The Power of One: The "Piller-School" in Actuopalaeontology

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Actuopaleontology sits at the intersection of the Earth- and Life-sciences and its goal is to explain the formation of fossils and fossil assemblages by the observation of processes acting in the Present. Werner Piller spent much effort researching himself and training his students in Fossil and Extant earth systems, searching for parallels or analogies in processes. Having grown up on the shorelines of the Paratethys, he has been surfing time, the fossil record, and modern ecosystems. Via his quest is to understand common processes that shaped Modern and Fossil assemblages, he trained young people in rigorous empirical and observational science and thus became nucleus of a still-expanding and increasingly international actuopaleontological endeavor. The formation and structure of coral reefs, as well as their degradation and disappearance, have been of great importance to him. Earth history demonstrates a fair share of reef crises and presently, repetitive coral mass mortality is increasingly common across the world. Thus, the world is unwittingly engaging in a grandiose actuopaleontological experiment that has, in a Pillerian way, the potential to teach much about past crises. These in turn may offer hints about potential future dynamics. Driven by proximal (environmental changes) or distal (societal) factors, the present reef crisis can upset established communities, leading to species-loss and altered communities. The Arabian Gulf is a reef environment with a subset of Indo-Pacific species and a good equivalent to the Miocene Paratethys. This high-latitude epicontinental sea witnesses frequent disturbances, both by distal and proximal drivers, and the severity of these impacts is increasing. Coral reef loss has considerably accelerated over the past decade. Many formally reef-rich areas are now completely devoid of such ecosystems. Local heating correlates with changes in coral population dynamics and community structure and leads to discrete population events (mortality and altered life-dynamics) that alternate with undisturbed dynamics. Such events are also evident in the Paratethyan fossil record. 25 years of monitoring recent Gulf reef systems led to the definition of three phases of coral population dynamics in response to the environment (a period of relative stability; a moderately disturbed, and a highly disturbed scenario) with three theoretical stable states of declining coral frequency and cover. Increased disturbance leads to progressive reduction in coral size, cover, and population fecundity. The first two attributes are easily visible in the fossil record, the third is not but it can now be inferred. More frequent disturbance increases connectivity requirements in metapopulations. Both in the Fossil and the Recent, basin-wide assessment, as much as practical, is required to understand the spatial structure of reefal fauna which decides persistence or extinction. Connectivity required to avoid extinction increases exponentially with linear increase in disturbance frequency and its correlation across the metapopulation. Variable extinction thresholds exist across communities that determine which species will be winnowed out and which will maintain acceptable population levels. Higher disturbance frequency will lead to net loss of coral cover and novel community arrangements in the Arabian Gulf – a situation that can be related to many Paratethyan outcrops. *Acropora* dominated on many Gulf and Caribbean reefs since the Pleistocene, but no longer does. Other common species (*Porites harrisoni*, *Dipsastrea pallida*, *Platygyra daedalea*) also declined and disappeared from some areas, but recovered in others. A degradation sequence in order of species loss exists: *Acropora* to *Porites* and/or *Platygyra* to *Dipsastrea* to *Cyphastrea*. Similar dynamics are, despite a strong taphonomic filter, also visible in Miocene Paratethyan outcrops, such as the Fenk in Burgenland. The Pillerian view of the world has prevailed.