Mueller *Marine Biodiversity Records* (2017) 10:10
DOI 10.1186/s41200-017-0111-4

Marine Biodiversity Records

MARINE RECORD Open Access

First documentation of encrusting specimen of *Cliona delitrix* on Curaçao: a cause for concern?

Benjamin Mueller

Abstract

The coral excavating sponge *Cliona delitrix* is one of the most aggressive and conspicuous excavating sponges on Caribbean reefs. While *C. delitrix* is very prominent displaying its typical encrusting growth form (*β*-stage) on the Caribbean island of Bonaire, it is rather elusive and only exhibits a papillated habitus (*α*-stage) on the neighboring island of Curaçao. Here I document the first two encrusting specimen of *C. delitrix* on Curaçao and discuss potential explanations for island-specific differences in its habitus and occurrence. An increase of encrusting specimen could have profound consequences for Curaçaoan reefs and should thus be monitored closely.

Keywords: *Cliona delitrix*, Sponge, Growth stage, Coral reef, Curaçao

Background

The coral excavating sponge *Cliona delitrix* (Pang 1973) (Hadromerida, Demospongiae) is one of the most destructive bioeroders on Caribbean coral reefs (e.g. Chaves-Fonnegra et al. 2007). It can excavate 10–12 cm into coral skeletons and/or the limestone framework (Pang 1973; Zilberberg et al. 2006), and spreads laterally at mean rates of ~1.5 cm y^{-1} (Chaves-Fonnegra and Zea 2011; Rützler 2002). While doing so it can kill adjacent corals by undermining tissue fronts and filaments (Chaves-Fonnegra and Zea 2007). Initially, *C. delitrix* forms discrete ostial and oscular papillae (*α*-stage) (Fig. 1a). Quickly these papillae start to fuse (Fig. 1b), until eventually all papillae are fused and connected by a tough layer of thin tissue, which starts to overgrow the substrate in an encrusting manner (*β*-stage) (Fig. 1c-d).

Due to its bright red-orange color and increasing abundance, *C. delitrix* is one of the most conspicuous excavating sponges on many coral reefs throughout the Caribbean and Eastern and North Eastern coast of Brazil (Chaves-Fonnegra et al. 2007; Rose and Risk 1985; Ward-Paige et al. 2005; see map in Van Soest 2010 for distribution range of *C. delitrix*). Interestingly, *C. delitrix* is rather elusive on the fringing reefs of the Southern Caribbean island of Curaçao, yet it is very prominent on the neighboring island of Bonaire, merely 41 km off Curaçao (Mueller et al. 2014) (Fig. 2). Fringing reefs on both islands are situated in the same physicochemical province (Chollett et al. 2012) and are characterized by a similar reef geomorphology with a narrow reef terrace and steep reef slope (20–50°) (Van Duyl 1985), as well as comparable reef community structures and reef health conditions (Jackson et al. 2014; Sandin et al. 2008). Despite the close proximity and similarities in environmental conditions of these two islands, *C. delitrix* on Curaçao appears to solely display the *α*-stage, with mostly unfused papillae, whereas large encrusting individuals occur commonly around Bonaire. It should be noted that the exclusively-papillated excavating sponge *Cliona laticavicola* (Pang 1973) (Hadromerida, Demospongiae) closely resembles the *α*-stage of *C. delitrix*. However, genetic and spicule analysis confirm that papillated specimen on Curaçao are indeed *C. delitrix* (Chaves-Fonnegra et al. 2015). Moreover, due to the fact that both species were described from the same reef on Jamaica (*C. laticavicola* from shallow-rocky habitats and *C. delitrix* from the reef slope), *C. laticavicola* has been proposed to be an early life history stage or ecophenotype of *C. delitrix* (Zea et al. 2014).

This study reports the first documentation of encrusting specimen of *C. delitrix* from Curaçao and discusses

Correspondence: muellerb@ymail.com
Carmabi Foundation, Willemstad, Curaçao

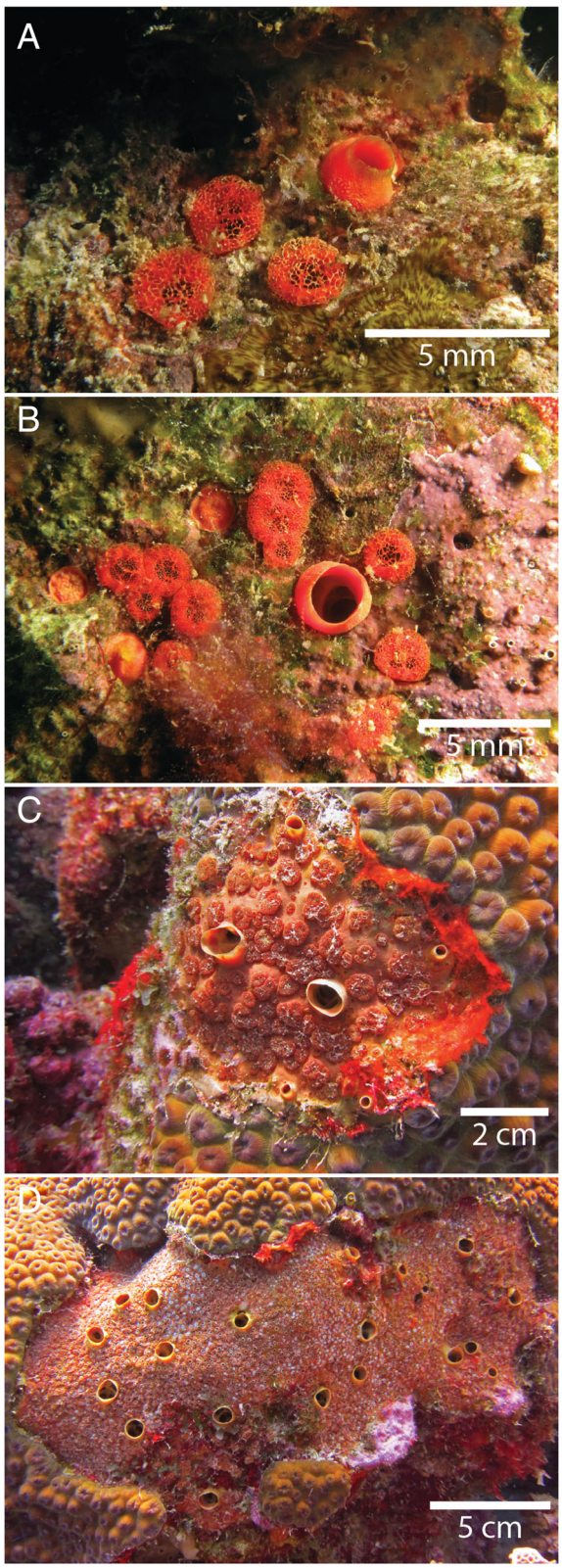

Fig. 1 Typical succession of growth phases in the excavating sponge *Cliona delitrix*. **a** Discrete ostial and oscular papillae (*α*-stage). **b** Papillae start quickly to fuse (*α*-stage transition to *β*-stage). **c** All papillae are fused and connected by a tough layer of thin tissue (*β*-stage). **d** Encrusting sponge continues to overgrow the substrate (*β*-stage). Tissue often harbors a dense population of whitish zoanthids at this stage. Pictures were taken on the fore reef slope of Bonaire, Southern Caribbean, between 10 and 15 m depth

potential explanations for island-specific differences in its habitus and occurrence.

Material and methods

Two encrusting specimen of *C. delitrix* were photographed during a dive on November 3, 2016 in front of the Sea Aquarium Park on Curaçao (12° 05' N, 68° 53' W). The site is characterized by a diverse coral community with >30% live coral cover, high structural complexity, and a steep fore reef slope (>50°) (Van Duyl 1985). The coral community at the drop-off (approx. 8 m depth) is dominated by *Orbicella* spp.

Results

Two encrusting specimen (*β*-stage) of *C. delitrix* were recorded on a single colony of *Orbicella faveolata* (formerly *Montastraea faveolata*) at 8 m depth (Fig. 3). Both specimen were located in two separate areas of partial coral-mortality and were surrounded by a band of turf algae. No additional encrusting specimen of *C. delitrix* were encountered in the vicinity during the 60 min dive.

Discussion

Cliona delitrix has been reported to occur on Curaçao (Bruckner and Bruckner 2006; Chaves-Fonnegra et al. 2015; Van Soest 1981), yet large encrusting specimen have not been recorded so far and were not encountered in the coral reef monitoring program and/or other research activities of the Carmabi Research Station (pers. comm. M. Vermeij). While it cannot be excluded that more *C. delitrix* displaying the *β*-stage exist or existed on Curaçaoan reefs, it is safe to say that this habitus is rare. This raises the question why encrusting *C. delitrix* are not as abundant as on Bonaire, where such specimen are commonly encountered and densities of 0.03 individuals m^{-2} have been documented (Mueller et al. 2014)? Possible explanations could include (1) differences in environmental conditions between the two islands and/or (2) genetic differences between the local populations of *C. delitrix*. However, environmental conditions including geomorphology and community structure are very similar on both islands (Chollett et al. 2012; Sandin et al. 2008; Van Duyl 1985). Given the suggested positive effect of anthropogenic disturbances (e.g. organic

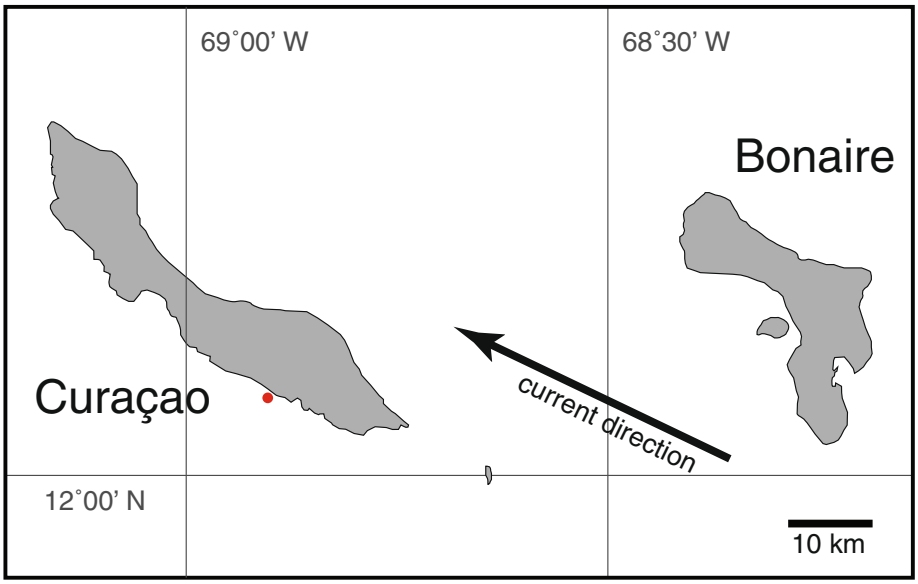

Fig. 2 Map of the Southern Caribbean islands of Curaçao and Bonaire. Red circle indicates the position of the observed encrusting specimen of *Cliona delitrix* in front of the Sea Aquarium Park on Curaçao. Predominant current direction of the Caribbean Current is indicated with an arrow

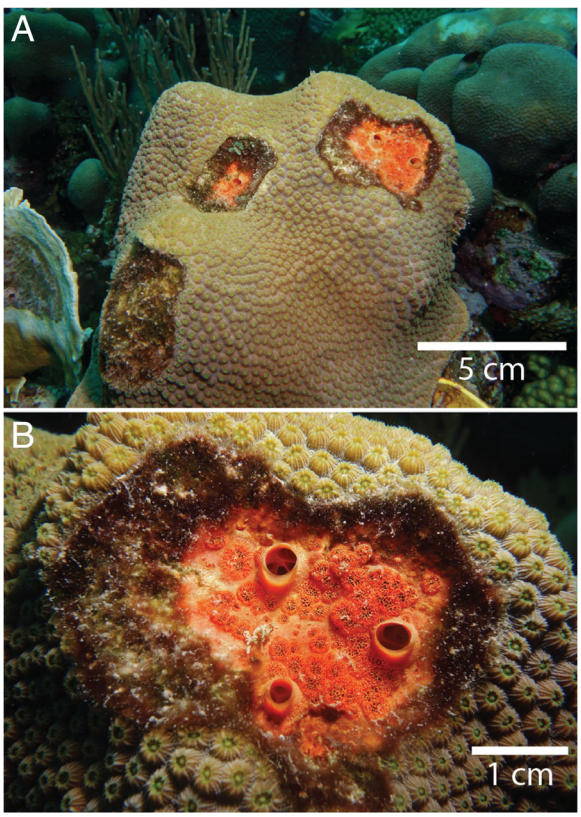

Fig. 3 Photographs of two encrusting specimen of *Cliona delitrix* growing on one single colony of *Orbicella faveolata* on Curaçao, Southern Caribbean. **a** Overview of the two specimen in two separate areas of partial coral-mortality and were surrounded by a band of turf algae. **b** Close-up of the larger specimen

pollution) on the abundance of *C. delitrix* (Chaves-Fonnegra et al. 2007; Rose and Risk 1985; Ward-Paige et al. 2005), a more than five times higher human population density (Centraal Bureau voor de Statistiek 2016; Central Bureau of Statistics Curaçao 2016), more industrial development, and a less restrictive marine resource management policy would rather suggest more favorable conditions on Curaçao than on Bonaire. Slightly higher dissolved organic carbon (DOC) and bacterial concentrations (Mueller et al. 2014) further suggest that food limitation is not a likely cause for the lower prevalence of *C. delitrix* on Curaçaoan reefs. Moreover, a planktonic larval period between 1 and 10 days (Mariani et al. 2006; Warburton 1958) in combination with the strong Caribbean Currents have been proposed to enable gene flow between populations of *Cliona delitrix* of up to 500 km across the Southern Caribbean (Chaves-Fonnegra et al. 2015). It is therefore highly likely that the Caribbean Currents flowing from Bonaire to Curaçao with up to 70 cm s^{-2} (Fratantoni 2001) (Fig. 2), should allow for a good connectivity between *C. delitrix* populations of both islands (Chaves-Fonnegra et al. 2015), as reported for local coral populations (e.g. Baums et al. 2005; Baums et al. 2006). Thus, as larvae of encrusting specimen of *C. delitrix* from Bonaire can be expected to seed Curaçaoan reefs, genetic differences are unlikely to be the reason for the lack of specimen displaying the *β*-stage on Curaçao.

In addition, *C. delitrix* is reported to spread particularly in the aftermath of catastrophic episodical disturbances, such as hurricanes and bleaching events, where recently deceased coral are rapidly colonized

(Chaves-Fonnegra et al. 2015; Chaves-Fonnegra and Zea 2011). In general, Curaçao has not been as strongly affected by bleaching events as other places in the Caribbean. However, during the 2010 bleaching event 12–30% of all coral colonies were affected and on average 10% of those subsequently died (Vermeij 2012). Despite this substantial opening of suitable substrate, no encrusting specimen of *C. delitrix* were recorded until now. This raises the question if the here reported occurrence constitutes an isolated event or marks the onset of an ongoing trend? Given the-fierce competitiveness of *Cliona delitrix*, its capability to kill live coral, as well as its high excavation rate, this could potentially have profound consequences for Curaçaoan benthic communities and their calcium carbonate budgets and should therefore be monitored closely.

Acknowledgements
I thank the staff of Carmabi for their logistic support. Fieldwork was performed under the research permit (#2012/48584) issued by the Curaçaoan Ministry of Health, Environment and Nature (GMN) to the CARMABI Foundation.

Funding
The author declares that there was no funding received for this study.

Availability of data and materials
All data generated or analyzed during this study are included in this published article.

Author's contributions
BM conceived and performed the experiment, analyzed the data, and wrote the manuscript.

Competing interests
The author declares that he has no competing interests.

Consent for publication
Not applicable.

Ethics approval and consent to participate
Not applicable.

Publisher's Note

Received: 23 December 2016 Accepted: 7 March 2017
Published online: 22 March 2017

References

Baums IB, Miller MW, Hellberg ME. Regionally isolated populations of an imperiled Caribbean coral *Acropora palmata*. Mol Ecol. 2005;14:1377–90.
Baums IB, Paris CB, Cherubin L. A bio-oceanographic filter to larval dispersal in a reef-building coral. Limnol Oceanogr. 2006;51:1969–81.
Bruckner A, Bruckner R. The recent decline of *Montastraea annularis* (complex) coral populations in western Curaçao: a cause for concern? Rev Biol Trop. 2006;54:45–58.
Chaves-Fonnegra A, Feldheim K, Secord J, Lopez JV. Population structure and dispersal of the coral excavating sponge. *Cliona delitrix* Mol Ecol. 2015. doi:10.1111/mec.13134.
Chaves-Fonnegra A, Zea S. Observations on reef coral undermining by the Caribbean excavating sponge *Cliona delitrix* (Demospongiae, Hadromerida) Porifera research: biodiversity, innovation and sustainability. Série Livros. 2007; 28:247–64.
Chaves-Fonnegra A, Zea S. Coral colonization by the encrusting excavating Caribbean sponge *Cliona delitrix*. Mar Ecol. 2011;32:162–73.
Chaves-Fonnegra A, Zea S, Gómez M. Abundance of the excavating sponge *Cliona delitrix* in relation to sewage discharge at San Andrés Island, SW Caribbean Colombia. Bol Investig Mar Costeras. 2007;36:63–78.
Centraal Bureau voor de Statistiek. Bevolkingsontwikkeling Caribisch Nederland. 2016. http://statline.cbs.nl. Retrieved 17 December 2016.
Central Bureau of Statistics Curaçao. Population tables. 2016. http://www.cbs.cw. Retrieved 17 December 2016.
Chollett I, Mumby PJ, Muller-Karger FE, Hu C. Physical environments of the Caribbean Sea. Limnol Oceanogr. 2012;57:1233–44.
Fratantoni DM. North Atlantic surface circulation during the 1990's observed with satellite-tracked drifters. J Geophys Res Oceans. 2001;106:22067–93.
Jackson J, Donovan M, Cramer K, Lam V. Status and trends of Caribbean coral reefs: 1970–2012. Switzerland: Global Coral Reef Monitoring Network, IUCN; 2014.
Mariani S, Uriz M-J, Turon X, Alcoverro T. Dispersal strategies in sponge larvae: integrating the life history of larvae and the hydrologic component. Oecologia. 2006;149:174–84.
Mueller B, de Goeij JM, Vermeij MJ, Mulders Y, van der Ent E, Ribes M, van Duyl FC. Natural diet of coral-excavating sponges consists mainly of dissolved organic carbon (DOC). PLoS One. 2014;9:e90152.
Pang RK. The ecology of some jamaican excavating sponges. Bull Mar Sci. 1973; 23:227–43.
Rose CS, Risk MJ. Increase in *Cliona delitrix* infestation of *Montastraea cavernosa* heads on an organically polluted portion of the Grand Cayman fringing reef. Mar Ecol. 1985;6:345–63.
Rützler K. Impact of crustose clionid sponges on Caribbean reef corals. Acta Geol Hispanica. 2002;37:61–72.
Sandin SA, Sampayo EM, Vermeij MJ. Coral reef fish and benthic community structure of Bonaire and Curaçao, Netherlands Antilles. Caribb J Sci. 2008;44:137–44.
Van Duyl FC. Atlas of the living reefs of Curaçao and Bonaire (Netherlands Antilles). vol 117. Studies of the flora and fauna of Surinam and the Netherlands Antilles. Utrecht: Uitgaven van de Stichting "Natuurwetenschappelijke Studiekring voor Suriname en Curaçao"; 1985. http://trove.nla.gov.au/work/11232553?selectedversion=NBD891739.
Van Soest R. A checklist of the Curaçao sponges (Porifera, Demospongiae) including a pictorial key to the more common reef forms. Verslagen entechnische gegevens/Instituut voor Taxonomische Zoölogie (Zoölogisch Museum), Universiteit van Amsterdam. 1981;31:1–44. http://www.repository.naturalis.nl/document/550110
Van Soest RWM. *Cliona delitrix* Pang, 1973. In: Van Soest RWM, Boury-Esnault N, Hooper JNA, Rützler K, de Voogd NJ, Alvarez de Glasby B, Hajdu E, Pisera AB, Manconi R, Schoenberg C, Klautau M, Picton B, Kelly M, Vacelet J, Dohrmann M, Díaz M-C, Cárdenas P, Carballo JL. World Porifera database; 2010. http://www.marinespecies.org/porifera/porifera.php?p=taxdetails&id=170437. Accessed 12 Mar 2017.
Vermeij MJA. The Current State of Curaçao's Coral Reefs. 2012
Warburton FE. Reproduction of fused larvae in the boring sponge, *Cliona celata*. Grant Nature. 1958;181:493–4.
Ward-Paige CA, Risk MJ, Sherwood OA, Jaap WC. Clionid sponge surveys on the Florida reef tract suggest land-based nutrient inputs. Mar Pollut Bull. 2005;51: 570–9. doi:10.1016/j.marpolbul.2005.04.006.
Zea S, Henkel TP, Pawlik JR. The sponge guide: a picture guide to Caribbean sponges. 3rd ed. 2014. Available online at, http://www.spongeguide.org.
Zilberberg C, Maldonado M, Solé-Cava AM. Assessment of the relative contribution of asexual propagation in a population of the coral-excavating sponge *Cliona delitrix* from the Bahamas. Coral Reefs. 2006;25:297–301.