

PATTERNS OF BRACHIOPOD SHELL ENCRUSTATION: A COMPARISON OF TROPICAL (UBATUBA BAY, BRAZIL) AND POLAR (ADMIRALTY BAY, ANTARCTICA) ENVIRONMENTS

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Despite considerable advances in our understanding of fossilization processes, one of the key unexplored topics of modern taphonomy is the variation in the nature and intensity of biostratinomic and early diagenetic processes across different geographic regions and climatic gradients. Yet, there is increasing evidence that this variation may be dramatic. For example, in nearshore tropical settings bioerosion, dissolution/corrosion and color alteration are among the most pervasive taphonomic processes operating on carbonate shells. In contrast, in polar coastal waters of Antarctica, bioerosion is rare (Cerrano et al. 2001), and dissolution (a process that is common on the organic-rich tropical bottoms) is negligible in Antarctic waters as well (Taviani et al. 1993).

Present-day shallow water settings around Antarctica harbor an abundant brachiopod fauna, which provides an opportunity to examine how biostratinomic processes, such as encrustation, operate in polar environments, and how do they compare to similar depositional systems from the tropics, where brachiopod shells are also common as sedimentary particles. In this context, we compare encrustation patterns on brachiopod shells from tropical (Brazil) and polar (Antarctica) environments. In order to keep environmental and taphonomic variables as constrained as possible, we restricted our data to (a) smooth, punctuated shells, (b) epifaunal terebratulid brachiopods, (c) carbonate-poor environments, and (d) shallow waters (10 to 20 meters of depth). One important difference exists, however, between the two compared datasets: the tropical samples are dominated by dead shells of *Bouchardia rosea* whereas the Antarctic material is represented mostly by live-collected shells of *Liothyrella uva*. To make data more comparable we focused on exterior encrustation patterns only.

Bouchardia rosea, is the most common, endemic, rhynchonelliform brachiopod on the Brazilian platform (Kowalewski et al. 2002, Simões et al. 2004). This sessile epifaunal, freelying brachiopod belongs to an austral group with the fossil record dating back to the K/T boundary. Their shells are small, low Mg-calcite, with a thin primary layer, a thick fibrous fabric secondary layer, and no tertiary shell layer. Shells and shell fragments (~2mm) of *B. rosea* are abundant in late Holocene death assemblages found in nearshore settings (depth range: 0-30 m) of the general area of Ubatuba (23° 26'S and 45° 02'W), northern coast of São Paulo State, Brazil, SW Atlantic. Bulk samples included a total of 1616 valves of *B. rosea* collected from 14 nearshore sampling localities. The samples were wet-sieved using 8-mm and 2-mm mesh sizes and then air-dried. We targeted the coarse fractions (2 to 8 mm) of the bioclastic material.

Liothyrella uva is the most common Antarctic brachiopod, occurring down to 300 meters of depth. Shell length is up to two centimeters. *L. uva* is a sessile terebratulid attached to the substrate (e.g., rocks, gravels, stylasterine corals, stony bryozoans) by a strong pedicle. The specimens analyzed here were recovered alive during a scuba diving program at the Napier Rock (15 meters of depth), near to the Henryk Arctowski Polish Antarctic Station (62°10' S and 58°28' W), Admiralty Bay, King George Island, South Shetland Islands, West Antarctica, during the PROANTAR XV (The Brazilian Antarctic Program) in 1997. Underwater images indicate that *L. uva* forms dense, closed packed clusters along the rock wall.

Because the abundance and diversity of epibiont assemblages is also affected by the size of the host (Rodland et al. 2004), shell size was estimated as the maximum dimension along the anterior/posterior axis. Each specimen was measured to the nearest 0.1 mm using electronic calipers and examined under a binocular microscope (10x) to evaluate the encrusting fauna. Epibionts were identified at the morphospecies level and grouped to higher taxonomic levels (e.g., serpulid worms, bryozoans, foraminifera), as commonly used in modern encrustation studies (Rodland et al. 2004).

Out of 155 shells of *B. rosea* from UBA Station 5 (20 meters), only 2 (1.3%) yielded external encrusters (serpulids). Out of 487 shells from UBA Station 9 (10 meters), 48 were externally encrusted (9.9%), particularly by worm tubes (serpulids, spirorbids) and bryozoans. Encrustation intensity values (% shell area covered by encrusters) for the encrusted *B. rosea* shells from this station are as follow: (a) shells having >10% of external shell surface covered (64.6%, n=31); (b) shells having 10% to 50% of external shell surface covered (31.3%, n=15), and (c) shells having >50% of external shell surface covered (4.2%, n=2). In contrast, out of 242 valves of *L. uva*, 185 (76.4%) are externally encrusted, mostly by worm tubes (serpulids, spirorbids), bryozoans, brachiopods (*L. uva*), bivalves, algae, and cnidarians. Encrustation intensity for *L. uva* is as follow: (a) shells having >10% of external shell surface covered (56.2%, n=104); (b) shells having 10% to 50% of external shell surface covered (20%, n=37), and (c) shells having <50% of external shell surface covered (23.8%, n=44). For both species, larger shells display greater encrustation intensity.

Despite of other important taphonomic differences, encrustation appears to be an important taphonomic process in polar environments. Indeed, and quite surprisingly, Antarctic encrusters on brachiopod shells are more diverse (at least 7 groups) and more abundant than tropical encrusters from comparable tropical/subtropical waters of the northern coast of São Paulo State, Brazil. In both cases, however, worm tubes (serpulids and spirorbids) and bryozoans are by far the most important encrusters on brachiopod shells.

Because the Antarctic shells were captured alive, in this case epibiont abundance and diversity reflect colonization rates during the life of the animal only. In contrast, *B. rosea* samples, dominated by dead shells that underwent extensive time-averaging (several hundred years for the UBA Station 9, see Carroll et al. 2003), were likely exposed to surface taphonomic processes (such as external encrustation) for a longer duration of time than the live collected shells of *L. uva*. The higher diverse and abundance of epibiont assemblages on *L. uva* shells suggests strongly that the brachiopod mode of live (e.g. attached, epifaunal - hard substrate versus unattached, free-lying - soft substrate) and the availability of epibionts in a given environment is more important than the shell exposure time. This is also consistent with the hypothesis that epibiont assemblages on individual shells may have high temporal resolution, even when host shells experience significant time-averaging (see Rodland et al. 2004, in preparation). Finally, this study shows that external encrustation, when used alone, may not be a reliable proxy for estimating the post-mortem shell residence time at the sediment/water interface.

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