

NON-LETHAL MARGINAL TRACES IN RECENT AND FOSSIL  
CYPLEASTEROID ECHINOIDS FROM FLORIDA

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Decapod crustaceans and some benthic fish produce non-lethal predatory traces or marginal traces on sand dollar (Echinoidea: Clypeasteroidea) tests in modern environments. Comparable marginal traces are also observed in fossil sand dollar specimens. These non-lethal marginal traces are underexplored, and they may provide quantifiable data on biotic interactions affecting both recent and fossil sand dollars. In this study, non-lethal marginal traces were characterised using SCUBA sampled live-collected sand dollars from the northeastern Gulf of Mexico. These include four species: *Encope aberrans* ( $n = 67$ ), *Encope michelini* ( $n = 304$ ), *Clypeaster subdepressus* ( $n = 401$ ), and *Mellita tenuis* ( $n = 409$ ). The traces were cusped in shape, healed, and located along the ambitus of the tests, rarely extending into the petals. The frequency of traces was higher in sand dollars with flatter tests (53.7% for *E. aberrans*, 79.3% for *E. michelini*, and 59.7% for *M. tenuis*) than sand dollars with thick-margined tests (9.3% for *C. subdepressus*). Traces comparable to the non-lethal traces documented in recent specimens were also observed in fossil sand dollars from Florida repositated at the Invertebrate Paleontology Division at the Florida Museum. The fossil species include *Clypeaster sunnilandensis*, *Clypeaster rosaceus*, *Encope aberrans*, *Encope tamiamensis*, and *Mellita acclinensis* from the Pliocene portion of the Tamiami Formation, *Abertella carlsoni* from the Late Oligocene of the Arcadia Formation, *Wythella eldridgei* from the Early Oligocene of the Bumpnose Limestone, and *Clypeaster rogersi* from the Early Oligocene of Florida. Several live-collected sand dollars were X-ray imaged and nano-CT scanned to determine the nature of the test damage. The scanned images suggest that the traces are of predatory origin, not a result of a growth deformation. The characteristics of modern traces provide a protocol to identify non-lethal marginal traces on fossil sand dollars and help us better understand the evolutionary history of biotic interactions, specifically non-lethal predation in the echinoid fossil record.

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