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Editorial

Diversity of Coral-Associated Fauna: An Urgent Call for Research

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Tropical coral reefs are considered the "rainforest of the sea" and are among the marine ecosystems with the highest biodiversity [1]. These "rainforests" are typically composed of assemblages of anthozoans, sponges, bryozoans, and ascidians, forming the three-dimensional matrix which provides architectural complexity for a myriad of organisms [2]. A large proportion of this biodiversity is represented by tiny invertebrates, usually known as cryptofauna, that are often overlooked because of their size, a lack of commercial interest, charisma, and/or taxonomic expertise [3–5]. Despite the fact that nearly a thousand invertebrates are known to depend to some extent on corals for habitat, food, shelter, or settlement cues [6], it is still to be elucidated how many species exhibit obligatory or facultative symbiotic relationships with all other coral reef framework-forming taxa, keeping the coral reefs a mystery in terms of their diversity and functioning.

Unfortunately, increasing evidence suggests that most coral reefs will undergo compositional, structural, and functional changes in response to local stressors, such as overfishing, eutrophication, and diseases [7], as well as in response to global stressors such as ocean acidification and climate-induced coral bleaching, impacting the world's coral reefs and the communities that depend upon them [8]. Indeed, in the future different environmental conditions not only will push some species towards and beyond their physiological limits, but will also modify the network of interactions [9]. Since species are highly interconnected, co-extinction events will have largely unknown ecological consequences as cryptic communities, with largely understudied ecological functions, may disappear accordingly [9]. Thus, it is evident that only by understanding the highly multifaceted interactions amongst the different coral reef organisms will we gain insights on how, where, and why coral reefs are changing [10].

In this respect, this Special Issue aims to provide more testimonies of the extreme diversity of coral-associated fauna, as well as to improve, through different perspectives and new methodological approaches, the knowledge of marine invertebrate diversity in general, and that of the coral reef-associated ones in particular. The contributions published in this volume address specifically a variety of topics including (i) the integrative taxonomy and genetic diversity of merulinid corals [11] and of crustaceans associated with pocilloporid corals [12], (ii) the diversity of coral reef fishes in the Western Indian Ocean [13], (iii) the spatial distribution, host range, and prevalence of associations involving sponges [14], alcyonaceans [15], and corals [16], and (iv) the possible negative impacts that some coral-associated invertebrates can have on the health of their hosts [17–21].

Coral reefs are globally recognized as a major ecosystem in need of conservation [22], which might require the inclusion in future studies of the so far largely ignored hidden or cryptic communities. These communities and their ecological functions are, in fact, markedly different than the visible or exposed ones [23]. Monitoring of coral reef benthos alone is, however, not enough to understand the effects of external drivers on the resilience of coral reefs and their sensitivity to community changes.

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Nowadays, it seems appropriate to move forward in adopting new strategies, in addition to multidisciplinary taxonomic studies, to study benthic communities, since this cryptobenthic fauna appears to play a relevant role in the biodiversity and conditions of coral communities. Thus, I advocate for the urgent development and use of emerging new technologies to facilitate and increase the repeatability of coral reef monitoring efforts, as well as to unravel the drivers and feedback mechanisms behind benthic community changes [24]. The systematic collection of data on the coral-associated fauna during free-living biodiversity surveys should strongly be encouraged to increase the knowledge about the diversity of coral-associated fauna, to discover its ecological roles, and to depict its functional traits within coral reefs ecosystems. This process may provide baselines of such hidden biodiversity, identify rare symbiotic species, and it could be used to monitor future changes in symbiotic assemblages. Furthermore, given the paucity of information on the natural history of many symbiont taxa, this approach would also potentially allow us to classify certain symbiont species and help raise awareness of their current endangerment status [5]. Indeed, the easiest and most cost-effective way to protect coral-associated invertebrates will usually be by conserving them alongside their hosts. This represents a paradigm shift from preserving single taxa to protecting symbiont assemblages and micro-ecosystems. However, without in-depth knowledge regarding their hosts range, rate of hosts shift, and symbionts' vulnerability, the level of endangerment of the symbionts may not reflect their real risk of extinction. In addition, novel threats (e.g., diseases and plastic pollution) and their interactions need to be taken into account as they might also play a role in benthic community changes [25]. Thus, the assessment of the health condition of coral-associated fauna should be considered a priority since it may help in understanding the resilience capacity of their host. Moreover, more accurate data on host specificity is strongly necessary for the transition to a new era of solution-oriented science with the potential to prolong the survival of coral populations [26]. In the context of the emerging field of restoration ecology, host translocation and active conservation efforts may threaten the survival of coral-associated species, and of their hosts. Thus, explicit actions to restore coral-associated fauna alongside hosts should be considered as a part of coral restoration planning. Hence, coral reef restoration monitoring plans that allow us to assess the effectiveness of the management approach for both hosts and coral-associated fauna are also needed [27].

In conclusion, as the restructuring of tropical coral reef communities towards different and, perhaps, emergent non-hard-coral-dominated communities becomes inevitable in many locations [10], a more complete overview of host-symbiont associations, the degree of specialization and codependence of these symbiotic relationships, as well as the diversity, distribution, and functional roles of coral and non-coral associated invertebrates is paramount to better understand the dynamics, ecological functions, and societal impacts of these communities.

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References

1. Fisher, R.; O'Leary, R.A.; Low-Choy, S.; Mengersen, K.; Knowlton, N.; Brainard, R.E.; Caley, M.J. Species Richness on Coral Reefs and the Pursuit of Convergent Global Estimates. *Curr. Biol.* **2015**, *25*, 500–505. [CrossRef] [PubMed]
2. Rossi, S.; Bramanti, L.; Gori, A.; Orejas, C. An overview of the animal forests of the world. In *Marine Animal Forests: The Ecology of Benthic Biodiversity Hotspots*; Springer International Publishing: Cham, Switzerland, 2017; pp. 1–28.
3. Hoeksema, B.W. The hidden biodiversity of tropical coral reefs. *Biodiversity* **2017**, *18*, 8–12. [CrossRef]

4. Montano, S. The extraordinary importance of coral-associated fauna. *Diversity* **2020**, *12*, 357. [CrossRef]
5. Bravo, H.; Xu, T.; van der Meij, S.E. Conservation of Coral-Associated Fauna. In *Earth Systems and Environmental Sciences*; Elsevier: Amsterdam, The Netherlands, 2021; p. 8.
6. Stella, J.S.; Pratchett, M.S.; Hutchings, P.A.; Jones, G.P. Coral-associated invertebrates: Diversity, ecological importance and vulnerability to disturbance. *Oceanogr. Mar. Biol. Annu. Rev.* **2011**, *49*, 43–116.
7. Hughes, T.P.; Kerry, J.T.; Álvarez-Noriega, M.; Álvarez-Romero, J.G.; Anderson, K.D.; Baird, A.H.; Babcock, R.C.; Beger, M.; Bellwood, D.R.; Berkelmans, R.; et al. Global warming and recurrent mass bleaching of corals. *Nature* **2017**, *543*, 373–377. [CrossRef]
8. Hughes, T.P.; Kerry, J.T.; Baird, A.H.; Connolly, S.R.; Dietzel, A.; Eakin, C.M.; Heron, S.F.; Hoey, A.S.; Hoogenboom, M.O.; Liu, G.; et al. Global warming transforms coral reef assemblages. *Nature* **2018**, *556*, 492–496. [CrossRef]
9. Strona, G. Modelling co-extinction. In *Hidden Pathways to Extinction*; Springer International Publishing: Cham, Switzerland, 2022; pp. 75–99.
10. Reverter, M.; Helber, S.B.; Rohde, S.; de Goeij, J.M.; Schupp, P.J. Coral reef benthic community changes in the Anthropocene: Biogeographic heterogeneity, overlooked configurations, and methodology. *Glob. Chang. Biol.* **2022**, *28*, 1956–1971. [CrossRef]
11. Chen, C.-J.; Ho, Y.-Y.; Chang, C.-F. Re-Examination of the Phylogenetic Relationship among Merulinidae Subclades in Non-Reefal Coral Communities of Northeastern Taiwan. *Diversity* **2022**, *14*, 144. [CrossRef]
12. Alonso-Domínguez, A.; Ayón-Parente, M.; Hendrickx, M.E.; Ríos-Jara, E.; Vargas-Ponce, O.; Esqueda-González, M.d.C.; Rodríguez-Zaragoza, F.A. Taxonomic Diversity of Decapod and Stomatopod Crustaceans Associated with Pocilloporid Corals in the Central Mexican Pacific. *Diversity* **2022**, *14*, 72. [CrossRef]
13. Samoilys, M.; Alvarez-Filip, L.; Myers, R.; Chabanet, P. Diversity of Coral Reef Fishes in the Western Indian Ocean: Implications for Conservation. *Diversity* **2022**, *14*, 102. [CrossRef]
14. Gobbato, J.; Magrini, A.; García-Hernández, J.E.; Virdis, F.; Galli, P.; Seveso, D.; Montano, S. Spatial Ecology of the Association between Demosponges and Nemalecium lighti at Bonaire, Dutch Caribbean. *Diversity* **2022**, *14*, 607. [CrossRef]
15. Canessa, M.; Bavestrello, G.; Bo, M.; Enrichetti, F.; Trainito, E. Filling a Gap: A Population of *Eunicella verrucosa* (Pallas, 1766) (Anthozoa, Alcyonacea) in the Tavolara-Punta Coda Cavallo Marine Protected Area (NE Sardinia, Italy). *Diversity* **2022**, *14*, 405. [CrossRef]
16. Maggioni, G.; Huang, D.; Maggioni, D.; Jain, S.S.; Quek, R.Z.B.; Poquita-Du, R.C.; Montano, S.; Montalbetti, E.; Seveso, D. The Association of Waminoa with Reef Corals in Singapore and Its Impact on Putative Immune- and Stress-Response Genes. *Diversity* **2022**, *14*, 300. [CrossRef]
17. Jandang, S.; Bulan, D.E.; Chavanich, S.; Viyakarn, V.; Aiemsomboon, K.; Somboonna, N. First Report of Potential Coral Disease in the Coral Hatchery of Thailand. *Diversity* **2022**, *14*, 18. [CrossRef]
18. Montano, S.; Aeby, G.; Galli, P.; Hoeksema, B.W. Feeding Behavior of *Coralliophila* sp. on Corals Affected by Caribbean Ciliate Infection (CCI): A New Possible Vector? *Diversity* **2022**, *14*, 363. [CrossRef]
19. Hoeksema, B.W.; Smith-Moorhouse, A.; Harper, C.E.; van der Schoot, R.J.; Timmerman, R.F.; Spaargaren, R.; Langdon-Down, S.J. Black Mantle Tissue of Endolithic Mussels (*Leiosolenus* spp.) Is Cloaking Borehole Orifices in Caribbean Reef Corals. *Diversity* **2022**, *14*, 401. [CrossRef]
20. Hoeksema, B.W.; Harper, C.E.; Langdon-Down, S.J.; van der Schoot, R.J.; Smith-Moorhouse, A.; Spaargaren, R.; Timmerman, R.F. Host Range of the Coral-Associated Worm Snail *Petaloconchus* sp. (Gastropoda: Vermetidae), a Newly Discovered Cryptogenic Pest Species in the Southern Caribbean. *Diversity* **2022**, *14*, 196. [CrossRef]
21. Hoeksema, B.W.; Timmerman, R.F.; Spaargaren, R.; Smith-Moorhouse, A.; van der Schoot, R.J.; Langdon-Down, S.J.; Harper, C.E. Morphological Modifications and Injuries of Corals Caused by Symbiotic Feather Duster Worms (Sabellidae) in the Caribbean. *Diversity* **2022**, *14*, 332. [CrossRef]
22. Bellwood, D.R.; Pratchett, M.S.; Morrison, T.H.; Gurney, G.G.; Hughes, T.P.; Álvarez-Romero, J.G.; Day, J.C.; Grantham, R.; Grech, A.; Hoey, A.S.; et al. Coral reef conservation in the Anthropocene: Confronting spatial mismatches and prioritizing functions. *Biol. Conserv.* **2019**, *236*, 604–615. [CrossRef]
23. Kornder, N.A.; Cappelletto, J.; Mueller, B.; Zalm, M.J.L.; Martinez, S.J.; Vermeij, M.J.A.; Huisman, J.; de Goeij, J.M. Implications of 2D versus 3D surveys to measure the abundance and composition of benthic coral reef communities. *Coral Reefs* **2021**, *40*, 1137–1153. [CrossRef]
24. Obura, D.O.; Aeby, G.; Amornthammarong, N.; Appeltans, W.; Bax, N.; Bishop, J.; Brainard, R.E.; Chan, S.; Fletcher, P.; Gordon, T.A.C.; et al. Coral Reef Monitoring, Reef Assessment Technologies, and Ecosystem-Based Management. *Front. Mar. Sci.* **2019**, *6*, 580. [CrossRef]
25. Lamb, J.B.; Willis, B.L.; Fiorenza, E.A.; Couch, C.S.; Howard, R.; Rader, D.N.; True, J.D.; Kelly, L.A.; Ahmad, A.; Jompa, J.; et al. Plastic waste associated with disease on coral reefs. *Science* **2018**, *359*, 460–462. [CrossRef] [PubMed]
26. Van Oppen, M.J.; Oliver, J.K.; Putnam, H.M.; Gates, R.D. Building coral reef resilience through assisted evolution. *Proc. Natl. Acad. Sci. USA* **2015**, *112*, 2307–2313. [CrossRef] [PubMed]
27. Montano, S.; Siena, F.; Amir, H. *Coral Reef Restoration Monitoring Manual-Maldives*, 1st ed.; University of Milano Bicocca: Milano, Italy, 2022; pp. 43–45.