Inventoring Indian Ocean reef biodiversity in the XXIth century: new challenges and opportunities

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Background

Assessing marine biodiversity has always been a challenge. Most of our knowledge about marine biodiversity comes from wide 19th and early 20th century expeditions that trawled around the world (such as HMS Challenger, 1872-1876, or the International Indian Ocean Expedition, 1959-1965), collecting masses of often damaged specimens that were sent dried or in formaldehyde to European or American museums. Such campaigns have become rarer nowadays, due to their financial and human cost, but also to a greater understanding of their ecological effects.

Modern environmental regulations and international treaties (such as the Nagoya protocol since 2010) have made difficult to carry on conventional inventories involving massive trawling and shipping of marine life. But at the same time, the progress of scuba diving, underwater photography, naturalist knowledge, citizen sciences and genetics have opened new ways of assessing the biodiversity of an ecosystem. Hence, combining today’s opportunities may render biodiversity inventories even more efficient than classical ones, while having minor effect on the environment and being more cost-effective. The aim of the present paper is to provide an integrated method for biodiversity assessment and inventories in Indian Ocean countries with little scientific facilities, dwelling on experiences from Réunion and Mayotte islands.

Methods:

Before starting any inventory campaign, the scope of the inventory must be defined. It can apply to specific target groups (marine mammals, fish, corals, sponges, mollusks, echinoderms, algae…) or to bulkier groups (marine vertebrates, marine invertebrates, sessile beings…), which will demand more work. The scope depends on the aim of the inventory: target groups are useful for conservation purposes, to monitor fishing or poaching, or to assess the state of the ecosystem using indicator groups. However, complete inventories of all macroscopic beings can also be led, but this demand more time and people involved, and are difficult to lead without a substantial research grant.

The first step of this study is to investigate the opportunities present in Indian Ocean countries with limited scientific infrastructures. There are two different sources of data, which we call actual and potential sources: actual sources include past bibliography and nearby bibliography (neighbor country, neighbor island or atoll, etc.), museum or private collections (including museum in remote countries: USA, England and France have collections from tens of countries), and, to finish with, pictures databases. These can be found from various sources,
including scientists (current or former), diving clubs, local sea enthusiasts, fishermen, or even on the web, especially on biodiversity observation sharing websites and networks. With the progress of modern underwater cameras, more and more species can be readily identified from pictures, or at least at the genus (or family) level, providing a huge database of observations that few professional teams could hope constituting.

The second step consists in building on potential sources of data. This demands to raise the awareness or even recruit some particular publics, such as fishermen, other sea professionals and users, diving clubs and nature enthusiast associations. Inventory targets must be defined and people must be trained to spot targets and document them properly, be it with pictures, parts (shells, tests, samples…) or whole specimens. As such data will always be biased (towards beautiful diving spots, rich fishing grounds…), dedicated field work will be necessary on areas not already covered by these populations, and which often match with specific assemblages (“ugly” areas shelter different species than touristic beaches). If no night dive data is available, night dives will also be needed as nocturnal species are often invisible during the day, and numerous. The aim is to cover the whole range of ecological niches, including chronological niches (hour, tides, seasons…) in order not to let any important niche unexplored. Hence, in this framework, the actual field work needed from the project managers is only a complement to field data collection from other stakeholders.

The final step is identification: here it is paramount to have a relay scientist, able of identifying common species and selecting observation worth sending to more specialized professionals. The involvement of a network of professional taxonomist is essential to ensure the safety of the identifications and to request, when necessary, the collection of samples for biometric or genetic analyses.

Results:

In Mayotte, an inventory of echinoderms using this method increased by nearly 50% the previous list, adding 78 new records for the region. In Réunion Island, 60 new records (counting only groups with a registered record) and 3 new species have been published, and over 1300 species identified at a professional level at no cost, making it one of the most important single biodiversity inventories in any coral reef in the Indian Ocean.

Discussion

The discussion will focus on limitations, bias and emerging virtues of this methodology, and its applicability to various socioecosystems other than coral reefs.

Conclusion

The use of modern tools may enhance the efficiency and cost-effectiveness of local scale inventories in countries with limited scientific infrastructures, dwelling on citizen science, local communities’ involvement, internet and modern technologies for DNA sequencing. While marine scientists have been mourning for decades the end of the great marine expeditions, the birth of modern biodiversity assessments may also be backed up by emerging virtues, such as local communities empowerment, and a more detailed documentation of ecological habits and phenotypic variations of sea life, which were less available with previous methods: a whole new field of marine science comes in reach.