The authors would like to thank the editor and the reviewer for their critical assessment of our work, as well as their invaluable and constructive comments, which significantly improve the manuscript. We have addressed all comments point by point as follows, and changes to the text in the manuscript are shown in **blue**.

Reviewer 2

In their manuscript Faithful transfer of radiolarian silicon isotope signatures from water column to sediments in the South China Sea" the authors present the first combined water column and surface sediment dataset of silicon isotope compositions of radiolaria. This data is further supplemented with radiolarian assemblage countings, which allows to investigate the influence of transfer from the water column to the sediment, especially via dissolution. The data presented is of great interest as d30Sirad has a high potential as a proxy to allow surface to intermediate water column reconstructions of the silica cycle, but is limited by few investigations on specific processes.

While I find the dataset of great importance and the presented findings are interesting and presented in a concise format, the authors should re-structure the discussion a bit and not solely discuss the influence of cleaning method and dissolution. This dataset has much more potential, especially as there is a dataset for d30Si-DSi values from the same area that could be used to investigate fractionation factors. I have summarized my main questions and comments below, followed by detailed comments per line.

Main questions:

1. The major question in terms of silicon isotope compositions of radiolaria in the community at the moment is the question about their fractionation factor. As your study provides $\delta^{30}Si_{rad}$ from the water column and the sediment I am wondering why there is no discussion at all about the fractionation of Si and a calculation of $\delta^{30}Si$ (fractionation factor) even if you just measured the bulk radiolarian composition, as there are silicon isotope compositions of DSi from the water column available (Cao et al 2012, https://doi.org/10.1016/j.gca.2012.08.039).

Response: We thank the reviewer for raising this important point. We understand that the fractionation between $\delta^{30}Si_{rad}$ and dissolved silicon isotopes ($\delta^{30}Si_{DSi}$), expressed as the apparent Si isotope fractionation factor ($\Delta^{30}Si_{rad} \sim {}^{30}\varepsilon = \delta^{30}Si_{rad} - \delta^{30}Si_{DSi}$), is an important parameter for understanding to what extent the radiolarians fractionate the $\delta^{30}Si_{DSi}$ during Si absorption, and a potential proxy for reconstructing the silicon cycle in mid-upper depth waters. Cao et al.,(2012) have documented that the $\delta^{30}Si(OH)_4$ values in the upper water column (above 100 m) of the northern South China Sea (SCS) range from 1.33 to 2.94 ‰, with a mean of 2.3 ‰. Based on $\delta^{30}Si_{rad}$ compositions in plankton samples and surface sediments from our study, and a mean $\delta^{30}Si(OH)_4$ values in the northern SCS from Cao et al., (2012), the radiolarian fractionation factors can be calculated to range from −0.45 to −0.74‰, with a mean of -0.56‰ in the SCS. The mean $\Delta\delta^{30}Si_{rad}$ value calculated in our study is more positive than the radiolarian fractionation factor (−1.5‰) applied by Hendry et al. (2014), but is close to the factor (-0.8‰) reported by Abelmann et al. (2015) and that (-0.62‰, mixed radiolaria) reported by Doering et al. (2021).

However, we do not report $\Delta\delta^{30}Si_{rad}$ values in this study for the following reasons: 1) the primary objective of the present study was to determine the depth interval from which the radiolarian community contributes to the $\delta^{30}Si_{rad}$ signature in the water column, and to ascertain whether and why radiolarian silicon isotopes ($\delta^{30}Si_{rad}$) signatures are faithfully transferred from the water column to the sediments. Consequently, our focus has been on comparing prominent radiolarian compositions at various water depths at each station, and $\delta^{30}Si_{rad}$ values between the water column and sedimentary record at individual stations. The calculation of $\Delta^{30}Si_{rad}$ is not essential for this specific investigation; 2) although Cao et al. (2012) have provided a $\delta^{30}Si(OH)_4$ dataset for the northern SCS, the spatial overlap with our sampling regime is not sufficient to permit an accurate constraint of $\Delta^{30}Si_{rad}$ and a meaningful discussion regarding the impact of $\delta^{30}Si_{DSi}$ signatures on $\delta^{30}Si_{rad}$ compositions. Actually, at each sampling station, when collecting plankton samples and surface sediments, we have also collected water samples from the relevant depth range for the $\Delta^{30}Si_{rad}$ constraint. Considering the typically low dissolved silicon concentrations in these water samples from the upper water column, we plan to use a Neoma MC-ICP-MS for the silicon isotopic analysis of dissolved silicon because of its enhanced sensitivity and mass resolution. However, isotopic analyses for seawater samples are pending due to ongoing instrument-related issues with the Neoma MC-ICP-MS at the Geochronology and Tracers Facility, British Geological Survey. Once these data are obtained, a more robust fractionation factor can be determined; and 3) A separate manuscript detailing the radiolarian fractionation factor and its implication for nutrient levels in the mid-upper water column is to be preparation in the near future.

Reference:

Abelmann, A., Gersonde, R., Knorr, G., Zhang, X., Chapligin, B., Maier, E., Esper, O., Friedrichsen, H., Lohmann, G., Meyer, H., Tiedemann, R.: The seasonal sea-ice zone in the glacial Southern Ocean as a carbon sink, Nat. Commun., 6(1), 8136, https://doi.org/10.1038/ncomms9136, 2015.

Cao, Z., Frank, M., Dai, M., Grasse, P., Ehlert, C.: Silicon isotope constraints on sources and utilization of silicic acid in the northern South China Sea, Geochimica et Cosmochimica Acta, 97, 88-104, https://doi.org/10.1016/j.gca.2012.08.039, 2012.

Doering, K., Ehlert, C., Pahnke, K., Frank, M., Schneider, R., Grasse, P.: Silicon isotope signatures of radiolaria reveal taxon-specific differences in isotope fractionation, Front. Mar. Sci., 8, 666896, https://doi.org/10.3389/fmars.2021.666896, 2021.

Hendry. K. R., Robinson, L. F., McManus, J. F., Hays, J. D.: Silicon isotopes indicate enhanced carbon export efficiency in the North Atlantic during deglaciation. Nat. Commun., 5(1), 3107, https://doi.org/10.1038/ncomms4107, 2014.

2. The sample preparation and evaluation should be described in a bit more detail as you are referring to a newly published method it would be good to at least mention the main steps involved in the preparation (see detailed comments below). Furthermore, I would be interested to know if sample amounts were generally too low to try to pick single species or orders of radiolaria, as this would help better understand how different radiolarians incorporate Si and if there is a difference in Si fractionation.

Response: According to the reviewer's suggestion, we have included a summary of the method used to extract and purify radiolarian tests for silicon isotope analysis (Zhang and Swann, 2023) in the revised version of the manuscript. The statement in the current manuscript "For isotope

analysis, sufficient radiolarian tests were extracted and purified from 7 plankton samples and 7 surface sediment samples following the method of Zhang and Swann (2023).” has been revised to “For isotope analysis, approximate 1 to 1.5 mg of radiolarian tests were extracted and purified from 7 plankton samples and 7 surface sediment samples following the method of Zhang and Swann (2023). Overall, the procedure for extracting and purifying radiolarian tests from marine sediments in Zhang and Swann (2023) comprises four stages: chemical treatment, initial sieving and differential settling, subsequent sieving, and finally density separation (Figure A). In the first stage, raw samples were treated with ~30% H_2O_2 and 15% HCl to remove the organic matters and calcareous components, and to facilitate particle dispersal. Following chemical treatment, the particles were rinsed and filtered using a 53 μm sieve to remove fine detritus, small diatoms, seaweed spines, and some sponge spicules. The filtered particles then underwent differential settling two to three times, followed by sonication, to further isolate radiolarians from large diatoms. Subsequently, particles were filtered three times using a 53 μm sieve by half immersing the sieve in a container filled with distilled deionized water (DDW) and gently tapping the base of the sieve for 10-15 minutes. This process aimed to remove all monoaxonic spicules and a portion of the small non-monoaxonic spicules. Finally, the retained fraction was further refined by density separation, using specific gravities from 2.1-2.0 g/cm^3 at 0.5-unit interval, to remove any remaining coarse detritus and non-monoaxonic sponge spicules. The purity of extracted radiolarian tests in each sample was visually assessed under a Nikon optical microscope at x100 magnification, with selected samples further examined using a scanning electron microscopy (SEM) (JEOL JSM-IT200) equipped with an energy dispersive X-ray spectroscopy (EDS) detector at the Nanoscale and Microscale Research Centre, University of Nottingham.”

Indeed, $\delta^{30}Si$ records from single-species tests may improve our understanding of how different radiolarians incorporate Si and allow us to examine potential variations in Si isotope fractionation between different radiolarian species. However, obtaining sufficient material for silicon isotopic analysis from individual radiolarian taxa in our samples proved to be a significant challenge, necessitating our focus on the bulk species record for this study. We did, in fact, attempt to isolate single-species tests via manual picking under a microscope, but encountered several obstacles. Firstly, for silicon isotope analysis using a Thermo Fisher Scientific Neptune Plus MC-ICP-MS at the Geochronology and Tracers Facility, British Geological Survey, 1 to 1.5 mg of purified radiolarian tests is typically required. Radiolarian tests from sediments in the tropical Ocean are notably lightweight, averaging 0.063 to 0.136 mg/shell (Moore, 1969; Takahashi, 1982). Consequently, a mean of approximately 7,000 to 15,000 individual tests are required to achieve the ~1 mg of material needed for the silicon isotope analysis. Given the high diversity of radiolarians in Holocene sediments, particularly in low-latitude oceans (Moore, 1969; Takahashi, 1982; Boltovskoy et al., 2010) and in our samples, which average over 100 species per sample, coupled with the observation that most species typically constitute less than 10% of the total radiolarian community (Boltovskoy et al., 2010; Chen et al., 2008), this means that 70,000 to 150,000 bulk radiolarian tests are required for each sample to obtain sufficient single-species material. Regrettably, the limited volume of the plankton samples made it difficult to obtain such a large number of radiolarian shells. Secondly, manually picking 7,000 to 15,000 individual tests out of 70,000 to 150,000 bulk radiolarian tests is highly time-consuming, rendering this approach impractical for the study of single-species radiolarian $\delta^{30}Si$. Furthermore, even with meticulous hand-picking under a microscope, the electro static adsorption of these light tests to transfer tools,

such as brushes, inevitably results in test loss during transfer to storage vials. This further compounded the difficulty of accumulating the required quantity of monospecific tests for the isotope analysis.

It was these challenges encountered during our attempts at hand-picking that prompted us to develop the method for extracting and purifying bulk radiolarian tests from the sediments for the study of the $\delta^{30}Si_{rad}$ (Zhang and Swann, 2023). This method enabled us to effectively obtain sufficient pure radiolarian tests to determine mixed-radiolarian $\delta^{30}Si$ compositions, prior to the availability of more effective techniques for obtaining sufficient monospecific tests for isotope analysis.

In the revised manuscript we have included a brief explanation regarding the absence of silicon isotopic analysis for individual radiolarian taxa: "Given the lightweight nature of shells and the high diversity of radiolarians, particularly in low-latitude oceans (Moore, 1969; Takahashi, 1982; Boltovskoy et al., 2010), combined with the observation that most species typically comprise less than 10% of the total radiolarian assemblage (Boltovskoy et al., 2010; Chen et al., 2008a), obtaining sufficient material from individual radiolarian taxa for silicon isotopic analysis remains a considerable challenge."

References:

Boltovskoy, D., Kling, S. A., Takahashi, K., Bjørklund, K.: World atlas of distribution of recent polycystina (Radiolaria), Palaeontologia Electronica, 13, 1–229, 2010.

Chen M H, Zhang L L, Zhang L L , et al. 2008a. Preservation of radiolarian diversity and abundance in surface sediments of the South China Sea and its environmental implication. Journal of China University of Geosciences, 19: 217–229.

Doering, K., Ehlert, C., Pahnke, K., Frank, M., Schneider, R., Grasse, P.: Silicon isotope signatures of radiolaria reveal taxon-specific differences in isotope fractionation, Front. Mar. Sci., 8, 666896, https://doi.org/10.3389/fmars.2021.666896, 2021.

Moore, JR. T. C: Radiolaria: change in skeletal weight and resistance to solution. Geological Society of America Bulletin, 80(10), 2103-2108. https://doi.org/10.1130/0016-7606(1969)80[2103:RCISWA]2.0.CO;2, 1969

Takahashi, K.: Vertical flux, ecology and dissolution of Radiolaria in tropical oceans: implications for the silica cycle. PhD thesis. Woods Hole Oceanographic Institution and Massachusetts Institute of Technology, 1982

Zhang, Q., Swann, G. E. A.: An effective method to extract and purify radiolaria from tropical marine sediments, Front. Mar. Sci., 10, 1150518, https://doi.org/10.3389/fmars.2023.1150518, 2023.

3. The discussion feels a bit shallow. The highlight of your manuscript is the investigation of any dissolution effect on the sedimentary radiolarian signal. However, as you point out in the discussion, the prominent radiolarian species in your samples turn out to be species that are considered to be quite resistant to resolution. I suggest including some of the references you refer to in the last part of the discussion in the introduction instead and cutting the actual discussion about dissolution shorter, as you basically show that there is no evidence on dissolution based on the abundance data and the silicon isotope data. While you show this with your statistical analyses, you can also highlight that your d30Sirad values of water column and surface sediments are the same within analytical precision as indicated in Figure 5.

Response: Thanks for the reviewer's comment. In the manuscript, the discussion section "4 Discussions" is structured in two parts. Given that radiolarians are distributed throughout the

water column from surface to bottom waters in the oceans (e.g. Kling, 1979; Boltovskoy et al., 2010; Hu et al., 2015), the first part of the discussion, "4.1 Radiolarian $\delta^{30}Si$ signatures in water column plankton and surface sediment samples", primarily aims to determine the depth interval from which the radiolarian community contributes to the $\delta^{30}Si_{rad}$ signature in the water column. This determination is achieved through the analysis and comparison of radiolarian diversity and abundance at various depths. The primary objective is to improve our understanding of the water depth interval represented by $\delta^{30}Si_{rad}$ records in both the water column and sediments, thereby providing the essential basis for reconstructing the silicon cycle within specific depth intervals, utilising radiolarian silicon isotope records from sedimentary sequences. To improve clarity concerning the focus of this section, the original title of this part "Radiolarian $\delta^{30}Si$ signatures in water column plankton and surface sediment samples" has been revised as "4.1 Contributors to radiolarian $\delta^{30}Si$ signatures in the water column plankton" in the revised version of the manuscript. Furthermore, the finding that "$\delta^{30}Si_{rad}$ signatures in the water column are primarily contributed to by radiolarians from the 0-100 m water depth layer in the SCS" has been added in the abstract.

The second part of the discussion "4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record" focuses on explaining why the $\delta^{30}Si_{rad}$ signal from the water column is faithfully transferred to the sediments. Our data indicate a good consistency between $\delta^{30}Si_{rad}$ signatures in the water column and the sedimentary record, indicating a faithful transfer of the $\delta^{30}Si$ signal incorporated into radiolarian skeletons from the water column to sediments. This suggests that dissolution has a minimal impact on the $\delta^{30}Si_{rad}$ signatures as radiolarian shells sink through the water column and become incorporated into the sediment record. This observation may be attributable to one of two possible reasons: 1) the radiolarian shells may not have undergone substantial dissolution during sinking; 2) the radiolarian shells have experienced substantial dissolution, but this process may not significantly alter their isotope composition. As shell fracture of microfossils preserved within sediments is commonly attributed to partial dissolution (e.g. Murray and Alve, 1999; Ryves et al., 2001), the proportion of fractured radiolarian shells may be indicative of the potential for radiolarian shell dissolution during sinking. Moreover, the preservation of delicate radiolarian skeletal structures, as assessed by SEM images, may also serve to determine whether the radiolarian shells have undergone significant dissolution. Therefore, in the revised manuscript, we have added the content regarding the assessment of the preservation of radiolarian shells in both the water column and sediments. This allows us to examine whether significant dissolution of radiolarian shells occurs during sinking within the water column. We have therefore made following essential revisions to the manuscript:

In the revised manuscript, the title of section 2.2 "Radiolarian composition analysis" has been revised to "Radiolarian composition and preservation analysis", and we have included a second paragraph regarding assessing the preservation of radiolarian shells: "To assess the preservation of radiolarian shells both within the water column and seabed sediments, the proportion of fractured radiolarian shells was quantified in each studied sample under a Nikon optical microscope at x100 magnification. Further scanning electron microscopy (SEM) was employed to examine the potential for dissolution-induced alteration of the radiolarian skeleton.".

Following the first paragraph of section 2.3, we have included the result of radiolarian preservation analysis and a new Figure 4 (see below): "The proportion of fractured shells was low in the studied samples (Figure 4), generally ranging from 2 to 5% (mean = 3%) in plankton samples and from 3 to 9% (mean = 6%) in surface sediments. SEM images revealed a typical

morphology of the pores on the radiolarian shell (Figure 4E), along with a high degree of integrity in the delicate skeletal structures (Figure 4F). These observations suggest good preservation of radiolarian shells, with no significant dissolution evident in either the water column or the sediments."

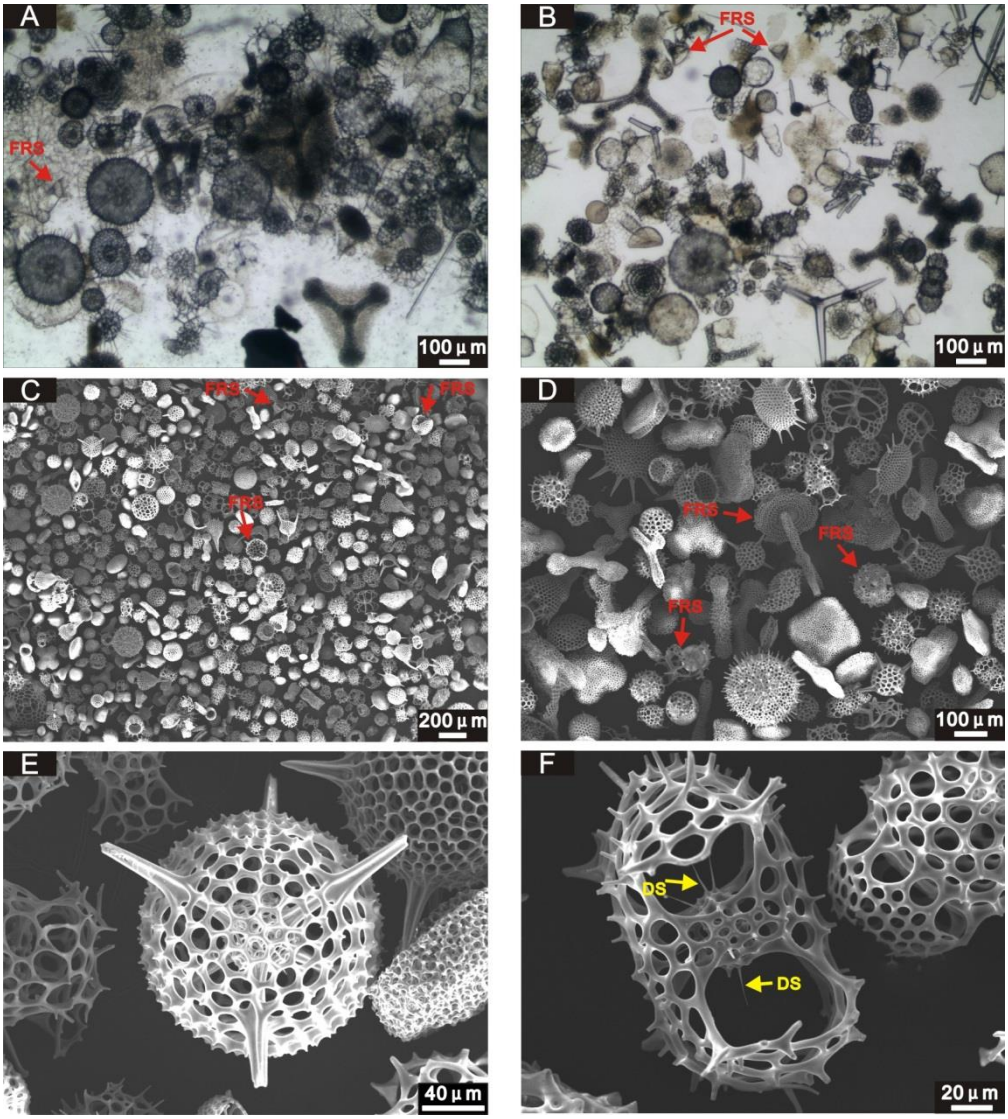

Figure 4 Observations of radiolarian shells preservation at station 12 (water depth: 3497 m) in the plankton sample (100-300 m) (A and C) and surface sediments (B, D, E, and F) using optical and the scanning electron microscope. FRS=Fractured radiolarian shells; DS=Delicate skeletons

The first paragraph of Section "4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record" has been revised to "At each sampling station, $\delta^{30}Si_{rad}$ compositions (mean = 1.73‰) in the surface sediment closely resembles those (mean = 1.74‰) in the overlying water column evidenced by the paired t-test (p=0.75), indicating a faithful transfer of the $\delta^{30}Si$ signal incorporated into radiolarian skeletons from the water column to sediments. This suggests that dissolution has a minimal impact on the$\delta^{30}Si_{rad}$ signatures as radiolarian shells sink through the water column and become incorporated into the sediment record. One of two possibilities may account for this observation: 1) the radiolarian shells may not have undergone substantial dissolution during sinking; 2) the radiolarian shells have experienced substantial dissolution, but this process may not significantly alter their isotope composition. Considering minor differences

in the mean proportion of fractured radiolarian shells between the plankton sample (~3%) and surface sediments (6%), the well-preserved state of radiolarian shells (Figure 4), and the approximate correspondence between prominent radiolarian species identified in plankton samples and those present in surface sediments at each sampling station (as detailed in section 4.1), we propose that radiolarian shells have not experienced substantial dissolution or remineralisation during their transfer from the water column to the sediments. ”

The dissolution characteristics of radiolarian shells vary considerably with different taxonomic groups due to notable differences in the chemical constituent of their skeletons. For example, Collodaria radiolarians, a group belonging to polycystine radiolarians, are highly susceptible to dissolution during sinking due to their skeletons composed of both opal and Celestine (Afanasieva et al., 2005; Afanasieva and Amon, 2014). However, as indicated above, our observations provide no evidence that the radiolarian shells have experienced substantial dissolution during sinking within the water column. Therefore, the second part of the discussion need to addresses why radiolarians preserved in surface sediments have not undergone significant dissolution. Only by clarifying the shell chemical composition and dissolution characteristics of different radiolarian groups, as well as the approximate proportion of each radiolarian group in our studied samples, can we better understand why the radiolarian shells are minimally impacted by dissolution during sinking through the water column. This thus allows for a compelling explanation of why the radiolarian silicon isotope signal from the water column is faithfully transferred to the sediments. Therefore, information regarding the radiolarian taxonomy, chemical composition and dissolution characteristics of each taxonomic group, and proportion of each taxonomic group in radiolarian community in our analyzed samples, is essential in the discussion of the manuscript.

In the revised manuscript, we have added “The susceptibility of radiolarian shells to dissolution varies considerably with different taxonomic groups due to the differences in the chemical constituent of their skeletons.” to the beginning of the second paragraph of section “4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record”.

While $\delta^{30}Si_{rad}$ values of water column and surface sediments are considered to be the same within analytical precision, we conducted a statistical analysis because it could more objectively describe this similarity in $\delta^{30}Si_{rad}$ values in water column and surface sediments.

References:

Afanasieva, M. S., Amon, E. O.: Biomineralization of radiolarian skeletons, Paleontological Journal, 48, 1473-1486, https://doi.org/10.1134/S0031030114140020, 2014.

Afanasieva, M. S., Amon, E. O., Agarkov, Y. V., Boltovskoy, D. S.: Radiolarians in the geological Record, Paleontological Journal, 39, 135-392, https://doi.org/10.1666/0094-8373(2005)031, 2005.

Boltovskoy, D.: Vertical distribution patterns of Radiolaria Polycystina (Protista) in the World Ocean: living ranges, isothermal submersion and settling shells, Journal of Plankton Research, 39(2), 330-349, https://doi.org/10.1093/plankt/fbx003, 2017.

Hu, W. F., Zhang, L. L., Chen, M. H., Zeng, L. L., Zhou, W. H., Xiang, R., Zhang, Q., Liu, S. H.: Distribution of living radiolarians in spring in the South China Sea and its responses to environmental factors, Sci. China Earth Sci., 58, 270-85, https://doi.org/10.1007/s11430-014-4950-0, 2015

Kling, S. A.: Vertical distribution of polycystine radiolarians in the central North Pacific, Mar. Micropaleontol., 4, 295-318, https://doi.org/10.1016/0377-8398(79)90022-7, 1979.

Comments per line:

L6: You should remove the comma after "water column".
Response: Yes, the comma after "water column" has been deleted in the revised manuscript.

L8: Add a comma before "as evidenced".
Response: Yes, the comma before "as evidenced" has been added.

L18: Add a comma behind "Based on this".
Response: Yes, the comma before "as evidenced" has been added.

L25: Remove "actually".
Response: Yes, the term "actually" has been deleted.

L26-27: Remove the commas behind "mechanism" and "impact" and "in both glacials".
Response: Yes, the commas behind "mechanism", "impact", and "in both glacials" have been deleted.

L29: I suggest removing "wider" or replacing it with "broader".
Response: According to the reviewer's suggestion, the term "wider" has been deleted.

L42: Remove "so".
Response: Yes, the term "so" has been deleted.

L46: Change to "others".
Response: We appreciate the reviewer's suggestion. However, we have confirmed that the term "others" is correct in line 46 of the current manuscript.

L49: Remove "also".
Response: Yes, the word "also" has been deleted.

L 54: The authors claim that purifying radiolarian test from the natural environment have difficulties. Can the authors add a reference here and specify what difficulties they mean?
Response: We agree with the reviewer that the reference is needed regarding the difficulties in purifying radiolarian test from the natural environment. Prior to the method for extracting and purifying radiolarians from sediments proposed by Zhang and Swann (2023), the approach to obtain purified radiolarians for isotope analysis was manual picking under a light microscope (Hendry et al., 2014; Fontorbe et al., 2016; Fontorbe et al., 2017; Doering et al., 2021). In general, there are three problems with manual picking. Firstly, radiolarian tests from Quaternary sediments in the tropical Pacific Ocean are light with an average weight from 0.063 to 0.136 mg/shell (Moore, 1969; Takahashi, 1982). As such, 7,000 to 15,000 radiolarian tests need to be handpicked per 1 mg of material needed for isotope analysis. Secondly, even if tests were handpicked under a

microscope, it is unavoidable to lose some radiolarian tests when transferring samples to a storage vial due to electrostatic adsorption of the light shells to the transfer tool, such as a brush. Finally, the composition of the radiolarian assemblages may be changed substantially because of the randomness of manual picking or priority selection of larger individuals, which may bias the measured isotope compositions. Because these difficulties were stated in Zhang and Swann (2023), we do not reiterate them in this manuscript.

In the revised manuscript, we have included the relevant references regarding the difficulties in successfully culturing radiolarians and purifying radiolarian test from the natural environment (Suzuki and Aita, 2011; Suzuki and Not, 2015; Zhang and Swann, 2023).

References:

Suzuki, N., Aita, Y.: Radiolaria: achievements and unresolved issues: taxonomy and cytology, Plankton and Benthos Research, 6(2), 69-91, https://doi.org/10.3800/pbr.6.69, 2011.

Suzuki, N., Not, F: Biology and Ecology of Radiolaria, In: Marine Protists, edited by: Ohtsuka, S., Suzaki, T., Horiguchi, T., Suzuki, N., Not, F., Springer, Tokyo, Japan, https://doi.org/10.1007/978-4-431-55130-0_8, 2015.

Zhang, Q., Swann, G. E. A.: An effective method to extract and purify radiolaria from tropical marine sediments, Front. Mar. Sci., 10, 1150518, https://doi.org/10.3389/fmars.2023.1150518, 2023.

L70: Remove the comma behind "box corer" and add an article (either "the" or "a") before "cold storage"

Response: Yes, we have deleted the comma behind "box corer" and added "the" before the term "cold storage".

L73-78: Under section 2.2 the authors refer to the preparation of radiolarian slides but only refer to a previous paper concerning the actual method. Please add some specifics of which steps this methodology includes concisely.

Response: Based on the reviewer's comment, we have added a brief description regarding the preparation of radiolarian slides to the revised manuscript. Furthermore, we have clarified the methodology used to estimate the total number of radiolarian individuals in each sample in accordance with the comment from the other reviewer.

The statement in lines 73-78 of the current manuscript "To determine the species composition of radiolarians, in both plankton samples and surface sediments, all samples were wet-sieved through a 63 μm sieve and prepared into radiolarian slides following the method described by Zhang et al. (2014). Radiolarian species were then identified and counted under a Nikon optical microscope at x100 or x200 magnification, with more than 500 specimens identified on slides using the publications of Chen and Tan (1996) and Tan and Chen (1999). Relative abundances of various species were then calculated based on individual count of each species and the total number of radiolarian specimens observed under the microscope." has been revised to:

"To determine the species composition of radiolarians, in both plankton samples and surface sediments, all samples were wet-sieved through a 63 μm sieve and prepared into radiolarian slides following the method described by Zhang et al. (2014). Briefly, samples were treated with a sufficient volume of 5% HCl solution for 15 minutes to eliminate calcareous organisms. Subsequently, the residual was processed using a sonic oscillator for one minute, and subjected to differential settling to remove impurities potentially adhering to the radiolarian tests. Following these procedures, all residual material was strewn nearly homogenously onto microscope slides

and permanently mounted with Canada Balsam. Radiolarian species were then identified and counted under a Nikon optical microscope at x100 or x200 magnification, with more than 500 specimens identified on slides using the publications of Chen and Tan (1996) and Tan and Chen (1999). Radiolarian diversity was determined by the species richness in each sample. The total number of radiolarian individuals in each sample was estimated from the count data as follows:

$$T = A * (Vt/V)*S*N \quad (1)$$

Where T is the total number of radiolarian individuals; A is the number of radiolarian shells counted from V fields of view on the slide; Vt is the total number of view fields on the radiolarian slide; V is the number of view fields examined under the microscope for the radiolarian individual count; S is the number of radiolarian slides; and N is the aliquot size of the sample (eight for the plankton sample, and one for the sediment sample in this study). Relative abundances of various species were then calculated based on individual counts of each species and the total number of radiolarian specimens on each slide observed under the microscope."

L78: Changes to "individual counts".

Response: Thanks for the meticulous review by the reviewer. The phrase that the reviewer mentioned should be "individual count", which appears on line 77 of the current manuscript. We have revised the manuscript accordingly, replacing "individual count" with "individual counts".

L 80-81: Similarly to my comment above the others only refer to a previous paper concerning the preparation of surface sediment, please add a short description what this includes, freezing, freeze-drying, wet-sieving as stated in the section above? Further, can you specify what "sufficient" radiolarian tests are?

Response: Yes, following the reviewer's comment, we have included a brief overview of Zhang and Swann (2023) in the revised manuscript as follows: Overall, the procedure for extracting and purifying radiolarian tests from marine sediments in Zhang and Swann (2023) comprises four stages: chemical treatment, initial sieving and differential settling, subsequent sieving, and finally density separation (Figure A). In the first stage, raw samples were treated with ~30% H_2O_2 and 15% HCl to remove the organic matters and calcareous components, and to facilitate particle dispersal. Following chemical treatment, the particles were rinsed and filtered using a 53 μm sieve to remove fine detritus, small diatoms, seaweed spines, and some sponge spicules. The filtered particles then underwent differential settling two to three times, followed by sonication, to further isolate radiolarians from large diatoms and other detrital fine-grains. Subsequently, particles were filtered three times using a 53 μm sieve by half immersing the sieve in a container filled with distilled deionized water (DDW) and gently tapping the base of the sieve for 10-15 minutes. This process aimed to remove all monoaxonic spicules and a portion of the small non-monoaxonic spicules. Finally, the retained fraction was further refined by density separation, using specific gravities from 2.1-2.0 g/cm^3 at 0.5-unit interval, to remove any remaining coarse detritus and non-monoaxonic sponge spicules. The purity of extracted radiolarian tests in each sample was visually assessed under a Nikon optical microscope at x100 magnification, with selected samples further examined using a scanning electron microscopy (SEM) (JEOL JSM-IT200) equipped with an energy dispersive X-ray spectroscopy (EDS) detector at the Nanoscale and Microscale Research Centre, University of Nottingham.

We are sorry for the lack of clarity regarding the typical mass of radiolarian tests for isotope analysis. For silicon isotope analysis, approximately 1 to 1.5 mg of purified radiolarian tests is typically required using a Thermo Fisher Scientific Neptune Plus MC-ICP-MS at the Geochronology and Tracers Facility, British Geological Survey. In this study, we typically extracted over 1.5 mg of pure radiolarian tests for isotope analysis from all surface sediment samples. However, due to limited sample volumes, the quantity of pure radiolarian tests obtained from plankton samples was approximately 1 mg.

In the revised manuscript, the statement "…sufficient radiolarian tests…" has been revised to "…approximate 1 to 1.5 mg of radiolarian tests…".

L85: rephrase to "using NaOH fusion".

Response: Yes, the phrase "using the NaOH fusion method" has been revised to "using NaOH fusion" in the revised manuscript.

L86: Remove "between".

Response: Yes, the word "between" has been deleted, and the phrase "a pH of between 2-8" has therefore been revised to "a pH of 2-8".

L95: You are referring to analytical replicates here. Was the same sample prepared by NaOH fusion measured on a different day, or are you referring to replicates within the standard sample bracketing procedure?

Response: "Analytical replicates" in our study refer to the repeated analysis of the standard-sample-standard bracket, typically performed for three times. As we usually do not have sufficient sample specifically for radiolarian tests from plankton samples, it difficult to conduct a full procedural replicate that encompass both chemical processing and analysis. The samples selected for replication following the standard sample bracketing procedure are the ones that have a higher Si concentration and which can, therefore, be diluted to run multiple times.

To clarify this point, in the revised manuscript, the statement "Analytical replicates were conducted where sample volume allowed…" has been revised to "Analytical replicates of the standard sample bracketing procedure were conducted where sample volume allowed…".

L96: "sampling of the standard (diatomite)" What does sampling mean here? Was the diatomite measured on several days? Were the columns prepared again? Was it prepared again?

Response: We are sorry for the confusion caused by the incorrect word. In the revised manuscript, the phrase "…repeated sampling of the standard (diatomite)…" has been revised to "…repeated analysis of the standard (diatomite)…".

L98: What do you mean by 2σ absolute?

Response: We are sorry for the confusion. The Greek letter σ (sigma) is the symbol for standard deviation. To ensure consistency in the abbreviation of standard deviation throughout the manuscript, the statement "All uncertainties are reported at 2σ absolute" has been revised to "All uncertainties are reported at 2 standard deviations (2 SD)" in the revised manuscript.

L98-100: I don't see the value of adding the error of the diatomite to your analytical uncertainty. The diatomite and other standards are mainly measured to see if you get the correct values. If at all you can use the diatomite value to normalize your values. But why would you add the uncertainty?

Response: Running Diatomite throughout the analytical session allows us to calculate excess variance i.e. measurements of Diatomite represent a single population, which should yield an MSWD (chi-square) of 1. Values much above 1 indicate the analytical error alone does not adequately capture the session variance and, as such, the addition of an excess is necessary.

L100: Reproducibility and instrument accuracy are generally indicated based on the NBS28, I don't see any values for the NBS28 at all.

Response: Thanks for the reviewer's comment. NBS28 is used as the primary reference against which all other samples are normalised. Therefore, the normalised value derived for the secondary reference material (Diatomite) is viewed as a reflection of the accuracy of the reproducibility and instrument.

L107: Remove "for" after "To assess".

Response: We appreciate reviewer's careful review. The word "for" after "To assess" has been removed in the revised manuscript.

Figure 3: The numbers in the figure and species names in the legend are hard to read. I suggest increasing the size of the figure for publication.

Response: Thanks for the reviewer's suggestion. In the revised manuscript, we have increased the size of Figure 3. Furthermore, we have also increased the front size of the numbers within the figure from 4 pt to 7 pt, and the front size of species names in the legend from 5 pt to 7 pt.

L125: Change to "constituents".

Response: Yes, the term "constitutes" has been replaced with "constituents".

L126: Remove "all".

Response: Yes, the word "all" has been removed. Furthermore, according to the comment from another reviewer, the statement in the manuscript "The concentrations of other elements (Fe, Al, Mg, Sr, Na, K and Cl) were all below the minimum detectable limit for the EDS detector (Figure 4)" has been revised to "other elements (Fe, Al, Mg, Sr, Na, K and Cl) flagged in red within the EDS (A" and B") spectrum images (Figure 5) indicates that either their concentrations were below the minimum detectable limit (~ 0.1 %) for the EDS detector, or the software lacked a 99% statistical confidence in the presence of these elemental signatures within the analysed sample".

Figure 4: I am wondering if samples have been checked at higher magnification as well. If radiolaria are not completely clean, contaminants are found within the radiolarian structure and are not visible at this resolution with EDS. These would rather be seen by looking closer at individual specimens. Also, what contaminations would the authors have expected to see with the help of the EDS and SEM here that would affect the silicon isotope composition? If the main goal was to check for the effects of dissolution, I would have expected a much

higher magnification of the SEM to be able to see if there were traces of dissolution or remineralization. which is hard with these pictures. Contamination by other Si phases, such as diatoms and sponges, is already visible with the light microscope. The SEM and EDS with this kind of use only show that there seems to be no clay contamination, which would also be better seen at higher magnification.

Response: Thanks for the reviewer's constructive comment. Yes, the extracted radiolarian tests have also been examined at higher magnification. We did not include high-magnification images of the radiolarian shells in Figure 4 in the current manuscript, because images derived from the SEM and EDS analyses were primarily employed to further ascertain the potential presence of any extraneous siliceous phases, such as silicate detritus that potentially affect the silicon isotope composition of the radiolarians. Even if contaminants specifically from siliceous detrital material are present within the internal structures of the radiolarian shells, they can be identified using EDS analysis. The numerous pores on the surface of radiolarian shells allowed the electron beam to penetrate through these pores during EDS mapping analysis, thereby enabling the identification of siliceous detrital material within the shell based on elemental composition.

The reviewer is correct to note that potential contamination from diatoms and sponge spicules could be assessed using light microscopy. However, some other contaminations from silicate detritus, such as clay mineral particles (typically less than 2 μm in size), which could adhere to or fill the radiolarian shells, are challenging to discern clearly even with high-magnification (400x) light microscopy. We, therefore, conducted EDS analysis on extracted radiolarian tests, as silicate detritus typically contains aluminium (Al) and iron (Fe), and can be identified by elemental composition via EDS mapping. Consequently, we used both light microscopy and SEM coupled with an EDS detector to evaluate the purity of radiolarian tests, as stated in lines 81-84 of the manuscript.

Based on the reviewer's valuable comment, we have included a new Figure (Figure 4, please refer to the figure in the response to main question 3 above) in the revised manuscript to indicate the preservation state of radiolarian shells and the potential for dissolution-induced alteration of the radiolarian skeleton (the original Figure 4 and 5 has been renumbered as Figures 5 and 6, respectively, in the revised manuscript). Consequently, we have made following revisions to the manuscript as detailed in the response to main question 3 above:

In the revised manuscript, the title of section 2.2 "Radiolarian composition analysis" has been revised to "Radiolarian composition and preservation analysis", and we have included a second paragraph regarding assessing the preservation of radiolarian shells: "To assess the preservation of radiolarian shells both within the water column and seabed sediments, the proportion of fractured radiolarian shells was quantified in each studied sample under a Nikon optical microscope at x100 magnification. Further scanning electron microscopy (SEM) was employed to examine the potential for dissolution-induced alteration of the radiolarian skeleton.".

Following the first paragraph of section 2.3, we have included the result of radiolarian preservation analysis and a new Figure 4 (see below): "The proportion of fractured shells was low in the studied samples (Figure 4), generally ranging from 2 to 5% (mean = 3%) in plankton samples and from 3 to 9% (mean = 6%) in surface sediments. SEM images revealed a typical morphology of the pores on the radiolarian shell (Figure 4E), along with a high degree of integrity in the delicate skeletal structures (Figure 4F). These observations suggest good preservation of radiolarian shells, with no significant dissolution evident in either the water column or the

sediments."

The first paragraph of Section "4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record" has been revised to "At each sampling station, $\delta^{30}Si_{rad}$ compositions (mean = 1.73‰) in the surface sediment closely resembles those (mean = 1.74‰) in the overlying water column evidenced by the paired t-test (p=0.75), indicating a faithful transfer of the $\delta^{30}Si$ signal incorporated into radiolarian skeletons from the water column to sediments. This suggests that dissolution has a minimal impact on the $\delta^{30}Si_{rad}$ signatures as radiolarian shells sink through the water column and become incorporated into the sediment record. One of two possibilities may account for this observation: 1) the radiolarian shells may not have undergone substantial dissolution during sinking; 2) the radiolarian shells have experienced substantial dissolution, but this process may not significantly alter their isotope composition. Considering minor differences in the mean proportion of fractured radiolarian shells between the plankton sample (~3%) and surface sediments (6%), the well-preserved state of radiolarian shells (Figure 4), and the approximate correspondence between prominent radiolarian species identified in plankton samples and those present in surface sediments at each sampling station (as detailed in section 4.1), we propose that radiolarian shells have not experienced substantial dissolution or remineralisation during their transfer from the water column to the sediments. "

At the beginning of the second paragraph of section "4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record", we have added "The susceptibility of radiolarian shells to dissolution varies considerably with different taxonomic groups due to the differences in the chemical constituent of their skeletons."

References:

Murray, J. W., Alve, E.: Natural dissolution of modern shallow water benthic foraminifera: taphonomic effects on the palaeoecological record, Palaeogeography, Palaeoclimatology, Palaeoecology, 146(1-4), 195-209, https://doi.org/10.1016/S0031-0182(98)00132-1, 1999.

Ragueneau, O., Tréguer, P., Leynaert, A., Anderson, R. F., Brzezinski, M. A., DeMaster, D. J., Dugdale, R. C., Dymond, J., Fischer, G., Francois, R., Heinze, C., Maier-Reimer, E., Martin-Jézéquel, V. Nelson D. M., Quéguiner, B.: A review of the Si cycle in the modern ocean: recent progress and missing gaps in the application of biogenic opal as a paleoproductivity proxy, Global. Planet. Change, 26(4), 317-365, https://doi.org/10.1016/S0921-8181(00)00052-7, 2000.

Ryves, D. B., Juggins, S., Fritz, S. C., Battarbee, R. W.: Experimental diatom dissolution and the quantification of microfossil preservation in sediments. Palaeogeography, Palaeoclimatology, Palaeoecology, 172(1-2), 99-113, https://doi.org/10.1016/S0031-0182(01)00273-5, 2001.

Treguer, P., Nelson, D. M., Van Bennekom, A. J., DeMaster, D. J., Leynaert, A., Quéguiner, B. The silica balance in the world ocean: a reestimate, Science, 268(5209), 375-379, https://doi.org/10.1126/science.268.5209.375, 1995.

Figure 5: $\Delta^{30}Si$ is usually referred to as the fractionation factor, so its use here is a bit confusing. Also, (A) already indicates that the data are the same within error, so I see little use in plotting the difference here as they are within your analytical uncertainty.

Response: We are sorry for the confusion from the use of the triangle symbol "Δ". Yes, the reviewer is correct to point out that $\Delta^{30}Si$ is usually used as the fractionation factor. In this context, the symbol "Δ" represents the uppercase of Greek letter Delta when denoting the fractionation factor. To distinguish this from the "Δ" used for the fractionation factor, we, in fact, employed a

triangle symbol "Δ" in Figure 5B to represent the differences in $\delta^{30}Si_{rad}$ values between plankton samples and surface sediments at each sampling station. While similar in appearance, these two symbols are actually distinct.

To avoid this confusion, we have replaced the triangle symbol "Δ" with the capital letter "D" of "Different" in Figure 5B of the manuscript.

Yes, the data presented in Figure 5A are consistent within the reported errors. However, these data points, representing the mean $\delta^{30}Si_{rad}$ values measured by the Neptune ICP-MS, also exhibit discrepancies between paired $\delta^{30}Si_{rad}$ data. Figure 5B provides the differences, or shifts, in the mean values of $\delta^{30}Si_{rad}$ as radiolarian shells are transferred from the water column to the sediment, thereby offering a supplementary perspective to the information presented in Figure 5A. Consequently, we respectfully suggest retaining Figure 5B in the revised manuscript.

L134-140: The discussion starts with a comparison of the absolute $\delta^{30}Si_{rad}$ values measured in this study with previous studies. While it is important to note that the range in silicon isotopes measured here agrees with previous studies, I don't see a value in solely comparing absolute values between regions here. While this can serve as an introduction to the discussion, a comparison of the impact of source signatures of δ^{30}Si-DSi and potential fractionation factors of radiolaria is missing from the discussion so far.

Response: Thanks for reviewer's comment. We have presented a comparison of the absolute radiolarian silicon isotope ($\delta^{30}Si_{rad}$) values obtained in this study with those from previous studies. This is because absolute $\delta^{30}Si_{rad}$ values documented herein, and a comparison with those from other regions, would provide a fundamental dataset for investigating the range of $\delta^{30}Si_{rad}$ composition and its spatial distribution in the oceans. This may advance the understanding of potential relationships between $\delta^{30}Si_{rad}$ composition and both dissolved silicon concentrations and δ^{30}Si of the dissolved silicon ($\delta^{30}Si_{DSi}$) in the surrounding seawater.

The fractionation between $\delta^{30}Si_{rad}$ and dissolved silicon isotopes ($\delta^{30}Si_{DSi}$), expressed as the apparent Si isotope fractionation factor ($\Delta^{30}Si_{rad} \sim {}^{30}\varepsilon = \delta^{30}Si_{rad} - \delta^{30}Si_{DSi}$), is an important parameter for understanding to what extent the radiolarians fractionate the $\delta^{30}Si_{DSi}$ during Si absorption, and a potential proxy for reconstructing the silicon cycle in mid-upper depth waters. Previous published data show that the $\delta^{30}Si(OH)_4$ values in the upper water column (above 100 m) of the northern South China Sea (SCS) range from 1.33 to 2.94 ‰, with a mean of 2.3 ‰ (Cao et al., 2012). Based on $\delta^{30}Si_{rad}$ compositions in plankton samples and surface sediments from our study, and a mean $\delta^{30}Si(OH)_4$ values in the northern SCS from Cao et al., (2012), the radiolarian fractionation factors can be calculated to range from −0.45 to −0.74‰, with a mean of -0.56‰. The mean $\Delta\delta^{30}Si_{rad}$ value calculated in our study is more positive than the radiolarian fractionation factor (−1.5‰) applied by Hendry et al. (2014), but is close to the factor (-0.8‰) reported by Abelmann et al. (2015) and that (-0.62‰, mixed radiolaria) reported by Doering et al. (2021).

As stated in the response to the main question 1, $\Delta\delta^{30}Si_{rad}$ values are not presented in this study for the following reasons: 1) the primary objective of the present study was to determine the depth interval from which the radiolarian community contributes to the $\delta^{30}Si_{rad}$ signature in the water column, and to ascertain whether and why radiolarian silicon isotopes ($\delta^{30}Si_{rad}$) signatures are faithfully transferred from the water column to the sediments. Consequently, our focus has been on comparing prominent radiolarian compositions at various water depths at each station, and $\delta^{30}Si_{rad}$ values between the water column and sedimentary record at individual stations. The

calculation of $\Delta^{30}Si_{rad}$ is not essential for this specific investigation; 2) although Cao et al. (2012) have provided a $\delta^{30}Si(OH)_4$ dataset for the northern SCS, the spatial overlap with our sampling regime is not sufficient to permit an accurate constraint of $\Delta^{30}Si_{rad}$ and a meaningful discussion regarding the impact of $\delta^{30}Si_{DSi}$ signatures on $\delta^{30}Si_{rad}$ compositions. Actually, at each sampling station, when collecting plankton samples and surface sediments, we have also collected water samples from the relevant depth range for the $\Delta^{30}Si_{rad}$ constraint. Considering the relatively low $Si(OH)_4$ concentrations in these water samples from the upper water column, we plan to use a Neoma MC-ICP-MS for the silicon isotopic analysis of dissolved silicon because of its enhanced sensitivity and mass resolution. However, isotopic analyses for seawater samples are pending due to ongoing instrument-related issues with the Neoma MC-ICP-MS at the Geochronology and Tracers Facility, British Geological Survey. Once these data are obtained, a more robust fractionation factor can be determined; and 3) A separate manuscript detailing the radiolarian fractionation factor and its implication for nutrient levels in the mid-upper water column is to be prepared in the near future.

L152: Correct to "all the radiolarian shells".

Response: The phrase "the all radiolarian shells" in the manuscript has been revised to "all the radiolarian shells".

L 153: Why did you expect the $\delta^{30}Si_{rad}$ values to differ between depths? (100-300m versus 0-100m).

Response: A previous study documented variations in the $\delta^{30}Si$ composition among different radiolarian taxa (Doering et al., 2021). Based on findings regarding the vertical distribution of living radiolarians in the water column of the South China Sea using protoplasm staining, Hu et al., (2015) demonstrated the variations in both radiolarian abundance and dominant species composition between the 0-75 m and 75-300 m water layers. Consequently, it is expected that $\delta^{30}Si_{rad}$ values from plankton samples at 100-300 m water depth would potentially differ from those at 0-100 m.

In the revised manuscript, we have briefly explained why $\delta^{30}Si_{rad}$ values from plankton samples at 100-300 m water depth were expected to potentially differ from those at 0-100 m. The statement in the manuscript "Whilst δ30Sirad values from plankton samples at 100-300 m water depth were expected to potentially differ from those at 0-100 m, no significant difference was detected (p = 0.52)." has been revised to "Given the differences in both the abundance and dominant species composition of living radiolarians between 0-75 m and the 75-300m water depth in the SCS (Hu et al., 2015), it is expected that $\delta^{30}Si_{rad}$ values from plankton samples at 100-300 m water depth might potentially differ from those at 0-100 m. However, no significant difference was detected (p = 0.52)."

References:

Doering, K., Ehlert, C., Pahnke, K., Frank, M., Schneider, R., Grasse, P.: Silicon isotope signatures of radiolaria reveal taxon-specific differences in isotope fractionation, Front. Mar. Sci., 8, 666896, https://doi.org/10.3389/fmars.2021.666896, 2021.

Hu, W. F., Zhang, L. L., Chen, M. H., Zeng, L. L., Zhou, W. H., Xiang, R., Zhang, Q., Liu, S. H.: Distribution of living radiolarians in spring in the South China Sea and its responses to environmental factors, Sci. China Earth Sci., 58, 270-85, https://doi.org/10.1007/s11430-014-4950-0, 2015

L170: Remove "(vital effects)" here.

Response: Yes, the phrase "(vital effects)" has been removed.

L169-172: I don't think this discussion is correct here. As far as I can see, there is no significant difference in species compositions or $\delta^{30}Si_{rad}$ between your water column and surface sediment data (line 153-159). So even if there is a difference in d30Sirad and/or fractionation between radiolarian species/order, there is no way to see any effect of this in your data.

Response: While statistical analysis suggests no significant difference in either the composition of prominent species or their relative abundances between plankton samples and surface sediments, variations in the relative abundances of some prominent radiolarian species are indeed observed. Due to the high diversity of radiolarians in low-latitude oceans, few species comprise more than 10% of the radiolarian community, and those exceeding 2-3% are generally defined as prominent species (e.g. Zhang et al., 2009; Hu et al., 2015). Therefore, a discernible difference in the relative abundance of a prominent species is considered to exist when the variation in its relative abundance between samples reaches approximately or exceeds a factor of two.

Radiolarian census data in this study showed that the relative abundances of certain prominent radiolarian species, including *Botryocyrtis scutum*, *Didymocyrtis tetrathalamus t.*, *Tetrapyle octacantha/quadribola*, *Zygocircus capulosus*, varied by near a factor of two or more between the water column (0-100) and surface sediments (please see table A below and Figure 4 in the manuscript; original census data will also be provided as supplementary material in the revised manuscript) at some stations (e.g. station 13). However, despite variations in the relative abundance of certain prominent radiolarian species, no substantial differences in $\delta^{30}Si_{rad}$ values were observed between plankton samples and the sediment at each sampling station. We therefore propose two potential reasons for the consistency of $\delta^{30}Si_{rad}$ values between plankton samples and the sediments, as detailed in lines 169-175 of the current manuscript: 1) the minor differences in the relative abundance of most prominent taxa between water column and sediment samples; 2) the high diversity of radiolarians in each sample averaging out the $\delta^{30}Si_{rad}$ signal across different taxa, mitigating potential bias from individual taxa.

Table A Variations in the relative abundance of typical prominent species between the water column (0-100) and surface sediments at station 13

Sample / Prominent species	Station 13 (0-100 m)	Station 13 (surface sediment)
Tetrapyle octacantha/quadribola	4.0 %	8.8 %
Didymocyrtis tetrathalamus t.	8.1 %	2.4 %
Tetrapyle octacantha/quadribola	11.7 %	18.1 %
Zygocircus capulosus	2.2 %	6.2 %

We hope this explanation adequately addresses the reviewer's concerns. In the revised manuscript, the statement in lines 164-165 of the manuscript "Although minor differences in the relative abundances of radiolarian species are observed…" has been revised to "Although discernible differences in the relative abundances of some prominent radiolarian species are observed…". Moreover, the statement in lines 169-172 "Although variations in the $\delta^{30}Si$ composition have been documented among different radiolarian taxa (Doering et al., 2021), the

relative abundance differences between plankton and surface sediment samples do not result in significant $\delta^{30}Si_{rad}$ disparities in our study in the SCS" has been revised to "Although variations in the $\delta^{30}Si$ composition have been documented among different radiolarian taxa (Doering et al., 2021), the relative abundance differences in certain prominent species, such as *Botryocyrtis scutum*, *Didymocyrtis tetrathalamus t.*, *Tetrapyle octacantha/quadribola*, and *Zygocircus capulosus*, between plankton and surface sediment samples do not result in significant $\delta^{30}Si_{rad}$ disparities in our study in the SCS".

L180-215: Section 4.2 Transfer of radiolarian d30Si signatures into the sediment record need some re-structuring and rewriting. The first paragraph is fine, picking up on the fact that there is little difference between the water column and the sediment d30Sirad. The following paragraphs, however, are mainly a summary of the literature and should be shortened, and the information from the radiolarian abundances investigated here should be more highlighted. Additionally, references to the SEM and EDS analysis conducted are not referred to at all here.

Response: As responded to the question 3, Section "4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record" focuses on explaining why the $\delta^{30}Si_{rad}$ signal from the water column is faithfully transferred to the sediments. Our data indicate a good consistency between $\delta^{30}Si_{rad}$ signatures in the water column and the sedimentary record, suggesting that dissolution may have a minimal impact on the $\delta^{30}Si_{rad}$ composition as shells sink through the water column and become incorporated into the sediment record. This may be attributable to one of two possible reasons: 1) the radiolarian shells may not have undergone substantial dissolution during sinking; 2) the radiolarian shells have experienced substantial dissolution, but this process might not have significantly altered their isotope composition. As shell fracture of microfossils preserved within sediments is commonly attributed to partial dissolution (e.g. Murray and Alve, 1999; Ryves et al., 2001), the proportion of fractured radiolarian shells may be indicative of the potential for radiolarian shell dissolution during sinking. In this study, the proportion of fractured radiolarian shells was low, and showed only slight difference between plankton samples (mean = 3%) and surface sediments (mean = 6%) (Figure 4). Considering these minor differences in the mean proportion of fractured radiolarian shells between the plankton sample and surface sediments, the well-preserved state of delicate radiolarian skeletons (Figure 4), and the correspondence between radiolarian species identified in plankton samples and those present in surface sediments at each sampling station (as detailed in section 4.1), we propose that radiolarian shells have not experienced substantial dissolution or remineralisation during their transfer from the water column to the sediments.

The susceptibility of radiolarian shells varies considerably with different taxonomic groups due to notable differences in the chemical constituent of their skeletons. For example, Collodaria radiolarians, a group belonging to polycystine radiolarians, are highly susceptible to dissolution during sinking due to their skeletons composed of both opal and Celestine (Afanasieva et al., 2005; Afanasieva and Amon, 2014). However, as stated above, our observations do not provide evidence that the radiolarian shells have experienced substantial dissolution during sinking within the water column. Only by clarifying the dissolution characteristics of different radiolarian groups which are closely related to the chemical compositions of their shells, alongside the approximate proportion of each group within the radiolarian community of our studied samples, can we better understand

why the radiolarian shells are minimally impacted by dissolution during sinking through the water column. This allows for a compelling explanation of why the radiolarian silicon isotope signal from the water column is faithfully transferred to the sediments. Therefore, the information presented in Section 4.2 regarding the radiolarian taxonomy, chemical composition and dissolution characteristics of each taxonomic group, and the proportion of each taxonomic group within the radiolarian community in our analyzed samples, is essential for this study, despite containing a summary of the literature.

The information of the radiolarian abundances in various water depths was primarily used to address the depth range from which the radiolarian community contributes to the $\delta^{30}Si_{rad}$ signature in the water column and sediments, and has been detailed in Section 4.1 as stated in the response to the main question 3.

The SEM and EDS images in the original Figure 4 were primarily employed to examine the purity and cleanliness of the radiolarian tests extracted from the plankton samples and surface sediments, thereby ensuring the reliability of the $\delta^{30}Si_{rad}$ data in this study. As such, the results of the SEM and EDS analysis were not referred in Section 4.2 of the original manuscript. However, we agree with the reviewer that the SEM images with a higher magnification may trace the potential dissolution of radiolarian shells as reviewer suggested above. Therefore, we have included a new Figure (Figure 4, please refer to the figure in the response to main question 3 above) in the revised manuscript to indicate the preservation state of radiolarian shells and the potential for dissolution-induced alteration of the radiolarian skeleton (the original Figures 4 and 5 have been renumbered as Figures 5 and 6, respectively, in the revised manuscript). Accordingly, we have made following revisions to the manuscript as detailed in the response to main question 3 above:

In section 2.2 of the revised manuscript, we have included a paragraph to assess the preservation of radiolarian shells following the line 78 "To assess the preservation of radiolarian shells both within the water column and seabed sediments, the proportion of fractured radiolarian shells was quantified in each studied sample under a Nikon optical microscope at x100 magnification. Further scanning electron microscopy (SEM) was employed to examine the potential for dissolution-induced alteration of the radiolarian skeleton.".

Following the first paragraph of section 2.3, we have included the result of radiolarian preservation analysis "The proportion of fractured shells was low in the studied samples (Figure 4), generally ranging from 2 to 5% (mean = 3%) in plankton samples and from 3 to 9% (mean = 6%) in surface sediments. SEM images revealed a typical morphology of the pores on the radiolarian shell (Figure 4E), along with a high degree of integrity in the delicate skeletal structures (Figure 4F). These observations suggest good preservation of radiolarian shells, with no significant dissolution evident in either the water column or the sediments."

The first paragraph of Section "4.2 Transfer of radiolarian $\delta^{30}Si$ signatures into the sediment record" has been revised to "At each sampling station, $\delta^{30}Si_{rad}$ compositions (mean = 1.73‰) in the surface sediment closely resembles those (mean = 1.74‰) in the overlying water column evidenced by the paired t-test ($p=0.75$), indicating a faithful transfer of the $\delta^{30}Si$ signal incorporated into radiolarian skeletons from the water column to sediments. This suggests that dissolution has a minimal impact on the $\delta^{30}Si_{rad}$ signatures of radiolarians as shells sink through the water column and become incorporated into the sediment record. One of two possibilities may account for this: 1) the radiolarian shells may not have undergone substantial dissolution during

sinking; 2) the radiolarian shells have experienced substantial dissolution, but this process might not have significantly altered their isotope composition. As shell fracture of microfossils preserved within sediments is commonly attributed to partial dissolution (e.g. Murray and Alve, 1999; Ryves et al., 2001), the proportion of fractured radiolarian shells may be indicative of the potential for radiolarian shell dissolution during sinking. In the present study, the proportion of fractured radiolarian shells was low, and showed only slight difference between plankton samples (mean = 3%) and surface sediments (mean = 6%) (Figure 4). Considering these minor differences in the mean proportion of fractured radiolarian shells between the plankton sample and surface sediments, the well-preserved state of radiolarian shells (Figure 4), and the approximate correspondence between prominent radiolarian species identified in plankton samples and those present in surface sediments at each sampling station (as detailed in section 4.1), we propose that radiolarian shells have not experienced substantial dissolution or remineralisation during their transfer from the water column to the sediments. ”

At the beginning of the second paragraph of section “4.2 Transfer of radiolarian δ^{30}Si signatures into the sediment record”, we have add “The susceptibility of radiolarian shells to dissolution varies considerably with different taxonomic groups due to the differences in the chemical constituent of their skeletons.”

L181: Change to “resemble”.

Response: Yes, the term “resembles” has been revised to “resemble”.

L201: Add a comma after “in the SCS”.

Response: Yes, we have included a comma after “in the SCS” in Line 201 of the current manuscript.

L206: Change to “in this study,…”.

Response: Yes, the phrase “in the current study…” in line 206 of the manuscript has been revised to “in this study,…”.

L209: Correct to “expected to have..”.

Response: Yes, the phrase “dissolution is expected have…” in Line 209 has been revised to “dissolution is expected to have…”.