

# DEAD-LIVE FIDELITY OF BRACHIOPOD ASSEMBLAGES IN THE UBATUBA BAY, BRAZIL: TAPHONOMICAL AND PALEOECOLOGICAL IMPLICATIONS

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Ecological/compositional fidelity, expressed by live-dead comparisons is not only an important proxy for assessing the quality of the fossil record, but also may offer data relevant to conservation biologists. This approach has already provided useful data for detecting recent changes in population density caused by short- to long-term environmental fluctuations or human-induced habitat alterations. The approach also demonstrated that the fossil record may often offer credible data useful for paleobiologic studies (see Kidwell 2001, Kowalewski et al. 2003, and references therein). In the last 30 years, numerous case studies of the compositional fidelity of marine shelly assemblages were published. However, these studies focused primarily on assemblages of shelly mollusks (particularly bivalves). Only recently, fidelity studies dealing with compositional fidelity of mixed brachiopod-mollusks assemblages were initiated with a project focused on present-day subtidal, mid-latitude environments (Kowalewski et al. 2003). Consequently, the compositional fidelity of present-day assemblages where brachiopods are common is still severely understudied, effectively limited to a single habitat (subtidal environments of San Juan Island, Washington State, USA) and two brachiopod genera (*Terebratalia*, *Hemithiris*) only (Kowalewski et al. 2003).

Here we document live-dead comparisons for assemblages of the terebratulid brachiopod *Bouchardia rosea* (Mawe) found in present-day, nearshore environments of Ubatuba Bay (Ubatuba and Picinguaba embayment, 23°-24°S and 44°-46°W), the northern coast of São Paulo State, Brazil. This is the first live-dead comparison study of shelly assemblages of rhynchoneliiform brachiopods conducted at low latitudes, a setting analogous to low-latitude brachiopod assemblages of the Paleozoic marine fossil record. This study targets the present-day assemblages of *Bouchardia rosea* (Bouchardiidae) found in shallow shelf siliciclastic-carbonatic bottoms. This species is the most common and abundant brachiopod found in shallow waters of the Brazilian platform.

Data were obtained from an extensive sampling program during the period of 2000 to 2003. We also supplemented our research with information gathered in this area during a pilot project in 1998 and 1999. Ubatuba and Picinguaba bays were chosen taking into account their persistent brachiopod-rich localities. The sampling program included 29 collecting stations at 5, 10, 15, 20, 25, 30, 35, and 45 meters of depth. For all sampling stations, at least 8 liters of surficial sediments were collected using a Van Veen grab sampler (1/40 m<sup>2</sup>). In addition, the bottom was dredged with otter-trawl nets with an anchor dredge, acquiring the uppermost several centimeters of bay sediments. Finally, the fidelity estimates were obtained by direct comparison of live biota (*B. rosea*) with dead shelly remains found in the bottom samples at each sampling station. We also compared the obtained data with the unique *B. rosea* population survey made during dredges in the 1960's (Tommasi 1970, table 5), in a region of the coast of the Rio de Janeiro State (~60 kilometers northward of our study area).

Out of 29 stations, 21 (72.4%) yielded brachiopod shells, 10 (76.9%) from Ubatuba Bay and 11 (68.7%) from Picinguaba Bay. A total of 4629 *B. rosea* shells were recovered from these bays, 3339 shells (72.1%) from Ubatuba, and 1290 shells (27.9%) from Picinguaba. In Ubatuba brachiopod shells were found at all depths along the investigated bathymetric gradient, except for two stations located at the 15 meters of depth. In the Picinguaba Bay brachiopod assemblages were found at the deepest parts of the studied bathymetric gradient, but were virtually absent in shallow water localities (5 and 10 meters of depth). Out of 3339 shells found in Ubatuba Bay, 71.5% (n= 2386) are small shells (≥2mm, ≤6mm), with the remaining shells partitioned among ≥6mm (15.6%, n=521) and ≥8mm (12.9%, n=432) size classes, respectively. A similar pattern is also observed in the samples from Picinguaba, where 73.8% shells (n=952) are small (≥2mm, ≤6mm), and only 28.5% (n=953) are larger than 6mm. The bay bottom in some sampling stations is enriched in brachiopod shells, as in the case of UBA Station 1 (30 meters of depth) and PIC Station 44: n=1026 and n=399 shells, respectively. However, live specimens of *B. rosea*

are absent on the present-day bay bottom, at least in the sampling period from June 2000 through June 2003. Even Ubatuba Bay, despite persistent occurrence of brachiopod-rich death assemblages of *B. rosea* there, did not yield any live specimen during that recent sampling period. Out of 4629 brachiopod shells recovered from both bays, 4623 (99.87%) are dead shells, and only 6 (0.13%) were *B. rosea* individuals found alive. Interestingly, the 6 specimens found alive were all recovered from Picinguaba Bay (stations PIC, 27, 28, 29), from sites located in the outer part of the bay. Four of those specimens (66.6%) were found in the sampling station PIC 29 (20 meters of depth). This station is also unique in that it yielded dead shells together with live specimens (n=2). Three of the six specimens alive were recovered in the  $\geq 8\text{mm}$  fraction, with the remaining three found in the  $\geq 6\text{mm}$  (n=2), and  $\geq 2\text{mm}$  (n=1) fractions.

Our data indicate that high dead-live disagreement (dead-live fidelity or % dead individuals found also alive) occurs in all environments, at all depths, and for all applied sieve sizes. The within-sample fidelity comparisons (dead-live fidelity) show poor or no compositional fidelity for *B. rosea* shelly assemblages. This is noteworthy considering the persistent and abundant occurrences of *B. rosea* shells on the bottoms of those bays. Even worse, apart from 3339 brachiopod shells recovered from Ubatuba Bay, no live specimens were found in the bioclastic-rich assemblages through the duration of this study. Notably, historical data published by Tommasi (1970) also indicate that poor compositional fidelity is a rule rather than an exception for *B. rosea* shelly assemblages. Tommasi sampled 300 stations along the coast of Rio de Janeiro, but live specimens were found in 12 stations (4%) only, and with exception of 2 stations (251 and 291) the number of live specimens was small at all sites (Tommasi, 1970, p. 1). Thus, the data suggest that living populations of *B. rosea* are very patchy (see also Kowalewski et al. 2002 for similar patterns observed for *B. rosea* populations on the outer shelves of the region) and rather reduced in numbers, at least in the present-day Ubatuba region. Several lines of taphonomic evidence indicate that those shelly accumulations are undergoing extensive temporal and spatial mixing, which may explain the observed low levels of dead-live fidelity. In the last 3 years, *B. rosea* shells collected from the study area (UBA stations 1 and 9 of the present study) were individually dated by combination of  $^{14}\text{C}$  (AMS-radiocarbon) and amino acid racemization (D/L aspartic acid) methods (Carroll et al. 2003, Barbour Wood et al. 2003). At the 30 meters site (UBA 1) shells range in age from modern to 23,820 years BP, while the shells at the 10 meter site (UBA 9) range in age from modern to 3,135 years BP. As indicated by our dead-live comparisons and the dated shells available for the studied assemblages, environmental factors and local fluctuations in populations of shell-producing organisms (*B. rosea*) are more likely to be the principal determinants of the observed low levels of dead-live fidelity. Out-of-habitat spatial mixing is also present, as indicated by the occurrence of *B. rosea* shells on sandy beaches in the vicinities of the two bays. Probably, the source of brachiopod shells is the sampled subtidal settings where brachiopod-rich accumulations are common. Given that *B. rosea* is an epifaunal, free-lying brachiopod that selectively colonizes coarse siliciclastic/bioclastic bottoms, this study provides a compelling example of out-of-habitat, landward transportation of brachiopod shells that may be one of the reasons for the noted dead-live disagreement.

## References

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