Biotechnology's Role in Advancing Cetacean Conservation in Taiwan

Wei-Cheng Yang

Conservation Medicine Laboratory, School of Veterinary Medicine, National Taiwan University, Taipei, Taiwan.
*E-mail: yangweicheng@ntu.edu.tw

Abstract

Conservation Medicine Laboratory (CML) recently has made significant contributions to cetacean conservation medicine, particularly through the development of innovative diagnostic tools and genetic analyses that enhance our understanding of cetacean health and the management of vulnerable species. One of the achievements is the development of field-deployable duplex insulated isothermal PCR (iiPCR) assays for the rapid and sensitive detection of key pathogens in cetaceans. One assay targets Toxoplasma gondii, a zoonotic pathogen indicative of land-to-sea pollution [1]. This iiPCR assay, which detects the B1 gene of T. gondii alongside a cetacean-specific internal control, provides a crucial tool for on-site diagnostics. Additionally, we have developed a similar iiPCR-based portable and user-friendly diagnostic tool, for detecting Cetacean Morbillivirus (CeMV), a significant viral threat to cetacean populations [2]. These iiPCR biotechnologies underscore the importance of rapid, on-site diagnostics in cetacean conservation medicine, facilitating detection and investigation to understand the impacts of diseases on cetacean populations.

In addition to pathogen detection, CML has advanced the understanding of illegal cetacean exploitation through the development of a portable recombinase polymerase amplification (RPA) assay [3], coupled with a dual-zone lateral flow strip, allows for the rapid identification of cetacean species, even in processed or digested products. By enabling the differentiation of baleen and toothed whales within 30 minutes, this tool enhances the monitoring of illegal cetacean trade and supports the enforcement of conservation regulations, which is critical for curbing illegal activities that threaten cetacean species and for promoting the sustainable management.

Our research has also focused on the health of cetaceans, providing insights into how environmental stressors impact cetacean physiological responses for developing strategies to mitigate these impacts. In captive beluga whales, a probe-based quantitative gene expression assay that monitors key immunological genes allows for the detection of deviations from normal immune function that could indicate underlying health issues [4]. We further explored the use of skin cortisol levels and acoustic activity as indicators to evaluate stress and welfare in captive beluga whales [5]. The studies on bottlenose dolphins exposed to low-frequency underwater sound have revealed stress-induced psychophysiological impact, suggesting that anthropogenic noise could have deleterious effects on cetacean health [6,7].

Our genetic research on stranded pygmy killer whales and Kogia spp. in Taiwan has provided new insights into the population structures of these species [8]. Contrary to the assumption that mass strandings are driven by tight kinship, our findings suggest that pygmy killer whale pods may be composed of multiple unrelated clans, with potential implications for understanding their social structure and

stranding behavior. Additionally, the genetic analysis of Kogia spp. has revealed significant differences in genetic diversity between species, highlighting the need for tailored conservation strategies to protect these vulnerable populations.

CML's work contributes to the broader field of cetacean conservation medicine by developing practical tools for disease monitoring, improving the understanding of human impacts on cetacean health, and providing genetic insights that inform conservation efforts. These advancements are essential for safeguarding the health and sustainability of cetacean populations in an increasingly human-dominated environment.

Literature Cited

1. ***Hsieh MJ, Yang WC. A field-deployable insulated isothermal PCR (iiPCR) for the global surveillance of Toxoplasma gondii infection in cetaceans. Animals. 2022;12(506).***
2. ***Lattao C, Hsieh CC, Yang WC. Development of reverse transcription-insulated isothermal PCR (RT-iiPCR)-based detection method for cetacean morbillivirus (CeMV). Unpublished manuscript.***
3. ***Ho Y, Chan KW, Yang WC. A rapid DNA amplification assay for cetacean product identification: providing insights for illegal cetacean utilization and implications for conservation. Ocean Coast Manag. 2024;251:107084.***
4. ***Tsai M, Chen I, Wang J, Chou S, Li T, Leu M, Ho H, Yang WC. A probe-based qRT-PCR method to profile immunological gene expression in blood of captive beluga whales (Delphinapterus leucas). PeerJ. 2017;5:e3840.***
5. ***Wong CH, Tsai MA, Ko FC, Wang JH, Xue YJ, Yang WC. Skin cortisol and acoustic activity: potential tools to evaluate stress and welfare in captive cetaceans. Animals. 2023;13(1521).***
6. ***Chen IH, Chou LS, Chou SJ, Wang JH, Stott J, Blanchard M, Jen IF, Yang WC. Sound exposure-induced cytokine gene transcript profile changes in captive bottlenose dolphin (Tursiops truncatus) blood identified by a probe-based qRT-PCR. J Vet Med Sci. 2018 Apr 18;80(4):601-605. doi: 10.1292/jvms.17-0548.***
7. ***Yang WC, Chen CF, Chuah YC, Zhuang CR, Chen IH, Mooney TA, Stott J, Blanchard M, Jen IF, Chou LS. Anthropogenic sound exposure-induced stress in captive dolphins and implications for cetacean health. Front Mar Sci. 2021;8:606736.***
8. ***Chen YR. Genetic structure analyses of Feresa attenuata and Kogia spp. stranded in Taiwan based on mitochondrial and nuclear DNA sequences. Master's thesis. Taipei (Taiwan): National Taiwan University; 202***