

Assessing Biological and Stratigraphic Determinants of Fossil Abundance: A Case Example from the Late Quaternary of Po Plain, Italy

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Absolute fossil abundance [AFA] can be defined as a relative concentration of identifiable fossils per unit of sediment. AFA, or “sediment shelliness”, is controlled by the interplay between the rate of input of skeletal remains (biological productivity), pace of shell destruction (taphonomy), rate of sedimentation, and sediment compaction. Understanding the relative importance of those drivers can augment both stratigraphic and biological interpretations of the fossil record. Using 336 samples from a network of late Quaternary cores drilled in Po Plain (Italy), we examined the importance of those factors in controlling the stratigraphic distribution of fossils. All samples were vertically and volumetrically equivalent, each representing a 10 cm long interval of a core with a diameter of ~ 7 cm (~ 0.375 dm³ sediment per sample).

Sample-level estimates of AFA (1) varied over ~ 4 orders of magnitudes (from <4 to 44200 specimens per dm³ of sediment); (2) appeared invariant to core depth ($\rho = -0.04$, $p = 0.72$); (3) were statistically indistinguishable ($\chi^2 = 1.53$, $p = 0.46$) across systems tracts; and (4) did not vary substantially across facies ($\chi^2 = 6.04$, $p = 0.20$) representing a wide range of depositional and taphonomic settings. These outcomes indicate that compaction (which should increase downcore), sedimentation rates (which vary predictably across systems tracts), and pace of shell destruction (expected to differ across depositional settings) are unlikely to have played important role in controlling fossils density in the sampled cores. In contrast, samples with very high shell density (AFA > 4000 specimens per dm³) were characterized by exceedingly low evenness reflecting dominance by one super-abundant species (Berger-Parker index > 0.8 in all cases). These super-abundant species were limited to small r-selective mollusks capable of an explosive population growth: the marine corbulid bivalve *Lentidium mediterraneum* and the brackish hydroid gastropod *Ecrobia ventrosa*. Moreover, despite high mollusk diversity (534 species total), $> 80\%$ of samples are dominated by one of the five mollusk species, which all represent small, r-selective, deposit and suspension feeders.

Trends in absolute fossil abundance within late Quaternary deposits of the Po Plain appear to have been driven primarily by biological productivity of opportunistic shelly species from lowest trophic levels. In the studied system, biodiversity and shelliness of samples is unlikely to reflect stratigraphic or taphonomic overprints, but rather records the ecological importance of r-selective species that dominated the investigated area throughout the late Quaternary. The joint consideration of sequence stratigraphy, facies architecture, and paleontological data, can provide insights regarding both stratigraphic (the origin of sedimentary biofabrics) and biological (the drivers of bio-productivity and observed biodiversity) aspects of the fossil record.