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Wei Zhang,
Marine Bioproducts Cooperative Research Centre, Australia

*CORRESPONDENCE
Yusuf Bozkurt
yusuf.bozkurt@mersin.edu.tr

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Editorial: Genomic cell preservation in aquatic animals: with emphasis on cryopreservation

Yusuf Bozkurt*

Department of Aquaculture, Faculty of Fisheries, Mersin University, Mersin, Türkiye

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Editorial on the Research Topic
Genomic cell preservation in aquatic animals: with emphasis on cryopreservation

In recent years, there have been significant advancements in the conservation of fish gametes and genomic cells. Techniques such as cryopreservation and chilled storage are now commonly used to enhance hatchery management. These methods help synchronize reproduction cycles, ensure year-round availability of gametes, and conserve broodstock lines developed through selective breeding programs (Bozkurt, 2023a).

Beyond aquaculture, germplasm preservation offers valuable tools for conserving natural fish populations, particularly during the early phases of domestication or genetic improvement. Preserving wild genotypes allows researchers and breeders to maintain a genetic reservoir for potential reintroduction, biodiversity enhancement, or the recovery of lost traits. Furthermore, as the number of fish species classified as threatened or endangered continues to grow, the use of cryobanks has become a vital strategy for supporting conservation, reducing genetic erosion, and facilitating species recovery.

Cryopreservation of fish genomes has been explored using various cell types, including spermatozoa, oocytes, spermatogonia, primordial germ cells (PGCs), somatic cells, blastomeres, and embryos. Among these, sperm cryopreservation is the most advanced and commonly implemented method (Bozkurt, 2023b). This is mainly due to the ease of sperm collection in most species, the small size and structural simplicity of spermatozoa, their resistance to chilling and freezing stress, and their suitability for fertilization using either conventional or androgenetic techniques. However, sperm-based cryopreservation only preserves the male germ line, which limits its capacity for genetic conservation.

On the other hand, the cryopreservation of other genomic cells, such as oocytes, embryos, and early germ cells, remains a complex and underexplored field in aquatic species. These cell types are more susceptible to cryoinjury because of challenges like intracellular ice formation, osmotic shock, cryoprotectant toxicity, and issues with membrane integrity. As a result, standardized and efficient protocols for the conservation of these cell types are still lacking, and significant research is needed to optimize the processes of freezing, thawing, and cell recovery.

This Research Topic, entitled "Genomic Cell Preservation in Aquatic Animals: With Emphasis on Cryopreservation," features five original articles that explore the application of cryopreservation techniques across various ecological, geographical, and commercial contexts. The articles highlight recent advancements in germplasm cryobiology and propose practical, scalable, and scientifically grounded methods for the conservation and sustainable use of aquatic genetic resources.

A study by Krasilnikova et al. examined the cryopreservation of sperm from the Mediterranean brown trout (*Salmo cettii*), a species that is of conservation concern in southern Europe. Researchers investigated how altering the osmolality of glucose-based extenders impacts post-thaw sperm motility, which is a key indicator of fertilization success. Their findings suggest that lower osmolality can significantly enhance post-thaw quality, offering an improved protocol for the reproductive management of endangered trout populations.

Another contribution by Mendoza-Gonzales et al. focuses on the cryopreservation of germ cells from two high-value species in Mexico: *Totoaba macdonaldi* and *Seriola lalandi*. These species face increasing pressures from overfishing and habitat loss. The study presents successful cryopreservation protocols for both, laying the foundation for germplasm banks that could support species conservation and future aquaculture production.

A national-level review from Poland provides a detailed assessment of male germplasm preservation activities across the country (Judycka et al.). This article documents existing infrastructure, research collaborations, and the development of cryopreservation techniques, emphasizing the importance of coordinated national strategies to secure the genetic diversity of native and cultured fish species.

In addressing the scale-up challenges of aquaculture, another article by Sotnikov et al. introduces a novel approach to sperm cryopreservation in common carp (*Cyprinus carpio*). By using large-volume containers and optimizing thawing temperatures, researchers provide a scalable, aquaculture-ready method that supports mass fertilization efforts without compromising sperm viability. This innovation demonstrates how cryobiology can evolve to meet the practical demands of commercial fish production.

Other significant paper by Di Iorio et al. highlights the LIFE Nat. Sal. Mo. conservation project in Italy's Molise region. The study explores the role of semen cryobanks in preserving the endangered *Salmo cettii*, demonstrating how cryopreservation can be embedded in long-term conservation planning. The project integrates biotechnological, ecological, and policy dimensions, offering a model for regional conservation initiatives.

These studies highlight the significant benefits of cryopreservation in promoting both the conservation of aquatic biodiversity and the sustainability of aquaculture. They also illustrate the practical advantages of germplasm banking, emphasize the importance of species-specific strategies, and showcase the increasing acknowledgment of cryopreservation as a vital tool in global resource management. I hope this Research Topic will serve as a valuable resource for researchers, conservationists, and aquaculture professionals dedicated to preserving the genetic foundations of aquatic life for future generations.

Author contributions

YB: Validation, Writing – review & editing, Writing – original draft, Visualization, Conceptualization.

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