

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/funeco

Effects of temperature and glucose concentration on the growth and respiration of fungal species isolated from a highly productive coastal upwelling ecosystem

Marcelo E. FUENTES^{a,b}, Renato A. QUIÑONES^{a,b,c,*},
Marcelo H. GUTIÉRREZ^d, Silvio PANTOJA^{a,d}

^aGraduate Program in Oceanography, Department of Oceanography, University of Concepción, Casilla 160-C, Concepción, Chile

^bInterdisciplinary Center for Aquaculture Research (INCAR), University of Concepción, Casilla 160-C, O'Higgins 1695, Concepción, Chile

^cPrograma de Investigación Marina de Excelencia (PIMEX), Faculty of Natural and Oceanographic Sciences, University of Concepción, Casilla 160-C, Concepción, Chile

^dCenter for Oceanographic Research in the Eastern South Pacific (COPAS Sur-Austral), Universidad de Concepción, Casilla 160-C, Concepción, Chile

ARTICLE INFO

Article history:

Received 18 October 2013

Revision received 2 August 2014

Accepted 25 August 2014

Available online 7 November 2014

Corresponding editor:

Felix Bärlocher

Keywords:

Allometry

Ascomycota

Central-south Chile

Glucose availability

Marine fungi

Respiration

Temperature

ABSTRACT

Respiration and growth rates were measured in five species of fungi (*Penicillium decumbens*, *P. chrysogenum*, *Acremonium strictum*, *Fusarium fujikuroi* and *F. sporotrichioides*) isolated from the upwelling system off the coast of central-south Chile to determine the effects of glucose availability and temperature. Growth was monitored by epifluorescence microscopy, ATP measurements, and optical density. Oxygen consumption was recorded via a respirometer with Optode sensors. Although species-specific responses were found, overall both respiration and growth increased with temperature and glucose concentration. Growth of *P. decumbens*, *F. sporotrichioides* and *F. fujikuroi* was more favoured by temperature when glucose remained stable. *P. chrysogenum* had a particular growth pattern, which seemed to be more linked to glucose availability than directly to temperature. Growth of *F. sporotrichioides* and *A. strictum* responded to the synergistic interaction between temperature and glucose. Values of Q_{10} for fungal respiration ranged from 2.2 to 6.7, indicating a strong temperature-dependence of respiration rates, especially in *A. strictum* and *F. sporotrichioides*.

© 2014 Elsevier Ltd and The British Mycological Society. All rights reserved.

* Corresponding author. Graduate Program in Oceanography, Department of Oceanography, University of Concepción, Casilla 160-C, Concepción, Chile. Tel.: +56 (041) 2661499; fax: +56 (041) 222 5400.

E-mail address: rquinone@udec.cl (R.A. Quiñones).

<http://dx.doi.org/10.1016/j.funeco.2014.09.006>

1754-5048/© 2014 Elsevier Ltd and The British Mycological Society. All rights reserved.

Introduction

Marine fungi constitute an ecological group mostly made up of filamentous ascomycetes, but also some basidiomycetes and yeasts (Pang and Mitchell, 2005). Fungi may be saprotrophic, pathogenic or mutualistic as an evolutionary consequence of the fungal cell and its feeding strategies (Adomas et al., 2008; Martin et al., 2011). Several ascomycete species in the marine environment are pathogens of algae (Kohlmeyer and Kohlmeyer, 1979). For example, certain fungi can cause abnormal growth in macroalgae (Richards et al., 2012).

The ecological success of fungi is linked to the fungal cell wall, composed of chitin/cellulose, which reinforces the fungal cell and allows it to resist the osmotic pressure produced during feeding, and to survive in diverse and heterogeneous environments (Richards et al., 2012). These adaptations have led to high metabolic rates and rapid growth (Bartnicki-García, 1979). Fungi are ubiquitous and capable of occupying every ecological niche (Richards et al., 2012). They are able to develop in nutrient-rich environments, such as those provided by plants and animals, soils, sediments and detrital environments, where they can adhere to substrata, secrete enzymes, decompose complex biological polymers and absorb nutrients (Richards et al., 2012). Temperature is one of the major factors affecting the diversity of marine fungi, along with salinity (Jones, 2000; Babu et al., 2010).

In the ocean, the rain of particulate matter from the photic zone down through the water column and ultimately reaching bottom sediments can represent a favorable niche for saprotrophs, making them an important component at the bottom of the detrital food chain and critical for the survival of detritivorous animals (Raghukumar, 2004; 2008). Indeed, fungi can be the dominant microeukaryotes in particular environments, such as methane seeps (Takishita et al., 2006) and deep water sediments (Damare and Raghukumar, 2008). This opportunistic strategy of fungal nutrition leads to a rapid response to changes in substrate conditions (Lindahl et al., 2010) and the production of structures for resistance and dispersal that allow fungi to persist despite limited growth under adverse environmental conditions (e.g. extreme coastal continental Antarctic, sea ice) (Gunde-Cimerman et al., 2003; Magan, 2007). The processing of detritus remains a poorly-studied subject in marine ecology, as well as the role of fungi as saprotrophs in the ocean, and thus is a central challenge in understanding nutrient cycling and the role of these organisms in the carbon cycle (Richards et al., 2012).

More than 500 species of marine fungi many of which have the capacity to decompose lignocellulose (Hyde et al., 1998) have been isolated from different marine environments (Jones, 2000). Lignocellulose is composed of structural blocks of glucose in combination with xylose and other minors (Mabee et al., 2006). Evidence of cellulolytic activity in seawater suggests the presence of a sufficient quantity of glucose for the growth and metabolism of microorganisms that take part in cellulolytic activity (Greene and Barnett, 1951; Sgueros et al., 1962). The concentrations of neutral free sugars in the ocean are generally very low (<50 nM; Rich et al., 1996; Skoog et al., 1999); in the surface ocean (<100 m) total hydrolyzable neutral sugars were found to range between 200 and 800 nM

(Benner, 2002). Neutral monosaccharides such as glucose have been examined more widely since the introduction of techniques capable of measuring their concentrations in seawater (Mopper et al., 1992).

It is widely known that the microbial realm plays a crucial role in the biogeochemistry of the ocean (e.g. Bowler et al., 2009; Giovannoni and Vergin, 2012). In the upwelling coastal ecosystem off central-south Chile, some of the highest primary productivity rates ever measured have been reported (e.g. Daneri et al., 2000; Montero et al., 2007). Moreover, studies on prokaryote assemblages in this zone have shown substantial biomass (bacteria and archaea) and very high secondary production (McManus and Peterson, 1988; Troncoso et al., 2003; Cuevas et al., 2004; Levipan et al., 2007; Quiñones et al., 2009), indicating that a significant fraction of the primary productivity is channeled through the microbial food web (Quiñones et al., 2010). The recent discovery, by Gutiérrez et al. (2011), of very high biomass and high extracellular enzyme activity on proteinaceous and glucosidic substrates by microscopic filamentous fungi in this ecosystem raises the question of the ecological and biogeochemical roles played by fungi within the microbial realm.

There is a positive association between the increase in fungal biomass and periods of high autotrophic biomass in surface waters of upwelling ecosystems in central-south Chile (Gutiérrez et al., 2011). Often phytoplankton groups have high quantities of glucose stored in polysaccharides and produce exopolymers (Biersmith and Benner, 1998; Aluwihare and Repeta, 1999; Janse et al., 1999), making them a potential source of substrate (i.e. mono(poly)saccharides) for fungal growth. During active upwelling periods, fungal biomass is comparable to that of bacteria and archaea in central-south Chile and increases after the maximum of phytoplankton biomass (Gutiérrez et al., 2011). Since glucose is the principal and preferred fuel for ATP production in eukaryotic microorganisms (Chambergo et al., 2002), glucose respiration can be considered as an indicator of heterotrophic activity.

The highly productive coastal upwelling area off Concepción (central-south Chile) presents drastic changes between hydrographic regimes over temporal scales of days (tides, summer sea breeze), to intraseasonal (upwelling events, river discharge pulses) and seasonal (coastal wind patterns, radiation) (Sobarzo et al., 2007; Hernández et al., 2012). All variations in physical and hydrographic forcing can lead to changes in the distribution and composition of phytoplankton (Iriarte et al., 2012), which is closely linked to the distribution of filamentous fungi (Gutiérrez et al., 2011). The effects of variations in temperature and nutrient availability on marine filamentous fungi have received minimal attention, despite their potential role in nutrient and energy fluxes of the coastal ecosystem.

Herein we tested the following hypotheses: (i) an increment in water temperature produces higher growth and respiration rates of filamentous fungi inhabiting the upwelling coastal ecosystem off south-central Chile, and (ii) an increment of glucose concentration in the culture medium produces higher growth and respiration rates of filamentous fungi from the upwelling coastal ecosystem off south-central Chile.

Download English Version:

<https://daneshyari.com/en/article/2053547>

Download Persian Version:

<https://daneshyari.com/article/2053547>

[Daneshyari.com](https://daneshyari.com)