

## *Gonyaulax hyalina* and *Gonyaulax fragilis* (Dinoflagellata), two names associated with ‘mare sporco’, indicate the same species

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**ABSTRACT:** Aggregates of mucilaginous material have been at times observed in coastal and oceanic sea waters. In the Adriatic Sea (Mediterranean Sea), these events have been known since the 18th century as ‘mare sporco’ (= dirty sea), and in recent years, they have been associated with the dinoflagellate *Gonyaulax fragilis*; whereas, in New Zealand mucilage events were linked to *Gonyaulax hyalina*. In summer 2012, during a ‘mare sporco’ event in the Gulf of Naples (Mediterranean Sea), numerous cells of a species tentatively identified as *Gonyaulax hyalina* were detected in the mucilaginous aggregates. Since the boundary between *G. fragilis* and *G. hyalina* was not clear, we compared a strain isolated from the Gulf of Naples in 2012 with two strains from the Adriatic Sea and New Zealand waters, the latter two identified as *G. fragilis* and *G. hyalina*, respectively. Detailed light microscopy and scanning electron microscopy observations of the three strains showed that all shared the same thecal plate pattern and morphological features. Partial small subunit and large subunit rDNA regions of the three strains were identical. Based on these results and on a revision of the taxonomic history of the two taxa, we propose that *G. fragilis* and *G. hyalina* are the same species. *Gonyaulax fragilis* was described as *Steiniella fragilis* by Schütt in 1895 and transferred to *G. fragilis* by Kofoid in 1911. *Gonyaulax hyalina* was described a few years later by Ostenfeld and Schmidt in 1901. Thus, the name *G. fragilis* has priority, while *G. hyalina* is to be considered a synonym.

**KEY WORDS:** *Gonyaulax fragilis*, *Gonyaulax hyalina*, HABs, LSU, Mare sporco, Marine slime, Mucilage, SEM, SSU

### INTRODUCTION

The Italian term ‘mare sporco’ (= dirty sea) refers to a phenomenon consisting of massive mucous aggregates, organized in flocks or strings up to several meters long, which accumulate at sea surface after being observed in the water column or at the pycnocline (Precali *et al.* 2005). In the northern Adriatic Sea, these events are relatively common, and reports date back to the 18th century (Fonda Umani *et al.* 1989). The mucus aggregates are generally detected in the warm season when the water column is stratified and meteorological conditions are stable (Herndl *et al.* 1989; Alldredge *et al.* 1998).

While planktonic and benthic diatoms have often been reported within mucous aggregates, Alldredge *et al.* (1998) first found high abundances of thecate dinoflagellates – most of them belonging to the genus *Gonyaulax* – within large aggregates of marine snow in the Santa Barbara Channel (California, USA). Subsequently *Gonyaulax hyalina* Ostenfeld & J.Schmidt was identified as the causative species of a mucilage event that occurred in New Zealand (MacKenzie *et al.* 2002); whereas, *Gonyaulax fragilis* (F.Schütt) Kofoid was repeatedly reported in mucous aggregates during ‘mare sporco’ events in the Adriatic Sea (Honsell *et al.* 1992; Pompei *et al.* 2003; Pistocchi *et al.* 2005; Totti *et al.* 2005). *Gonyaulax fragilis* was also reported during similar events in the Marmara Sea (Tüfekçi *et al.* 2010; Balkis *et al.* 2011), in the North Aegean Sea (Nikolaidis *et al.* 2008) and along the Spanish coast (Sampedro *et al.* 2007). In the summer of 2012,

tongues of mucilage, clearly visible at the surface level (Fig. 1), were observed in the Gulf of Naples. An *ad hoc* sampling revealed high concentrations of a thecate dinoflagellate tentatively identified as *G. hyalina*. Studies performed with cultures showed that both *G. hyalina* and *G. fragilis* constitutively produce and exude abundant polysaccharides (MacKenzie *et al.* 2002; Pistocchi *et al.* 2005). Cell proliferations during ‘mare sporco’ events, in which these species have been recorded, are caused by yet unknown factors but are largely influenced by oceanographic and meteorological conditions (Russo *et al.* 2005).

*Gonyaulax fragilis* (syn. *Steiniella fragilis* F.Schütt) and *G. hyalina* were described around the turn of the 20th century (Schütt 1895; Ostenfeld & Schmidt 1901) with limited information on plate morphology and thecal plate pattern. Morphological features such as the fragile theca, longitudinal striae on thecal plates, the quadrangular 6'' plate and the extension of the sulcus into the epitheca up to the apex were included in the description of both species (Schütt 1895; Schütt 1896; Ostenfeld & Schmidt 1901). More details were provided in subsequent years (e.g. Kofoid 1911; Schiller 1937); although, the description of the thecal plate pattern remained incomplete. Several authors, including Balech (1962) and Balech *et al.* (1984), highlighted the difficulty of distinguishing the two species. Nonetheless, in the following years, specimens from natural samples and cultures were still identified using one or the other name, based on cell shape and thecal ornamentation (e.g. Wood 1954; Taylor 1976; Dodge 1989).

In the present study, three dinoflagellate strains, one collected from the Adriatic Sea (Mediterranean Sea) and originally identified as *G. fragilis*, and two from the Tyrrhenian Sea (Mediterranean Sea) and Tasman Bay

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