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Sapropels S1, S3, S4 and S5 in the Ionian Sea: a study based on dinoflagellate cysts

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Introduction

The Eastern Mediterranean late Neogene to Quaternary sedimentary record is characterized by the distinct quasi-periodical occurrence of organic carbon-rich layers, called sapropels (Fig. 1). Their deposition is related to significant changes in climate, in the pattern of water circulation and in the biogeochemical cycles. In general, an increase in organic matter preservation at the seafloor due to hypoxia or anoxia and enhanced productivity in surface waters are indicated as two major contributing factors for sapropel formation. While the triggering mechanism for sapropel formation is still debated, it is clear that each sapropel has its own peculiar feature (review in [1]).

Material & Methods

Samples are from core M25/4-12 collected in the Ionian Sea core (Fig. 1). Samples across sapropel S1, S3, S4 and S5 were taken at 1 cm resolution and analyzed for palynology (dinoflagellate cysts) and Total Organic Carbon (TOC) weight percentage.

Results & Discussion

TOC percentage within all sapropels is always above 1.4%, indicating the expected increase in organic carbon burial during sapropel deposition. S5 has the highest TOC (Table 1).

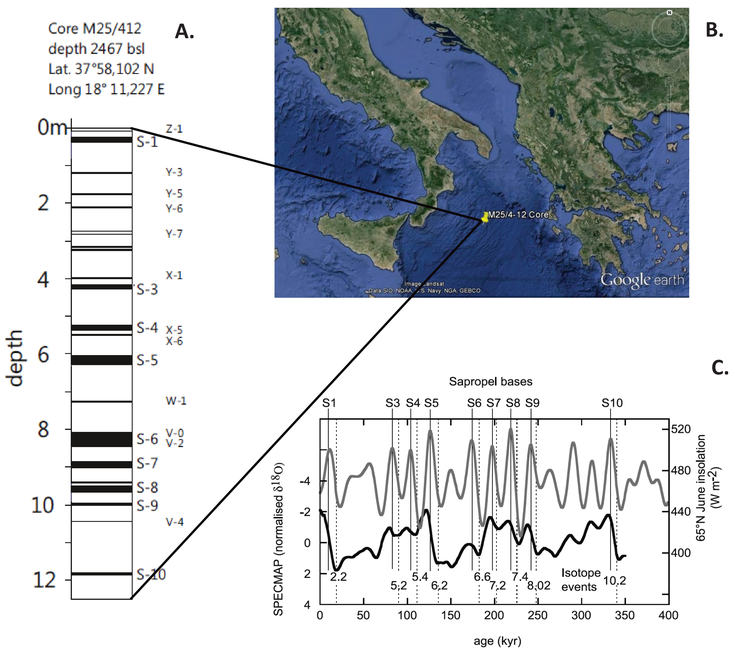

Fig 1. Location (A) and log (B) of the core M25/4-12 in the Ionian Sea at 2500 m water depth [2]. The age (kyrs BP) of the 10 most recent sapropels in shown in C[3]

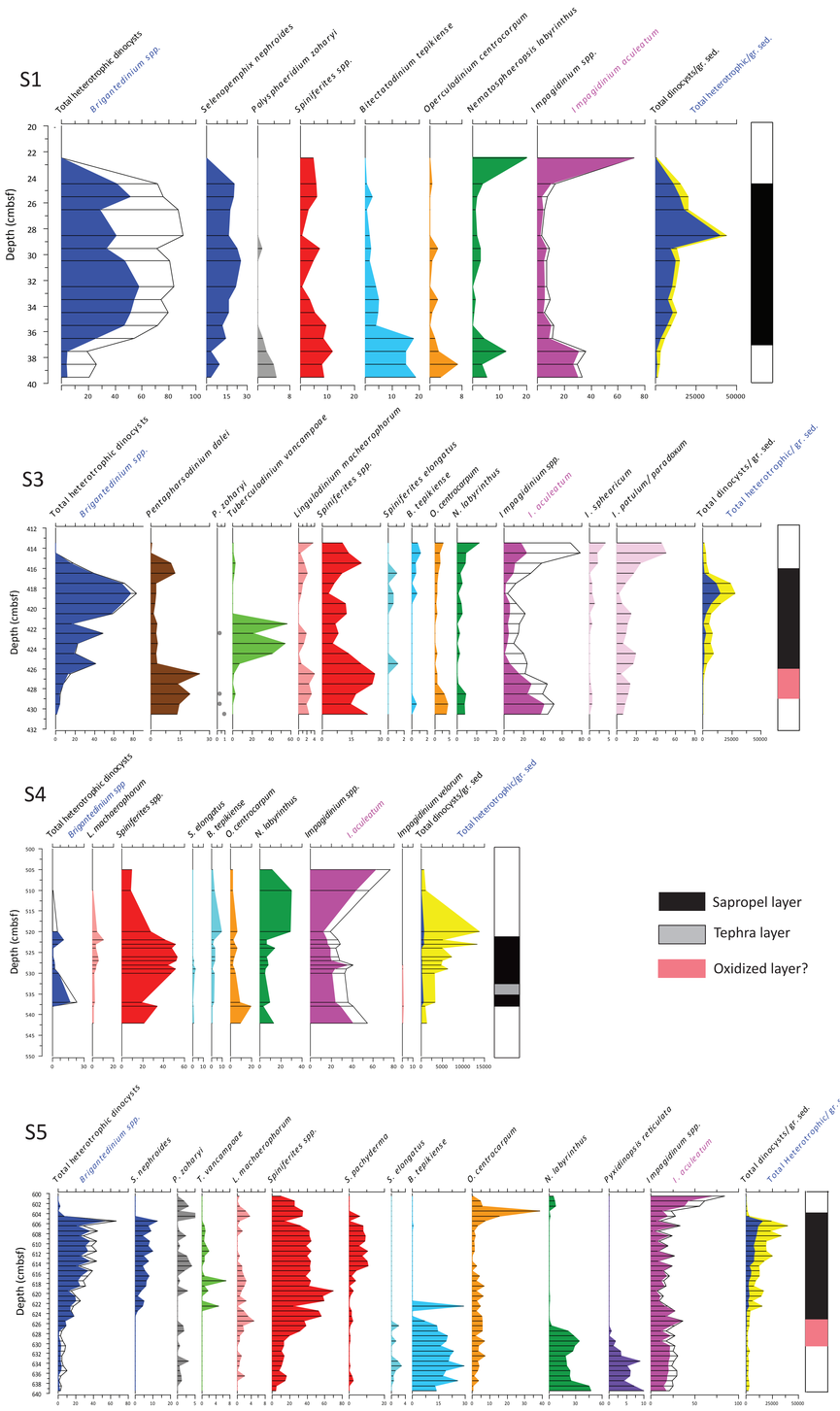

Fig 2. Dinocyst assemblages in sapropels S1, S3, S4 and S5.

Table 1. Sapropel thinkness (cm), TOC (weight %) and sediment accumulation rate SAR (cm/kyr)

	Duration (kyrs)[4]	Thickness (cm)	SAR (cm/kyr)	TOC%
Sapropel S1	4.4	12.5	2.8	>1.4
Sapropel S3	4	10	2.5	>1.6
Sapropel S4	6.2	12.5	2.0	>1.5
Sapropel S5	7.4	24	3.2	>2

The **percentage of heterotrophic dinocysts**, mainly *Brigantedinium* spp., increases in all sapropels, suggesting higher productivity and/or enhanced preservation during sapropel formation[5].
Dinocyst concentration (dinocysts/gram sediment), another indicator for primary productivity, increases in all sapropels.
S4 has the lowest dinocyst diversity, and lowest concentration of both total dinocysts and mainly heterotrophic dinocysts. Given the sediment accumulation rate, **S4 seems to have the lowest productivity**

Both sapropel S1 and S5 show highest percentages of **cold-loving species** (*Bitectatodinium tepikiense* and *Spiniferites elongatus*)[6] mostly before sapropel deposition and during the their lower part
A thin layer with abundant *B. tepikiense* seems to indicate S5 interruption. In contrast, **the upper part of S5 has abundant warm-loving species** (*Spiniferites pachyderma*).

Sapropel S3 and S5 contain *Tuberculodinium vancampoae,* which becomes very abundant in S3. *T. vancampoae* percentages of 10-30% are at present found in coastal bays of subtropical areas where winter temperature is ~17°C, summer temperature ~27°C and summer salinity lower than 35 psu[6].

The lagoonal species *Polysphaeridium zoharyi* indicates warm conditions and high water stratification during the upper part of S5.

Take home message

- Sapropels S1, S3 and S5 all show high productivity, higher than in S4. Preservation seems to be very important during S1, but productivity remains high after sapropel termination
- Abundant *Tuberculodinium vancampoae* in S3 suggests warm year-round surface water temperatures and summer salinity lower than 35 psu.
- Dinocysts in S5 indicate relatively cold water conditions during the deposition of its lower part while warm stratified waters characterize the deposition of its upper part.

References
1. Rohling et al. (2015) *Earth-Science Reviews 143*, 62-97
2. Negri et al. (1999) *Marine Geology 157*, 89-103
3. Emeis et al. (2003) *Paleoceanography 18(1)*
4. Grant et al. (2012) *Nature, 491*, 744-747
5. Versteegh & Zonneveld (2002) *Geology 30(7)*, 615-618
6. Zonneveld et al. (2013) *Review of Palaeobotany and Palynology 191*, 1-198