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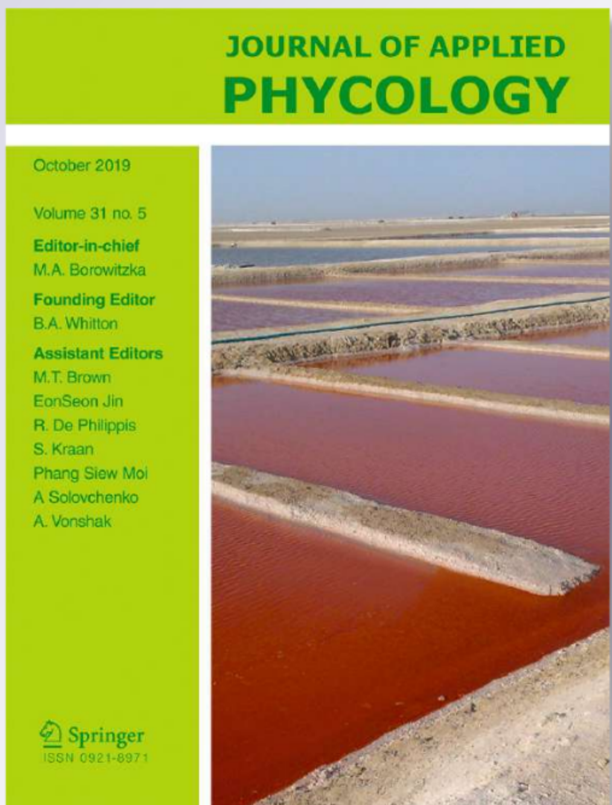

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Long-term reliable culture of a halophilic diatom, *Amphora* sp. MUR258, in outdoor raceway ponds

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Abstract

The microalgal industry as a source of high-value products (i.e. β-carotene, astaxanthin) was established over 50 years ago. However, only a very small number of species have been commercialised. There is a need for new species and new products to expand this industry. The objective of this study was to examine the reliability and productivities of long-term outdoor culture of a newly isolated halophilic diatom, *Amphora* sp. MUR258 (Bacillariophyceae), in raceway ponds in Perth, Western Australia. The *Amphora* sp. was grown in outdoor raceway ponds as a semi-continuous culture for about 13 months at a culture salinity between 8.6 and 14.9% (*w*/*v*) NaCl. The highest cell density (167×10^4 cells mL^{-1}), specific growth rate (0.29 day^{-1}) and biomass and lipid productivities (24 and 6.8 g m^{-2} day^{-1}, respectively) were achieved in summer. The annual average of biomass (ash-free dry weight) and lipid productivities was 7 and 2.2 g AFDW m^{-2} day^{-1}, respectively. Minor contamination by a *Navicula* sp. was seen during winter, but was not a significant problem. No major protozoan contamination was seen. These results indicate the potential of reliable large-scale cultivation of *Amphora* sp. MUR258 as a potential source of diatom lipid and/or fucoxanthin.

Keywords Bacillariophyceae · Halophilic diatom · Long-term culture · Raceway pond · Productivity

Introduction

Microalgae have become of particular interest over the last few decades due to their capability to synthesise a range of valuable compounds making them a potentially important source of chemical products than can be used in the feed, food, nutrition, cosmetics, pharmaceuticals and biofuels industries (Gong et al. 2011). Moreover, microalgae are very diverse (estimated several million species) compared with about 250,000 species of higher plants, around 77,000 fungal species and 2500 bacterial species, and they are an untapped resource of natural compounds waiting to be discovered (Radmer and Parker 1994). Currently, only a few microalgae species such as *Chlorella*, *Spirulina* (*Arthrospira*), *Dunaliella* and *Haematococcus* are being successfully grown commercially at large scale (Borowitzka 2018). Successful commercial large-scale microalgae production depends on many factors, one of which is the development of cost effective large-scale culture systems for the algae. There are two main types of cultivation systems currently available, open ponds and closed photobioreactors (Borowitzka and Moheimani 2013a; Zittelli et al. 2013). To date, open ponds are more economical to build and operate compared with closed photobioreactors. This makes open cultivation systems such as paddle wheel–driven raceway ponds as the most widely used cultivation system for large-scale microalgae production (Borowitzka and Moheimani 2013a).

One of the main challenges for large-scale culture is contamination especially by other algae and grazers, making it difficult to operate a reliable mono-species culture for a long term. Most of current commercially produced microalgae (i.e. *Spirulina*, *Chlorella* and *Dunaliella*) have a common characteristic which is their ability to grow in highly selective environments allowing them to grow in open air systems and still remain relatively free of contamination by other algae or protozoa (Borowitzka 2013). For instance, *Chlorella* prefers nutrient-rich media for optimum growth, *Dunaliella salina* grows at very high salt concentrations (up to 35% NaCl) and *Spirulina* requires a high alkalinity (Borowitzka 2005). Therefore, selecting the right algal species for large-scale outdoor culture is a critical factor in the development of

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