Title: Intertidal Mediterranean coralline algae reef is expecting a shift towards a reduced growth and a simplified associated fauna under climate change
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**SUPPORTING INFORMATION**

**S1. Experimental design**

An orthogonal design incorporating seawater with two levels of both *p*CO2 and temperature representing current and predicted conditions for the year 2100 were used. *Ellisolandia elongata* tufts were exposed to one of these two *p*CO2x temperature levels for three months (August-October 2015). Three samples of *E. elongata* tufts were collected monthly from August to October, from four randomly selected areas at the sampling site in Palmaria island, as well as from the control and treatment aquaria of the experimental system.

The experimental system was set up in a room maintained at approximately 20°C (12h light: 12h dark), and adapted from Melatunan et al. (2011) and Lucey et al. (2016). The system consisted of six header tanks (HT: three control HT + three treatment HT; fiberglass, size (cm): 60  40  45), each containing 108 l of seawater and provided with three air-stones each (As 40, Tetra, Italia) and closed in order to reduce gas exchanges. From each of the control (C) HT (H1-H3-H5), seawater was gravity fed at a rate of 60 ml min-1 continuously to control each aquarium (60 l each) (C1-C2-C3-C4). Conversely from each of the treatment (T) HT (H2-H4-H6) seawater was fed at a reduced rate of 30 ml min-1 to each treatment aquarium (60 l each) (T1-T2-T3-T4) in order to control degasification and maintain the *p*CO2 levels, through flow control valves on PVC connection tubes. All flow rates were checked three times per day. CO2 gas was slowly released *via* a multistage regulator (6000 CO2, BOC, La Spezia) in a Buchner flask to enable mixing, monitored *via* gas Analyzer (Li- 820, Li-Cor, Biosciences, Lincoln, USA), and then bubbled with powerful air pump (Pro-Plus 4200, Zolux, France) in the treatment HT. The pH condition expected in 2100 was progressively (one month) reached in each treatment HT.

All aquaria (glass, 50  35  35 cm) were provided with a submersible pump for circulation and wave simulation (Wave & Circulation Pump 2200 l h-1, Hydor Koralia, USA) and another submersible pump dedicated to ensuring an effective gas exchange with the surface (HJ-311 300 l h-1, Sunsun, China). On each aquarium, light was guaranteed by suspended metal halide ceiling (Radior TS 150/230V, Ndl) equipped with two bulbs (32 HITLITE 150W – 10,000 K, HQI-Metal Halide Lamp) positioned at 19 cm from the aquarium cover for avoiding any heating on the sea water due to the intense light. Neutral gray-scale filters (15%) were placed on each cover (about 5 cm below the water surface) control the light intensity and the photoperiod was fixed at 10 h light:14 h dark for the entire duration of the experiment. At the beginning of the experiment, the projected 2100 temperature (+3 °C of the monthly mean) was gradually (one month) reached by adding a heater in each treatment aquarium (V2 Therm 300 W, TMC, Portugal).

From each aquarium, the overflow was filtered through a mesh (0.125 µm) for avoiding the loss of the macro-fauna associated to the turfs, and then drained into the sump by gravity (750 l) (fiberglass, size (cm): 250  100  40) passing through a system for seawater degasification. This system comprised rigid drilled tubes (ø: 1, 1.5, 2, 2.5 mm), a bio-balls layer and a pierced PVC sheet. Once on the bottom of the sump, two pumps (NJ3000 l h-1, Newa Jet, UK) were designed for favouring complete CO2 removal.

In order to guarantee sea water cleaning, sterilization and to reach the control temperature, the sump was provided with two protein skimmers (diameter: 5 cm, height: 50 cm), each one equipped with two submerged pump (NJ400 l h-1 and NJ3000 l h-1, New Jet, UK) and an air pump (Mouse Air Pump 4, Delta, USA), and with a chiller (TK3000H, Teco, Italy) provided with a UV bulb. Once degassed, sterilized and bring at the required temperature, part of the seawater was pumped back to the HT (*via* pump NJ 3000 l h-1 for each couple of HT) whereas a part was discharged.

Temperature in the experimental system was controlled *via* chiller to follow the mean monthly temperatures from July to October recorded in the Gulf of La Spezia in 2013 and 2014 by the ENEA observatory (<http://www.santateresa.enea.it/wwwste/osservatori/osservatorio_portovenere_parametri_fisici4.html>; Accessed July 2018) and adjusted on real-time weekly temperature collection.

In the aquaria, *E. elongata* turfs were self-sustained, however 1 l (0.125 l per aquarium) of *Chlorella* sp. mix (concentration: 2.3  105 algae l-1) was provided to the ecosystem once a week in order to guarantee enough food for the associated fauna.

Fifty percent of the seawater in the system, approximately 1000 l, was replaced weekly, aquaria were cleaned once per month, and deionized water was added as needed to maintain stable salinity levels and guarantee good water quality (i.e., to minimize ammonia accumulation).

New seawater was collected once per week from a site nearby the laboratory, prior pH and temperature monitoring, by pumping the water (RAY mod 91855, 230V, 50Hz 600W, 3000 l h-1, Papillon; USA) into 20 l and 30 l tanks transported in the laboratory with the van. Once in the laboratory, the water was stored in two connected containers (capability: 1000 l and 500 l) provided with submergible air pumps (NJ 3000 l -1h, Newa Jet, UK), and then filtered for 24 hours by using either mechanical (0.1 µm) and UV light filters (V2ecton 120, TMC, Portugal). After 24 hours, the water was pumped (NJ3000 l h-1, Newa Jet, UK) to the mesocosm *via* an irrigation system consisting of PVC tubes positioned on the top of the six HT and provided with flow control valves calibrated on a water flow rate of 60 ml min-1 (flow-rate check: three times per day).

Temperature (HI 935005 K-Thermocouple, Hanna, Usa), pH (pH meter SevenGo, electrode: inLAB® 413 SG/2m, Metter Toledo, Switzerland), salinity and oxygen (HQ30d Felxi and LDO probe, Hach, Usa) were collected three times per day (at 9:00, 13:00 and 16:00) for the entire experiment duration (from August to October 2015) from each HT, aquarium and the sump (Tab. 1, see main text). Water samples for total alkalinity (AT) were collected one time per day at 14.00 randomly from one aquarium in both conditions, control and treatment, and measured using Grant titration method (Dickson et al. 2007) (794 Basic Titrino, electrode: LL Unitrode Pt1000, Metrohm, Switzerland). Water sample for determining nutrient concentrations (N-NO2, N-NO3, Si-Si(HO4) and P-PO4) were collected from each condition once a week and measured (Autoanalyzer 3, Bran + Luebbe, Germany). Once a month, nutrient concentrations were also checked in the protein skimmers and the heater tanks (Tab. 2, see main text). Carbonate system parameters that were not directly measured were calculated using CO2SYS (Pierrot et al. 2006), employing constants from Mehrbach et al. (1973) refitted to the NBS pH scale by Dickson and Millero (1987) and the KSO4 dissociation constant from Dickson (1990) (**Table S1**).

**S2. Physico-chemical conditions of the mescosm unit**

In order to confirm that the values of temperature, salinity and CO32- monitored during the experiment differed significantly between control and treatment conditions and among months, data were analyzed by using General Linear Model (GLM). Normality and homoscedasticity were assessed by visually checking the residuals distributions and relation versus predicted values (Zuur et al., 2007). A more formal Levene’s test was also used to assess the variance homogeneity. When the test was significant (p < 0.05), transformations (square root, logarithmic) were applied. In the case of failure of the transformation, the more stringent criterion of α< 0.01 was applied (Underwood, 1997). Post-hoc Student-Newman- Kelus (SNK) tests was performed whenever a significant difference was found. These statistical analyses were performed using Statistica® v.7.

The analyses of physico-chemical variables confirmed that temperature, salinity and CO32- significantly differed between conditions (temperature: F1= 190.40, p < 0.01; salinity: F1= 425.4, p < 0.05; CO32-: F1= 82.76, p < 0.01). Temperature was significantly different between treatments (pH: F1= 94556.25, p < 0.01) and months (F2= 59105.08, p < 0.01) and post-hoc showed significant differences in August, September and October (p < 0.01) (SNK: August > September > October) (**Table S1**). Dissolved inorganic carbon was significantly different between conditions (F1= 174.95, p < 0.05) and among months (F2=166.96, p < 0.05; SNK: August < September = October). Similarly, *p*CO2 was significantly different between conditions (F1= 3080.65, p < 0.01) and among months (F2= 69.96, p<0.01; SNK: August=September< October) and condition \* month (F2= 42.53, p < 0.01). Finally, also HCO3- was significantly different between conditions (F1=127.75, p < 0.05), among months (F3=46.05, p<0.05; SNK: August>September>October) and condition \* month (F2=65.07, p < 0.01). Regarding saturation states, both Ω calcite and Ω aragonite were significantly different between conditions (ΩCal F1=86.24, p < 0.01; ΩAra F1=84.17, p < 0.01) and condition \* month (ΩCal F1=110.39, p < 0.01; ΩAra F2= 106.72, p < 0.01).

Regarding nutrients, both forms of nitrogen (N-NO3 and N-NO2), as well as silica (Si(OH)4) did not differ between treatments, although they all differed among months (N-NO3: F2= 247.31, p < 0.01; SNK: August = September > October; N-NO2: F2= 88.72, p < 0.05; SNK: August = September > October; Si(OH)4: F2= 291.19, p < 0.01; SNK: August = September > October), and both forms of nitrogen additionally differed significantly in condition  month (N-NO3: F2= 10.95, p < 0.01; N-NO2: F2= 10.95, p < 0.01).

**S3. Associated fauna**

The peracarid community associated to *E. elongata* at Palmaria exhibited a set of species that are already known to be associated to this alga from other areas of the Atlanto-Mediterranean region (Guerra-Garcia et al. 2009, 2012; Izquierdo & Guerra-Garcia 2011; Zakhama-Sraieb et al., 2011), e.g. *Caprella grandimana*, *Elasmopus pocillimanus*, *Parhyale stebbingi, Paranthura costana*; **(Table S2).** Additionally, we report here for the first time a caprellid amphipod belonging to the *Caprella acanthifera* group (Krapp-Schickel & Wader, 1998), which shows affinity to the species *Caprella stella* (J. Guerra-Garcia, pers. comm.), known from the Azores and Roscoff, but never reported before from the Mediterranean Sea (previous records being questionable, according to Krapp-Schickel & Wader, 1998). Our finding, from samples of August and October, could represent either a first confirmed record of *C. stella* from the Mediterranean, or a population of a related endemic species belonging to the *C. acanthifera* group, but yet undescribed. However, the juvenile stage of our individuals does not allow to reach a conclusive identification.

As regards Polychates, most of the species found in the Palmaria *E. elongata* turfs were already known to occur from this habitat **(Table S3)**, except from two species, namely *Prionospio* aff. *caspersi* and *Proceraea picta*, both occurring very sporadically in the Palmaria island samples, but not yet reported from other *E. elongata* turfs (Rubbiani, 1985; Abbiati et al., 1987; Somaschini, 1988; Alos, 1990; Muntoni, 1996; Tena et al., 2000; Kitsos, 2003; Melero et al., 2017; Langeneck & Castelli, unpublished). The recorded individuals identified as *Prionospio* aff. *caspersi* correspond well with this species as regards the shape of branchiae, but differ in the absence of eyes (Laubier, 1962; Dağli & Çinar, 2009). Moreover, this species is typically related to clean fine sand, while these individuals occur on hard bottoms among algae. It is possible that these individuals represent an undescribed species, but the scarce number of available specimens compels to be cautious in this regard.

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**List of Tables (see** **Supporting Information - Tables S1, S2, S3)**

**Tab. S1 -** Physico-chemical parameters (means ± SD) of the seawater in the mesocosm unit measured or calculated during the duration of the experiment: pH (National Bureau of Standards scale; Mettler-Toledo pH meter), temperature, salinity, oxygen saturation (%), total alkalinity (AT; Alkalinity Titrator Metrhom) using the method developed by Dickson et al. (2007), dissolved inorganic carbon (DIC; Total CO2 Analyser, CIBA Corning 965D, Essex, United Kingdom, carbon dioxide partial pressure (*p*CO2), bicarbonate and carbonate ion concentration ([HCO3-] and [CO32-]), calcite and aragonite saturation states (ΩCal and ΩAra), and nutrients (N-NO3, P-PO4, Si-Si(OH)4, N-NO2).

\*Parameters were calculated using the CO2SYS program (Pierrot et al. 2006), employing the dissociation constants of Mehrbach et al. (1973) as refitted by Dickson and Millero (1987).

**Tab. S2** - Peracarid crustaceans associated to *Ellisolandia elongata* in the present work and in the literature. Species in bold font are those reported only from Palmaria island and not from other areas.

**Tab. S3 -** Polychaetes associated to *Ellisolandia elongata* in the present work and in the literature. Species in bold font are those reported only from Palmaria island and not from other *E. elongata* areas.