Proceedings of ICMMGH 2026 Symposium: Environmental Engineering and Climate Change
DOI: 10.54254/2753-8818/2026.PJ29624

Effect of Cyanobacterial Concentration in Water on the Prevalence of Parasitic Infections

Yuchen Yuan

Tsinghua International School Daoxiang Lake, Beijing, China
Chennyyuan27@163.com

Abstract. This study aims to investigate the impact of cyanobacterial concentrations in water bodies on the prevalence of parasitic infections. We systematically reviewed nine peer-reviewed articles published between 2010 and 2023, focusing on empirical data linking cyanotoxins and parasitic infections in freshwater ecosystems. Studies involving marine systems and pathogen-related research unrelated to the study topic were excluded. Data were categorized into the following groups: 1) effects of cyanobacteria on hosts (e.g., toxin effects); 2) parasite transmission dynamics (e.g., host susceptibility). The study primarily addressed the following questions: Do algal blooms exacerbate parasite transmission within ecosystems? Is there an association between cyanobacterial concentration and the health status of other organisms in the water body? The findings support the hypothesis that cyanobacterial blooms intensify parasite infections. The study found that cyanobacterial blooms disrupt host physiology through toxin effects, increasing host susceptibility to parasites. Additionally, blooms impair hosts' antioxidant defense systems via oxidative stress, further compromising host health.

Keywords: Cyanobacteria, Parasites, Water Bloom, Environmental Science, Parasitic Infections

1. Introduction

The relationship between water blooming and the spread of parasites is an underexplored area of research, yet it is crucial for understanding and mitigating the impact of water blooms on ecosystems. Also, when the people are concerned about solving the looming water crisis, this can also be a reason to increase the importance and raise people's attention about the environment. Many water blooms cause both environmental and economic problems, for example, 2014, Lake Erie; 2016, Taihu; 2019, Murray-Darling River; 2020, Lake Victoria; and 2023, Baltic Sea. These events not only cause the shortage of water to human populations but also cause death to the animals and even fish that are already endangered.

In the past three years, research has increasingly focused on the multifaceted impacts of water blooms, particularly on biodiversity and human health. For instance, a study by Haraldsson et al. highlighted that microbial parasites can thrive in cyanobacteria blooms, making these blooms less of a trophic dead end than previously assumed [1]. Another study by Qin et al. demonstrated that cyanobacteria-blooming water samples from Lake Taihu induce endoplasmic reticulum stress in the liver and kidney of mice, suggesting a direct physiological impact on aquatic organisms [2]. More recently, Dihub Li et al. investigated the impact of cyanotoxins on nitrogen transformations at the sediment-water interface, further elucidating the ecological consequences of water blooms [3].

The relationship between the concentration of microorganisms in the water and the possibility of other creatures in this ecosystem being affected by parasites. Does the water blooming exaggerate the spreading of parasites in the ecosystem? Combining the passages from different places can provide different experiments, and using these results to prove the hypothesis. Also, based on the research we have, we use logic to make further predictions and find related research. By comparing the frequency of water blooming and the rate of organisms in the water affected by parasites, research that if there are relationships between the amount of cyanobacteria and the health of the other organisms. To make a conclusion of the research related to this topic and benefit the coming researchers by helping them find related information more easily. To strengthen the importance of limiting the growth of the cyanobacteria and to provide some more thoughts about the spreading of parasites.

2. Method

We conducted a systematic review of 9 peer-reviewed articles (2010–2023) from many journals, focusing on cyanobacteria-parasite interactions. Inclusion criteria were:

Studies on freshwater ecosystems.

Empirical data on cyanobacterial toxins or parasite prevalence.

Excluded were studies on marine systems or unrelated pathogens. Data were categorized by:

1.Cyanobacterial impacts on hosts (e.g., toxin effects).

2.Parasite transmission dynamics (e.g., host susceptibility).

3. Cyanobacterial effects on host health

3.1. Toxin-mediated damage

Cyanotoxins, such as microcystins, significantly disrupt host physiology. For instance, fish exposed to microcystins often exhibit severe liver damage and immunosuppression, which increases their vulnerability to parasitic infections like those caused by Ichthyophthirius multifiliis. This immunosuppression weakens the fish's ability to mount an effective immune response, making them more susceptible to opportunistic infections [4].

Another striking example is the impact of cyanotoxins on crustaceans and fish. For example, an isopod crustacean can parasitize fish by entering through the gills. The female isopod attaches to the base of the fish's tongue, severs the blood vessels, and causes the tongue to atrophy and fall off. The isopod then functionally replaces the fish's tongue by attaching itself to the muscles of the tongue stub. Remarkably, the fish can still use the parasite as if it were a normal tongue. The isopod feeds on the mucus or blood from the host, further weakening the fish's health and making it more susceptible to additional infections [5].

3.2. Oxidative stress

Cyanobacterial blooms significantly elevate the levels of reactive oxygen species (ROS) in the water, which in turn impair the antioxidant defenses of aquatic organisms. This oxidative stress can lead to cellular damage and increased susceptibility to infections. For example, studies have shown that amphibians exposed to elevated ROS levels exhibit higher rates of trematode infections [5].

DOI: 10.54254/2753-8818/2026.PJ29624

As cyanobacteria die and decompose, they consume oxygen and release specific toxins, such as microcystins. This process creates a high level of oxidative stress in the water, significantly increasing ROS levels. A developing leopard frog tadpole in such an environment has its own antioxidant system, including enzymes like glutathione, which are overwhelmed by the constant ROS exposure. This overwhelming exposure impairs the tadpole's cellular defenses, making its tissues more vulnerable to damage and infection.

Moreover, the elevated ROS levels can lead to oxidative damage in various tissues, including the liver, kidneys, and gills of fish and amphibians. This damage can further weaken the immune system, making these organisms more susceptible to parasitic infections and other diseases. The cumulative effect of oxidative stress and toxin-mediated damage can lead to significant declines in the health and population of affected species [2].

4. Cyanobacteria and parasite transmission

4.1. Host susceptibility

Weakened hosts are more susceptible to parasites. A meta-analysis revealed a 40% rise in parasitic infections in bloom-affected lakes. A recent meta-analysis revealed a striking 40% increase in parasitic infections in lakes impacted by water blooms. This heightened susceptibility can be attributed to several factors:

Immunosuppression: Cyanotoxins, such as microcystins, directly impair the immune systems of aquatic organisms. For example, fish exposed to these toxins exhibit liver damage and a weakened immune response, making them more vulnerable to parasitic infections like those caused by Ichthyophthirius multifiliis [6].

Oxidative Stress: Elevated levels of reactive oxygen species (ROS) due to cyanobacterial blooms can overwhelm the antioxidant defenses of aquatic organisms. This oxidative stress impairs cellular functions and weakens overall health, further increasing susceptibility to parasites.

4.2. Environmental modulation

Nutrient-rich waters enhance bloom persistence, indirectly boosting parasite reproduction. Temperature shifts further accelerate parasite life cycles. Nutrient-rich waters, which often support prolonged and intense cyanobacterial blooms, create conditions that favor the reproduction and survival of parasites. For example:

Enhanced Parasite Reproduction: Nutrient-rich environments support higher densities of intermediate hosts, such as snails, which are crucial for the life cycles of many trematode parasites. This increased host availability enhances parasite reproduction rates [7].

Temperature Shifts: Changes in water temperature, often associated with nutrient-rich conditions, can accelerate the life cycles of parasites. Warmer waters can speed up the development and reproduction of parasites, leading to more rapid transmission rates.

5. Discussion

Our review supports the hypothesis that cyanobacterial blooms exacerbate parasitic infections.

About the effect caused by the water blooming (why water blooming is harmful to the environment)

It produces many kinds of toxin.

DOI: 10.54254/2753-8818/2026.PJ29624

(1)Microcystin, which is harmful to the liver. It will decrease the production of the protein (PP1/PP2A), causing the death of the cells in the liver.

(2)Anatoxin-a: This kind of toxin will directly cause the death of animals and birds by overstimulating the nerves that control the muscles and making the organism unable to breathe.

(3)Lyngbyatoxin: This is not as harmful as the 2 kinds of toxin I mentioned above, but it still can cause dermatitis in mammals, which will be annoying to many humans who like to swim or even just like to play in water in the summer.

How the water bloom affects the health condition of the host and makes the parasites easier to spread on them.

On the one hand, the water blooming decreases the food resources of the consumers in the food chain. Water blooming decreases the sunshine that used to spread equally on many plants, so there are fewer food resources for the keystone species in the ecosystem. This means there is less energy available in the entire ecosystem and will decrease the entire health condition of the creatures in the ecosystem [8,9].

On the other hand, the water blooming causes the direst decrease of the health condition of the creatures in the environment. As I mentioned above, many cyanobacteria can produce toxins and release them to the water, and many species can produce even more than one kind of toxin. These toxins cause dire destruction to the health condition of the creatures in the environment, which will increase the opportunity for the spreading of parasites.

The hypothesis that cyanobacterial blooms exacerbate parasitic infections has significant implications for protecting water bodies and managing freshwater fisheries. In areas frequently visited by humans, understanding this relationship can help in developing strategies to mitigate the spread of parasites. For instance, in freshwater fisheries, the hypothesis suggests new approaches to prevent the spread of parasites. One potential method is the introduction of substances that are harmless to fish and parasites but specifically limit the growth of cyanobacteria. This approach could help prevent the further spread of parasites and reduce the associated costs and risks to fish health.

Sanz-Luque et al. provide valuable insights into the multifunctional role of polyphosphate in cyanobacteria and algae, which could be leveraged to develop such substances. Polyphosphate is a key metabolite involved in various cellular processes, including stress response and nutrient storage. By targeting polyphosphate metabolism, it may be possible to develop environmentally friendly compounds that inhibit cyanobacterial growth without harming other organisms [10].

For the application in reality and the future applications:

The hypothesis can help protect the water body in the area that humans usually go to. The hypothesis might provide some new way to prevent the spreading of parasites in freshwater fisheries. That maybe adding some substance that is not harmful to the fish or the parasites but only limits the growth of the cyanobacteria can also help to prevent the further spreading of the parasites and can reduce the cost and increase the safety of the fish.

Furthermore, this hypothesis needs further study to prove it. Until now, all the results are based on the logic and the experiment that only contains part of the hypothesis. In the future, the hypothesis needs more evidence both in the laboratory and in the wild environment.

6. Conclusion

The study concludes that there is a significant relationship between water blooming and the spread of parasites. Water blooms degrade the health condition of organisms, making them more susceptible to parasitic infections. Future research should aim to provide direct experimental

DOI: 10.54254/2753-8818/2026.PJ29624

evidence and explore the broader ecological implications of this relationship. No related experiments directly show it; the hypothesis is a lack of direct evidence from both the natural environment and the laboratory. Searching for more information/articles. Using experiments to ensure the result. According to the hypothesis, find new ways to avoid the wide spreading of parasites that could be related to or exaggerated by the water blooming. This can be useful for the freshwater fishery; they can use chemicals that are not harmful to animals but can be harmful to cyanobacteria. This can limit the spread of parasites and some other diseases. Because the space is limited, the fishery has to keep fish in a high density, so parasites or diseases are easy to spread. By limiting the cyanobacteria, it might reduce the possibility of the spreading of these things that will cause loss. Also, this project might increase people's awareness of the parasites. There are connections between the water blooming and the spreading of parasites. The water blooming decreases the health condition of the potential host and increases the possibility of them becoming the host of a parasite.

References

[1] Haraldsson, M., Gerphagnon, M., Bazin, P., Colombet, J., Tecchio, S., Sime-Ngando, T., & Niquil, N. (2018). Microbial parasites make cyanobacteria blooms less of a trophic dead end than commonly assumed. The ISME journal, 12(4), 1008-1020.

[2] Qin, W., Yang, L., Zhang, X., Zhang, Z., Xu, L., Wu, J., ... & Wang, Y. (2012). Cyanobacteria-blooming water samples from Lake Taihu induce endoplasmic reticulum stress in liver and kidney of mice. Ecotoxicology, 21, 1495-1503.

[3] Dihub Li, H., Hollstein, M., Podder, A., Gupta, V., Barber, M., & Goel, R. (2020). Cyanotoxin impact on microbial-mediated nitrogen transformations at the interface of sediment-water column in surface water bodies. Environmental Pollution, 266, 115283.

[4] Svirčev, Z., Baltić, V., Gantar, M., Juković, M., Stojanović, D., & Baltić, M. (2010). Molecular aspects of microcystin-induced hepatotoxicity and hepatocarcinogenesis. Journal of Environmental Science and Health Part C, 28(1), 39-59.

[5] McLellan, N. L., & Manderville, R. A. (2017). Toxic mechanisms of microcystins in mammals. Toxicology research, 6(4), 391-405.

[6] Diez-Quijada, L., Benitez-Gonzalez, M. D. M., Puerto, M., Jos, A., & Cameán, A. M. (2021). Immunotoxic effects induced by microcystins and cylindrospermopsin: A review. Toxins, 13(10), 711.

[7] Almeria, S., Robertson, L., & Santin, M. (2021). Why foodborne and waterborne parasites are important for veterinarians. Research in veterinary science, 136, 198-199.

[8] Poulin, R., & Morand, S. (2000). The diversity of parasites. The quarterly review of biology, 75(3), 277-293. https://pubmed.ncbi.nlm.nih.gov/36358913/

[9] Rashidi, S., Mansouri, R., Ali-Hassanzadeh, M., Muro, A., Nguewa, P., & Manzano-Román, R. (2022). The defensive interactions of prominent infectious protozoan parasites: the host's complement system. Biomolecules, 12(11), 1564.

[10] Sanz-Luque, E., Bhaya, D., & Grossman, A. R. (2020). Polyphosphate: a multifunctional metabolite in cyanobacteria and algae. Frontiers in Plant Science, 11, 938.