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New ocean, new needs: Application of pteropod shell dissolution as a biological indicator for marine resource management

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ABSTRACT

Pteropods, planktonic marine snails with a cosmopolitan distribution, are highly sensitive to changing ocean chemistry. Graphical abstract shows pteropod responses to be related to aragonite saturation state, with progressing decrease in Ω_{ar} causing deteriorating biological conditions. Under high saturation state ($\Omega_{ar} > 1.1$; zone 0), pteropods are healthy with no presence of stress or shell dissolution. With decreasing Ω_{ar} (zone 1), pteropod stress is demonstrated through increased dissolution and reduced calcification. At $\Omega_{ar} < 0.8$ (zones 2 and 3), severe dissolution and absence of calcification prevail; the impairment is followed by significant damages. Pteropods responses to OA are closely correlated to shell dissolution that is characterized by clearly delineated thresholds. Yet the practical utility of these species as indicators of the status of marine ecosystem integrity has been overlooked. Here, we set out the scientific and policy rationales for the use of pteropods as a biological indicator appropriate for low-cost assessment of the effect of anthropogenic ocean acidification (OA) on marine ecosystems. While no single species or group of species can adequately capture all aspects of ecosystem change, pteropods are sensitive, specific, quantifiable indicators of AO's effects on marine biota. In an indicator screening methodology, shell dissolution scored highly compared to other indicators of marine ecological integrity. As the socio-economic challenges of changing ocean chemistry continue to grow in coming decades, the availability of such straightforward and sensitive metrics of impact will become indispensable. Pteropods can be a valuable addition to suites of indicators intended to support OA water quality assessment, ecosystem-based management, policy development, and regulatory applications.