J Appl Phycol (2013) 25:285–297
DOI 10.1007/s10811-012-9863-8

Response of Antarctic, temperate, and tropical microalgae to temperature stress

Ming-Li Teoh · Siew-Moi Phang · Wan-Loy Chu

Received: 14 March 2012 / Revised and accepted: 30 May 2012 / Published online: 17 June 2012

Abstract The global temperature increase has significant implications on the survival of microalgae which form the basis of all aquatic food webs. The aim of this study was to compare the response of similar taxa of microalgae from the Antarctic (*Chlamydomonas* UMACC 229, *Chlorella* UMACC 237, and *Navicula glaciei* UMACC 231), temperate (*Chlamydomonas augustae* UMACC 247, *Chlorella vulgaris* UMACC 248, and *Navicula incerta* UMACC 249), and tropical (*C. augustae* UMACC 246, *C. vulgaris* UMACC 001, and *Amphiprora* UMACC 239) regions to changing temperature. The Antarctic, temperate, and tropical strains were grown over specific temperature ranges of 4 °C to 30 °C, 4 °C to 32 °C, and 13 °C to 38 °C, respectively. The three Antarctic strains survived at temperatures much higher than their ambient regime. In comparison, the tropical strains are already growing at their upper temperature limits. The three *Chlorella* strains from different regions are eurythermal, with a large overlap on tolerance ranging from 4 °C to 38 °C. The specific growth rate (μ) of the Antarctic *Navicula* decreased (<0.34 day^{-1}) at temperatures above 4 °C, showing it to be sensitive to temperature increase. If further warming of Earth occurs, *N. glaciei* UMACC 231 is likely to have the most deleterious consequences than the other two Antarctic microalgae studied. The percentage of polyunsaturated fatty acids (PUFA) decreased with increasing temperature in the Antarctic *Navicula*. As temperature increases, the growth and nutritional value of this commonly occurring diatom in the Antarctic may decrease, with consequences for the aquatic food web. Of the three *Chlamydomonas* strains, only the Antarctic strain produced predominantly PUFA, especially 16:3 (48.4–57.2 % total fatty acids).

Keywords Antarctic microalgae · Temperature stress · *Chlamydomonas* · *Chlorella* · Diatoms

M.-L. Teoh · S.-M. Phang
Institute of Ocean & Earth Sciences, University of Malaya,
50603 Kuala Lumpur, Malaysia

S.-M. Phang (✉)
Institute of Biological Sciences, Faculty of Science,
University of Malaya,
50603 Kuala Lumpur, Malaysia
e-mail: phang@um.edu.my

W.-L. Chu
International Medical University,
No. 126, Jalan 19/155B, Bukit Jalil,
57000 Kuala Lumpur, Malaysia

Introduction

Global warming over the last few decades has been associated with increased temperature and carbon dioxide (CO_2) levels, rising sea levels, thinning of icebergs, retreats of sea ice, and chaotic weather patterns all over the world (IPCC 2007). The recent warming has been greatest over the mid- to high-latitudes of the Northern Hemisphere, especially in the winter half-year (IPCC 2007). Anthropogenic chlorofluorocarbons, CO_2, and other greenhouse gases released into the atmosphere are causing rapid global climatic warming which can be seen having its greatest impact in the Antarctic Peninsula (Huiskes et al. 2006; Clarke et al. 2007; IPCC 2007). In the temperate region, the effects of global warming are obvious in Europe, as the summer 2003 heat wave was probably the highest temperature ever recorded since 1500 (Gomez and Souissi 2008). Warming has also occurred in the tropical region. For instance, during the last 42 years from 1961 to 2002, the surface temperatures in most regions in Malaysia showed significant