

Bridging the gap between people and Philippine coral diversity

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The Philippines cradles at least 505 species of hard corals (DeVantier and Turak 2017), which is the highest number of species presently recorded in the Indo-West Pacific. In a region with such extraordinary diversity, distinguishing between species or even between genera can be a challenge, especially since the distinctions between species may be blurred at larger geographic scales. This challenge emphasizes the need for locally specific, quality field guides and monographs, and access to an array of well-curated specimens collected from the region by taxonomic authorities. The Coenomap website, hosted by the Br. Alfred Shields FSC Ocean Research (SHORE) Center of De La Salle University, was initially developed to provide a free and accessible repository of relevant taxonomic references for hard corals of the Order Scleractinia. The repository brings together the original descriptions and high-resolution photographs of both the macromorphology and the micromorphology of 156 type specimens of Francisco Nemenzo in The Nemenzo Virtual Museum page of Coenomap. The Nemenzo Virtual Museum is one of the vital elements of Coenomap in the pursuit of encouraging and facilitating the identification of corals and the mapping of their distributions in the Philippines.

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coenomap, virtual museum, Francisco Nemenzo, coral taxonomy, type specimens

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Francisco Nemenzo and his coral collection

The roots of traditional coral taxonomy always lead us back to the coralla, the skeletons of hard or stony corals. For a long time, coral taxonomic schemes and species identifications were based solely on the skeletal features (Vaughan and Wells 1943; Veron and Pichon 1980; Veron 2000). Whenever a new species is being described, the original type specimens of corals that have close affinities to the new species being proposed are required for comparison and validation. These type specimens are the original coralla used to describe a new species. Thus, the description of new species often requires visiting natural history museums in Europe, the US, or Australia, where most of the type specimens are deposited.

The Philippines, being at the center of coral diversity, also has extensive collections of type specimens. Francisco Nemenzo, a zoologist who spent decades studying the coral fauna of the Philippines, was the Filipino pioneer in describing new species of corals. His work earned him the title of “Father of Philippine Coral Taxonomy.”

Professor Nemenzo described a total of 160 new species of corals (WoRMS Editorial Board 2020) through careful investigations of countless coral specimens brought to him by diver friends and scientists. These specimens were sampled mainly from reefs in Cebu, Luzon, Mindoro, and Palawan for him to examine and describe. Some of the species that Professor Nemenzo described were named after his family members, friends, students, and colleagues who have made an impact on coral research. An example is *Acropora caroliniana* (Figure 1), an exquisite branching coral that Professor Nemenzo named after his second child, Carol.

Currently, 37 of the species that Professor Nemenzo described as new are considered valid, while three are of *nomen nudum*,

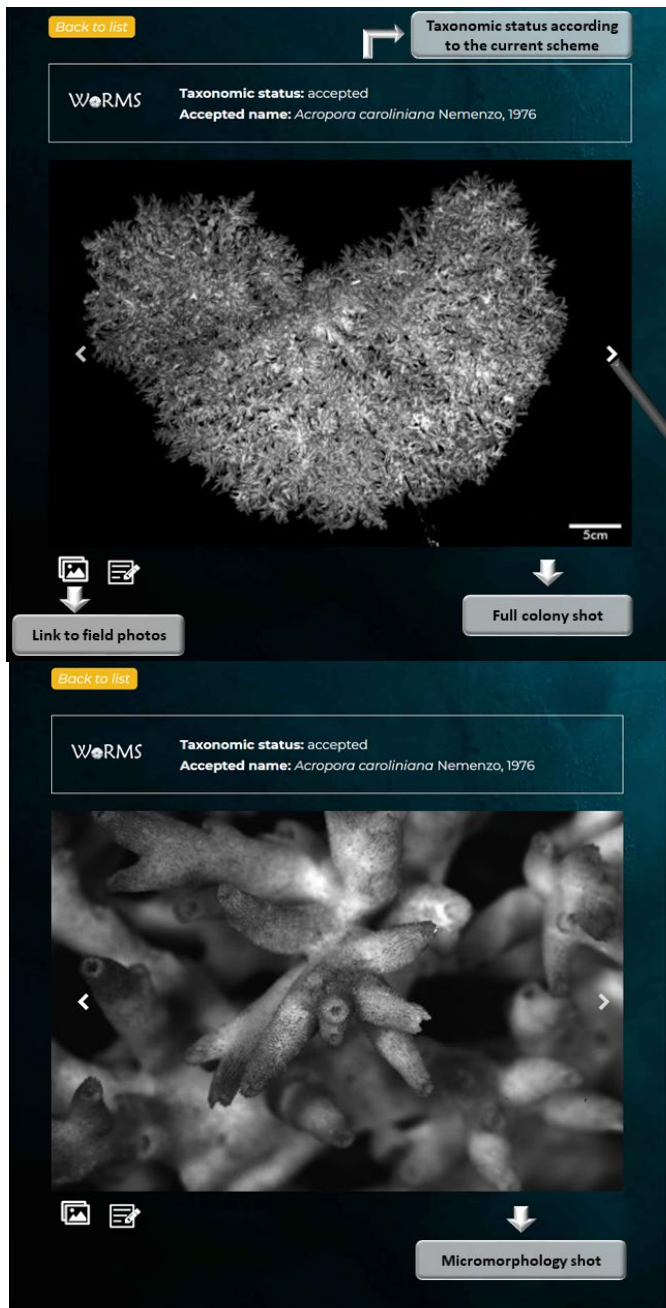


Figure 1: The web interface of The Virtual Museum in Coenomap. The example shown is the species information for *Acropora caroliniana*. (A) The general information, including the full colony shot, a brief description of the specimen, the place of collection, and the current location of the institution that houses the type is displayed first. (B) More details, such as photographs of the micromorphology and a detailed description of the specimen by Professor Nemenzo, are also available.

and eight are of *taxon inquierendum* status (WoRMS Editorial Board 2020). The rest of his species are currently synonymized. However, all coral species are being re-examined under a new taxonomic scheme that integrates both phenotypic and genotypic characteristics (Huang et al. 2011; Huang et al. 2014; Huang et al. 2016). Hence, some of these synonymized species may turn out to be valid. The phenotype, in the current taxonomy, includes the characteristics of the macro- and micromorphology and the patterns of skeleton growth (skeletonogenesis) embodied in microstructures.

Professor Nemenzo's extensive work is immortalized in his published works and coral collections, which, when put together, is one of the largest in the country. The Institute of Biology (IB) of the University of the Philippines alone holds a total of 709 coral specimens of Professor Nemenzo (Pedales and Batomalaque 2014; NB This paper got Professor Nemenzo's

first name wrong). The rest are under the care of The Marine Science Institute (MSI) of the University of the Philippines, Silliman University (SU), and the University of San Carlos (USC).

The Nemenzo Virtual Museum in Coenomap

The type specimens are vital in studying coral taxonomy and, consequently, in quantifying diversity. Given the limited availability of references and limited access to coral collections, a virtual museum of Professor Nemenzo's type specimen collection was developed to break these barriers.

The Nemenzo Virtual Museum provides high-resolution digital images of the corals' macromorphology and micromorphology. The latter were few in Professor Nemenzo's publications, almost all of which are out of print. All the available type specimens in

the four institutions mentioned were revisited and photographed in more detail. Unfortunately, some of the types are missing, and some are undocumented and therefore cannot be traced, as in the case of *Acropora rectina* (WoRMS Editorial Board 2020). The Nemenzo types that were found: 109 from IB, 18 from MSI, 13 from SU, and eight from USC are now exhibited in The Nemenzo Virtual Museum (<http://www.coenommap.org/nemenzo-virtual-museum/>).

The latest interface of the page includes the original descriptions of each coral, as published by Professor Nemenzo, and other details such as the place of collection and the institution that houses the specimen (Fig. 1). The Nemenzo Virtual Museum also aligns Professor Nemenzo's taxonomy with the current taxonomic scheme. The wider accessibility of the page protects the types from exposure to repeated handling by different examiners.

There are more Philippine specimen collections of other taxonomic authorities housed at The Marine Science Institute. These collections include those of J.E.N. Veron, and the types of *Nemenezophyllia turbida* (the only species of the genus named after Professor Nemenzo by his students), and *Leptoseris kalayaanensis* (from the first Philippine expeditions to the Kalayaan Islands). The DLSU SHORE team plans to feature these collections in the Virtual Museum section of Coenommap. The Nemenzo Virtual Museum is the only active page of The Virtual Museum at present.

Coenommap: The first online resource on corals in the Philippines

The title, Coenommap, was coined from the term “coeno”, which comes from the Greek word *koinos*, meaning “common”. For example, the coenosteum is the skeletal structure that grows between and connects adjacent corallites in a corallum. Coenommap is a website that was conceptualized in 2005 when the Philippine ‘Center of Excellence’ of the World Bank-funded Global Environment Facility - Coral Reef Targeted Research (GEF-CRTR) Program was under the management of late National Scientist Edgardo D. Gomez. A project was opened under the CRTR program to serve the other working groups by building their capacity for coral taxonomy. This taxonomy project conducted regular bi-annual training to members of CRTR, other coral researchers across the country, and even recreational divers who are coral enthusiasts. One way that the training materials and the field guides were disseminated to the public, especially to the trainees, was through Coenommap. The Virtual Museum served as the corallum reference of Coenommap back then. During the infancy of Coenommap, the website was already intended to be participatory. The site was slowly being developed to be a “common” platform that allowed local divers or snorkelers, especially the participants of the early taxonomy trainings, to submit photographs of corals taken during their dives for identification or species verification. With its participatory feature, Coenommap was envisioned as a vehicle for coral taxonomy to have a broader reach in the Philippines.

Making coral biodiversity matter

In 2017, the DOST-PCAARRDD funded project named ‘Capacity-Building on Reef Assessments and Coral Taxonomy’ propelled the revival and further development of the Coenommap website. The expansions planned for The Virtual Museum and the original objectives of Coenommap will be integrated into the new framework for the website.

Aside from The Virtual Museum, the new Coenommap framework includes the following sections: Explore, Corals of the Philippines, IUCN Red List, Materials, and Glossary of

Terms. The Explore section would focus on basic coral taxonomy concepts to help budding marine enthusiasts and scientists identify corals in the field. Corals of the Philippines would feature images of over 500 coral species photographed in the country. The IUCN Red List section would be an online resource for threatened coral species. Additional field guides and other resources could be downloaded in the Materials section, and coral taxonomic jargon are explained in the Glossary of Terms. With this framework, Coenommap seeks to reach more people in the future through education and a more extensive offering of coral-related information.

The opening of The Nemenzo Virtual Museum is the first step to reiterate the importance of coral taxonomy and biodiversity in the Philippines. True to the original vision of Coenommap, the Virtual Museum will integrate the participatory element on the website. A Field Photos section was already made part of The Nemenzo Virtual Museum to complement the black and white photos of coralla. The same will be done for the other collections that will be included in The Virtual Museum. Initial verified photos taken from the latest ‘National Assessment of Coral Reef Environments’ Project 1 would be uploaded. The Field Photos section will also be open for the submission of images of corals taken from the field by marine enthusiasts and scientists. Multiple images allow for the documentation of morphological variation in the species in different reefs with different environmental conditions, thereby helping improve the recognition of these species. The Field Photos section could then serve as a guide for those who want to submit their images through the crowd-sourced species identification platform called iNaturalist.

iNaturalist is an existing nature app and website that connects people to nature through the sharing of images and field observations, which could then be validated by scientists from across the globe. With this, it is possible to create an iNaturalist project specifically for tracking the distribution and occurrence of coral species found in Philippine waters. Such a project could be valuable for the conservation and management of coral species, especially those that are rare and threatened.

With the degradation of our reefs due to direct anthropogenic impacts and climate change, we have to raise awareness and reach more people to join scientists in advocating for the protection of the extraordinary diversity of coral species in the Philippines. Coenommap seeks to popularize coral biodiversity and bridge the gap between people and our seas—capturing the imagination of Filipinos to fully appreciate the beauty and bounty of Philippine corals and coral reefs.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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