Section: Paleontology, Paleoecology/Taphonomy

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Shark body size distributions reflect migration rates and temperature gradients: four fossil cases studies from the Eocene

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Organismal body size is a central physiological trait that reflects energetic constrains and integrates physiological, environmental, and ontogenetic factors. Sharks have a long and rich evolutionary history as marine predators that are resilient to past climate change, yet there are few studies exploring the mechanistic processes giving rise to fossil shark body size distributions. As ectotherms, shark metabolic rate and growth rate are constrained by temperature, but how do these physiological parameters interact with ontogenetic distribution and seasonal migration patterns, and how does these factors combine to influence body size distributions? Here, we measured anterior tooth crown height for Eocene Sand Tigers (*Striatolamia macrota* or *Carcharias macrota*) from four localities that include two high latitude sites, the Eureka Sound Formation [Fm.] on Banks Island in Arctic Canada and the La Meseta Fm. in Antarctica, and two mid-latitude sites, Bashi/Tuscahoma Fm. and Crockett Fm. in the Gulf of Mexico. We then constructed a demographic population model to evaluate how temperature likely constrained growth and reproduction of a migrating population straddled between spatially separate nursery and adult sites. We find significant differences in body size distributions across fossil sites and anterior tooth crown heights suggesting that the Eocene Sand Tiger was larger than its modern analogue *Carcharias taurus.* Further, demographic population simulations reveal how migration duration and plasticity for adults and juveniles impact the mean and modality of body size distributions at each fossil locality. We find relatively good correspondence between empirical and simulated body size distributions , allowing a direct examination of the potential influence of alternative life history characteristics influencing migration on observed body size distributions. These results are the first to compare fossil shark demographics among localities and allow us to assess the environmental plasticity and evolutionary success of Sand Tigers.