral communities are generally scarce and incomplete. It is my aim to improve the knowledge regarding distribution and host range for *Pteroclava* and *Sphaerocoryne* hydroids in the reefs of St. Eustatius. Moreover, considering that *Zanclea* hydroids living in association with corals are not yet reported in the whole Caribbean Sea, to assess the geographic distribution of this association as well as to understand the nature of this relationship. I believe that we are likely to find undescribed hydroids taxa and symbiotic associations involving hydroids that are still unknown. Since the nature of these symbioses is still unknown, a future project will explore the role of the hydroids in relation to healthy and unhealthy reef coral conditions.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/lionfish-statia/

Lionfish at Statia

Posted on 02-07-2015 by Marion Haarsma

On the 6th of July I, Marion Haarsma, arrived at Sint Eustatius (Statia) as a member of the “Statia Marine 2015 Expedition” team. The next day we started the monitoring of the underwater life. We received a heartwarming welcome by Mike and Marieke at Scubaqua Dive Center Statia. (Marion Haarsma)

After the breefing we went to the boat (The Green Flash) for the first dive on Princess Corner. During the very first dive in the warm waters around Statia, I found a big Lionfish (Pterois volitans). It is a beautiful and elegant fish, but here it is not loved! In the Indo-Pacific it is a normal sight, this species is found everywhere and lives in balance with the other animals. But in the Caraibic region it is considered a threat to the reef and especially for the small and rare fish species. The biologist are scared it has a voracious appetite and will eat everything and as it has no natural enemy, it cannot be stopped! It is a member of the scorpionfish and the spines are poisonous. A sting will not kill you, but it is very painful. How this fish species got here is a strange story. It should have escaped from an aquarium in Florida during a storm in 1992. Other reports mention first sightings in 1985. It is probably released intentionally or accidentally, but now it is considered an ecological problem. This invasive species spreads very fast. The female Lion fish spawns regulary and releases many eggs (up to 15.000) and they spread at a depth of a hundred meters. My first sighting on Curaçao was in 2010 and now it is abundant in the waters around Statia. What to do? One solution is to encourage the fishermen to fish it and the public to eat it, it should be very tasty! Here on Statia the biologist from STENAPA are hunting it as well.

Back to my meeting with the Lionfish in the overhang which created a kind of cave. There it was surrounded by a group of Damselfish (Brown chromis, Chromis multilineata). The interesting thing about the Brown Damselfish was some of them had a parasite on their cheek, an isopod. The isopod buries its snout in the fish, preferably near the head and lives on its blood. It will not kill its host, but it certainly will not be good for the fish! The Lionfish hung around, just floating. The Damselfish kept their distance, very clever! While I was taking pictures of the 'poor' Damsels the Lionfish got annoyed and started moving in on me!?! That gave me the opportunity to take some pictures of its snout (I had macro lens on the camera), but that really got him/her aggravated! I decided not to risk a painful attack and let them be...

Brown chromis, *Chromis multilineata*

http://www.onderwaterfilm.nl/

More on the Lionfish:
http://www.anstaskforce.gov/spoc/lionfish.php

More info about the Damselfish and their parasite:
http://nsf.gov/discoveries/disc_summ.jsp?cntn_id=129643&org=GEO

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/living-together-coral-associated-fauna/

Living together: coral-associated fauna

Posted on 02-07-2015 by Bert Hoeksema

Coral reefs are well known for their high species richness. Many coral reef species depend on reef corals for their existence. They use corals as food, substrate or hiding place. (Bert Hoeksema)

Many coral-associated animals live protected inside the coral. For instance, boring sponges excavate tunnels inside the coral skeleton, serpulid worms make a tube which becomes partly overgrown by the host coral, and gall crabs manipulate the coral to construct a shelter.

We hardly know how many species of animals are able to live inside the skeleton of a particular coral species and we also know little about which coral species can act as host for a particular species of worm, crab, shrimp, snail, and so on. In other words, the coral-associated fauna is not well known and it is unclear whether a species is host-specific or a generalist. If a species is host-specific and if its host coral disappears, the associated species will also get lost.

A coral of *Helioseris cucculata* inhabited by a Christmas Tree Worm and anotherone with a gall crab dwelling inside (circle)

Rare coral species are hardly investigated for their associated fauna. One has to look specifically for these species and also be able to recognize the symbiont. One of the coral species encountered at Statia is the Sunray Lettuce Coral, *Helioseris cucculata*, which is an iconic coral, usually observed below 15 m depth. During the Statia Marine Biodiversity 2015 Expedition only two of its associates were found, an unidentified gall crab and a Christmas Tree Worm, both of which are not known to have been reported before from this coral species. These findings serve to illustrate the rich marine biodiversity of Statia.

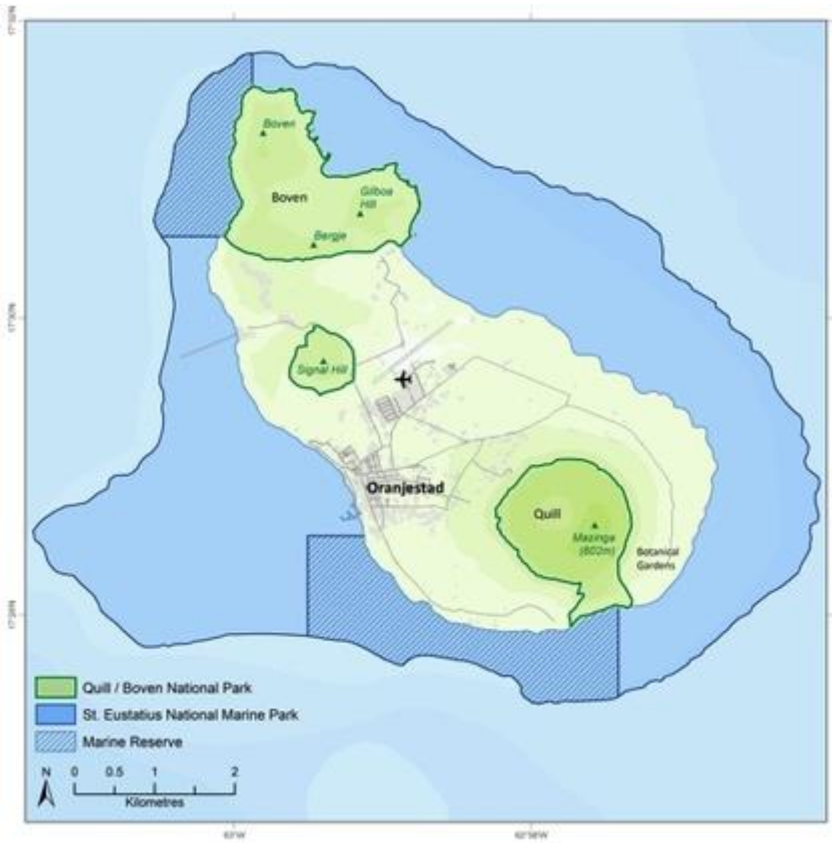
http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/contribution-park-ranger/

Contribution from a park ranger

Posted on 03-07-2015 by Matt Davies

St Eustatius marine park was established in 1996, encompassing a total area of 2750 hectares extending from the shoreline to the 30 m (100 ft) depth contour. (Matt Davies)

Within the marine park two marine reserves exist; the Northern and Southern reserve, which encompass a total of 527 hectares. In the reserves anchoring and fishing were prohibited up until 2015, and 30 permanent moorings have been placed to enable dive operations to use a variety of dive sites whilst preventing damage caused by anchoring.



Currently, parts of the marine park are under threat after recent legislation was passed enabling the harbour authority to expand the harbour area to the North and West. This transfers control over much of Statia's leeward sea's from the St Eustatius National Parks Foundation (STENAPA) to the harbour authority. This expansion includes part of the Northern reserve and 11 dive sites. There has also been a recent challenge to the legal status of the reserves. The result of this is that the reserves have no legal protection, and fishing and other activities are able to resume. We hope that the results of this expedition will give weight to our fight to protect Statia's unique marine environment.

As marine park ranger at STENAPA, I was recruited onto the expedition for my knowledge of local icthyofauna and dive sites. Until present, there has been no published list of fish species for St Eustatius' waters. Using roving visual surveys, our aim is to create an official list, and map the species distribution within the marine park. As we had recently completed a project involving 100 visual fish census transects, we began with the list of fish species observed during those transects, combined with species that have been caught by local fishermen, along with unconfirmed reports from divers. We have since confirmed a total of 165 species from that list of 201, and a further 25 species not previously reported. This includes several rare species and several that have not yet been reported in the Lesser Antilles, such as *Chaenopsis resh* (the resh pikeblenny).

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/sampling-materials-and-hidden-starfish/

Sampling materials and hidden starfish

Posted on 09-07-2015 by Koos van Egmond

Part of organizing Naturalis biodiversity expeditions consists of the logistic support by ordering, sending, and maintaining a sufficiently large stock of sampling materials, such as labels, vials, jars, barrels, buckets, plastic bags, nets, sorting trays, hammers, chisels, scissors, herbarium equipment (such as old newspapers), etc, etc. (Koos van Egmond)

Although some of this was already available in supermarkets at Statia, most of it had to be arranged weeks before the start of the expedition. Many of the 22 expedition participants were diving two times a day and six days per week. Nearly all of them needed plastic bags for collecting samples and for storing samples after sorting and identification in the lab. Fortunately, there was no shortage of anything and if there was any, this was only temporary, because there are many shops on Statia where basic equipment could be bought.

During diving, my responsibility consisted of sampling echinoderms for this expedition. This was easier said than done because animals like starfish usually do not run away but hide themselves underneath boulders or inside crevices. Most of these were Ophiuroidae (brittle stars), which resulted in a nice collection.

Ophiothrix (Acanthophiothrix) suensoni http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/botanical-coastal-research-sint-eustatius/

Botanical coastal research on Sint Eustatius

Posted on 09-07-2015 by Willem F. Prud'homme van Reine

Although my first priority was to prepare a good dried collection of the marine macroalgae collected by diving by Luna van der Loos, there was also the task to visit the marine localities where Vroman (in 1958) and Wagenaar Hummelinck (in 1949) had collected marine macroalgae along the coastline of Statia.

Together with one or both of the ladies who collected marine molluscs, I tried to visit these localities. This was not always successful, because the littoral areas of these coasts were washed by rather high waves (exposed!) and the boulders forming the coastal zone are mostly covered by thick packets of drift brown seaweeds. Thus we did not manage to collect at all localities visited by us.

Suringar, a former director of the Rijksherbarium but also a botanical collector, wrote in his notebook already in 1885 that it was difficult to collect seaweeds at the exposed shores of the island. Some of his collections were later studied by Vroman, who tried to identify all seaweeds from Statia presently in the botanical collections of Naturalis Biodiversity Center.

The checklist of all published seaweed names for Statia contained 53 red algae, 19 brown algae and 31 green algae when we started our visit. In that checklist we also included the first data on seaweeds and seagrasses that were recently collected by diving by DeBrot et al. (2014). To that total of 77 seaweeds we could add 45 new names, thus bringing the total number to 102 taxa. This is, however, not the final number for our research, because Luna and I could not directly identify all collected seaweeds. Especially the smaller specimens, but also members of species-rich genera, need a more detailed study in Leiden.

And what about the drift brown algae? Our first seaweed experience was in the aircraft bringing us from Sint Maarten to Sint Eustatius. Through the windows we saw long rows of reddish-orange objects in the sea below us. At some positions the reddish-brown rows formed considerable oil-drop-like structures and we also saw much larger drifting concentrations (rafts). There we observed the notorious Sargasso weed, formerly the reason why sailing ships during periods of calm weather (the doldrums) could not navigate to get rid of these fields of floating unattached seaweeds and got stuck. In fact we saw separate ecosystems with the large seaweeds *Sargassum fluitans* and *Sargassum natans*, but also with populations of many specialized organisms, like fishes, snails, crabs, hydroids etc. As long as this *Sargassum* weed does not wash ashore on one of the many Caribbean islands (see photograph by Bert Hoeksema), these special seaweeds, which never attach to hard substrate and continuously grow by asexual propagation, thus exclusively by vegetative growth, can form large rafts covering a considerable surface area of the tropical Atlantic Ocean, also known as the Sargasso Sea.

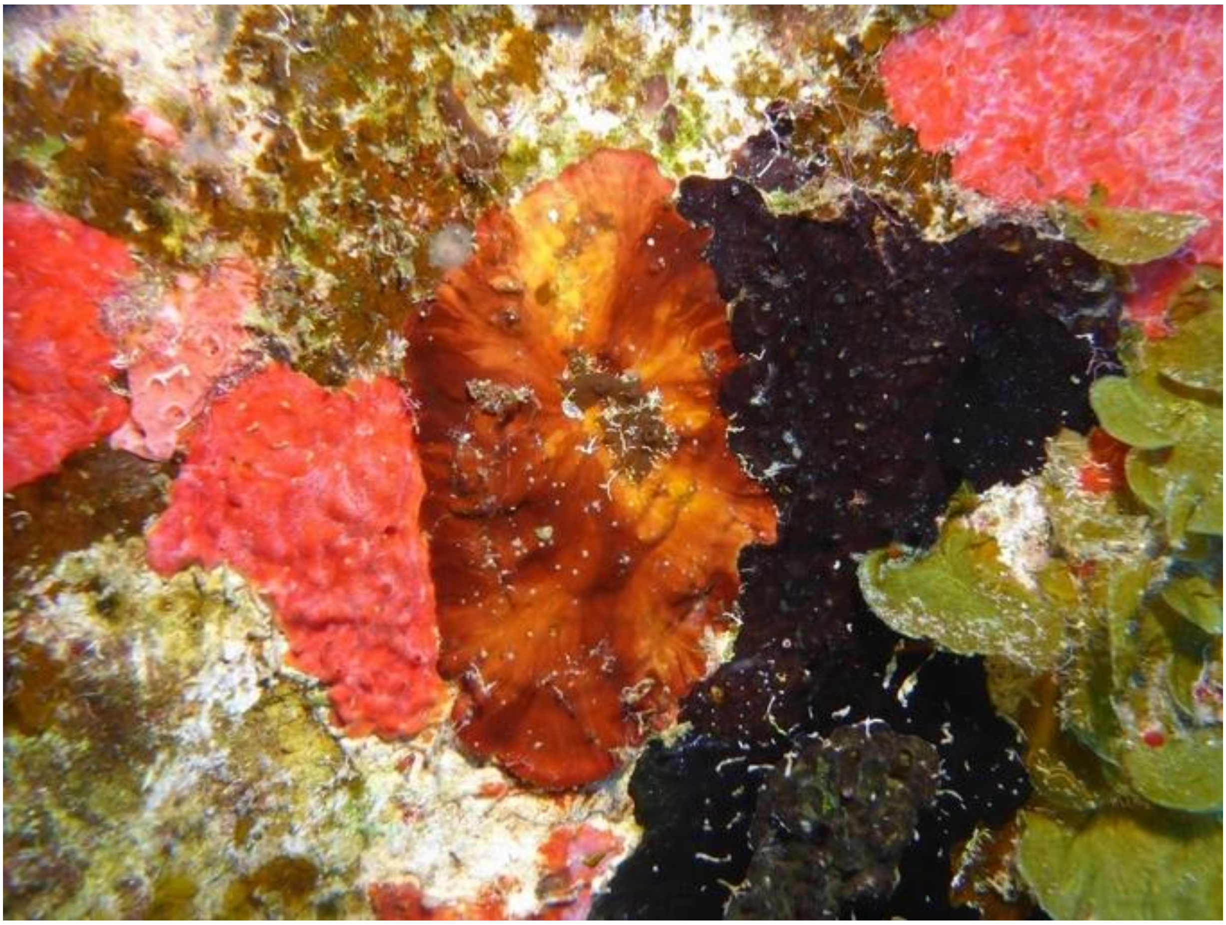
http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/diving-algae-statia/

Diving for Algae on Statia

Posted on 10-07-2015 by Luna van der Loos

Even though scleractinian corals are known to be the main builders of coral reefs, a reef does not solely exist of corals.

Many other groups of species contribute to the structure and biodiversity of the benthic reef community as well, such as sponges, ascidians and algae. When coral reefs are concerned, algae have received quite some negative publicity in the past decades. They are mostly known for their ability to compete for space with corals and overgrow (dead) coral, which is associated with a degraded state of the reef. On the other hand, algae, especially thalloid seaweeds, provide both food and habitat to other reef organsims. Such, turf algae and fleshy sheet-forming algae make up only part of the functional diversity on reefs. Calcareous algae for instance are vitally important for reef health and coral recovery. They do not only increase the mechanical support of the reef, due to deposition of calcium carbonite which acts as cement, but they also facilitate coral metamorphosis by providing a suitable habitat for coral larvae or by producing chemicals that are used as a cue for metamorphosis. In addition, algae are responsible for the major part of the high primary production typical of coral reef



ecosystems. Actually, coral reefs could not exist without algae.

The Naturalis Biodiversity Statia expedition aimed to make a full base-line of species diversity in several different habitats. So far, more than 100 algae species have been found during the expedition. Many more species will be added to the list, which will require many enjoyable hours behind the microscope. The result - a full base-line of algal biodiversity - will be a solid foundation for future research and conservation.


Calcareous algae are vitally important for coral reef communities

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/pike-blennies-and-barracudas/

Pike blennies and barracudas

Posted on 14-07-2015 by Steve Piontek

As Data Monitoring Officer based on St Eustatius, I have been working on a fish species list for Statia, using opportunistic sightings, past records and fisher landings for the last three years.

The Naturalis expedition was a great opportunity to do a comprehensive study of the waters surrounding St Eustatius. I jumped at the opportunity to join the expedition, and was able to make 36 dives covering more than 37 hours underwater with the team. As a result of spending this time searching for fish species we were able to add 29 new species records for Statia. One of the interesting finds was the Resh Pikeblenny, previously only reported along the coastal islands of Venezuela.

Resh Pikeblenny at Statia

We were also able to photograph the majority of the species in order to confirm the identification. Some of the species have yet to be identified; we are hopeful of adding a few more species to our inventory. I hope this work will enable us to assess overall reef health and resilience through continued monitoring of the fish biodiversity. This baseline study provides a substantial resource to refer to which had been lacking. I wish to thank the entire team for coming to our small island and contributing their expertise for the scientific advancement of St Eustatius

Barracuda, curious and frequently encountered on the reefs of Statia http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/citizens-science-and-ascidians-statia/

Citizens science and ascidians from Statia

Posted on 27-07-2015 by Niels Schrieken

As MOO-coordinator of the ANEMOON-foundation, co-organizer of the expedition and citizen scientist I participated in the Statia Marine Expedition 2015.

The major goal of this expedition was to make a base-line of the marine species diversity of St. Eustatius. A goal for the ANEMOON foundation is to make a list of around 150 characteristic and recognizable species for monitoring the marine life in collaboration with citizens scientists in the Caribbean. During the expedition the major marine groups were covered by the scientists and citizen scientists.

More information about the citizen science projects of the ANEMOON foundation can be found following this link.

The marine animal group I focused on during the dives were the Ascidians. Ascidians, also known as sea quirts, are among the most widespread marine invertebrates and probably the least easily recognized. These filter-feeding animals are commonly overlooked, ignored or mistaken for sponges.

The ascidians are attached to the substrate at one end; at the opposite end they have two siphons. Water is drawn in through the incurrent or oral siphon, pumped through a gill net in the body, where the food and oxygen are extracted, and is discharged trough an excurrent or artrial siphon. Body shape, as well as size, varies considerably among species; some are only a 0,5 cm in length while others may exceed 10 cm. Ascidians come in a dazzling array of colors that is often enhanced by transculent quality of the tunic. Ascidians can be found as solitary species, which include most of the larger species. Many of de smaller species grow in varying degrees of colonialism. The best feature to recognize ascidians from sponges is that you can always see the incurrent siphon and the excurrent siphon. By sponges you usually can only see the artrial opening.

For me it became an exciting discovery trip. After having make myself familiar with where to look for ascidians on the reef it is great fun to find and photograph them. Each dive you can find around 5 different species of ascidians on hard substrate. Especially overhangs seem to be a preferred spot for ascidians. With a good buoyancy it is a challenge to make a sharp recognizable picture of the ascidian. Afters 39 dives on 37 different locations the first results are that during the expeditions more than 20 species of ascidians with different growth forms are found around the island. See the pictures for the main grow forms.

The limited number of total species, the limited number of species per dive and the recognizable features after making oneself familiar with ascidians makes it a great group to search for and photograph as scuba diver on St. Eustatius.

The solitary reef tunicate *Rhopalaea abominalis*. Dive location Chien Tong Wreck.

A colony-forming ascidian only joined at its base, the Blue bell tunicate*Clavelina puertosecensis*. Dive location The Humps. Special about this ascidians is that this green color phase is not known from another location in Caribbean.

The encrusting social tunicate *symplegma viride*. Dive location Crooks castle. Tiny ascidians grow in clusters, their tunics join at their bases to form a common tunic.

The condominium tunicate *Eudistom sp.*. Dive location Mushroom. The tunic consists of numerous individuals completely embedded in a firm, globular common. Identification of this genus is tentative, because this could also be*Polycitor* or *Stomozoa*.

The mottled encrusting tunicate *Distaplia bermudensis*. Dive location The Humps This most specialized colony is not only embedded in a common tunic, but the excurrent siphons open into a large common chamber or cloaca.

http://www.naturalis.nl/en/news/Sint_Eustatius_Marine_2015/epilogue-back-home/

Epilogue: Back home

Posted on 30-07-2015 by Bert Hoeksema

By now each participant of the Statia Marine Biodiversity Expedition 2015 has returned to her / his regular base in the Netherlands, Italy, Japan, Puerto Rico, Russia, USA, and Statia. (Bert Hoeksema)

All of us seem to be very pleased and satisfied with the results. We have found several new species for science and many new species records for St Eustatius (or even the Caribbean and Atlantic Ocean). Therefore we know that Statia's marine biodiversity is higher than recorded before. This has been possible because of the friendly collaboration among the participants and the local support given by the Caribbean Netherlands Science Institute (CNSI), St Eustatius National Parks (STENAPA), and dive centre Scubaqua.

The CNSI supplied accommodation, laboratory space, and other kinds of logistic support. STENAPA welcomed us to perform our research and motivated us to by making the research applicable to nature conservation: we need to know what we protect. Scubaqua was extremely helpful by their professional attitude towards safe diving and by being our guide. We were able to establish 40 dive stations all together in addition to 20 coastal sites visited by the shore team.

The work is not finsihed. We need to make a progress report in which the preliminary results will be presented. We plan to write many scientific papers and some of these will be published in a special volume of a scientific journal. Our primary ambition was to establish a baseline and we are sure that we shall succeed in doing that. Eventually, St Eustatius has to be known as a place of scientific importance in the Caribbean. Personally, I hope that each one of us will remember how we explored its rich biodiversity, enjoyed its variable seascape and marine life, and developed a camaraderie by working hard together for a good cause.