

Drilling predation on molluscs in the northern Adriatic Sea: Spatial variability and temporal trends over the last millennia

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Competition and predation are essential ecological factors influencing biodiversity. In a palaeontological context, the rate of predatory interactions between animal species is difficult to reconstruct because traces of predation are rarely incorporated into the fossil record. In the marine environment, the calcareous shells of molluscs, however, have good, long-time preservation potential, and predation in this group is often exerted by carnivorous gastropods that drill holes into mollusc shells. The prey's perforated shells remain in the sediment and can be used to study rates and intensities of predatory interactions in past marine molluscan communities. Differences in drilling frequencies along a sediment core not only reflect changes in local species richness and predation pressure, but may also mirror ecosystem changes through space and time. This makes the analysis of drilling predation an important tool when investigating the historical ecology of marine habitats. We used 1.5-m-long sediment cores from seven shelf locations spread throughout the northern Adriatic Sea basin to investigate regional and down-core variations in drilling frequencies. In total, about 54,000 bivalve and 40,000 gastropod shells were analysed to determine the following parameters: 1) overall drill frequency (DF), the proportion of shells drilled by predators; 2) edge drill frequency (EDF, only in bivalve shells), the proportion of shells with drilling traces at the shell edge; 3) multiple drill frequency (MDF), the percentage of individuals with more than one drill hole, 4) incomplete drill frequency (IDF), the percentage of shells unsuccessfully drilled; 5) prey effectiveness (PE), the proportion of individuals resisting the predator's attacks. Total drill frequency across all cores is 18% for bivalves and 13% for gastropods, but there are marked regional differences, with minima in the Po Delta (5%) and maxima in Panzano Bay (24%). Edge-drilled shells and multiple drill holes on single shells are very rare and occur on less than 1% of the investigated specimens. Also very low (< 1%) is the percentage of incomplete drill holes, except for the sampling location at the Brijuni Islands, Croatia (4%). Drilling frequencies show stronger differences between localities than along individual cores. Significant correlations exist between drilling intensities and prey species ecotype (especially for bivalves): commensals, parasitic and suspension-feeding species are more frequently drilled than other feeding types, as are infaunal species compared to species with epifaunal life habits. Despite the strong spatial variation in drilling intensities, the DF values of our samples are comparable to those typical for Cenozoic shelf environments.