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Management Strategies for Mitigating Winter Box Jellyfish Bloom's Impact on Pancham Aquaculture Shrimp Farm, Palghar, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This abstract examines the challenge of mitigating winter box jellyfish blooms' impact on Pancham Aquaculture's shrimp farm in Palghar. The intrusion of box jellyfish during winter poses a significant threat to the sustainability and profitability of shrimp farming in the region. This study aims to explore effective management strategies to address this pressing issue. The proliferation of box jellyfish in aquaculture facilities during winter presents multifaceted challenges. Not only do these jellyfish directly threaten shrimp populations by preying on juveniles, but they also pose risks to shrimp aquaculture. This interference has led to decreased shrimp yields and profitability, highlighting the urgent need for comprehensive research and proactive measures. The study seeks to analyze the ecological and environmental triggers behind the escalation of box jellyfish presence

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in Pancham Aquaculture's shrimp farm. By understanding these factors, effective mitigation strategies can be developed to safeguard both shrimp aquaculture and the surrounding marine environment.

Keywords: Box Jellyfish blooms; Palghar; shrimp farming; winter intrusion; management strategies; aquaculture challenges.

1. INTRODUCTION

In the last three decades, jellyfish (cnidarian classes Cubozoa, Scyphozoa, and Hydrozoa) have received increased scientific attention due to their fluctuations in abundance that frequently result in population explosions (i.e., blooms) in marine ecosystems worldwide [1].Jellyfish blooms negatively affect fisheries by clogging nets [2], pen aquaculture by causing fish death [3,4], power generation and desalination by clogging intake screens [5] and tourism by stinging swimmers [6-8].However, the basic biology, population dynamics, and species identity are poorly understood [9].

The class Cubozoa, commonly known as box jellyfish due to the cube-shaped bells, consists of a small group of cnidarians with approximately 50 described species and is well-known to the public for containing some of the most venomous marine animals in the world [10-13]. Cubozoa is divided into two monophyletic orders, the Carybdeida and Chirodropida [14]. The two orders can be easily distinguished, as carybdeids possess only one tentacle per pedalium, whereas chirodropids possess multiple tentacles per pedalium [15-18].

Shrimp aquaculture is a vital component of the economy and food security in coastal regions worldwide, including Palghar, India. However, the sustainability and profitability of shrimp farming in this region face a formidable threat during the winter months - the proliferation of box jellyfish blooms [19-25]. These gelatinous organisms not only pose a direct threat to shrimp populations by preying on juveniles and adults but also disrupt shrimp aquaculture operations, leading to decreased yields and profitability [26-33].

In recent years, the escalation of box jellyfish presence in aquaculture facilities like Pancham Aquaculture's shrimp farm in Palghar has raised concerns among local authorities, aquaculture farmers, and marine scientists [34-37]. This pressing issue necessitates a comprehensive understanding of the ecological and environmental triggers behind these blooms and the development of effective mitigation strategies. This research paper aims to address this gap by exploring the challenges posed by winter box jellyfish blooms to shrimp aquaculture in Palghar and proposing sustainable management strategies to mitigate their impact. Through collaboration among stakeholders and the application of scientific research, this study seeks to contribute to the long-term viability of shrimp aquaculture in the region [38-44].

In this paper, we will first examine the multifaceted challenges presented by box jellyfish blooms, including their direct impact on shrimp populations and the broader implications for shrimp aquaculture sustainability. We will then delve into the ecological and environmental factors contributing to the proliferation of box jellyfish in aquaculture facilities, focusing on Pancham Aquaculture's shrimp farm as a case study [45-52].

By analyzing these factors, we aim to develop targeted mitigation strategies that balance the need for effective control of box jellyfish populations with environmental sustainability. Collaboration among local authorities, aquaculture farmers, and marine scientists will be emphasized as a key component of implementing these strategies [53-56].

Overall, this research paper seeks to provide valuable insights into the challenges posed by winter box jellyfish blooms to shrimp aquaculture in Palghar and to propose actionable solutions for sustainable shrimp farming practices in the region.

2. MATERIALS AND METHODS

2.1 Study Area

We selected Pancham Aquaculture shrimp farm in Palghar, India.

Pancham Aquaculture's shrimp farm in Palghar, India. (Latitude 19.5255, Longitude 72.7997 plays a crucial role in supporting the livelihoods of local fishing communities, who rely on its rich biodiversity for sustenance and economic activities.

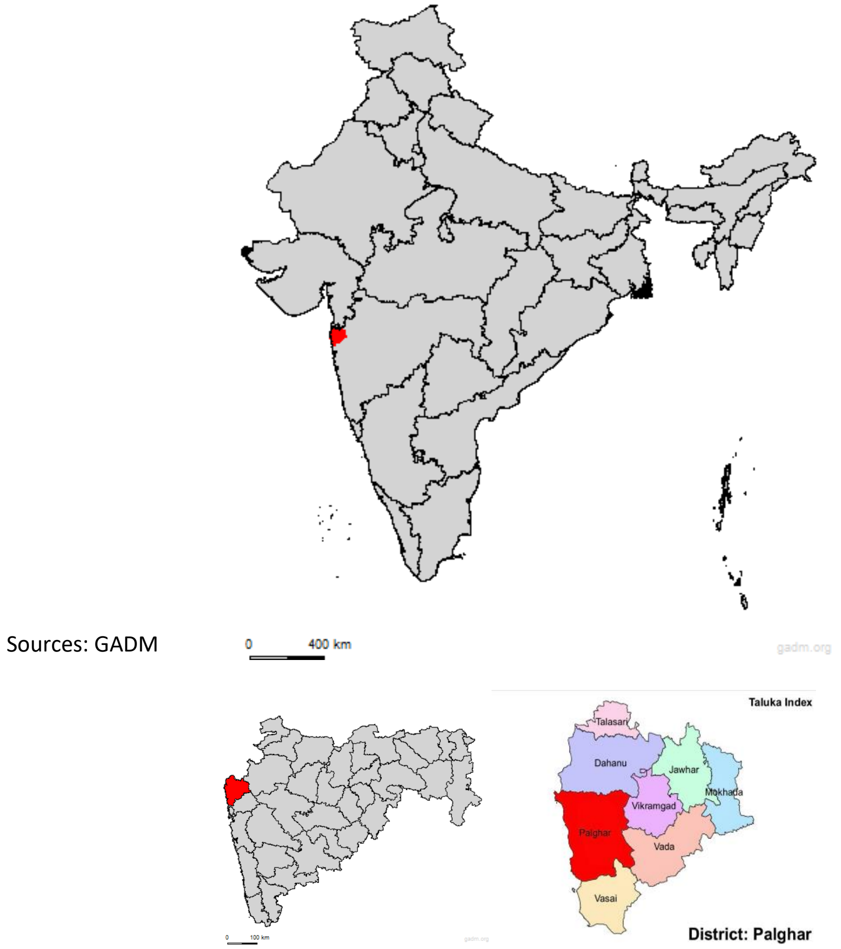

Fig. 1. Location map showing the study area of Palghar district

Situated in the Konkan region of Maharashtra, Palghar district boasts numerous breathtaking beaches including Shirgaon, Kelve, Vadrai, Dahanu, Bordi, Chinchani, Arnala, Rajodi, and Suruchi. To the east and northeast, it is bordered by Thane and Nashik districts, while to the north lies the Valsad district of Gujarat state and the Dadra and Nagar Haveli district of the Dadra and Nagar Haveli and Daman and Diu union territory. The Arabian Sea forms its western boundary, encompassing the fastest-developing northern part of the Mumbai Metropolitan Region, India.

Flowing through the district is the Vaitarna River, characterized by its numerous tributaries such as Barvi, Bhatsa, Pinjal, Surya, Daherja, and Tansa. Originating in the Trimbakeshwar hills of Nashik district, the Vaitarna River, the largest of the Konkan Rivers, meanders through Shahapur, Vada, and Palghar talukas before emptying into the Arabian Sea through a broad estuary off Arnala. Spanning 154 kilometers in length, the river's drainage area covers virtually the entire northern part of the palghar district, India.

The Ulhas River, which ultimately flows into the Arabian Sea, marks the district's southern border as it merges with Vasai Creek. Arnala Island lies within Vasai taluka, situated at the mouth of the Vaitarna estuary.

2.2 Jellyfish Sampling

Jellyfish sampling was conducted using a nylon mesh, grid 100 mesh, width 1m, length 2m to collect specimens from the water surrounding Pancham Aquaculture's shrimp farm. This mesh size was chosen to effectively capture jellyfish specimens of various sizes.

2.3 Environmental Parameter Measurements

Daily measurements of temperature, salinity, and pH were recorded throughout the duration of the

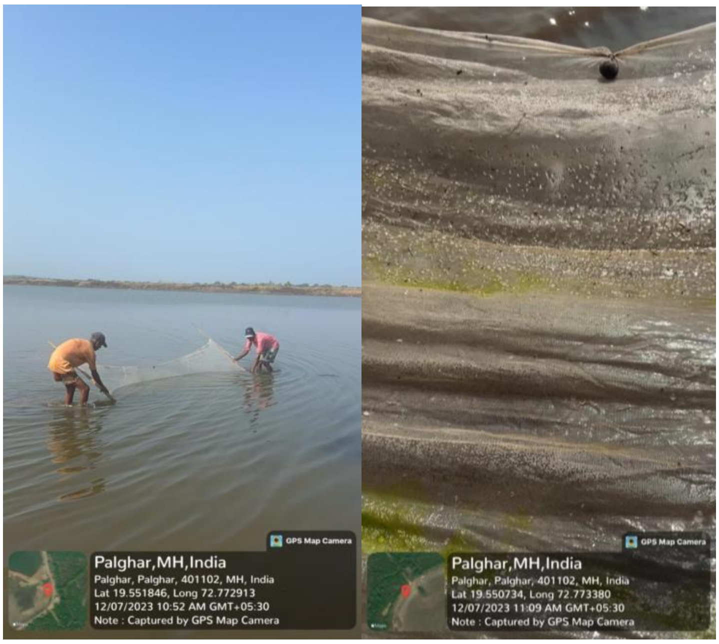

Fig. 2. Collection of sample (*Tripedalia cystophora*, Conant, 1897) using nylon nets from shrimp farm in palghar, India during winter season

study. These measurements were taken over the course of a year, specifically targeting three cycles of shrimp aquaculture during the winter season when box jellyfish blooms occurred. This allowed for a comprehensive understanding of the environmental conditions associated with jellyfish blooms.

2.4 Field Observation

Field observation was conducted to monitor the interactions between jellyfish and shrimp populations in their natural habitat. This involved studying the behavior of both jellyfish and shrimp over an extended period to identify any patterns or correlations.

2.5 Laboratory Analysis

Following the field observation period, a subset of collected specimens and environmental samples was subjected to laboratory analysis. This analysis aimed to further investigate the effects of jellyfish blooms on shrimp populations, and water quality parameters.

2.6 Data Interpretation

The data collected from jellyfish sampling, field observation, and laboratory analysis were interpreted to assess the impact of jellyfish blooms on shrimp aquaculture. This involved identifying trends, and potential causal relationships between jellyfish population, and environmental conditions.

Overall, these methods facilitated a comprehensive investigation into the effects of box jellyfish blooms on shrimp aquaculture, providing valuable insights for future management and mitigation strategies.

3. RESULTS AND DISCUSSION

Based on the study, when the quantity of jellyfish in Palghar, India, increases, they compete with shrimp for food. This competition hinders shrimp growth and survival. Jellyfish blooms also disrupt water quality, such as salinity, causing harm to shrimp farms and increasing their maintenance costs.

To fix these problems, we must act before they worsen. Solutions include utilizing nets with the appropriate size openings to keep jellyfish out, improving waste management, and using gates to restrict water flow. Drying and plowing the pond bottoms also prevent jellyfish babies from emerging.

3.1 Impact of Jellyfish Population Increase on Shrimp Population

The study revealed a significant correlation between the increase in jellyfish population and adverse effects on shrimp populations. With the rise in jellyfish numbers, competition for food resources intensified, leading to reduced food availability for shrimp. This resulted in stunted growth and decreased survival rates among the shrimp population.

3.2 Effects on Water Quality Parameters

Analysis of daily measurements of temperature, salinity, and pH indicated notable changes associated with jellyfish blooms. Specifically, it was observed that the increase in jellyfish population led to a decrease in salinity levels. This decrease in salinity can be attributed to the excretion of mucus by jellyfish, which alters the chemical composition of the water.

Temperature variations of seawater might be the major inducing factor which could result in jellyfish blooms. Jellyfish blooms may benefit from warmer temperature that could increase the food availability of jellyfish and promote jellyfish reproduction, especially for warm temperate jellyfish species. Eutrophication, climate change, overfishing, alien invasions and habitat modification were all possible important contributory factors of jellyfish blooms. Jellyfish could significantly influence the form distribution and biogeochemical cycling of biogenic elements.

3.3 Infrastructure Damage and Operational Challenges

The study also highlighted the detrimental impact of jellyfish blooms on aquaculture infrastructure. Clogging of nets, pumps, and filters occurred as a result of the increased jellyfish population, leading to operational disruptions and increased maintenance costs for the shrimp farm. Additionally, the presence of jellyfish in aquaculture facilities posed a direct threat to shrimp populations, with jellyfish preying on shrimp juveniles and adults.

3.4 Implications for Sustainable Shrimp Farming

The findings of this study emphasize the critical need for proactive measures to mitigate the impact of jellyfish blooms on shrimp aquaculture and promote long-term sustainability. Several key strategies emerge from the research that can be implemented to address these challenges effectively.

3.5 Installing Proper Mesh Sizes

Implementing mesh nets with appropriate mesh sizes can act as physical barriers to prevent jellyfish intrusion into shrimp cultivation areas. By selecting the optimal mesh size, aquaculture facilities can effectively minimize the entry of jellyfish while maintaining proper water flow and circulation.

3.6 Adopting Efficient Waste and Water Management Practices

Efficient waste and water management practices are essential for reducing nutrient accumulation and organic matter in aquaculture ponds, which can exacerbate jellyfish blooms. Proper management techniques, such as regular water exchange and removal of excess nutrients, can help maintain water quality and minimize the conditions favorable for jellyfish proliferation.

3.7 Implementing Sluice Gates

The installation of sluice gates can aid in regulating water flow and controlling the ingress of jellyfish into aquaculture facilities. By strategically positioning sluice gates, aquaculture operators can effectively manage water levels and minimize the impact of jellyfish on shrimp populations and infrastructure.

3.8 Sundrying and Ploughing Pond Base

Another important measure is the sun-drying and ploughing of the pond base to remove jellyfish larvae settlements effectively. This practice can disrupt the lifecycle of jellyfish and prevent their proliferation in subsequent aquaculture cycles, contributing to long-term control of jellyfish populations.

Incorporating these proactive measures into shrimp farming practices can significantly minimize the adverse effects of jellyfish blooms and enhance the sustainability of aquaculture operations.

3.9 Need for Further Research and Management Strategies

While this study provides valuable insights into the interactions between jellyfish and shrimp populations, further research is needed to develop more effective management strategies. Collaborative efforts among aquaculture farmers, marine scientists, and policymakers are essential to address the challenges posed by jellyfish blooms and ensure the long-term sustainability of shrimp farming in the region.

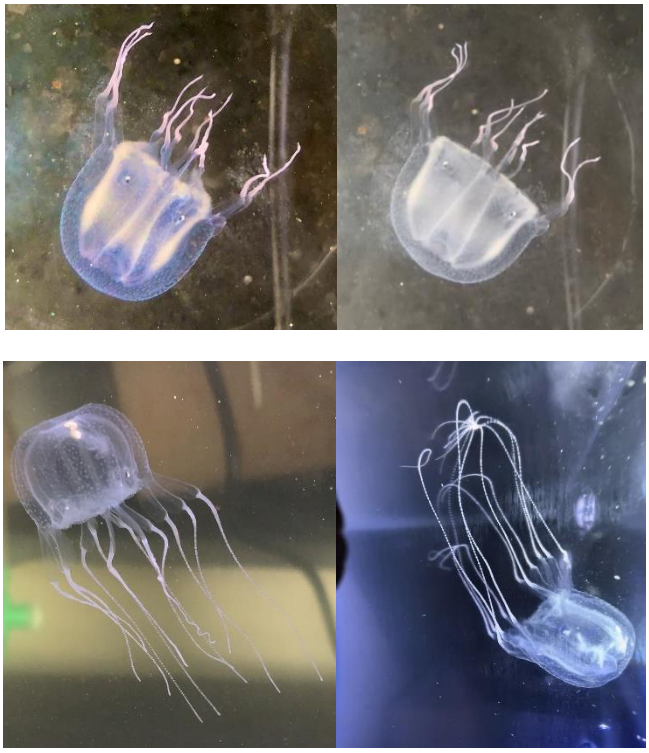

Fig. 3. Box Jellyfish (***Tripedalia cystophora*** **Conant, 1897**)

4. CONCLUSION

We still need additional research to identify better solutions to control these issues and ensure the viability of Palghar's shrimp farms. Understanding why jellyfish blooms arise and discovering solutions to prevent them and allowing us to protect shrimp farms and maintain them healthy for the future.

CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented and published in the conference: An International Conference on Coastal and Marine Conservation CMC-2024 dated from 1st and 2nd March, 2024 in Mumbai, India. Web Link of the proceeding: https://mithibai.ac.in/wp-content/uploads/2024/02/CMC2024-CONFERENCE-brochure..pdf

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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