Supplement

Exploring Silicon Isotope Fractionation by Silicoflagellates:

Results from a KOSMOS Experiment off Peru

Grasse et al.

Figures

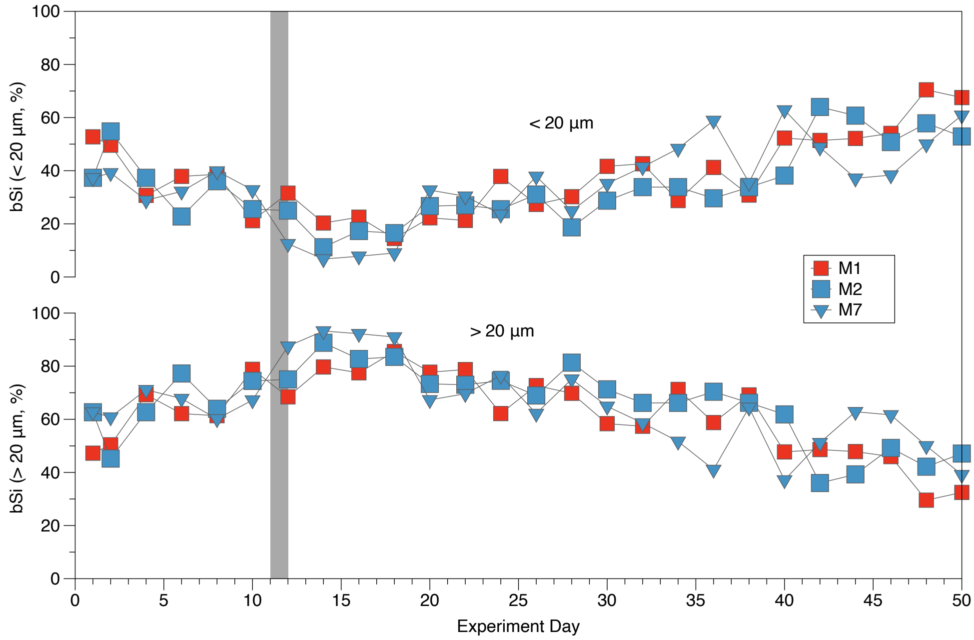

Figure S1: BSi size fraction separated for sizes smaller (a) and larger (b) than 20 µm for M1(red square), M2 (blue square) and M7 (blue triangle). The grey bar indicates the Deep Water addition on day 12.

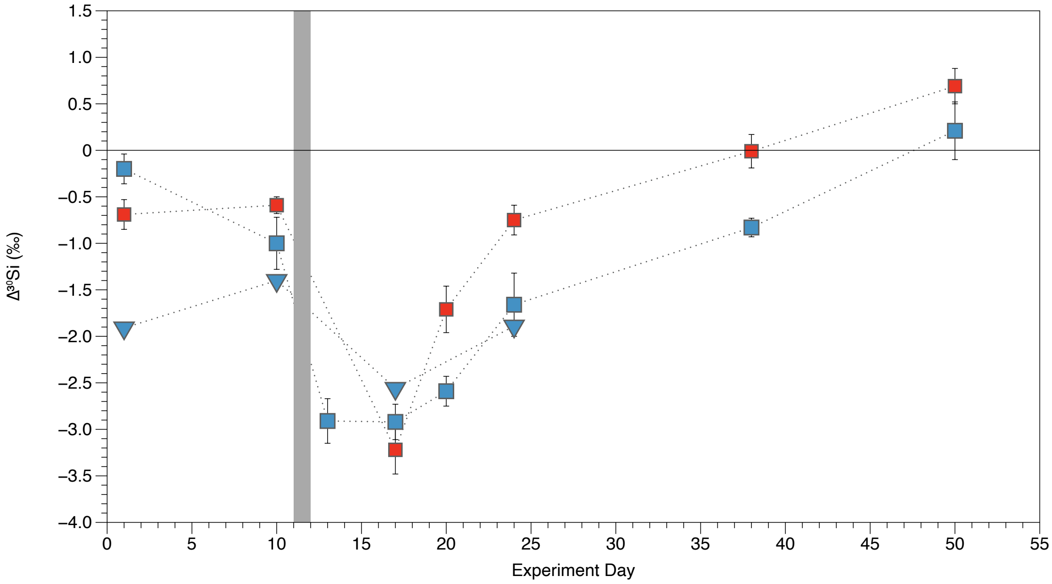

Figure S2: The apparent fractionation factor between $\delta^{30}Si_{bSi}$ and $\delta^{30}Si_{dSi}$ ($\Delta^{30}Si$) during the course of the experiment. The grey bar indicates the addition of DW on day 12 in surface water. For values above the horizontal line, the bSi fraction is isotopically heavier compared to the dissolved fraction and vice versa. Error bars are the propagated error according to equation (8).

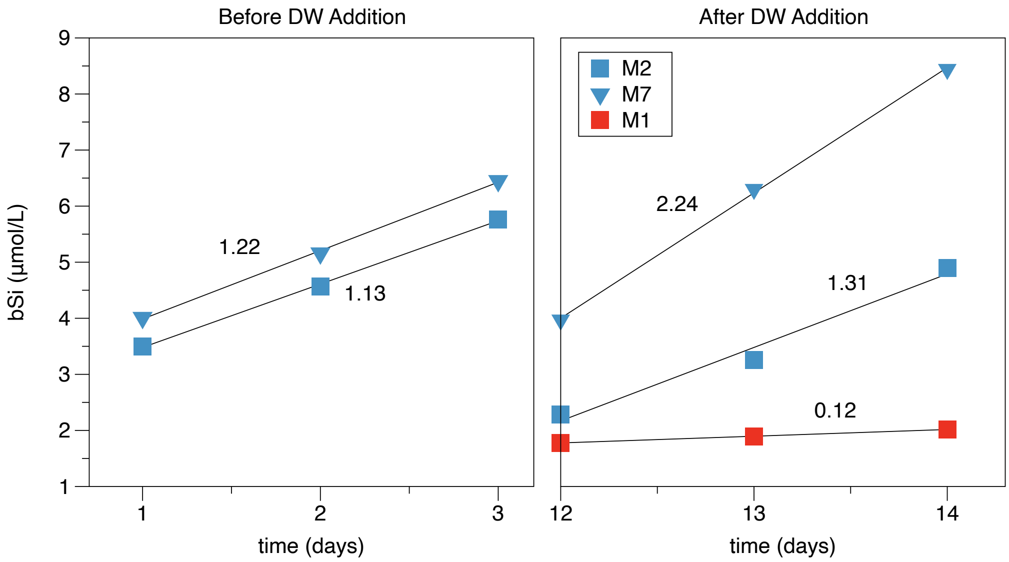

Figure S3: Net bSi growth rate per day for samples before (left figure) and after DW addition (right figure). Numbers indicate the bSi growth rate ranging between 0.12 and 2.4 µmol/day.

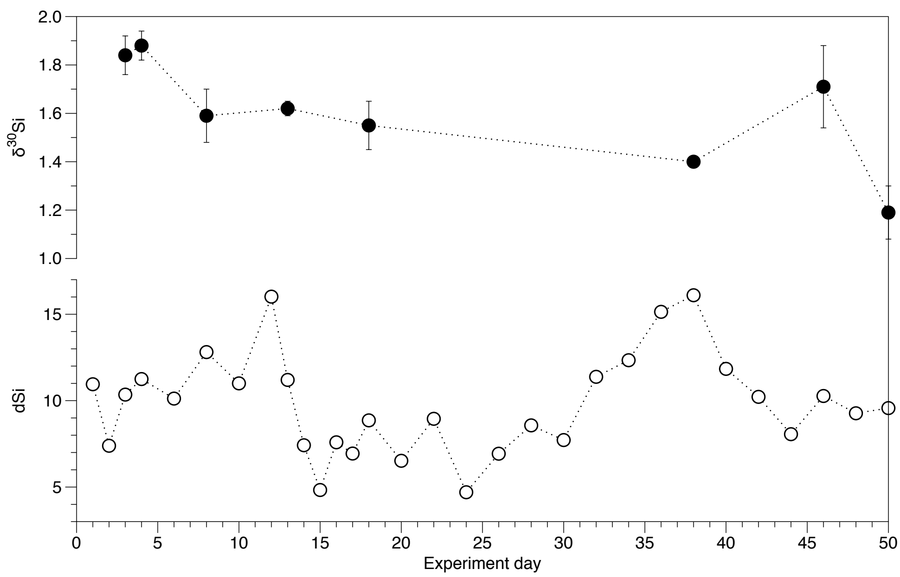

Figure S4: (a) $\delta^{30}Si_{dSi}$ in Pacific surface samples outside of the mesocosms (black closed circles). (b) dSi (in µmol L^{-1}; open circles).

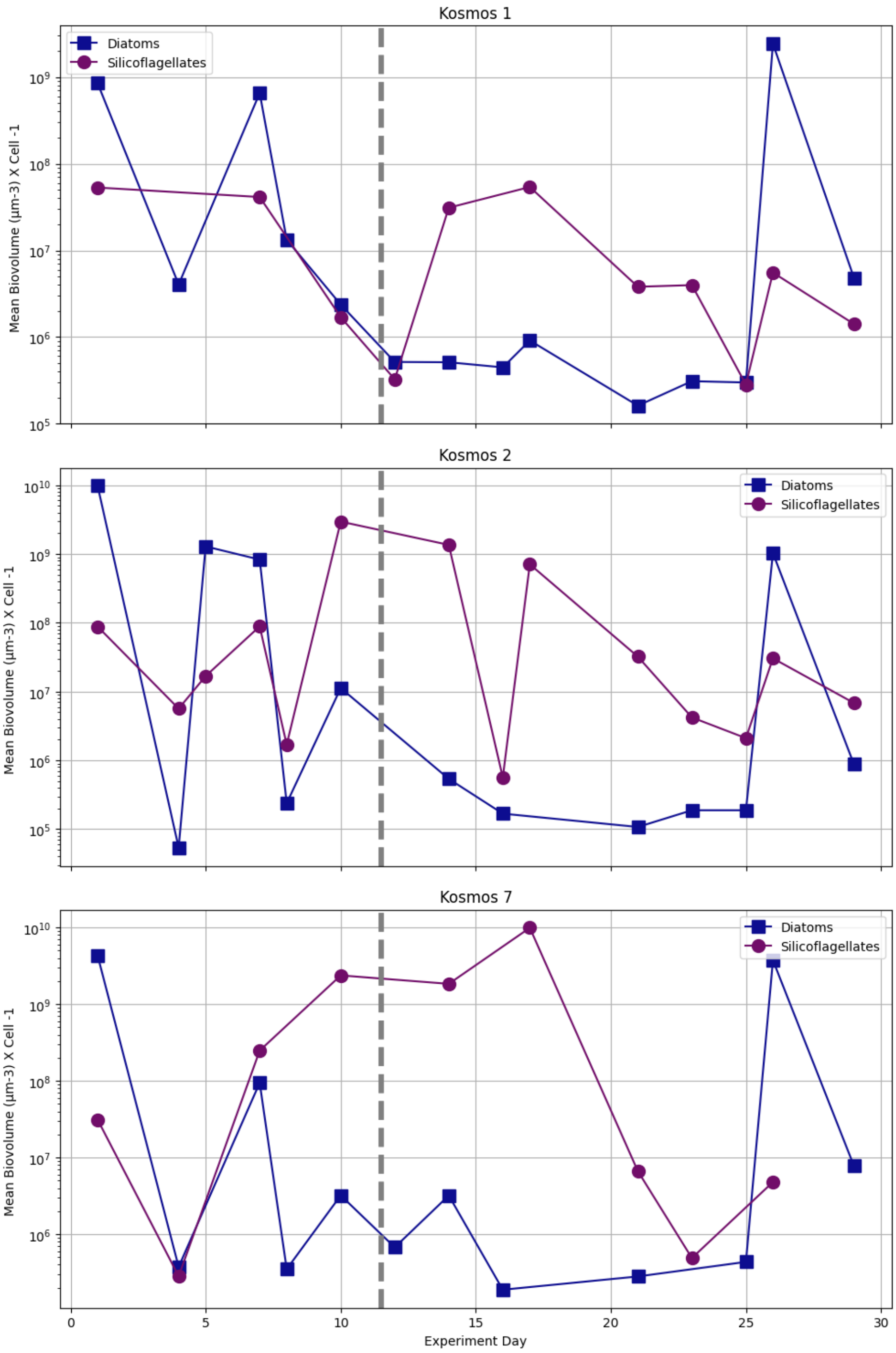

Figure S5:
Mean Biovolume (µm^3) times the amount of diatom (blue line, blue square) and silicoflagellates (purple line, purble dots) cells during the experiment in Kosmos 1, Kosmos 2 and Kosmos 7.

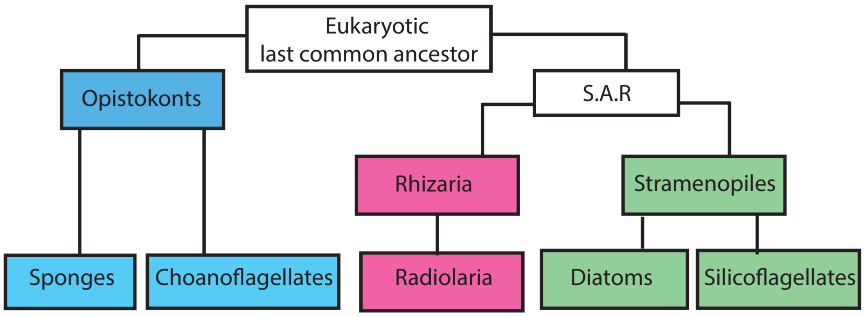

Figure S5:
Simplified presentation of the eukaryotic phylogeny of the most important marine silicifier groups based on Marron et al., 2016. S.A.R. describes the group of Stramenopiles, Alveolats and Rhizaria

Table S1:
The table includes a complete list of the nutrient data, particulate data, phytoplankton data as well as the as the silicon isotope data from KOSMOS experiments (M1, M2, M7) and the sample from surrounding water (Pacific) and will be uploaded to Pangaea.

Table S2:
List of selected species with mean diameter (µm), mean Biovolume (µm^3), minimum biovolume and maximum biovolume.

Group	Species	Diameter (µm) mean	Diameter (µm) This study	Biovolume (µm -3/cell) mean	Biovolume (µm -3/cell) min	Biovolume (µm -3/cell) max	Comment
Silicoflagellate	*Dictyocha octonaria*		30	7069			not in NOMP list, biovolume calculated for a half-sphere shape
Silicoflagellate	*Dictyocha fibula*	23	20	4069	1072	7065	
Diatom	*Skeletonema costatum*	6		372	13	1649	species not found in NOMP list, comparable species *Skeletonema marinoi*
Diatom	*Cylindrotheca closterium*	4		168	29	317	
Diatom	*Leptocylindrus danicus*	6		1339	550	3925	
Diatom	*Thalassiosira*	40		46735	64	235500	
Diatom	*Actinoptychus senarius*	80		399475	24041	1400126	
Diatom	*Coscinodiscus wailesii*	252		9277758	4846590	13203700	
Diatom	*Coscinodiscus centralis*	200		1972313	1262133	2682492	

Text S1: Description of silicoflagellates

Silicoflagellates were first described by Ehrenberg (1839). They are a small group of single celled freshwater and marine heterokont algae (widely distributed in all oceans) that belong to the genus of Dictyocha. The cells range from 20 to 100 µm in size and have up to two external flagellums per cell with an external, basket-like siliceous skeleton. Living silicoflagellates in the uninulceate stage may occur in at least two morphotypes: the skeleton-bearing and naked forms (Van Valkenburg & Norris 1970; Moestrup & Thomsen 1990; Henriksen et al. 1993). Blooms are frequently observed in environments enriched by organic matter, which suggests that these organisms are capable of mixotrophy (Quéguiner 2016). The knowledge about silicoflagellates is very limited. Despite several publications on paleo records (e.g., McCartney et al., 2022; Murray & Schrader, 1983), only very few culture studies (Valkenburg & Norris, 1970) or field observations exist (e.g., Hernández-Becerril & Bravo-Sierra, 2001; Murray & Schrader, 1983; Pérez-Cruz & Molina-Cruz, 1988). These studies have shown controversial results in regard to controlling environmental conditions. Whereas a culture study has indicated that optimal growth conditions are at 10°C and a salinity of 24 (Valkenburg & Norris, 1970), well below the surface temperature and salinity in the Peruvian Upwelling (SST: >17°C, Salinity: 35; Graco et al., 2017). There are few indications that specific species are rather adapted to cold waters (e.g., *Distephanus speculum*; Murray, 1982, Ignatiades 1970), whereas other are indicators for warm water masses and El Niño events (among other, *Dyctiocha fibula*, the species found during the experiment; Pisias et al. 1986; Pérez-Cruz & Molina-Cruz 1988). The silicoflagellate bloom during the mesocosm experiment was associated with rather high surface temperatures (21°C to 24°C) and high salinities (35.2 Sal.; see Bach et al., 2020). However, besides a possible dependence on the temperature and salinity, there might be other controlling factors

Dictyocha fibula **(**Ehrenberg)

A well-characterized taxon, which has a robust skeleton, subcircular to broadly elliptical in shape. Skeletons look coarse and rather symmetrical. The radial spines are longer in the major axis, as the other spines are reduced. The basal ring is constricted at the junction of the lateral and basal rods; the basal rods are smoothly curved. The windows next to the apical bridge are larger than those opposite the apical bridge, which are more rhomboid in shape. The apical bridge is parallel or slightly oblique and shows no conspicuous apical spine. Sup-porting spines are inconspicuous or absent (Hernández-Becerril & Bravo-Sierra 2001).

The optimum temperature for growth is 10°C at a salinity 24. Average generation time is 49 hrs (Valkenburg & Norris 1970).

Dictyocha octonaria (Ehrenberg)

Octactis octonaria (Ehrenberg) Hovasse (conspecific with *O. pulchra* J. Schiller) (Throndsen 1997) and *Distephanus speculum* var. *octonarius* (Ehrenberg) Jörgensen (Jörgensen 1899) are synonyms of *Dictyocha octonaria.*

The specimens have a nearly circular to slightly elliptical skeleton (octagonal basal ring) with usually eight radial spines (specimens having seven or nine were also found) which are variable in length. The radial spines on the axis of elongation may be slightly longer. The apical ring, supported by lateral rods arising from the basal ring between the radial spines, is more delicate than the basal ring. No apical spines or supporting spines were seen in our material. The apical ring may be missing, probably due to breakage, or may be shorter. This fact and the relative length of the basal spines are the major source of morphological variation.

References

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