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Managing Invasive Sea Lampreys with TFM and Niclosamide Piscicides: Toxicological Insights, Achievements and Future Directions

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Abstract

The incursion of sea lampreys (*Petromyzon marinus*) into the Laurentian Great Lakes of North America during the early 20th century led to the depletion of vital commercial, recreational, and culturally significant fish populations. This devastation severely impacted the economies of communities dependent on fisheries. In response, a robust integrated pest management strategy was employed to curb sea lamprey populations. This approach encompassed the installation of barriers and traps to impede their migration to spawning grounds, coupled with the utilization of piscicides (known as lampricides) including 3-Trifluoromethyl-4-nitrophenol (TFM) and niclosamide to eliminate larval sea lampreys from their nursery streams. Despite the Great Lakes still housing residual sea lamprey populations, their numbers have been curtailed to less than 10% of the peak levels observed in the mid-1900s, predominantly through the sustained application of lampricides. This initiative has heralded one of the most triumphant invasive species management programs globally. However, there exist significant knowledge gaps concerning the uptake, processing, and toxicological mechanisms of TFM and niclosamide in lampreys and non-target species. In the past decade, substantial progress has been made in elucidating these aspects.

Keywords: Lampricides • 3-Trifluoromethyl-4-nitrophenol (TFM) • Niclosamide

Introduction

Recent research underscores the similarity in TFM toxicity between lampreys and non-target fish, with both experiencing interference in oxidative phosphorylation by mitochondria, resulting in reduced Adenosine Triphosphate (ATP) production. This vulnerability to TFM is influenced by abiotic factors, such as water pH and alkalinity, which modulate the availability of the un-ionized form of TFM in the gill microenvironment. Similarly, niclosamide, also utilized as a molluscicide to combat schistosomiasis in human-prone areas, likely operates by disrupting oxidative phosphorylation. However, less is understood about other dimensions of its toxicological impact.

The repercussions of TFM exposure encompass diminished energy reserves, particularly glycogen and high-energy phosphagens. Notably, non-target fish exhibit swift recovery from sub-lethal TFM exposure, evident in the rapid restoration of energy stores and TFM clearance. While both TFM and niclosamide are environmentally transient and pivotal for sea lamprey management, escalating public and institutional apprehensions regarding pesticide persistence necessitate the exploration of alternative methods for sea lamprey control.

In this context, it is imperative to investigate potential "next-generation" approaches to sea lamprey regulation. These include the integration of genetic tools like RNA interference and CRISPR-Cas9, aimed at impairing critical physiological processes in lampreys such as reproduction, digestion, and metamorphosis. Furthermore, the concept of green chemistry holds promise in the development of environmentally benign chemical modalities for sea lamprey control.

In summation, the intrusion of sea lampreys into the Laurentian Great Lakes wrought significant ecological and economic havoc. The subsequent adoption of a multifaceted management strategy, encompassing lampricides TFM and niclosamide, has yielded substantial success in reining in these invasive populations. While further research is required to comprehend the intricate toxicological pathways, the progress achieved underscores the potential for future strategies involving genetic tools and greener chemical alternatives to complement existing efforts and ensure the preservation of these vital aquatic ecosystems.

Description

Invasive species pose a significant threat to ecosystems and native species, often disrupting natural balance and causing ecological and economic harm. Among these invaders, the sea lamprey (*P. marinus*) stands out as a prime example of a highly destructive aquatic pest. Native to the Atlantic Ocean, the sea lamprey invaded the Great Lakes of North America through shipping canals, wreaking havoc on native fish populations and prompting the development of innovative control methods. Two such methods involve the use of piscicides-TFM (3-trifluoromethyl-4-nitrophenol) and niclosamide-proven to be effective in controlling sea lamprey populations. This article explores the toxicology, successes, and future prospects of using TFM and niclosamide in the fight against invasive sea lampreys.

Toxicology of TFM and niclosamide

TFM and niclosamide are both potent piscicides designed to target lampreys during their larval, or ammocoete, stage. These chemicals disrupt the lampreys' ability to undergo metamorphosis and reach their parasitic phase, thus preventing them from attaching to host fish and feeding on their bodily fluids. While highly effective against lamprey larvae, it is crucial to understand the potential ecological impacts and risks associated with these piscicides.

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Toxicology studies have extensively evaluated the effects of TFM and niclosamide on non-target species. Research has shown that both chemicals have a narrow range of selectivity, primarily affecting lampreys and a few closely related species. However, proper application and dosage are crucial to minimize harm to non-target organisms. Regulatory agencies and researchers work diligently to ensure that the use of these piscicides is ecologically responsible and well-managed.

Successes in sea lamprey control

The application of TFM and niclosamide in controlling sea lampreys has yielded notable successes. Since their implementation, these piscicides have played a vital role in reducing sea lamprey populations and mitigating their impact on native fish species. The Great Lakes Fishery Commission, in collaboration with various agencies and partners, has successfully implemented integrated pest management programs that incorporate these piscicides as key components. The successes of TFM and niclosamide-based control strategies extend beyond the immediate reduction of lamprey populations. They have contributed to the restoration of native fish populations, particularly those of economically and ecologically valuable species like lake trout, salmon, and whitefish. Moreover, the reduction in sea lamprey numbers has led to improved overall ecosystem health and balance within the Great Lakes.

As the fight against invasive sea lampreys continues, there are promising prospects for the refinement and advancement of TFM and niclosamide-based control methods. Ongoing research aims to enhance the efficacy of these piscicides while further minimizing their impact on non-target species and the environment. Additionally, developments in application techniques and technologies may lead to more precise and targeted treatments.

However, challenges persist. Continuous monitoring and adaptive management are essential to ensure the long-term effectiveness of piscicide-based control strategies. The evolution of sea lamprey populations and the potential emergence of resistant individuals underscore the need for a multifaceted approach to invasive species management. Integrating piscicides with other control methods, such as physical barriers and pheromone-based attractants, may provide a more comprehensive solution [1-6].

Conclusion

The use of piscicides TFM and niclosamide in controlling invasive sea lampreys has demonstrated significant successes in preserving native fish populations and restoring ecosystem balance within the Great Lakes. Through careful toxicology assessments, strategic implementation, and ongoing research, these piscicides offer promising prospects for the continued management of sea lamprey populations. As science and technology advance, the collaborative efforts of researchers, regulatory agencies, and stakeholders will shape the future of invasive species control, ensuring the protection of vulnerable ecosystems and native species for generations to come.

Acknowledgment

None.

Conflict of Interest

None.

References

1. Allen, JL., and JB Hunn. "Renal excretion in channel catfish following injection of quinaldine sulphate or 3-trifluoromethyl-4-nitrophenol." *J Fish Biol* 10 (1977): 473-479.
2. Al-Reasi, Hassan A., Chris M Wood and D Scott Smith. "Physicochemical and spectroscopic properties of Natural Organic Matter (NOM) from various sources and implications for ameliorative effects on metal toxicity to aquatic biota." Aquat Toxicol 103 (2011): 179-190.
3. Paquette, LA., PT Anastas and TC Williamson. "Green chemistry: Frontiers in benign chemical synthesis and processing." (1998).
4. Andrews, P., J Thyssen and D Lorke. "The biology and toxicology of molluscicides, Bayluscide." *Pharmacol Therapeut* 19 (1982): 245-295.
5. Armitage, James M., Russell J Erickson, Till Luckenbach and Carla A Ng, et al. "Assessing the bioaccumulation potential of ionizable organic compounds: Current knowledge and research priorities." Environ Toxicol Chem 36 (2017): 882-897.
6. Beamish, FWH, and IC Potter. "The biology of the anadromous Sea lamprey (*P. mannus*) in New Brunswick." *J Zool* 177 (1975): 57-72.

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