

In situ observation confirmed a hypothesis that sea currents are the main spreading vector of marine alga *Caulerpa cylindracea*

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Introduction

Caulerpa cylindracea Sonder 1845 is a marine green alga. It is native to the Australia and introduced to the Mediterranean in the early 1990s with a first record in Libya (Verlaque *et al.*, 2000). Around 2000 it is spreading rapidly in almost every part of the Mediterranean and is considered an invasive species (Piazzi *et al.*, 2005). First report in the Adriatic Sea was in 2000 on Pakleni Islands (Croatia) (Žuljević *et al.*, 2003). Reproduction in the Adriatic but probably in the entire Mediterranean is exclusively by fragmentation (Žuljević *et al.*, 2012).

Scientific question

Based on numerous records of *Caulerpa cylindracea* along the Croatian part of the Adriatic Sea in a few years after its first observation (Figure 2), we published a hypothesis in 2004 that the sea currents represent a major factor in its spread (Žuljević *et al.*, 2004). However, human mediate transport, particularly ballast water and fishing equipment, are still considered as the main secondary spread vectors within the Mediterranean Sea (Cantasano *et al.*, 2017). We have attempted to verify our hypothesis through *in situ* testing of the ability of the alga to float and disperse by currents.

Methodology

Fragments of algal fronds were released by a diver approximately 1 m above the sea bottom. The time required for the fragment to reach the bottom was measured under no current while transport distance was measured under minimal current conditions. Experiment was conducted in summer 2010 and autumn 2018 and 2019.

Results

Summer 2010. Fragments sank relatively fast, with rate of 1 m in 2 min 30 sec or faster. Under conditions with minimal bottom currents, released fragments were transported as far as 10 m (Video 1). Autumn 2018 and 2019. Majority of released fragments floated for a prolonged period (> 5 min). Under conditions with minimal bottom currents, some of the fragments were lifted and drifted on indefinite distance (Video 2).

Discussion and conclusion

More than hundreds of distant locations have been recorded within 20 years in Croatia, documenting fast algal spread. Today it is present almost everywhere except in Velebit Channel. Majority of the locations are remote from ports and fishing areas. The conformation that this alga can float for a prolonged period presented here (Video 1 & 2), together with high spatial spreading dynamics (Figure 2.), indicate that currents are a predominant vector for secondary algal spread while human mediate transport probably has marginal impact. Majority of spreading occur during autumn and strong stormy weather that can produce numerous algal fragments that might float and in that circumstances can be easily dispersed along the coastline. Why the fragments can float during autumn despite sinking relatively quickly during summer remains unknown.

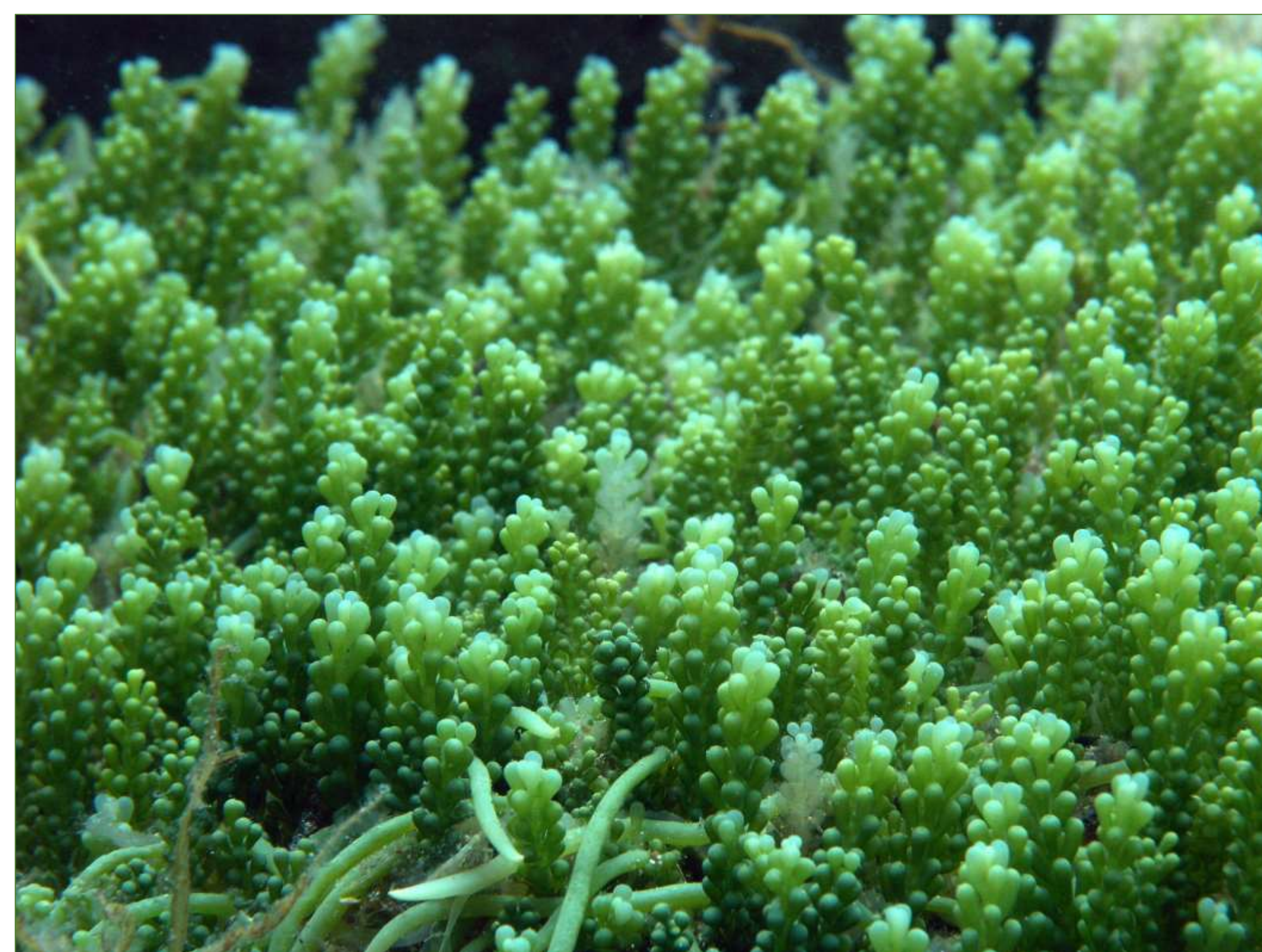


Figure 1. Dense settlements of *Caulerpa cylindracea*, July 2004., Island of Hvar, 2 m depth.

Synonyms and misidentification:

Caulerpa racemosa (Forsskål) J. Agardh

Caulerpa racemosa var. *cylindracea* (Sonder) Verlaque, Huisman & Boudouresque 2003



Video 1.



Video 2.



Figure 2.

Video 1. Relatively fast sinking of the *Caulerpa cylindracea* fragments in summer period. [LINK](#)

Video 2. Floating of *Caulerpa cylindracea* fragments in autumn period. [LINK](#)

Figure 2. Recorded locations of *Caulerpa cylindracea* in Croatia from 2000 till the end of 2010. [LINK](#)

References

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