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SYNOPSIS

New Perspectives on Marine Biodiversity

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Marine and terrestrial ecosystems are so fundamentally different in some aspects that many of the issues concerning biodiversity cannot be interpreted using a single theory of common application to all ecosystems.

It is true that biological variability is a rule, rather than an exception, and that all ecological communities tend to attain diversity. How they achieve and maintain it has since long been a topic of discussion. The classic theory explains that a harmonious coexistence of various species in a community requires different niches for competitors to be able to perform their roles (Volterra 1926; Lotka 1932; MacArthur 1972), suggesting that niche differences or in a broader sense ecological differences, maintain the diversity (MacArthur 1972; Tilman 1982; Chase and Leibold 2003). This is contradicted by the Neutral Theory of Biodiversity presented by Hubbel (2001), which assumes that the niche differences between members of an ecological community of trophically similar species are neutral, or irrelevant to their success. The basis of this concept is ecological equivalence among all individuals of every species that occupy a given trophic level in terms of their multiplication in number by reproduction and mortality.

Levine and HilleRisLambers (2009) concluded that it remains to be scientifically verified whether the niche differences are unimportant, only stabilizing the interactions of nearly equivalent competitors (as suggested by the neutral theory) or the species diversity is maintained by strong niche differences stabilizing the interactions of highly unequal competitors.

The neutral theory is not broad enough to cover all the natural ecosystems. It seems to be short of answers when it comes to the factors that maintain and promote marine biodiversity. This theory excludes parasitism and predation in the context of the issues it discusses, and allows competition for resources such as food. It is lopsided towards fauna, not considering the plant species of a floral community that obtain food by photosynthesis. It also does not account for the critical role that symbiosis plays in survival in animals such as giant clams, which need symbiotic dinoflagellates to synthesize food for them while providing housing support to these microbial organisms.

If we use the neutral theory as a guiding principle, we might not be able to plan special measures for conservation of the depleted and threatened marine populations of some red-listed species such as humphead wrasse (*Cheilinus undulatus*) and species of groupers that are protogynous with naturally skewed sex ratio and where preponderance of females reaches critical threshold due to absence of environmental cues required for sex differentiation.

It is hard to believe that any of the two above main theories can be effectively applied to highly biodiverse and interconnected marine ecosystems such as the coral reefs. Not just that the diversity of species is exceptionally high in coral reefs, the uniqueness and complexity of the ecological links is too complicated to explain the survival of species and maintenance of diversity within the rigid confines of the trophic similarities. Trophic links are a major factor, but space, breeding, shelter from predators, environmental cues, behavior ingrained in the genotype, genetic tendencies towards variability, mutations, and connectivity of marine habitats are also important. The importance of the connectivity of habitats such as coral reefs, seagrasses, and mangroves in influencing diversity has been realized in recent years (Mumby 2006; Mustafa 2010a).

None of the main theories of biodiversity appear to take into consideration the real nature of species interactions in the backdrop of dynamic forces operating in the marine critical habitats. There is a growing body of evidence suggesting that natural connectivity of marine habitats is important in survival, population recruitment, and biodiversity (Nakamura et al. 2009; Treml 2009). Habitat shifts that take place in migratory marine animals mean that all the habitats utilized by adults and juveniles serve as corridors to connect them for the life cycle to complete and population recruitment to take place. Corridors facilitate the population dispersal and genetic exchanges, and reduce the population fluctuations (Mumby 2006). Ransangan et al. (1999) have discussed the crucial role of marine corridors for the grouper population. Working on the genetic structure of fish populations in Borneo, they identified the northern part of Sabah where the South China Sea joins the Sulu Sea to be the main passageway for the gene flow along the two coasts. Obviously, excessive pressure on the habitat or the fish resources in this region will disrupt the gene flow and genetic structure of the populations. Earlier, Meffe (1990) also investigated how habitat influenced the natural gene flow resulting in serious consequences for some rare species of fish in North America. Explaining life as a non-equilibrium phenomenon, Banvar and Maritan (2009) have described how the organisms distribute themselves in space and compete for resources while at the same time undergoing diffusion in the so-called 'genome space' that results in the birth of new species and promotes diversity. With the multiplicity of links involved in biodiversity and limited scientifically verified data available, the best way to conserve it is to holistically protect the environment that provides links to sustain all the levels of the biodiversity.

A new theory is also needed for the response of marine biodiversity to climate change since this appears to be beyond the scope of the biodiversity theories documented so far. The fact that natural ecosystems and biodiversity form a bulwark against climate change (Turner et al. 2009), emergence of a concept that relates them to global environmental change becomes all the more important. It should be considered a matter of utmost urgency for the reason that the rate at which the species are being lost, we have already crossed the boundary that separates the environmental stability from dangerous thresholds (Rockström 2009).

The biological attributes of many marine species are so different that their response will be specific according to their physiological and genetic constraints, and resilience. The expected changes in the marine ecosystem include acidification, sea level rise, reduced upwelling of nutrients, and increased thermal stratification. These changes will influence the blooming of phytoplankton and associated food chain (Thuiller 2007).

It is inconceivable at this stage to determine the applicability of any of the existing theories to explain the complexity of environment and diversity in the community of the abyssal plains of the ocean floor and the deep sea trenches. These environments are cold, dark, and oxygen-deficient, with pressures 1,000 times greater than at the surface, and where geothermal energy fuels life processes. In organisms living in such an environment, chemosynthesis, not photosynthesis, produces organic molecules that provide the biomass for the next higher trophic cycle. The neutral theory will not be able to deal with potential scenarios outlined by Mustafa (2009, 2010b) concerning such deep trench marine extremophiles venturing into the non-extremophile environment with the worsening of climate change. If this happens, the potential decline in marine biodiversity will be masked by appearance of the species which were never before a part of the community in the moderate environment as we see it now.

In conclusion, an accurate understanding of marine biodiversity requires comprehensive knowledge of the ecological interrelationships and new perspectives that reflect the reality of global environmental change.

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