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First record of *Chrysophaeum taylorii* Lewis & Bryan and their benthic mucilaginous aggregates in the Aegean Sea (Eastern Mediterranean)

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Abstract

Chrysophaeum taylorii Lewis & Bryan is a marine chrysophytes belonging to Sarcinochrysidales. This species is known as one of the mucilaginous producer species in the benthic areas. They form large colonies that resemble thalli of macroalgae. Geographical distribution of this species and their copious mucilage production in benthic areas were reported in tropical and subtropical Atlantic and Western Pacific coasts. In this study, *Chrysophaeum taylorii* Lewis & Bryan and their mucilaginous macro aggregates reported for the first time on the benthic substrata in the Aegean Sea, Eastern Mediterranean.

Keywords: *Chrysophaeum taylorii,* benthic mucilage, Bodrum, Aegean Sea, Eastern Mediterranean

Introduction

The mucilage phenomenon in the sea has been highlighted in recent years by the occurrence of increasingly severe planktonic (Vollenweider and Rinaldi 1995; Giani *et al*. 2005a; Aktan 2008; Danovaro *et al*. 2009; Balkıs 2010) or benthic algal blooms (Sartoni *et al*. 1995; Hoffmann *et al*. 2000; DePhilippis *et al*. 2003; Schaffelke *et* *al*. 2004; Schiaparelli *et al*. 2007; Luglié *et al*. 2008) in the world. The mass development of marine mucilaginous aggregates in the coastal ecosystems have a great ecological impact due to significant role in the benthic and pelagic food web (Leppard 1995; Metaxatos 2003) and negative effect on marine ecosystem by causing oxygen deficiency, mass mortalities of fish and benthic organisms and trophic disruption (Degobbis *et al*. 1995; Metaxatos 2003; Giuliani *et al*. 2005). As a result of these changes, environmental and economical losses (causing problems to recreation, public health, fisheries and aquaculture) are inevitable (Rinaldi *et al*. 1995; Metaxatos 2003; Giuliani *et al*. 2005; Danovaro *et al*. 2009).

Earlier studies demonstrated that Mediterranean marine biota is also changing under the influence of men, climate and invasion of alien species as well (Bianchi and Morri 2000; Gomez 2003 and references therein; Coll *et al*. 2010). Huge phenomena of pelagic mucilage formation and their negative effects on benthic substrata have been extensively studied in the coastal and open waters of the Mediterranean since the 1980's. Along the coastlines of the Tyrrenian Sea for the Mediterranean, however, limited number of studies are available about benthic mucilage caused by Sarcinochrysidales (Chrysophyceae) (Janssens 1996; Luglié 2008; Hoffmann *et al*. 2000; Caronii *et al*. 2010).

Chrysophaeum taylorii is a member of the order Sarcinochrysidales (Chrysophyta) and responsible for the production of mucilaginous material (Schaffelke *et al*. 2004). The Chrysophytes are small and neglected members in the marine algal groups. It contains about 200 genera and only a few species are to be found in brackish or salt water. In this group, the members of Sarcinochrysidales occur in estuarine and coastal marine waters. Most of the species are unicellular or colonial, simple multicellular forms, either filamentous or thalloid, and grow in the upper part of the intertidal zone (Hoek *et al*. 1998).

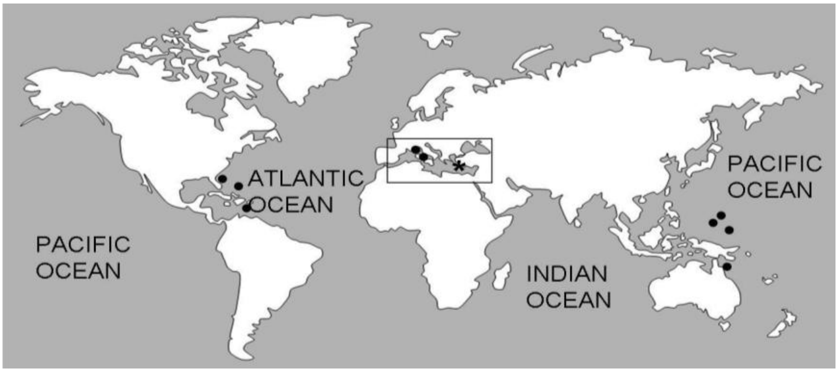


Figure 1. Distribution of *Chrysophaeum taylorii* in the world seas*:* the Atlantic (Guiry and Guiry 2011 and references therein) and Pacific oceans (Lobban and Tsuda 2003; Lobban *et al*. 2005; Schaffelke *et al*. 2004) and the western Mediterranean Sea (Luglié *et al*. 2008 and Caroni *et al*. 2010). * First record from the Aegean Sea (eastern Mediterranean) in the present study.

The distribution of this species was given in the tropical regions of the Atlantic and Pacific Oceans (Figure 1). The first record of *C. taylorii* was recorded in shallow waters of Florida by Lewis and Bryan (1941), and then it was observed in the tropical and subtropical Atlantic islands, North America, Caribbean and Pacific islands (Guiry and Guiry 2011). It has been rarely reported from the Mediterranean Sea. Although the mass occurrence of benthic mucilaginous material, resulting from *Chrysonephos lewisii* and *Nematochrysopsis marina* (Chrysophyceae) and *Acinetospora crinata* (Phaeophyceae), was documented in the early 1990's from the Italian and French coasts, an anomalous presence and a great public nuisance of *C. taylorii* was documented in the Western Mediterranean Sea (Sardinia, Tyrrhenian Sea) for the first time in summer 2007 (Luglié *et al*. 2008). Later studies in the summer period of 2009 indicated that *C. taylorii* continued to spread along the central-eastern coast of Sardinia (Caronni *et al*. 2010).

In this study, benthic marine chrysophytes *C. taylorii* Lewis & Bryan is reported for the first time from Eastern Mediterranean Sea. This new record contributes to the algal flora in Turkish seas in terms of species diversity, and also supplies new information about spreading areas of *C. taylorii*, defined as "*a nuisance algae*" due to its mucilaginous colonies in the benthic marine ecosystems, in the Mediterranean Sea.

Materials and Methods

Field observation and sampling were made in May 2011 at several locations (Great Reef, Karaada and Orak Island) along the Bodrum coasts (southwest of Turkey) in Eastern Mediterranean (Figure 2). Benthic mucilaginous aggregates were sampled by SCUBA divers. Samples were fixed with neutralized formalin (4%). Microscopic studies were made on both unfixed-living and fixed materials with a Nikon TE2000U inverted microscope at X400 magnification. Water temperature was measured with a thermometer.

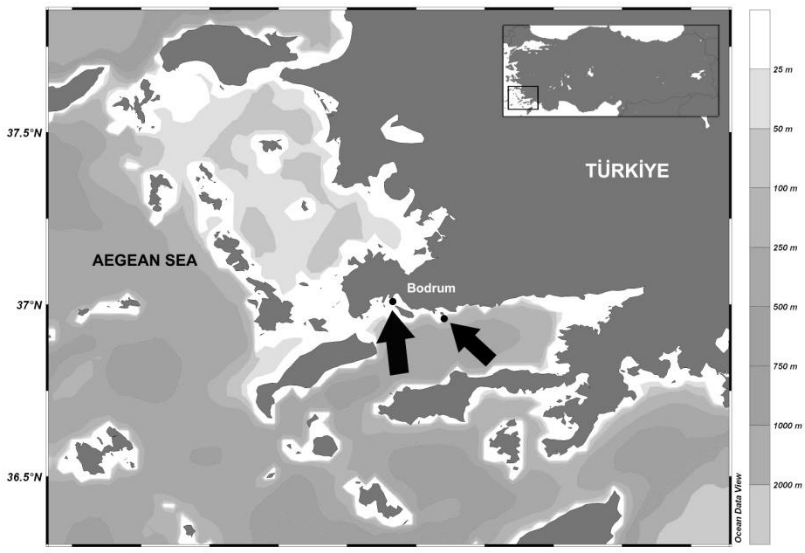
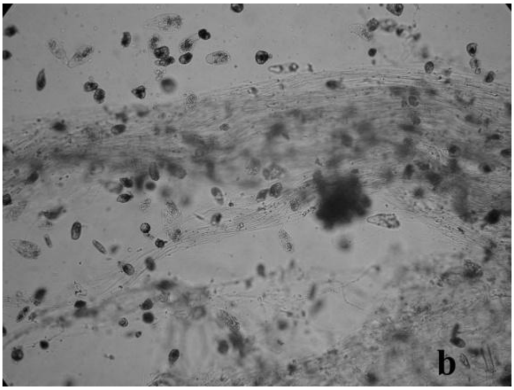


Figure 2. Sampling sites in Bodrum Peninsula

Results and Discussion

Benthic mucilaginous aggregates with a yellow-brownish color were in situ observed in May of 2011 in the benthic area along the Bodrum coasts in the Aegean Sea (eastern Mediterranean) (Figure 2). The water temperature was 18 °C. The mucilaginous material was observed as a thick cover on macroalgae and other benthic organisms including rocky substrata between 5 to 20 m depths. In the microscopic observation of samples, we observed that *Chrysophaeum taylorii* was the most abundant species within an amorphous mucilage matrix, intertwined cohered mucilage stalks and *Chrysophaeum* cell colonies. The size of cells was 72±4µm long and 40±2µm wide and had a characteristics shape of cells with their peculiar tubular invagination and light yellow-brown chromatophores in the cells (Figure 3).



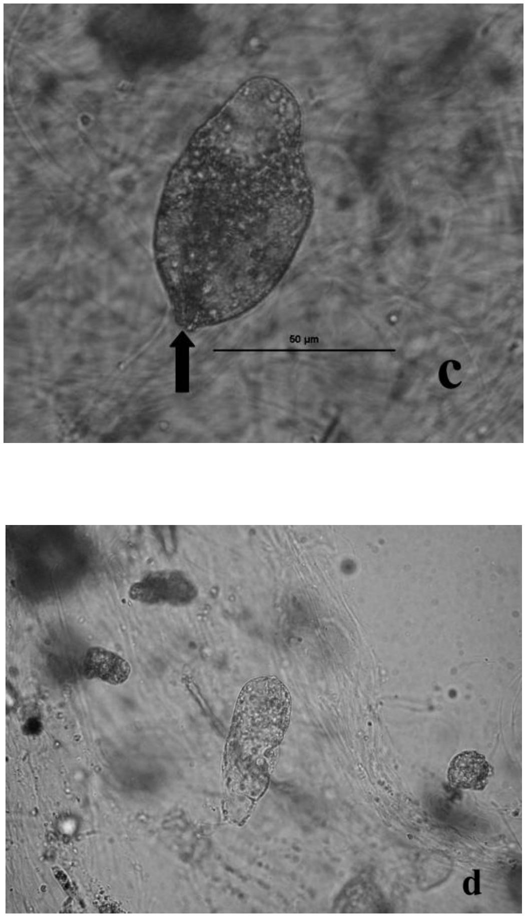


Figure 3. (a) Mucilaginous aggregate on the benthic substrata, (b) *Chrysophaeum* cells within an amorphous mucilage matrix, (c, d) *Chrysophaeum taylorii* within an amorphous mucilage matrix, intertwined cohered mucilage stalks.

The classification of this species is not clear and it seems that more detailed research is necessary to determine the phylogenetic affinities of the algae. They have been traditionally included in Chrysophyceae. However, some researchers evaluate it as a separate class Sarcinochrysidophyceae in Heterocontophyta because of some similar and/or different features with Phaeophyceae (Hoek *et al*. 1998; Hoffmann *et al*. 2000). On the other hand, in the subsequent study, some marine species of chrysophytes that form macroscopic colonies has been considered to be in the Pelagophyceae as a class of heterocont algae (Lobban and Tsuda 2003).

Some organisms extend their geographical range following natural or man-made changes in the environment. In many cases the introductory vector of a new species or their presence and changing abundance in their native areas is unknown or assumed (Streftaris *et al*. 2005). The presence of *C. taylorii* in the Mediterranean Sea has been hypothesized as this species is a very rare native warm-water species and has become more abundant with climate change or it is an introduced species. The first presence and intense growth of this species in the western Mediterranean (Tyrrhenian Sea), which has colder water than in eastern Mediterranean Sea, seems like an evidence for the second hypothesis. However, at this point, high trophic status (supporting algal production) in the western Mediterranean than that of eastern and, of course, the lack of scientific studies in eastern Mediterranean should be taken into account. In recent decades, scientific awareness has increased and algal monitoring studies started on a regular basis considering the effect on ecosystem and human health, fisheries and aquaculture activities (deBoer 2006). Therefore, monitoring studies in the western Mediterranean have improved. The invasion of alien or exotic species in the Mediterranean Sea has been recorded for many years (Öztürk 2010). Algal species may also have been introduced by natural (water currents via straits, birds) or anthropogenic (ballast water, aquaculture or aquarium products) means (deBoer 2006). Mediterranean biota has started to change with the introduction of alien species in the last few decades due to lessepsian migration, Atlantic influx, intentionally or unintentionally introduction and climate change (Öztürk 2010). Consequently, to make a clear comment of the biogeographical distribution of this species is not easy and we can consider it as a "*questionable*" introduced species.

In recent studies on extensive blooms of benthic colonial chrysophytes algae in oligotrophic waters, although temperature is regarded as one of the important environmental factor triggering blooms (Schaffelke *et* *al*. 2004; Sparrow and Heimann 2007), researches also continue to focus on nutrient limitation in algal blooms. The Mediterranean Sea is known as the least productive water of the world (Azov 1991). However, considering the enrichment coastal areas of this sea due to river discharges and municipal sewage (Coll *et al*. 2010 and references therein), more detailed researches are needed to demonstrate the role of nutrients on the spread of this algae. Monitoring studies are of great importance in terms of determination of the change in the Mediterranean and revealed the potential causes and consequences of these changes. If the occurrence of benthic mucilage continues and more widely spreads around the coastal areas of the Mediterranean Sea in future, benthic ecosystem may be damaged and even seriously environmental and economical losses occur.

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Chrysophaeum taylorii Lewis & Bryan ve oluşturduğu bentik müsilajlı birikimin Ege Denizi'nden (Doğu Akdeniz) ilk kaydı

Özet

Chrysophaeum taylorii Lewis & Bryan Sarcinochrysidales ordosuna dahil denizel Chrysophyta üyesidir. Makroalg tallusuna benzeyen büyük koloniler oluşturan bu alg, denizel bentik alanlarda müsilaj üreten türlerden biri olarak bilinir. Bu türün coğrafik dağılımı ve bentik alanlarda meydana getirdiği yoğun müsilaj üretimi tropikal ve subtropikal Atlantik ve Batı Pasifik kıyılarından kaydedilmiştir. Bu çalışmada *Chrysophaeum taylorii* Lewis & Bryan ve onun meydana getirdiği müsilajlı makro birikim Ege Denizi (Doğu Akdeniz)' de ilk kez kaydedilmiştir.

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