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Reliability of foraminiferal Na/Ca as a direct paleo-salinity proxy in various planktonic species from the eastern tropical North Atlantic

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Foraminiferal Na/Ca in planktonic and benthic foraminifers is a promising new method to assess directly past seawater salinities, which complements existing approaches (e.g., paired shell Mg/Ca and $\delta^{18}O$, shell Ba/Ca). Recent culture and field calibration studies have shown a significant positive relationship of Na incorporation into foraminiferal calcite shells with increasing salinity [1, 2], as confirmed by our culture study of *Trilobatus sacculifer* [3]. However, we note that the sensitivity of Na/Ca in response to salinity changes is species-specific and regional dependent, whereas temperature could be excluded as a secondary influencing factor [2, 3, 5]. Na/Ca values vary from 1–3 mmol/mol for the same salinity within and between foraminiferal species, suggesting a dominant biological control.

To further evaluate the robustness of Na/Ca for its application as a reliable proxy, we here examine possible secondary controls on foraminiferal Na/Ca with new data for commonly used species for paleoreconstructions (*Globigerinoides elongatus*, *G. ruber* (pink), *Orbulina universa*, *Globigerina bulloides*, *Neogloboquadrina dutertrei*) collected by plankton tows in the eastern tropical North Atlantic during R/V Meteor cruise M140. We performed laser ablation ICP-MS measurements on single foraminiferal shells from depth-resolved plankton tows in 20 m net-intervals from locations where salinity was essentially constant, while seawater pH and total alkalinity differed by ~0.5 and 100 µmol/kg, respectively. Plankton tow samples provide new insights into the possible effects of natural variations in carbonate system parameters on Na incorporation into calcite tests with increasing water depth. The comparison of living foraminifers to sedimentary shells gives further information about the preservation state of Na/Ca in calcite shells over time, whereas fossil shells have mostly undergone gametogenesis during their life-time, or were affected post mortem by early diagenesis (sedimentation) processes. Those foraminifers were collected from surface sediments (M65-1) located in proximity to plankton tows. Our results show that all measured species, either from plankton tows or buried in the sediment, are within the Na/Ca range of previous studies [1-5], which increases the confidence for a robust Na/Ca to salinity proxy. However, the offset of ~2-5 mmol/mol between living foraminifers collected in surface waters (0-20 m) and fossil assemblages of the same species could be related to spine loss at the end of a foraminiferal life cycle [4]. In addition, the usage of inconsistent test sizes

could further influence the foraminiferal Na/Ca signal. Our results reveal significant (R = -0.97, p <0.03) decreasing Na/Ca values with increasing test sizes between 180-250 µm for *G. ruber* (pink, white), *N. dutertei* and *T. sacculifer*, whereas values increase again with larger size classes >355 µm (R = 0.87, p<0.02).

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