Socio-economic impacts of DNA barcoding on Philippine fisheries and aquatic resources

Mudjekeewis D. Santos, Minerva H. Ventolero, Benedict Maralit, Angellie Marie J.M. Asis, Rey C. Thomas, Altair Agmata, Apollo Marco D. Lozano, Joanne Krisha M. Lacsamana, June Feliciano F. Ordonez, and Roselyn Aguila

Genetic Fingerprinting Laboratory, National Fisheries Research and Development Institute, 101 Mother Ignacia St., Quezon City 1103, Philippines.
Corresponding author: Mudjekeewis D. Santos (e-mail: mudjiesantos@gmail.com).

The Philippines possess one of the largest fisheries in the world and is now reported to be the center of marine biodiversity in the planet. Ironically, however, basic taxonomic studies in the country are severely lacking. Moreover, the Philippines is also considered as one of the hotspots in terms of fisheries and marine conservation due to numerous threats. For example, despite having a number of aquatic species being regulated in the country, illegal trade still persists through the transport of live and processed products. Fry or juvenile fisheries that potentially contribute to growth overfishing are existent because they are an important source of food and livelihood, especially by artisanal fishermen. Here, our studies revealed new records of a number of marine species. We reported the presence of the recently resurrected beaked whale, *Mesoplodon hotaula*; a recently resurrected giant clam, *Tridacna noae*; the reef manta ray, *Manta alfredi*; and the mobula ray, *Mobula japonica*. We even discovered the presence of two possible invasive species, the tilapia flowerhorn *Cichlasoma urophthalmus* and the black chin tilapia *Sarotherodon melanotheron* in Manila Bay. In terms of trade-related studies, we identified confiscated juvenile eels (elvers) at the Ninoy Aquino International Airport and confiscated dried products of sharks and rays at the North Harbor in Manila, and we showed mislabelling in various fishery products sold in major supermarkets in Manila. Finally, we elucidated the following fry (juvenile) fisheries for fisheries management: the siganid "padas" fishery in Northern Luzon; the goby fry "ipon" and Anguilla eel "elvers" fisheries in Aparri, Cagayan; the "dulong" fry fishery in Verde Island Passage, Batangas; and the milkfish "bangus" fry fisheries and its bycatch. Taken together, our studies highlighted DNA barcoding as a powerful tool in addressing some of the major taxonomic and socio-economic issues in Philippine fisheries management and marine biodiversity conservation.

DNA barcoding of Philippine fish: first record of marine species in a biodiversity hotspot

Mudjekeewis D. Santos,[1] Minerva H. Ventolero,[1] Angellie Marie J.M. Asis,[1] Apollo Marco D. Lizano,[1] Joanne Krisha M. Lacsamana,[1] Billy Joel Catacutan,[1] John T. dela Pena,[1] June Feliciano F. Ordonez,[1] Jacqueline Pereda,[1] and Jom Acebes[2]

[1]*Genetic Fingerprinting Laboratory, National Fisheries Research and Development Institute, 101 Mother Ignacia St., Quezon City 1103, Philippines.*
[2]*Department of Biology, Ateneo de Manila University Katipunan, Quezon City, Philippines.*
Corresponding author: Mudjekeewis D. Santos (e-mail: mudjiesantos@gmail.com).

The Philippines is home to the highest number of marine species per square area in the world, gaining the distinction of being the center of marine biodiversity in the world. Unfortunately, it is also considered as one of the hotspots in terms of marine conservation due to numerous threats to its biodiversity. This is compounded by the absence of a comprehensive taxonomic listing of marine species in the country. Here, we present our recent results at the NFRDI-Genetic Fingerprinting Laboratory on the application of DNA barcoding to discover new records of aquatic organisms in the Philippines. We established the first records of rare and regulated species such as the recently resurrected beaked whale, *Mesoplodon hotaula* stranded in southern Philippines; a recently resurrected giant clam, *Tridacna noae*; and the reef manta ray, *Manta alfredi*. We established the first report in the country of two possible invasive species, the tilapia flowerhorn *Cichlasoma urophthalmus* sampled from fish ponds in Bulacan as well as the black chin tilapia *Sarotherodon melanotheron* in Manila Bay. We provide the first direct evidence of the presence of mobula ray *Mobula japonica* sampled from an illegal shipment of dried shark meat and bones. Finally, we also present recent discovery of new fish species in the country by other collaborating authors. Our results highlight the Philippines as truly a marine biodiversity haven because of the still high rate of discovery of new species and that conserving it should take paramount importance. It also highlights the important role of DNA barcoding as a powerful tool in species discovery and conservation in a marine biodiversity hotspot.

Genetic characterization of the red algae *Asparagopsis armata* and *Asparagopsis taxiformis* (Bonnemaisoniaceae) from the Azores

R. Santos,[1] A. Ferreira,[1] J. Micael,[1] M.C. Gil-Rodríguez,[2] M. Machín,[2] A.C. Costa,[1] D. Gabriel,[1] F.O. Costa,[3] and M.I. Parente[1]

[1]*INBIO/CIBIO Azores, Department of Biology, University of the Azores, Portugal.*
[2]*Department of Botany, Ecology and Plant Physiology, University of La Laguna, Canary Islands, Spain.*
[3]*CBMA – Centre of Molecular and Environmental Biology, Department of Biology, University of Minho, Portugal.*
Corresponding author: R. Santos (e-mail: rod_msantos@hotmail.com).

The Azores is situated in the North Atlantic Ocean (37–40N, 25–31W), astride the Mid-Atlantic Ridge, and is strongly influenced by the sea-surface pathway from the Gulf Stream. Nevertheless, the affinities of the marine algal flora are to the continental coasts of Europe and Africa, the Mediterranean Sea, and the other Macaronesian islands. Azorean marine ecosystems are relevant because of their uniqueness, geographic position, biogeographic mixed algal flora, and insularity—all of which highlight their susceptibility to alien species introduction. Algae invasions in marine habitats represent a recognized worldwide threat to the integrity of native communities, to economies, and even to human health. The genus *Asparagopsis* is known for being invasive in several regions of the world. Until now, two species of this genus have been reported to the Azores: *Asparagopsis armata*, described from the western coast of Australia and displaying today a worldwide distribution, although preferentially in cold temperate regions; and *Asparagospis taxiformis*, originally described for the southern hemisphere and widely distributed across tropical and temperate regions. We investigated the phylogeography of these two species in the Macaronesia, with focus in the Azores, to better understand biogeographic relationships within the North Atlantic. Populations of *A. armata* and *A. taxiformis* from Azorean Islands, Madeira, Canary Islands, and mainland Portugal were genetically scrutinized using two molecular markers, the mitochondrial COI-5P barcode (cytochrome c oxidase subunit I) and the nuclear ITS (ribosomal internal transcribed spacer). Our preliminary results will be presented.

DNA barcodes for authentication of commercially important Indian spices

M. Saravanan,[1] S.G. Newmaster,[2] S. Ragupathy,[2] S. Dhivya,[1] and R. Sathishkumar[1]

[1]*Plant Genetic Engineering Laboratory, Department of Biotechnology, Bharathiar University, Coimbatore – 641046, Tamil Nadu, India.*
[2]*Centre for Biodiversity Genomics, Biodiversity Institute of Ontario (BIO), University of Guelph, Guelph, Ontario, Canada.*
Corresponding author: M. Saravanan (e-mail: saravananmohan.bu@gmail.com).

Background: Spices are expensive aromatic and pungent food ingredients that are added to food in several forms as whole, in ground form, or as isolates from their extracts. An investigation on the beneficial physiological consequences of spices is a thrust area for almost three decades. India is one of the largest producers, consumers, and exporters of a variety of spices. The spice trade has been rising globally with increasing consumer demand for top quality, as it determines the cost. There are several reports of illicit or fraudulent adulteration of spices for commercial gains, and hence, a foolproof monitoring system is mandatory. Three common examples of adulteration are (*i*) *Capsicum annumis* is adulterated with *Ziziphus nummularia* fruit, (*ii*) *Brassica juncea* is adulterated with *Argemone mexicana* seed, and (*iii*) *Curcuma longa* is adulterated with the wild type *Curcuma zedoaria*. To date there are several techniques reported for detecting the adulteration and authentication of food material or its substances, one of which is DNA barcoding. In this technique, universal genomic regions are used to