TAPHONOMY AND TIME AVERAGING AS A TOOL IN (PALEO)OCEANOGRAPHY: A CASE STUDY ON A SHALLOW SUBTROPICAL SHELF FROM BRAZIL

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Actualistic taphonomic studies encompassing fine-scale time-averaging analysis can provide useful data for (paleo)oceanographic studies, especially sedimentation rates. In an ongoing project, more than 100 individual brachiopod (*Bouchardia rosea*) and bivalve mollusk (*Semele casali*, *Glycymeris* sp.) shells were dated individually by combination of ^{14}C (AMS-radiocarbon) and amino acid racemization (D/L aspartic acid) methods. These shells were collected from surficial shelly accumulations along a shallow water transect (10 and 30m), including three nearshore localities from the general area of Ubatuba Bay (collecting stations UBA 1, 2 and 3), northern coast of São Paulo State, Brazil. The bay, located on the inner part of the Southeast Brazilian Bight (SW Atlantic), opens to the east and has a constricted coastline that induces wave diffraction. The bottom is characterized mainly by terrigenous sediments with a considerable admixture of terrestrial organic matter (mainly supplied by four small rivers that drain the coastal area). Coarse sand bottoms characterize all studied stations. However, while stations UBA 1 and 2 are located in open parts of the bay, and thus are more prone to the action of wave trends, station 3 is located in a protected area sheltered from the most effective wave action. At the 30m site (UBA1) shells range in age from modern to 23,820 years, while the shells at the 10m protected site (UBA 3) range in age from modern to 3,900 years. On the other hand, shells from the 10m exposed site (UBA 2) range in age from modern to 3,135 years. Because the dated shells where collected from the several uppermost centimeters of the substrate, they indicate that the sedimentation rate in the bay is very low, even at very shallow water sites inside the bay and near the river mouths. In other words, the burial rate at these sites is not high enough to remove the old shells from the TAZ (Taphonomically Active Zone) to the FBZ (Final Burial Zone), below which shells can no longer be reworked up into the TAZ. These data corroborates the idea that sedimentation rate is negligible in the inner parts of the bay. Most importantly, because these accumulations formed in protected bay areas that are sheltered from the active wave action and winter storms, the extensive temporal mixing of the surficial shelly accumulations documented here is not likely to be intrinsically related to hydraulic reworking, but rather reflects pervasive bioturbation by burrowing organisms.

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TAPHONOMY OF BRACHIOPOD SHELLS FROM THE UBATUBA BAY, NORTHERN OF SAO PAULO COAST: CAN METHODOLOGICAL DECISIONS MASK THE (PALEO)ENVIRONMENTAL INFERENCES?

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Taphonomic signatures have been used for recognizing physical, chemical and biological processes (e.g. abrasion, corrosion, incrustation, among others), acting in different modern and ancient marine environments. Yet, recent literature recommendations favor the use of discrete size-fractions (=8mm), rather than broad spectra in the analyses of those signatures. Here taphonomic signatures (valve type, articulation, fragmentation, abrasion) were independently investigated for accumulations of *Bouchardia rosea* (target taxon), an abundant brachiopod in many superficial accumulations of the Ubatuba Bay. Bulk samples were obtained from a 0 to 30 meters of depth gradient by using a 31 x 40cm Van Veen grab sampler. A total of 1605 brachiopod shells were sampled in 13 stations, but only five (informally, UBA1=0 meters, UBA2=10 meters, UBA3=20 meters, UBA4= 25 meters, UBA5= 30 meters stations) provided enough material (>150 specimens) to statistical analyses. At the laboratory, bioclats were wet-sieved, and portioned through ≥8mm, ≥6mm and ≥2mm mesh sizes. All the three fractions were analyzed, and each bioclast on it was studied under 10, 16 and 20x of magnification. Notably, shells of different mesh sizes exhibit distinct damage profiles, even considering the distinct fractions of a single station. For example, shells from UBA2 station have similar percentage of ventral valves in the following fractions: ≥8mm (33%) and ≥2mm (35%). A slightly increase (48%) is, however, observed in the ≥6mm fraction. On the other hand, ventral valves are absent in the ≥6mm fraction from UBA3 station. However, 74% of the shells found in this station (≥2mm fraction) are ventral. Additionally, in the UBA4 station, there were no ventral valves in some fractions (≥8mm), but they are well represented in the ≥6mm (44%) and ≥2mm (38%) fractions. Note that if a discrete fraction (≥8mm or ≥6mm) is used to characterize those stations, sorting phenomena should be misattributed. Fragmentation is another taphonomic signature that is sensitive to the mesh size considered. Fragmentation in samples from beaches is 2% in the ≥8mm, 15% in the ≥6mm, and 26% in the ≥2mm fractions. Again, if only the coarse fraction (≥8mm) is target, low levels of fragmentation are detected. Similarly, abrasion in all the fractions provided distinct profiles (33% in the ≥2mm, and absent in the ≥8mm fractions of the UBA5 station). Our data show that taphonomic analyses are sensitive to some methodological decisions, mesh size, for example. This may lead to erroneous environmental interpretations, particularly in the fossil record, when bioclastics cannot be studied in all fractions or split apart from the matrix. Since the tested parameters are commonly employed to define taphofacies, caution is recommended when delineating analytical strategies for such studies. Hence, taphonomic analyses should be based on broad spectra fractions (≥8mm, ≥6mm and ≥2mm), more than on the discrete one, as suggested in the taphonomic literature.

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BRACHIOPOD SHELL SURFACE TEXTURES IN THE UBATUBA BAY, SÃO PAULO STATE, BRAZIL: TAPHONOMIC AND (PALEO)ENVIRONMENTAL IMPLICATIONS

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Surficial brachiopod-dominated (*Bouchardia rosea*, Bouchardiidae) accumulations were sampled along a shallow water transect (beach to 35 meters of depth), including 13 stations at the Ubatuba Bay, northern coast of São Paulo State. The bay is characterized by terrigenous sediments, mainly sands and muds. The shell textures of 1391 specimens were examined under the binocular and scanning electron microscopes. Shell surfaces were compared with those illustrated in the literature. Also, shell surfaces were experimentally altered via abrasion and dissolution under laboratory conditions. Four different types of shell textures were determined: Biogenic (*e.g.*, gallery, cratered, perforated and root etching textures), Chemical (chalk texture), Physical (abrasion texture), and Palimpsest (composite) textures. Biogenic textures are characterized by a variety horizontal and vertical borings produced by sponges, worms and algae. Cratered and perforated textures have been produced, most likely, by infesting *Clione* sponges, and are characterized by *Domichnia* (*Entobia* sp.) traces. Cratered (weakly infested) and perforated (strongly infested) textures are variants of the same bioerosional process. Worms have produced gallery textures. Brachiopod specimens kept alive in an aquarium were infested by worms producing similar structures (horizontal, parallel to shell layers, linear or gently arched borings). Thus, these textures need not be acquired only after the death of the organism, and should not be used as a proxy of shell residence at the TAZ (Taphonomically Active Zone). Finally, algae and fungi likely produced root-etching textures, represented by *Cubichnia* traces. Chemical textures, a product of calcium carbonate dissolution, are characterized by chalky textures. Physical textures, mainly produced by mechanical processes, are characterized by abrasion textures. V-shaped, apically located scars, chipped and rounded shell margins, reduced shell micro-relieves, and pale colors are all features associated with abrasion textures. Caution should be exercised, however, when comparing abrasion textures with those produced by chemical abrasion (corrosion) process. Finally, palimpsest (composite) textures are produced by a combination and/or overprinting of the texture types listed above, and can be very complex and difficult to interpret. Biogenic textures produced by microborers, dominant in the examined material, are typical of sheltered, shallow water, environments, but are rarely observed in specimens found on the beach (foreshore). Under deep water settings the biogenic textures can be overprinted by the dissolution texture (chalk texture); this texture is common below 25m depth, especially in shells dredged from organic rich bottoms. In contrast, abrasion textures are typical of shells exposed to high-energy environments. Finally, although palimpsests textures can be difficult to interpret, they offer us valuable data for documenting a local brachiopod shell transport among environments of the Ubatuba bay.

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