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Editorial

Mesophotic Ecosystems: The Link between Shallow and Deep-Sea Habitats

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Abstract: Mesophotic ecosystems (MEs) are characterized by the presence of light-dependent organisms, found at depths ranging from ~30 to 150 m in temperate, subtropical and tropical regions. These communities occasionally create massive reef structures with diverse but characteristic morphologies, which serve as the framework builders of those ecosystems. In many localities, MEs are physically linked with shallow and deep-sea habitats, and while taxa from both environments share this space, a unique and endemic biodiversity is also found. The main MEs studied to date are the mesophotic coral ecosystems (MCEs) and the temperate mesophotic ecosystems (TMEs), which have received increased attention during the last decade. As shallow coral reef ecosystems are among the most threatened habitats on Earth, the potential of MEs to act as refugia and contribute to the resilience of the whole ecosystem has been a subject of scrutiny. New technologies and methods have become more available to study these deeper parts of the reef ecosystems, yielding many new discoveries. However, basic gaps in knowledge remain in our scientific understanding of the global diversity of MEs, limiting our ability to recognize biogeographic patterns and to make educated decisions for the management and conservation of these ecosystems.

Keywords: coral reefs; deep reefs; marine habitats; vertebrates; invertebrates; community dynamics; light; biodiversity; ecology; natural history; refuge; technical diving

1. Introduction

Shallow marine habitats occupying photic-zone areas over a large latitudinal gradient, from tropical to temperate waters, are part of the most productive and diverse ecosystems. For example, tropical coral reefs are among the most diverse habitats on the globe [1,2], demonstrating high efficiency in the retention and recycling of carbon and nutrients, which contribute to the productivity of the ecosystem [3,4]. Compared to shallow habitats, mesophotic coral ecosystems (MCEs) and temperate mesophotic ecosystems (TMEs) have received little research attention [5,6]. Although those mesophotic ecosystems (MEs) represent approximately 60–80% of the potential reef habitat area worldwide [7,8], knowledge of their distribution, biodiversity, community composition and ecological processes remains limited [6,9,10].

The criteria for defining MEs is poorly established and still in question. Scientists usually follow arbitrary depth ranges without geomorphological or biological rationale. For modern MCEs, the common definition is based on physical water depth, involving light-dependent coral ecosystems from 30 to 150 m in tropical and subtropical regions [11]. Subdivisions of upper MCEs and lower MCEs are also common [12] and although a general global 60 m community break is suggested [13], there have been a few attempts to define those zones by light levels [14,15]. Recently, scientists have also started to use fixed depth ranges to study temperate ecosystems [5], investigating from upper TMEs between 50 and 60 m to lower TMEs at 100–150 m [16,17]. A few ecological and biological studies have also tried to explain the boundaries between shallow and mesophotic reefs by using light-dependent coral assemblages and light levels to define the zonation along the depth gradient [13–15,18].

Geologists usually use the mesophotic definition to characterize assemblages of fossil platy corals, where estimates of surface photosynthetic active radiation (PAR) between 1% and 20% are found [19–22]. Furthermore, in some cases, further zoning is used to define the depth gradient, including "euphotic" (20–100%; good light and, in open seas, commonly with high wave energy), "mesophotic" (5–20% PAR; sufficient light for coral growth, commonly below normal wave base), "oligophotic" (1–5%; sufficient light for coralline red algal growth), "disphotic" (0–1%; absence of sufficient light for photosynthesis) and "aphotic" (absence of light) zones [20–23].

Biodiversity studies conducted to date have revealed diverse coral and fish communities in MCEs [12,24,25]. The highest diversity levels have been reported for regions such as the Coral Triangle [26,27] and the Hawaiian Archipelago [28]. Unique communities have been reported [29], and the discovery rate for new fish species is currently around 2.0 species per hour in unexplored lower MCEs of the Pacific and Atlantic Oceans [26]. However, there is a strong geographic bias for MCE research, and the locations of existing MCE habitats are not related to the locations where most research has been conducted to date [8].

Moreover, despite a widely reported trend of a decrease in species richness along the depth gradient [12,30–33], recent contributions have suggested that extensive fish species turnover (species replacement), instead of purely nestedness (species loss), characterize this spatial gradient from shallow to mesophotic depths [26,29]. Historically, however, MCEs have been considered more stable ecosystems compared to shallow reefs [34–37], and, due to the attenuation of climate change stressors (tropical storms and rising sea temperature) with depth, they were suggested to provide refuge for shallow water species —a concept known as the "Deep Reef Refuge Hypothesis" (DRRH) [38–40].

Concluding, although the number of publications on the biodiversity and community structure of MEs compared to that on any other theme of mesophotic research is high [5,41], there is an urgent need to increase the scientific knowledge on the diversity of fish, corals and other associated taxa in mesophotic ecosystems, and how they relate to shallow and deep-sea ecosystems. This Special Issue aims to promote scientific knowledge on the diversity of MEs, a step to a better understanding of biogeographic patterns, and also to make educated decisions for the management and conservation of these ecosystems.

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