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Prevention or cure : what should aqua farmers prioritize for healthy fisheries?

Dwindling migratory freshwater fish population

Probiotics in aquaculture mechanisms, applications, and future perspectives

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Fisheries Schemes Catalyzing the Blue Revolution in India

The fisheries sector plays a vital role in ensuring food security, providing livelihoods to millions, and significantly contributing to the national economy. Recognizing its immense potential, the Government of India launched several schemes aimed at enhancing productivity, improving infrastructure, and promoting sustainable practices in this critical sector. The flagship Pradhan Mantri Matsya Sampada Yojana (PMMSY), launched in 2020, has been a transformative program for the fisheries sector. With an ambitious outlay of ₹20,050 crore, the scheme aims to double fishers' incomes, increase fish production, and create employment opportunities. PMMSY emphasizes modernizing fishing practices, improving post-harvest infrastructure, and advancing aquaculture.

The National Fisheries Development Board (NFDB) has also played a pivotal role in implementing programs focused on skill development, fish seed production, and disease management.

Another noteworthy initiative is the Fisheries and Aquaculture Infrastructure Development Fund (FIDF), which offers low-interest loans to entrepreneurs and cooperatives for establishing modern infrastructure, including fishing harbors, cold chains, and processing units. Additionally, schemes like Kisan Credit Cards (KCC) for fishers have facilitated financial inclusion, ensuring easy access to credit for small-scale operators.

Despite these commendable efforts, India's fisheries sector faces several challenges. Overfishing, pollution, habitat degradation, and climate change have severely impacted fish stocks. Many traditional fishers lack access to modern boats, gear, and storage facilities, which limits their productivity and profitability. Furthermore, limited awareness about government schemes often prevents fishers from availing themselves of the intended benefits.

To address these issues, the government has focused on promoting sustainable fishing practices, including enforcing bans during breeding seasons, regulating mesh sizes, and introducing artificial reefs. Capacity-building programs and awareness campaigns aim to educate fishers on sustainable methods and the availability of financial and technical support. The aquaculture sector, in particular, faces environmental and health challenges. In this context, the latest edition of Aqua Post magazine cover an article that advocates a preventive approach to ensure sustainable and healthy fish and shrimp farming practices. From a marketing perspective, the sector also faces significant hurdles. With rising uncertainties in global markets, companies—especially those involved in commercial shrimp farming—are exploring strategies to strengthen the domestic retail market. While the government has made remarkable progress, a more integrated approach is needed to fully realize the potential of India's fisheries sector. Encouraging public-private partnerships and fostering innovation through research and development can further bolster growth. Additionally, promoting exports and value-added products will help India establish itself as a global leader in the fisheries trade. The Central government has already set an ambitious target to double export volumes. Investments in climate-resilient infrastructure and the adoption of digital tools for tracking, marketing, and management are crucial for future-proofing the sector. Government schemes should prioritize creating markets for fish and aquaculture products, shifting the focus from being solely production-centric to market-centric.

India's fisheries schemes have laid a robust foundation for the sector's growth. With sustained efforts and strategic interventions, the country is well-positioned to achieve a true Blue Revolution—ensuring prosperity for millions while safeguarding aquatic ecosystems for generations to come. ■■■

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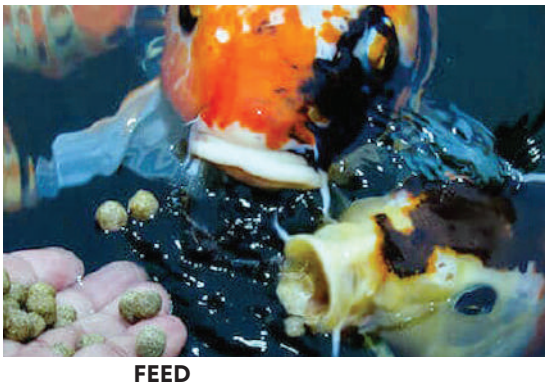

Prevention or Cure

What Should Aqua Farmers Prioritize for Healthy Fisheries?

The fisheries sector, integral to the Indian economy and dubbed the 'Sunrise Sector,' faces significant environmental and health challenges which leads to the use of chemotherapeutics.

Arunashri Aa*, Daniel Danib
Md Imran Shahc ...

The fisheries sector, integral to the Indian economy and dubbed the 'Sunrise Sector,' faces significant environmental and health challenges which leads to the use of chemotherapeutics. These treatments, while addressing disease outbreaks, often lead to issues such as toxicity, resistance, and environmental damage. Prophylactic measures, focusing on prevention rather than treatment, offer a cost-effective and eco-friendly alternative. This article explores the balance between prophylactics and therapeutics in aquaculture, advocating for a preventive approach to ensure sustainable and healthy fish farming practices.

Introduction

The fisheries sector significantly contributes to India's economy, providing national income, food security, and employment. With India ranking as the third-largest fish

producer globally, achieving a record fish production of 175.45 lakh tonnes in FY 2022-23, the sector sustains the livelihoods of approximately 30 million people. However, disease outbreaks pose a major threat to aquaculture, driven by the complex interactions between farmed animals, pathogens, and the environment. Effective disease management is crucial for the sector's sustainability.

Intensification and Disease Outbreaks

The current trend in aquaculture development has led to intensification, which in turn increases the risk of disease outbreaks. Factors contributing to this menace include:

- Increased globalization
- Intensification of fish farming
- Introduction of exotic species
- Expansion of the ornamental fish trade
- Enhancement of marine and coastal areas through stocking of hatchery-raised aquatic animals
- Interactions between cultured and exotic species
- Insufficient prevention of harmful organisms' introduction and spread
- Lack of awareness on emerging diseases
- Misuse of specific pathogen-free stocks
- Global warming
- Lack of clinical facilities for emerging diseases
- Insufficient prophylactic measures for crucial diseases.

Economic Loss Due to Diseases

Disease outbreaks in aquaculture result in significant economic losses, affecting the livelihoods of fishery communities by reducing income and employment. It's estimated that diseases contribute 10-15% to production costs in Indian aquaculture. For instance, in Andhra Pradesh, an annual loss of 40 million INR was reported due to diseases, accounting for about 10% of the production cost. Similarly, parasitic infestations in carp farms in Mandi, Himachal Pradesh, caused an estimated loss of 67,102 INR (US$1428) per hectare per year. The import of disease-infected prawn seeds from neighbouring countries led to the spread of white tail disease, crippling the freshwater prawn industry in India.

Therapeutics in Aquaculture

Disease outbreaks in aquaculture are typically managed with mass therapy, often administered through medicated feed. Other methods, such as direct injection and bathing treatments, are less common. Chemotherapy, while a major method of controlling diseases, poses several issues, including:

Common chemotherapeutics used in aquaculture include Florfenicol, Oxytetracycline, Ormetoprim-sulpha-dimethoxine, hydrogen peroxide, formalin, Chloramine-T, copper sulphate, potassium permanganate, diquat and diflubenzuron. However, these treatments often lead to unabsorbed and un-ingested medicated feed, antibiotic resistance, and potential health risks to farm workers and consumers.

- Triggering toxicity
- Resistance development
- Residue persistence in the environment
- Public health and environmental consequences

Common chemotherapeutics used in aquaculture include Florfenicol, Oxytetracycline, Ormetoprim-sulpha-dimethoxine, hydrogen peroxide, formalin, Chloramine-T, copper sulphate, potassium permanganate, diquat and diflubenzuron. However, these treatments often lead to unabsorbed and un-ingested medicated feed, antibiotic resistance, and potential health risks to farm workers and consumers.

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Problems with Chemotherapy

Chemotherapeutic treatments face numerous challenges:

- Residue persistence in the aquatic environment
- Uptake by aquatic flora and fauna, causing possible toxicity
- Unmetabolized drugs in fish excretions
- Effects on human health, including exposure to carcinogenic substances and antibiotic resistance.

Additionally, the lack of pharmacokinetics data, standardized protocols, and licensed products complicates effective disease management.

Prophylactic Approach

Prophylactic measures, recommended by the World Health Organization (WHO), offer a proactive alternative to disease management. These include:

- Improved husbandry practices
- Movement restrictions
- Use of genetically resistant stock
- Dietary supplements
- Non-specific immunostimulants
- Vaccines
- Probiotics and prebiotics
- Water disinfection
- Biological control

These measures reduce dependence on antimicrobials and other harmful chemicals, supporting sustainable and eco-friendly aquaculture practices.

"Disease outbreaks in aquaculture result in significant economic losses, affecting the livelihoods of fishery communities by reducing income and employment. It's estimated that diseases contribute 10-15% to production costs in Indian aquaculture."

General Prophylactic Measures

Effective prophylactic strategies encompass better management practices (BMPs) at both hatchery and farm levels. Key measures include:

- Hatchery Level:
- Use of good quality water (UV filter, sand filter)
- Use of healthy, pathogen-free broodstock
- Strict sanitary and hygienic conditions
- Regular health monitoring
- Use of good quality live feeds
- Use of treated water

Farm Level:

- Proper pond preparation (drying, waste removal, liming)
- Use of good quality water
- Use of good quality seed (screened and healthy)
- Rational feeding and fertilization schedules
- Rational stocking policy to reduce stress
- Strict hygiene and quarantine programs
- Regular health monitoring
- Use of good quality live feeds

Practicing Microbial Bioremediation with Probiotics and Prebiotics

Probiotics:

Probiotics, derived from the Greek words "pro" and "bios," meaning "for life," are microbial feed additives that confer benefits to the host by modulating intestinal microbiota. Common probiotics in aquaculture include Bacillus, Lactobacillus, and Bifidobacterium species. These organisms, administered via feed or water, improve disease resistance, health status, growth performance, feed utilization, and stress response.

Prebiotics:

Prebiotics are long-chain complex carbohydrates that provide energy to beneficial microorganisms, enhancing the health of the host. Sources include plant-based products, edible mushrooms, and dairy products. Common prebiotics in aquaculture include -glucan, inulin, arabinoxylan-oligosaccharides (AXOS), mannan-oligosaccharides (MOS), galacto-oligosaccharides (GOS), and fructooligosaccharides (FOS). These prebiotics promote growth performance, increase feed utilization efficiency, and enhance immune response.

Enhancing General Disease Resistance with Immunostimulants

Immunostimulants, such as essential fatty acids, amino acids, vitamins, and minerals, enhance the immune system of aquatic animals without harmful side effects. These nutrients support immune system function, antioxidant activity, anti-inflammatory responses, and infection resistance.

Immunization with Vaccines

The development and use of aquatic vaccines are the safest and most effective ways to prevent diseases. Vaccines, defined as preparations that elicit acquired immunity, can be monovalent, multivalent, or mixed, and prepared as live, inactivated, or genetically engineered. Over 26 licensed fish vaccines are available globally, promoting sustainable aquaculture practices.

Nutritional Interventions with Nutraceuticals

Nutraceuticals, combining "nutrition" and "pharmaceutical," are bioactive compounds from natural sources believed to offer health benefits beyond basic nutrition. Used as growth promoters and immunity boosters, nutraceuticals include nucleotides, enzymes, methyl donors, immunostimulants, chitin, vitamins, amino acids, antioxidants, minerals, organic acids, carotenoids, and phytochemicals. These compounds support defence systems, especially under stress, and enhance overall health.

Conclusion

Disease prevention is crucial for the growth and sustainability of the aquaculture industry. A proactive approach, combining various prophylactic strategies, offers a more effective solution than reactive treatments. Establishing national or regional information exchanges and implementing robust surveillance and diagnostic measures are essential for maintaining healthy aquaculture practices. By prioritizing prevention, aqua farmers can ensure better production, environmental sustainability, and economic viability. ■■■

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(Views expressed are personal. References can be availed on request.)

Unlocking the Potential Transcriptomics in Advancing Aquaculture

Transcriptomics revolutionizes aquaculture by decoding genetic networks governing immunity, reproduction, and growth. It unveils mechanisms of disease resistance and stress responses through differential gene expression analysis

Siyag Anant Dhere, Borra Tejaswi, Banothu Divya, Tuturanjan Gogoi, Kiran Rasal, K.N. Mohanta...

Transcriptomics revolutionizes aquaculture by decoding genetic networks governing immunity, reproduction, and growth. It unveils mechanisms of disease resistance and stress responses through differential gene expression analysis. Moreover, it aids in identifying molecular markers for selective breeding, ensuring resilient aquaculture systems. Transcriptome profiling enhances understanding of reproductive patterns and metabolic pathways, enabling targeted interventions. It also generates genetic resources and identifies SNPs for precise management. Ultimately, transcriptomics reshapes aquaculture research, offering insights for enhanced productivity and environmental stewardship.

Introduction

Recently, biological science has benefitted from the applications of several "omic" techniques. Transcriptomics is one of the omic techniques that serves great advantages in aquaculture. It aids in deciphering the molecular mechanism of a fish ina certain environment. With the increasing demand for fish production, transcriptomics holds great promise in aquaculture for gene identification that pertains to traits like adaptation, functional traits, growth, and disease resistance.

Moreover, to optimize aquaculture practices, researchers employ cutting-edge techniques such as transcriptomics, offering unprecedented insights into crucial aspects of aquaculture. Transcriptomics unveils intricate genetic networks governing immunity, reproduction, growth, and responses to stressors in aquatic organisms. For instance, by scrutinizing differential gene expression during pathogen exposure or nutrient assimilation, researchers elucidate mechanisms underpinning disease resistance, reproductive fitness, and growth patterns. Furthermore, transcriptomics facilitates the identification of molecular markers crucial for selective breeding and management strategies, promising more resilient and sustainable aquaculture systems. As this article illuminates the transformative power of transcriptomics reshapes

aquaculture research, paving the way for enhanced productivity and environmental stewardship in the burgeoning field of aquatic farming.

Disease and Immunity

The functional genetic network associated with immunity can be revealed by transcriptome profiling of the immune tissues of the infected fish. The impacts of pathogens on fish or specific tissue of fish can be analyzed using transcriptome analysis and their effects can be studied at the molecular level. This aids in determining the differentially expressed genes (DEGs) between the healthy and diseased organisms. This analysis ultimately aids in proper therapeutic and health management strategies. RNA sequencing was performed to examine cyprinid herpes virus in common carp, which involved three specific antibodies, and kidney transcriptome during viral infection. Also, transcriptome examination in hepatopancreas of Machrobrachium rosenbergii infected with Vibriyo parahaemolyticus reported several up- and down-regulated genes revealing antibacterial mechanisms.

Reproduction and Development

To maintain reproductive fitness and enhance artificial breeding programs, a proper understanding of the reproductive pattern in aquaculture species is fundamental. To analyze the process of spermatogenesis and sexual maturity, the determination of relevant transcripts from brain and gonadal tissues is a major pre-requisite. The differential expression of testicular genes of spotted snakehead (Channa punctatus) was analyzed using de novo testicular transcriptome. The biological processes such as cell proliferation, differentiation, sperm motility, and spermatogenesis revealed several transcripts upregulated. The gonads of the swimming crab Portunustrituberculatus were subjected to transcriptome analysis to enhance seed production and knowledge ofthe molecular mechanism of gonad development.

To determine the molecular mechanism of residual feed intake, the muscle transcriptome of Litopenaeus vannamei was analyzed. A total of 383 differentially expressed genes related to residual feed intake were been identified. These genes reflected higher expression levels in fish with high feed efficiency and lower expression was observed in fish with lower feed efficiency.

Growth and Nutrition

In aquaculture, for the development of an optimal feed for any cultured species, an idea about the metabolic pathways of a particular nutrient is animportant aspect. Particularly in nutrition, the study of molecular mechanisms in response to a particular diet has become easy with the advent of new techniques such as nutrigenomics(Martin & Krol, 2017).Feed efficiency is very important for the aquaculture species involved in breeding programs. Transcriptomics can be applied in analyzing the gene expression in fish fed with plant-based diets. The transcriptomic analysis was conducted in zebrafish fed with a plant-based diet. To determine the

molecular mechanism of residual feed intake, the muscle transcriptome of Litopenaeus vannamei was analyzed. A total of 383 differentially expressed genes related to residual feed intake were been identified. These genes reflected higher expression levels in fish with high feed efficiency and lower expression was observed in fish with lower feed efficiency.

Toxicology and Stress

The impacts of several pollutants on the tissues of different aquatic organisms can be studied by transcriptomic profiling of the organisms. Various transcriptomic studies revealed the toxicity of different pollutants like heavy metals, polyaromatic hydrocarbons, pesticides, nanoparticles, microplastics, human pharmaceuticals,and pharmaceutical pollutants on fishes and other aquatic organisms. Zebrafish embryo exposed to the insecticide deltamethrin (DTM) was subjected to transcriptome analysis. The study indicated dysregulation of nervous system development and cell signaling in zebrafish embryos. Moreover, transcriptome analysis of Crassostrea gigas, which differs in their tolerance of heat shock, has been identified with candidate genes involved in stress tolerance.

Potential Applications of Transcriptomics in Aquaculture

Generation of Genetic Resources

Transcriptomics aids in identifying genes associated with economic traits, growth, immune response, sex determination, and gonad differentiation. It also facilitates a genomic approach for regulating the sex ratio, improving growth and resistance to pathogens.

Analysis of Differential and Correlated Expression of Genes

Transcriptomics sheds light on variations in gene expression under different environmental conditions. The immune-related genes were found to be differentially expressed in Micropterussalmoides against Nocardiaseiolae.

Molecular Markers

SNPis the most abundant molecular marker in the genome. In Atlantic salmon, several Quantitative Trait Loci (QTL) were identified for resistance against the infectious pancreatic necrosis (IPN) virus.

Conclusion

Transcriptomics revolutionizes aquaculture research by unravelling disease mechanisms, enhancing reproduction, and understanding growth patterns. It identifies crucial genes, enriches genetic resources, and enables targeted breeding for resilient species. Molecular markers like SNPs aid in precise management, promising sustainable aquaculture practices.

The Authors are M.F. Sc Scholar, ICAR-Central Institute of Fisheries Education, Versova, Andheri West, Mumbai-40061, Maharashtra, India; Corresponding Author: sdhere166@gmail.com (Views expressed are personal. References can be availed on request.)

Artemia: Biological Insights and Studies

"Artemia is the only genus in the family Artemiidae. Artemia is a genus of aquatic crustacean salso known as brine shrimp. Breeds of Artemia are marketed as "Sea-Monkeys" and sold as novelty items."

Pranav Kumar Upadhyay*,
Akansha khati** ...

Little crustaceans called artemia have long been used in shrimp and fish aquaculture as beginning feed for various species. Their cysts can be stored until needed and hatched as live food. It is the only genus in the family Artemiidae. Artemia is a genus of aquatic crustacean salso known as brine shrimp. Breeds of Artemia are marketed as "Sea-Monkeys" and sold as novelty items.

INTRODUCTION

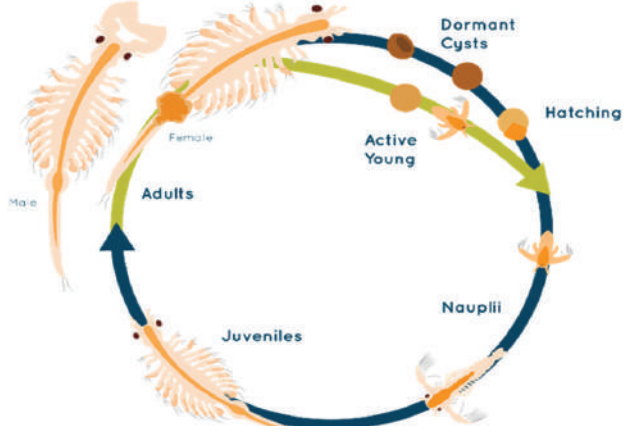
Artemia is a genus of aquatic crustaceans also known as brine shrimp. Breeds of Artemia are marketed as "Sea-Monkeys" and sold as novelty items. The abundance of Artemia in aquaculture results from its capacity to create cysts, which are dormant eggs. Inland saltwater lakes are home to populations of artemia but not oceans. Because artemia can survive in environments with extremely high salinities (up to 25%),they can avoid sharing habitat with most predators, including fish. When the Messinian salinity crisis occurred around 5.5 million years ago, a group of seven to nine species known as the brine shrimp, called Artemia, very likely separated from an ancient form that was present in the Mediterranean region.

ANATOMY

The primordial arthropod Artemia has a segmented body and broad, leaf-like appendages that are linked to it. Typically, the body is divided into 19 segments: the first 11 have pairs of appendages, the next two, which are sometimes fused together, carry the reproductive organs, and the final three lead to the tail. The mature male's total length is typically 8-10 mm (0.31-0.39 in) and the adult female's is 10-12 mm (0.39-0.47 in), however both sexes' width, including the legs, is only around 4 mm (0.16 in).

The head, thorax, and abdomen make up Artemia's body. A thin, flexible exoskeleton made of chitin covers the entire body; it is periodically shed and contains internal attachments for the muscles. Every ovulation in female Artemia is preceded by a moult.

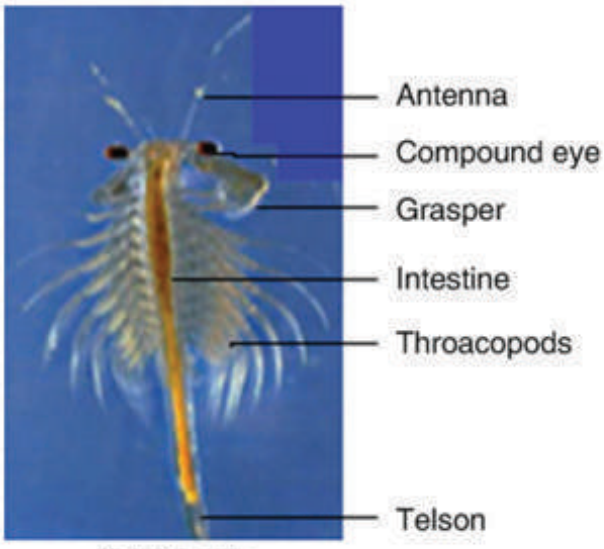
ECOLOGY & BIOLOGY



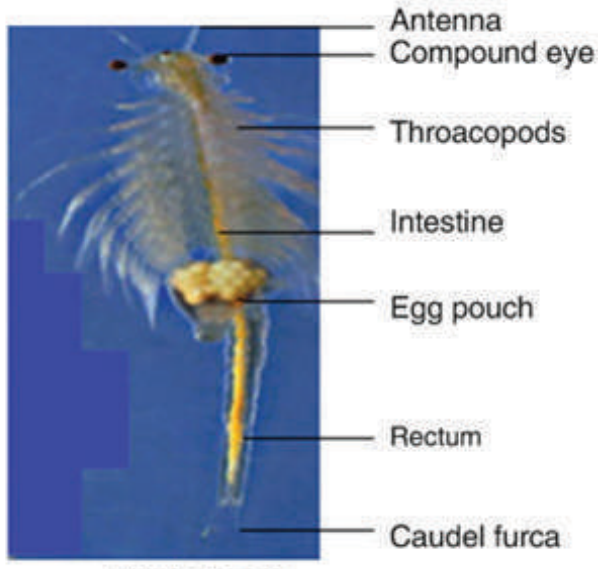
In an ideal conditions, Artemia went through a complex life history cycle similar to other crustaceans, progressing from cysts to nauplii and finally to its adult stage. Artemia are able to release their young into a latent, encysted form rather than just releasing swimming nauplius in order to assure survival in harsh and complex settings like salt lakes.

The cyst shell is crucial in shielding the embryo inside from additional harmful environmental stimuli in addition to preventing mechanical harm. Yet, dried Artemia cysts can withstand harsh conditions and be kept for a long time if they continue.

SEX DIFFERENTIATION



Adult male



Adult female

CYST MORPHOLOGY

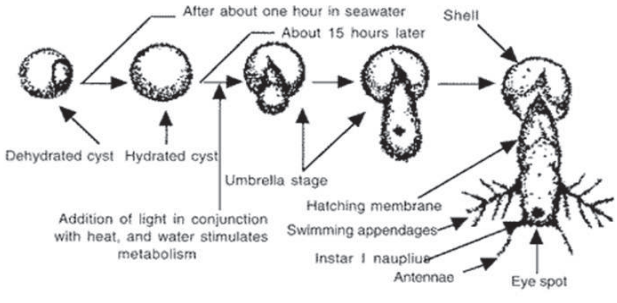
The cyst shell consists of three layers:

1. Alveolar layer: a hard layer consisting of lipoproteins impregnated with chitin and haematin; the haematin concentration determines the color of the shell, i.e. from pale to dark brown. Its main function is to protect the embryo against mechanical disruption and UV radiation. This layer can be completely removed (dissolved) by oxidation treatment with hypochlorite •

2. Outer cuticular membrane: protects the embryo from penetration by molecules larger than the CO2 molecule (= multilayer membrane with very special filter function; acts as a permeability barrier).

3. Embryonic cuticle: a transparent and highly elastic layer separated from the embryo by the inner cuticular membrane (develops into the hatching membrane during hatching incubation).

Physiology of the hatching process



Changes of developing *Artemia* from the cyst stage to Instar I nauplius.

DECAPSULATION

Short-term exposure to a hypochlorite solution can entirely dissolve the hard shell that encysts the latent Artemia embryo. Decapsulation is the term for this action.

Process of Decapsulation

- Prepare 200 Lit. Fresh Water in 500 Lit. Decapsulation tank.
- Socking 20 Kg Artemia Cyst in a Decapsulation Tank for 1 to 2 Hours.
- After 2 hours should were PPE and add NaOH Solution (180ml/Tin)(1KG /4 Lit. Fresh Water)
- Then add Chlorine (2 Lit./Tin).
- Maintain the Temperature below 40 with Ice and Fresh Water.
- Observe the Cyst color GRAY- WHITE- BROWN – ORANGE. Decapsulation time is 10 to 15 Minutes.
- Prepare the 20 Lit. 300 ppm Sodium thiosulphate (Hypo) Water.
- Add 5 Lit. 300 ppm Hypo Water in a Decapsulation tank for elimination of Chlorine.
- Harvest the Artemia cyst and wash it with fresh water.
- Dip the Artemia cyst in 300 ppm Sodium thiosulphate water to eliminate the complete Chlorine.
- Wash the Artemia Cyst with Fresh water and store it in the refrigerator at < 5 for one week or we can also use freshly prepared Artemiaas a live feed for shrimp and fish.

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Massive floods affected fish production in HP in 2023

Economic Survey Report

"The unprecedented floods last year washed away many fish farms and destroyed breeding and feeding grounds of the fish. The destruction was at a massive scale that caused losses to not only farm owners but also impacted the overall fish production," said Bhupinder Kumar, Deputy Director, State Fisheries Department.

The total fish production in the Himachal Pradesh dropped substantially from 17026 MT in 2022 to 11377 MT in 2023 due to unprecedented flood, according to the Economic Survey for the year 2023-24, released recently.

Floods in Himachal Pradesh

The floods in the year 2023 have wreaked havoc resulting in fall of fish production in the State.As per the Economic Survey Report for 2023-24, report, the total fish production in the state has declined to 11377MT in 2023from 17026 MT in 2022. The drop is about 33.4%.

The Department of Fisheries of Himachal Pradesh cites mass flooding in the year 2023 as reason for the decline in the fish production."The unprecedented floods last year washed away many fish farms and destroyed breeding and feeding grounds of the fish. The destruction was at a massive scale that caused losses to not only farm owners but also impacted the overall fish production," said Bhupinder Kumar, Deputy Director, State Fisheries Department.

"The flood also affected the fish production in the reservoir of dam Iike Bhakra and Pong as the flood water brought along huge amount of silt that destroyed not only the fish but also the ecosystem. Hopefully we will have a

> **"The flood also affected the fish production in the reservoir of dam like Bhakra and Pong as the flood water brought along huge amount of silt that destroyed not only the fish but also the ecosystem. Hopefully we will have a better fish production this year, "added Kumar.**

better fish production this year, "added Kumar.

In the year 2023, during the monsoon season there was a massive flood in almost all the rivers of the State. Due to this flood, most of the private fish farms which had been situated near by the river bank were washed away in many districts, especially in Kullu and Mandi. The Central Inland Fisheries Research Institute (CIFRI) had also blamed mud dumpling in Bhakra Dam as one of the main reason behind substantial drop in fish production in the reservoir over the year.

Drop in Production

In the year 2022, the State had recorded its highest production of 17026 MT. For the first time since 2012-13, the state had recorded the fall in the production of fish in 2023.The total monetary value of the fish, which was rupees 211.5 crore in year 2022 also came down to rupees 179.49 crore in 2023.The trout production in the state had been dropped gradually from the highest 19.18 MT in 2012-13 to 7.7MT in year 2023.

Action taken

To rejuvenate the aquatic ecosystem and boost angling tourism, the Department Fisheries of the state had released over 21,000 rainbow trout fingerlings into the Pabbar river, a tributary of the Yamuna. The department had also set up a farm in Dhamwari to help improve the fish population and production. There are in all 12 fish seed farms under the department's control, of which, six are trout farms and another six carp farms. Trout farms have been set up in Patlikuhl in Kullu district, Barot in Mandi district, Holi in Chamba, Dhamwari in Shimla, Sangla in Kinnaur.

The department has been making efforts to revive the fish production in the reservoirs, dams and rivers and introduced 16,000 fingerlings of rainbow trout near Dhamwari in Rohru.

"Our intention is to rejuvenate all possible fisheries resources in the state so the ecosystem balance and biodiversity is maintained and sustainable livelihood is provided to the people living in the remotest areas," said State Fisheries Secretary, Priyatu Mandal, adding that the department is working hard to reach each and every corner of the state.

Conclusion

More than 6000 fishermen directly depend on the dam reservoir like Bhakra Nangal dam, Chamer dam, Ranjeet Sagar dam and Kol dams as the major source of fish in the state for their livelihood. There are more than 50 species of fishes but trout is the most popular among them. However, it had been noticed that trout production also has been decreasing from the last many years due to numerous reasons including massive floods.

Sourcre(https://timesofindia.indiatimes.com/ and https://www.hindustantimes.com/)

The Future of Fisheries and Food Security

"The fishing community has to often look for a second source of income during the non fishing months to be able to sustain a living. With the financial security from fishing reducing even further, the younger generation finds it easier to take up an alternative livelihood altogether"

Akansha Tiwari, social activist and conservationist...

Pritesh Shiyal, a 23 year old fisherman from Mumbai and the third generation involved in trawl and purse seine fishing from the family, studied hotel management and works as a senior bartender on the side. "The demand and availability for the species has changed over the last few years, and it is so high that the fishes we used to catch before are not available anymore."

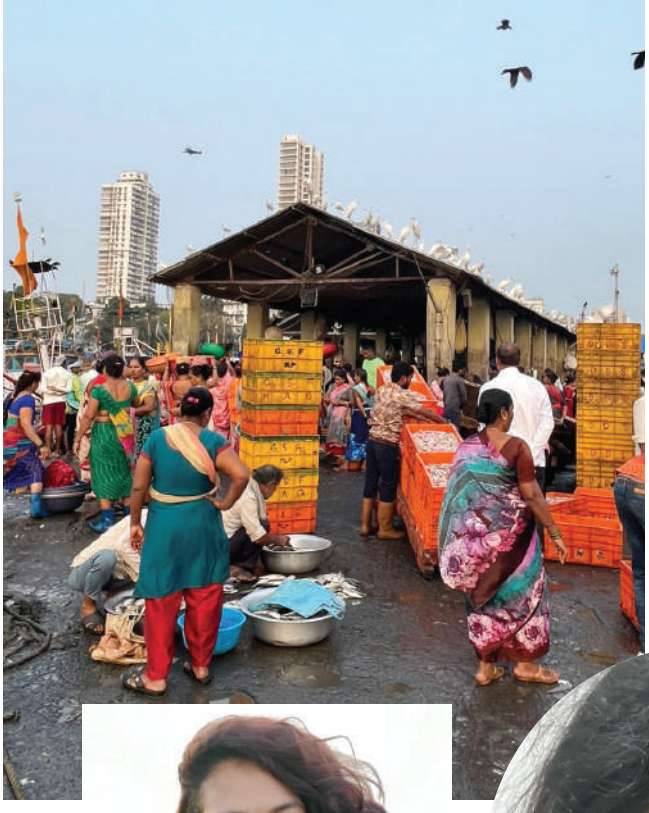
"Our current boats are over 16 years old, and my family has been buying and selling fish for more than 40 years. I have been visiting the docks since I was a kid, fishing seemed to be a lot more sustainable before, groups of fishermen would go and catch fish and there was every species available in plenty, there was no scarcity of the fishes like we see in these years"

"Nowadays fishermen go and target the species that are reproducing and the entire cycle goes wrong, we cannot find fishes now. There is so much demand for usual species like prawns, pomfrets and we cannot find good quality fishes in the ocean just because of this overfishing factor."

Marine fishing in India supports around four million people (CMFRI-FSI-DoF, 2020) and gets foreign exchange worth US$7.76 billion through export (MPEDA, 2022), it is also a major contributor to national food security. The fishing sector in India constitutes 6.3% of the global fish production and contributes to 1.1% of the overall GDP and 5.15% of the agricultural GDP of the country.

During 2021, Maharashtra saw an estimated 1.23 lakh tonnes of fishing landings which was a 12% decrease from the 1.4 lakh tonnes the previous year. This was mainly because of loss of fishing days, scarcity of labour for fishing and allied activities associated with frequent bad weather warnings to add to factors like the pandemic. (CMFRI - CFD/RMP/13). 33 year old Govind Chavan, a fisherman from Karnataka whose family is involved in farming, now works on buying and selling in Mumbai, because job opportunities are better on these landing sites. "Anyone who is educated does not come back to the industry, they choose to find a job elsewhere that has more financial security."

"I had to move here as soon as I was done with my primary education. Initially I lived with my elder brother and his wife who spent their whole life working in Mumbai and slowly made local influential contacts in this industry.



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I would have preferred to continue my education but unfortunately family debt was high and that made us have to start earning as soon as possible"

"My family did not have the resources to continue my education, and I was left with no other choice", he added

"I shifted to Gujarat because the payment system here is different, we get a salaried amount every month despite the money that the boat is making", Vijay Tandel from Talasari in Konkan, Maharashtra prefers this system instead of the catch dependent payment system in Mumbai or the daily wage labour back home. "Currently we are facing some weather issues when we go to the deep sea or far away from the shore. Sometimes we are not in the range of VHF (Very High Frequency) radios that the government provides so we don't know when a storm is coming or when the seas are about to get choppy"

"The amount of good quality fish has also reduced and all we get is low quality or medium quality bycatch."

"There is high diesel consumption in our boat, so diesel price is also high and becoming a major issue."

The fishing community has to often look for a second source of income during the non fishing months to be able to sustain a living. With the financial security from fishing reducing even further, the younger generation finds it easier to take up an alternative livelihood altogether.

Other factors like an economic shift in the sector, has put families in debt because of reduced catch or increase in frequency of repairs needed for their nets and engines due to the currently harsh weather conditions.

"Over the last 10 years, changes in the climate have made the seas harsher, affecting fish behaviour and fishing safety. The weather conditions are simply not the same as we saw growing up. The average temperature has increased, there is rise in sea level, increase in frequency of floods, cyclones, landslides, unpredictable rain, habitat destruction and unregulated pollution.", says Ganesh Nakhawa, a seventh generation purse seine fisherman from Mumbai.

"Fishing and allied activities have become highly unreliable and seen as a low status or rural job by most youth. Growing urbanisation with the aspiration of a better life, stable income and a higher social status directs their interests to move out of the sector."

"Basic skills that require understanding of the industry are also lacking in the younger generation because of the reduced time they have spent on ground with their parents"

"The attitude and treatment of the general population towards the community, looking down on them as a poor or rural population has influenced the way we are looked at by society, and now we have no sense of self identity left" "With other initiatives like the White and Green Revolution, the authorities focused on the upliftment of the indigenous communities, they provided better facilities and developed the quality of the industry, but with us there is almost a gap of two generations that has lost interest in the trade and not been on field, it is already too late to develop the community"

"Traditional knowledge is passed on from one generation to another and when this chain is broken, it leaves room for someone else to occupy this space and get involved in the trade influencing the whole ecosystem and moving the economic autonomy outside the community more than it already has."

"An additional internal competition of access to catch between small scale and large scale fishing, has not worked in providing a stable future for the industry."

Nature's Hidden Banquet

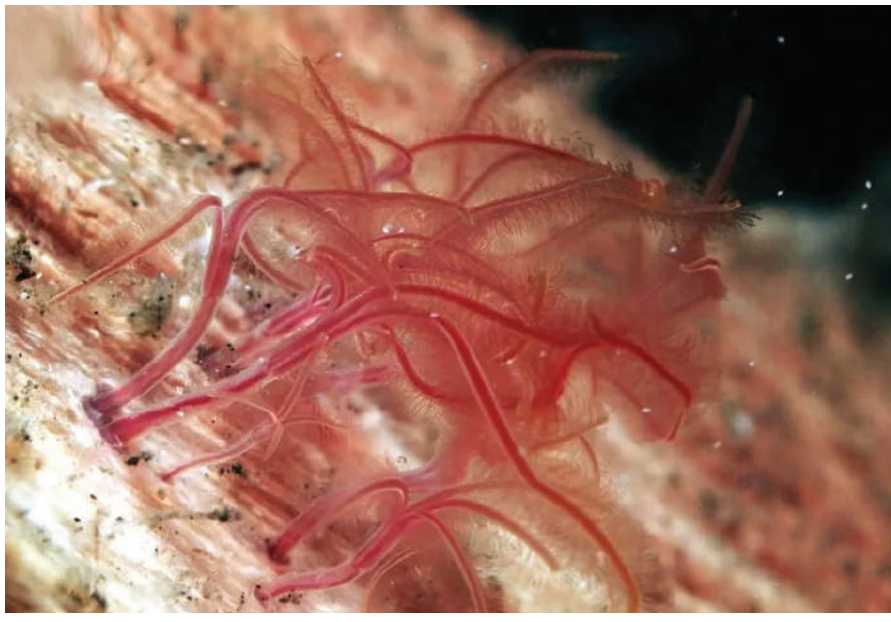
The Enigmatic World of Whale-Falls

Whale-falls produce remarkable ecosystems with rich organic content and high levels of sulphides on the ocean floor. Recent years have witnessed a substantial increase in research focused on both contemporary and ancient whale remains.

Shruthi H. U.1*, Manjunath N.1
Bhavanjali M. R.1...

Whale-falls produce remarkable ecosystems with rich organic content and high levels of sulphides on the ocean floor. Recent years have witnessed a substantial increase in research focused on both contemporary and ancient whale remains. This surge in investigation has yielded intriguing insights into the unique habitats associated with whale-falls. Within these deep-sea environments, metazoan communities undergo a series of successive stages, with variations influenced by factors such as size of the corpse, water depth, and surrounding environmental conditions. These communities host a diverse array of extraordinary species and evolutionary adaptations, including bone-eating worms, snails, and organisms that graze on sulphur bacteria. Given that human activities like whale hunting can diminish the occurrence of whale-falls, it is imperative that we refrain from interfering with the natural creation of these ecosystems in the abyssal zone. To ensure broader awareness of the significance of whale-falls, there is a pressing need to initiate awareness programs aimed at educating the general public.

Whale-falls may have been hotspots for adaptive radiation for a specialised fauna, as well as evolutionary stepping stones for vent and seep mussels, and a potential catalyst for speciation in other vent/seep species, according to Molecular and Paleoecological research.



Introduction

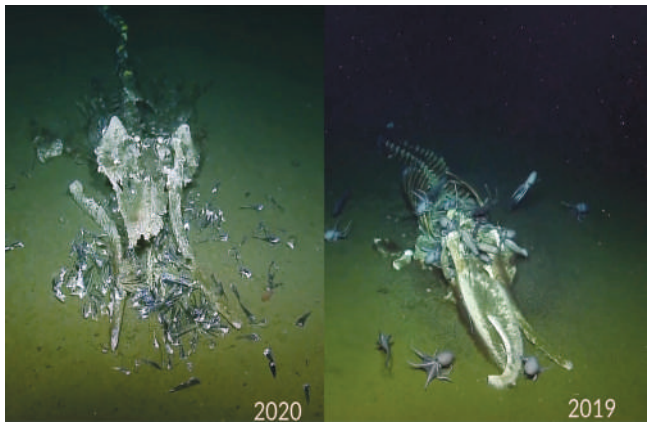
The bodies of dead whales in the ocean ultimately sink to the bottom. This is referred to by biologists as a whale-fall once the body has come to rest. As one might expect, the meat from the carcass is first consumed by other fish and sea creatures. However, the discovery that dead whales support entire ecosystems surprised ocean experts. The majority of great whale species, with the exception of right and sperm whales, have bodies that are slightly denser than saltwater aiding in sinking of the remains. Most natural whale mortality occurs during migrations as a result of nutritional or illness stress, which leads to reduced buoyancy and carcass sinking. The extraordinary characteristics of whale-falls result in special, energy-rich ecosystems at the ocean floor.

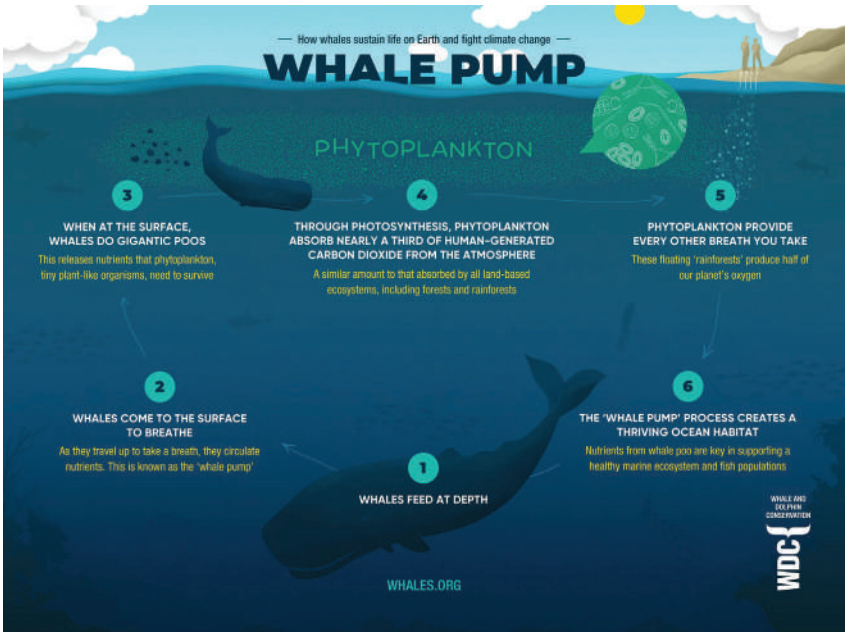
Where Does Whale-falls Occur?

Once a whale dies, its carcass sinks to the bathyal or abyssal zones, or a depth greater than 1,000 m or 3,300 ft.; These zones have no light with temperatures around 2 °C to 3 °C. There is strong evidence that whale-falls, even at relatively shallow depths, decompose at the seafloor. Additionally, because they descend quickly after their lungs deflate, and as there aren't any big scavengers of sinking whales in the ocean water column, sinking whale carcasses reach the seafloor relatively undamaged. The distribution of whale-falls in the ocean shows spatial-temporal variation. Numerous mysticetes travel many miles each year between their feeding and calving regions, which causes stress and higher mortality. Sperm whales are concentrated in feeding sites where falls are more common while having a larger oceanic spread and possibly being the main source of cetacean debris in the abyss.

History and Investigation:

For at least 80 years, scientists have speculated about what happens to sunken whale carcasses, and more than 150 years ago, the taxonomic literature contained the first indications that whale-falls may be home to a peculiar fauna. The findings of a chemolithoautotrophic assemblage on a balaenopterid skeleton in the deep sea off California in 1987, which surprisingly mirrored the recently identified communities at hydrothermal vents and cold seeps, led to the recognition of whale-fall ecosystems. The initial whale-fall discovery sparked a rapid sequence of discoveries of unusual chemolithoautotrophic communities on contemporary whale-falls in the deep North and South Pacific as well as on Oligocene-era fossil whale skeletons from the deep Northeast Pacific. These findings led to the first whale-carcass implantation experiments, which were carried out off the coast of southern California to explore the ecology and phylogenetics of whale-fall communities. Submersibles and ROVs, or remotely operated underwater vehicles, have since been used to propel a number of whale-falls. Researchers from the University of Hawaii began one of the greatest investigations on the incidents in 1988. The experts of the project made the astounding discovery that





> Once a whale dies, its carcass sinks to the bathyal or abyssal zones, or a depth greater than 1,000 m or 3,300 ft.; These zones have no light with temperatures around 2 °C to 3 °C. There is strong evidence that whale-falls, even at relatively shallow depths, decompose at the seafloor.

a 40-ton whale carcass is comparable to two thousand years' worth of typical carbon.

Stages and Timeline of Decomposition

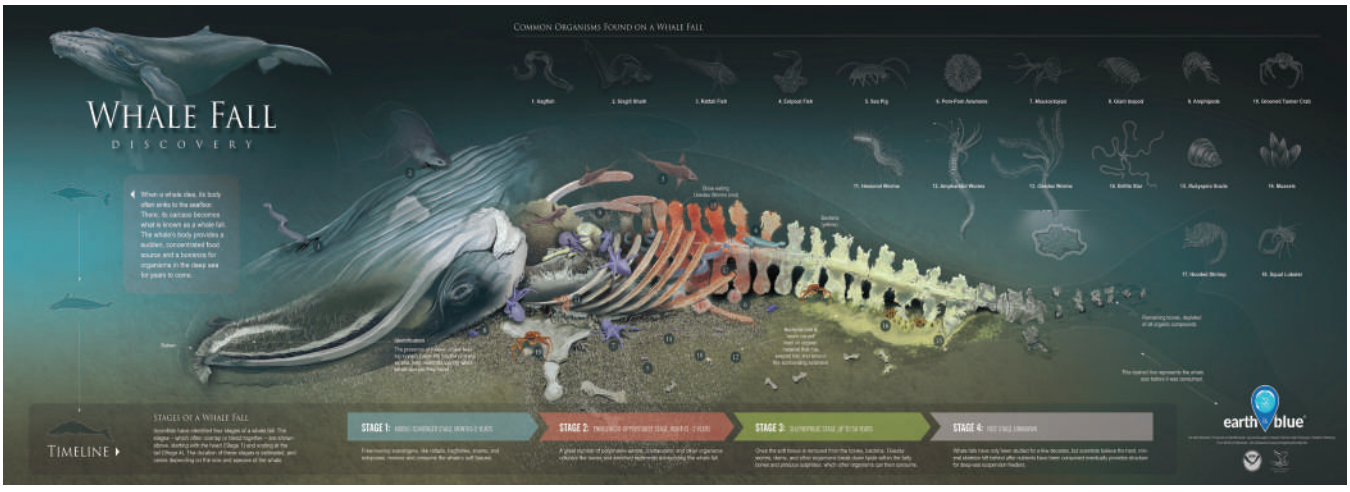
Deep-sea whale-fall communities have been hypothesized and observed to pass through up to four stages of ecological succession:

- **The mobile-scavenger stage:** Large, active necrophage clusters in dense aggregations strip the carcass to its soft tissue. A large number of hagfishes (Eptatretusdeani) feast upon the carcass, and it can include sizable bite marks from sleeper sharks (Somniosispacificus).This stage may last for months or up to 1.5 years.
- **The enrichment-opportunist stage:** The bones andorganically rich sediments surrounding the body are populated by dense assemblages of heterotrophic macro fauna including polychaetes and crustaceans. There will only be a few hagfishes left, and the skeleton will almost entirely devoid of soft tissue. In response to conditions of organic enrichment close to the whale-fall, juvenile bivalves, gastropods, dorvilleid polychaetes, and cumacean crustaceans can be seen as white dots on the substrate. This stage can lastmonths or up to 4.5 years.
- **Thesulphophilic (or "sulphur-loving") stage:** As sulphide is released from the anaerobic bacterial degradation of bone lipids and other tissue, an assemblage that includes chemolithoautotrophs colonises the sediment and bones. Additionally, methane can be generate during the decomposition of anaerobic tissue, promoting free-living or endosymbiotic bacterial methanotrophs. On the vertebrae, Osedax worms (Zombie-worms/ Bone-eaters) and Pyropelta limpets can be seen together with white and pink bacterial mats. As whale bones possess high lipid content, which represents 4–6% of its body weight, the final digestion phase can last between 50 and perhaps 100 years.
- **The reef stage:** Following the decomposition of organic material, suspension feeders that take advantage of flow rate and hard substrates i.e. filter-feeders are principally responsible for colonising the mineral remains of the skeleton. This bone may have presumably arrived to the seafloor more than 10,000 years ago based on the existence of the manganese crust.

Juvenile whale bones have much smaller size, weaker calcification and smaller lipid reservoirs that result in faster decomposition rate compared to adult carcasses. In the deep water, whale-falls are numerous on a regional scale, and maintain a diverse, recognisable fauna with an incredible local species diversity. Further, faunal communities dependent on big adult whale carcasses can go through at least three stages of succession, which could continue for decades.

Service to the Ecosystem

Great whales, which have adult body weights ranging from 8 to 160 metric tonnes, are among the largest creatures



to have ever existed. Because of the protection that the size can afford against the majority of predators, great-whale biomass often enters marine detrital food webs as practically complete carcasses.

For a wide range of species, whale-falls provide an exceptional source of nutrients, frequently in places where those nutrients are scarce. The carcasses generate intricate local ecosystems in the bathyal and abyssal zones that experience ecological succession. Deep-sea critters can continue to feast on the body for decades.

Whale-falls may have been hotspots for adaptive radiation for a specialised fauna, as well as evolutionary stepping stones for vent and seep mussels, and a potential catalyst for speciation in other vent/seep species, according to Molecular and Paleoecological research.

Effects of Whale Hunting

The whaling business, through the killing of numerous huge whales and a decrease in whale-falls, has had an impact on the biological pump. It has been hypothesised that the loss of huge whales may have resulted in a 30% or greater decrease in the total biomass of the deep sea. Massive amounts of carbon were held in reserve by whales and transferred to the deep ocean during whale-fall episodes. Thus, whaling has also decreased the deep sea's capacity to store carbon. In the deep water, carbon can be stored for hundreds of thousands of years sustaining benthic organisms.

Future Issues

- The colonisation and succession of whale-fall communities remain poorly understood in contemporary shallow-water habitats, the Arctic Ocean, and the vast abyssal regions that make up the majority of the ocean floor. These regions warrant the studies of both natural and experimental whale-fall populations.
- Weak knowledge exists regarding how ecosystem engineers, particularly bone-eating Osedax annelids, affect microbial colonisation, metabolism, and faunal succession at whale-fall sites. The nature and rates of microbial processes, as well as the patterns of metazoan community succession, biodiversity, and ecosystem function, must be studied in controlled whale-bone implantation experiments to determine how the abundance and diversity of bone-eating Osedax species interact with whale-bone size and lipid content.
- We still only have a small sample size for understanding the paleobiogeography of whale-fall groups. Studies of fossil whale-fall assemblages from many more areas and depths may shed light on the ecology and evolution of whale-fall communities in ancient waters.
- Due to the lack of data from various ocean depths, particularly abyssal and hadal depths, and from some ocean basins and areas, particularly central gyres, the biogeography and connectivity of contemporary whale-fall populations also remain poorly understood. Our understanding of the inter-connectivity, evolutionary novelty, and biogeography of whale-fall biota throughout the world ocean could be quickly advanced by studies using controlled seafloor implantations of whale bones across various depths and regions.

Conclusion:

For sustenance, animals at the bottom typically rely on tiny, decomposing plants and animals that fall to the ocean floor which is commonly termed as "marine snow." On the ocean floor, there is a great deal of joy when a whale dies as it indeed is a Nature's secret Banquet after all. The equivalent of one whale-fall is one thousand years of marine snow. Intervention of anthropogenic activity in whale-fall shall strictly be prohibited as it significantly alters the ecosystem equilibrium. Whale-fall is nature's gift to support the diverse ecosystem thriving at greater depths. The amazing organisms and their intriguing peculiarity wouldn't exist in the unfriendly ocean depths without whale carcasses. There is a dire need to educate ourselves and act for conserving the whale and support a healthy ecosystem. ■■■

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Dwindling migratory freshwater fish population

According to the report, habitat loss and degradation, including fragmentation of rivers by dams and other barriers and conversion of wetlands for agriculture, account for half of the threats to migratory fish. Overexploitation (overfishing) is the second most significant factor. The report also notes that increasing pollution and the worsening impacts of climate change contribute to the fall in freshwater migratory fish populations

Name...

Globally there are approximately 900 migratory fishes reported. These fish species undergo periodical migrations i.e. on time scales ranging from daily to annually or longer and over distances ranging from a few meters to thousands of kilometers. Usually fishes migrate for feeding or breeding (reproduction) purpose. Migratory freshwater fish partially or exclusively rely on freshwater systems – some are born at sea and migrate back into fresh water, or vice versa. They can in some cases swim the width of entire continents and then return to the stream in which they were born

In a study it is revealed that migratory fish populations have crashed by more than 80% since 1970. Populations

of migratory freshwater fish species including salmon, trout, eel and sturgeon, are declining dramatically. The 2024 update on the Living Planet Index for Migratory Freshwater Fishes shows an average 80% decrease in these fish populations between 1970 and 2020. The decline in migratory fish population is seen all over the world but in South America and the Caribbean, the abundance of these species has dropped by 91% over the past 50 years. In Europe, populations of migratory freshwater fishes have fallen by 75%, according to the latest update to the Living Planet Index.

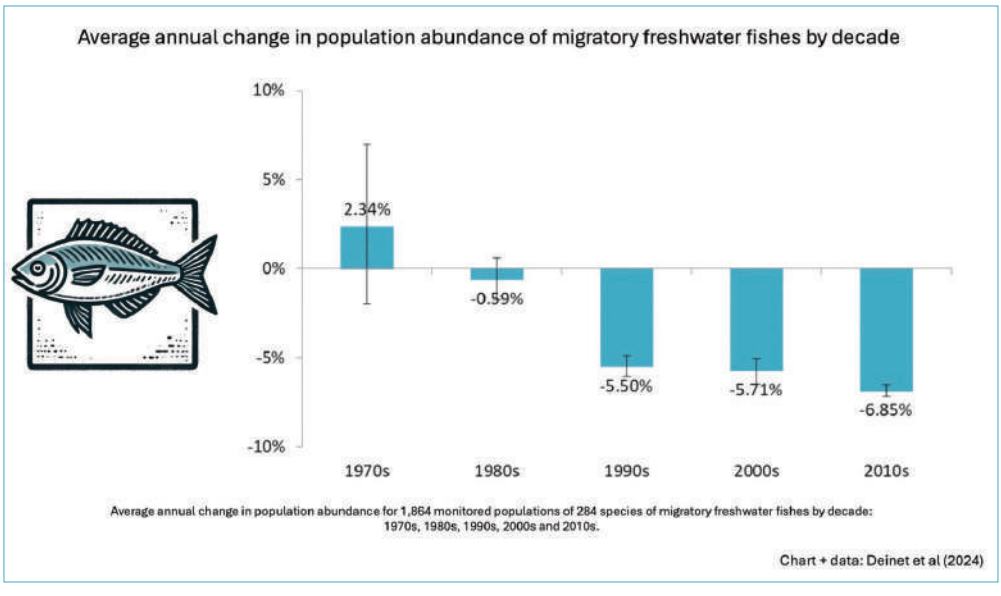
Current Scenario

The report analyzed data from 1,864 populations of 284 migratory freshwater fish species across the globe. The researchers from the World Fish Migration Foundation, the Zoological Society of London (ZSL), the International Union for Conservation of Nature (IUCN), The Nature Conservancy (TNC), Wetlands International and WWF contributed to this report.

The researchers found that fish populations had declined significantly more in some regions than in others.

- Latin America and the Caribbean experienced the most severe decrease at 91% in migratory fish population
- Europe saw a 75% decline.
- North America showed a 35% decline,
- Asia-Oceania reported a 28% decline.

Reason for Declination



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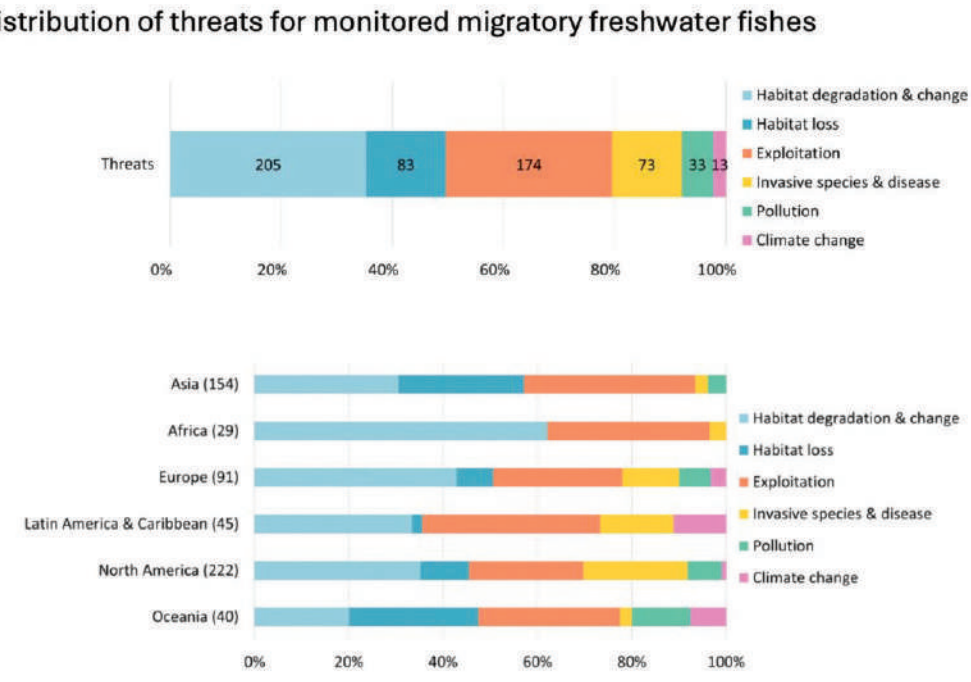
"Generally, threats are many fold and depend on the location and species, but the main ones are overexploitation, and habitat loss and degradation, which also includes the disruption of migration routes through dams and other river barriers," Stefanie Deinet of ZSL's Institute of Zoology and a co-author of the report, told Mongabay.

Herman Wanningen, founder of the World Fish Migration Foundation, one of the organisations involved in the study said, "The catastrophic decline in migratory fish populations is a deafening wake-up call for the world. We must act now to save these keystone species and their rivers."

Challenges and The way Foward

Despite the grim overall picture, the report does offer some hope. While the majority (65%) of species have declined, nearly one-third (31%) of monitored species have shown increases in population, suggesting that conservation efforts and improved management can have positive impacts. Fish populations under some form of management fared better than those without, showing less severe declines. The report notes that fisheries management was the most common type of intervention, accounting for 42% of management activities. These efforts included imposing fishing limits, restocking fish populations,



The distribution of threats for monitored migratory freshwater fishes globally (top) and for different regions (bottom). Threat information was available for 328 populations of 146 species, totalling 581 recorded threats. The numbers in the bars (brackets) correspond to the number of times a threat was listed.

Chart + data: Deinet et al (2

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reducing by catch, providing additional food sources, and establishing protected areas where fishing is prohibited. These management practices were most frequently reported in North America and Europe.

Hydropower dams also pose serious threats to the migratory fish population. The barrier used for the hydropower dam impedes the movement of the fishes from one place to another. Researcher suggest if we focus on renewable energy sources, thereby minimizing the dependency on the hydropower dams, then there is a to reverse the collapse of freshwater population.

Michele Thieme, deputy director of freshwater for WWF-US, said: "We have the tools, ambition and commitment to reverse the collapse of freshwater fish populations ... Prioritizing river protection, restoration and connectivity is key to safeguarding these species."

Conclusion

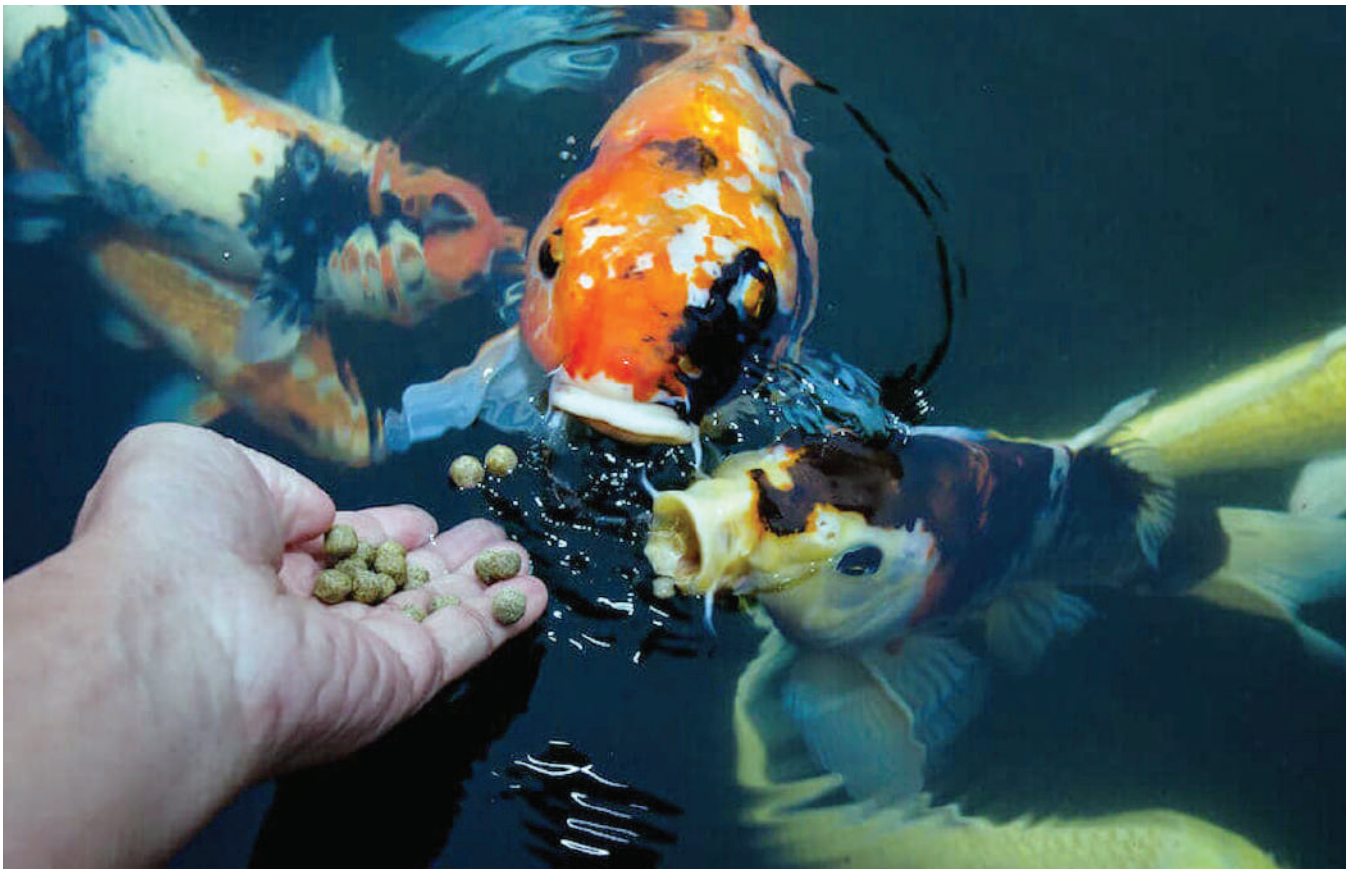
The report concludes with a call for stronger monitoring efforts, especially in underrepresented regions like Asia, Africa and South America. The study also emphasizes the need to meet the goals set in the Kunming-Montreal Global Biodiversity Framework, which aims to protect 30% of inland waters and restore 30% of degraded inland waters, as well as to protect and restore free-flowing rivers through basin-wide planning.

Other recommendations include supporting the Global Swimways initiative, which identifies and prioritizes key river migration routes; listing more freshwater migratory fish species on the Convention on Migratory Species; and meeting the Freshwater Challenge's goal of restoring 300,000 kilometers (186,000 miles) of degraded rivers globally.

Source: news.mongabay.com & www.theguardian.com

Medicated Aquafeed

Antibiotics are usually incorporated into feed via a powdered premix along with a binder like gelatin (up to 5%), fish, or vegetable oil. Proper mixing is essential to ensure even drug distribution and pellet coating.



Patekar Prakash *1, Swapnil Narsale 1, Siyag Dhare 1, Rajaram Hansda 1, Ad. Viralkumar 1, Manish Jayant 1, Sunil Kumar Nayak 1, K. N. Mohanta 1 ...

Although using medicated feeds in aquaculture to prevent/control diseases is comparatively a new approach to the health management of cultured fish, it is fast gaining popularity worldwide. However, the degree of its treatment success depends on various factors, including stressors such as overcrowding, poor water quality, and handling issues. Medicated feeds come in sinking or floating pellets but can be less appealing to sick fish, emphasizing the need for accurate diagnosis and dosage calculations. The dosage of medicated feed to be supplied is derived based on fish weight and drug concentration, and it is administered within specific treatment periods followed by withdrawal intervals for food safety. Proper storage conditions are crucial for maintaining the quality of feed and drug effectiveness, requiring cool, dry storage spaces. Different methods for preparing medicated feeds, such as surface coating and initial incorporation, are described, each with pros and cons regarding drug distribution and manufacturing efficiency. Oral administration of medicated feed is highlighted as cost-effective and practical for treating large fish populations.

Several factors are affecting antibiotic bioavailability and efficacy in aquatic settings, including the challenges related to seawater's impact on drug availability. Environmental impacts of medicated feed, such as drug leaching and sediment residue, have been studied, along with variations in drug effectiveness among fish species and accordingly tailored the strategies for prevention or treatment of specific diseases.

Introduction

In the realm of food fish or ornamental aquaculture, many bacterial diseases in fish can effectively be treated using medicated feeds, which is generally the preferred method of treatment. Recently, there has been a shift towards administering parasitic disease treatments, such as those for sea lice, via feed as well. However, caution is warranted as factors like stress can result in treatment failures or the recurrence of disease post-treatment. Stressors include elevated fish density, inadequate nutrition, poor water quality (like low dissolved oxygen, high ammonia, and nitrite levels), parasite infestation, and improper handling of cultured fish (Durborow and Francis-Floyd, 1996).

Medicated feeds are typically commercially prepared and available as sinking or floating pellets, though they have a limited shelf life. One major challenge in using the medicated feeds is that the sick fish may stop eating, compounded by the unpalatable nature of the feed due to drug presence, exacerbating the issue. Hence, accurate disease diagnosis, including the antibiotic sensitivity test, is crucial for effective treatment of fish at an early stage of disease occurrence. Antibiotics are usually incorporated into feed via a powdered premix along with a binder like gelatin (up to 5%), fish, or vegetable oil. Proper mixing is essential to ensure even drug distribution and pellet coating.

Research on teflubenzuron medication in salmon farms reveals significant variability in drug residues among wild fish species and even within species. In a separate study, barramundi fed garlic-enriched diets showed resistance to flatworm parasites compared to those on unenriched diets. Similarly, treating shrimp with oxytetracycline in feed upon early detection of necrotizing hepatopancreatitis exemplifies a targeted approach to bacterial diseases in crustaceans.

The dosage of medicated feed required depends on the initial active ingredient level per kilogram of fish body weight. This feed is administered for a specified treatment period based on the type and intensity of the disease and according to the advice of an experienced veterinarian. Harvesting treated fish for food should only occur after a specified withdrawal period to ensure the safety and quality of the product. Medicated feed must be stored appropriately in a cool, dry place separate from other feeds to maintain quality and drug efficacy.

For the amount of medicine to be used in the medicated feed varies depending on the antibiotic used, typically measured in g per 100 kg of fish per day. The exact dosage considers the number and average weight of fish, daily feeding rate, and whether the fish are freshwater or marine species. Notably, antibiotics are less effective in seawater due to reduced bioavailability caused by binding with divalent cations like Mg2+ and Ca2+ found in seawater (Lunestad and Goksøyr, 1990; Smith et al., 1996). This poses challenges for certain antibiotics as their minimum inhibitory concentrations (MIC) may be significantly

higher in seawater compared to freshwater. For example, the quinolone oxolinic acid has shown a 40- to 60-fold higher MIC in seawater against the bacterial fish pathogen Aeromonas salmonicida (Barnes et al., 1995).

Preparation of Premixes of Medicinal Agents

Daniel (2009) emphasizes that mills and mixers/ blenders are essential tools for processing premixes. The primary objectives include ensuring the uniformity of the drug throughout the finished feed, its compatibility with common feed ingredients, and its stability during storage and transportation. It's crucial to verify that the correct dosage of medication is evenly distributed and blended into the end product.

Weight of fish x treatment level

Weight of drug =.....X 100

% Activity

Methods of Application

1. Surface Coating Technique

Surface coating stands out as the most suitable

approach for medicating feeds containing heat-sensitive compounds. Additionally, it is the most cost-effective method for producing small quantities of medicated feeds. This process can occur either at the feed mill or on-farm. At the feed mill, the drug can be introduced post-extrusion and pre-cooling, typically using a fat coater. Advanced vacuum coaters enable the addition and thorough blending of minute amounts of additives in liquid or powder form. On farms, mixing is commonly carried out in a concrete mixer, where pellets are initially loaded, followed by the careful blending of powdered drugs and a binding agent into the feed, often an edible oil like sunflower or cod liver oil. The medicated feed is then allowed to absorb the added oil until a uniform consistency is achieved. Despite its advantages, achieving complete homogeneity in the mixture remains a significant challenge in surface coating.

In summary, medicated feeds play a crucial role in managing bacterial diseases and parasitic infections in aquaculture. Success hinges on factors like accurate diagnosis, proper dosage calculation, and optimal administration techniques. Storage conditions and medication preparation methods are vital for maintaining efficacy and minimizing environmental impacts.

2. Initial Incorporation Method

To ensure optimal uniformity in drug concentration, the preferred approach is to incorporate the drug at the beginning of the premixing stage, mixed with other micro-ingredients just before pelleting. However, a major drawback of this "initial incorporation" method is the potential risk of carry-over throughout the manufacturing process, leading to cross-contamination of non-medicated feeds with medicinal drugs. This method is suitable only for heat-stable compounds due to the high temperature and humidity conditions involved in the pelleting process. Furthermore, it is more practical mainly for large batches of medicated feeds since thorough cleaning of the entire production line is necessary after each batch of medicated feed is produced.

3. Storage of Medicated Feed

It should be packed in standard bags and kept under varying temperature, humidity, and light exposure conditions to assess their stability during shipping and handling. These conditions help determine the shelf life

of the feed, ensuring its effectiveness. It's recommended to store the medicated feed in a cool, dry place, with a freezer being suitable for long-term storage if kept dry. However, it's crucial to avoid moisture, as antibiotics and essential nutrients degrade quickly in warm, moist environments, potentially leading to ineffective treatment. Any unused feed stored at room temperature should be discarded after 3 to 4 months to maintain its efficacy.

4. Administration Route

In aquaculture, medications for microbial infections are typically administered orally, through water immersion or bath, or via injection. While injections can be time-consuming and labor-intensive for every individual, medicated feed offers a cost-effective and straightforward alternative, especially when treating a large population. To ensure all fish receive the medication, providing the medicated feed quickly throughout the net pen at optimal intervals and frequencies is essential.

5. Administering Medicated Feed

Using medicated feed is often a preventive measure rather than a therapeutic one, aiming to protect healthy fish from diseases they may encounter from diseased individuals. Fish already affected by a disease may not respond to treatment. Successful administration of medicated feed depends on proper feeding practices within the infected population. Factors such as drug bioavailability, accumulation in host tissues, and elimination rates should be considered when using medicated feeds, following manufacturer instructions, including withdrawal periods.

6. Antimicrobial Leaching

The extent of drug leaching from medicated feed depends on factors like water solubility, time in water before consumption, and pellet size. Smaller pellets tend to leach more. For example, small feed pellets coated with oxolinic acid and oxytetracycline experienced significant leaching, especially at higher temperatures. Coating agents like vegetable oil were effective in reducing leaching, with smaller pellet sizes exhibiting higher leaching rates for certain drugs like florfenicol, which decreased with larger pellet sizes.

In the realm of food fish or ornamental aquaculture, many bacterial diseases in fish can effectively be treated using medicated feeds, which is generally the preferred method of treatment. Recently, there has been a shift towards administering parasitic disease treatments, such as those for sea lice, via feed as well. However, caution is warranted as factors like stress can result in treatment failures or the recurrence of disease post-treatment. Stressors include elevated fish density, inadequate nutrition, poor water quality (like low dissolved oxygen, high ammonia, and nitrite levels), parasite infestation, and improper handling of cultured fish (Durborow and Francis-Floyd, 1996).

7. Palatability of Medicated Feed

Rigos et al. (2002) discovered that surface-coated oxytetracycline significantly repelled sea bass and reduced their feed consumption by 90%. One approach to overcome this unpalatability issue is to apply a special binder (attractant) to the medicated feed. Militz (2013) also noted an unexpected finding from their study: fish showed a strong preference for garlic, with those on garlic-enriched diets consuming more. This stands in contrast to the poor acceptability of current feed additives for treating parasites, which often have bitter tastes and lead to fish

spitting out the medicated pellets. On the other hand, the garlic-enriched feed had the positive effect, suggesting garlic's potential as an effective antiparasitic agent that can be easily administered in aquaculture settings.

8. Bioavailability of Antimicrobial

Bioavailability is a subcategory of absorption and is the fraction of an administered dose of unchanged medicine that reaches the systemic circulation. By definition, when a medication is administered intravenously, its (absolute) bioavailability is 100%. The efficacy of a drug is a function of the rate and extent of absorption. Relative bioavailability is derived as a relationship (%) between the bioavailability from an oral dose-form (or other non-IV dose) relative to an IV dose.

$$F\% = \frac{(AUC\ oral \times dose\ intramuscular\ injection)}{(AUC\ intramuscular \times dose\ oral\ administration)} \times 100$$

Antibacterial have been shown to be less effective in seawater, which is related to their reduced bioavailability, e.g., tetracycline has a low bioavailability in fish (< 10%) due to binding with sea-water-borne divalent cations such as Mg^{2+} and Ca^{2+}. It is noteworthy that non-bioavailable tetracyclines contaminate the environment. The bioavailability (F%) of a drug represents the fraction of an oral dose that is effectively absorbed into the circulatory system. It is determined by comparing blood levels following the drug's single oral and intravenous administration.

The pharmacokinetics and pharmacodynamics of antimicrobial drugs refer to how these drugs are processed within the body and how they exert their effects. Pharmacokinetics involves the drug's absorption, distribution, metabolism, and excretion, along with

Table 1. FDA- Approved Fish Drugs - Type a Medicated Articles Used to Make Medicated Feed

Trade Name (established name)1	Application Type & Number
Aquaflor® (florfenicol)	NADA 141-246
Terramycin® 100 for Fish and Terramycin® 200 for Fish (oxytetracycline dihydrate)	NADA 038-439
Romet® 30 (sulfadimethoxine & ormetoprim)	NADA 125-933
SULFAMERAZINE FISH GRADE (sulfamerazine)	NADA 033-950

Trade Name	Species	Indications	Dosing	Limitations
TERRAMYCIN®200 for Fish (Oxytetracycline)	Salmonids	Ulcer disease (*Hemophiluspisium*), furunculosis (*Aeromonas salmonicida*), bacterial hemorrhagicsepticemia (*A. liquefaciens*), and pseudomonas disease (*Pseudomonas* spp.)	2.5 – 3.75g per 100lbs fish per day for 10 days	21-day withdrawal time
	Freshwater-raised Salmonids	Mortality due to coldwater disease caused by *Flavobacterium psychrophilum*	3.75g per 100 lbs fish per day for 10 days	21-day withdrawal time
	All freshwater raised Oncorhynchus mykiss	Mortality due to columnaris disease	3.75g per 100lbs fish per day for 10 days	21-day withdrawal time
	Catfish	Bacterial hemorrhagic septicemia(*A. liquefaciens*) and pseudomonas disease (*Pseudomonas* spp.)	2.5 - 3.75g per 100 lbs fish per day for 10 days	Water temperature not below 62°F 21-day withdrawal time
ROMET@30 and ROMET@TC	Salmonids	Furunculosis due to *Aeromonassalmonicida*	50mg per kg fish per day for 5 days	42 day withdrawal time
	Catfish	Enteric septicemia due to *Edwardsiellaictaluri*	50mg per kg fish per day for 5 days	3-day withdrawal time
Aquaflor® (Florfenicol)	Catfish	Mortality due to enteric septicemia associated with *Edwardsiellaictaluri*	10mg per kg fish per day for 10 days	15 day withdrawal time

considerations such as withdrawal periods and environmental residue estimation. On the other hand, pharmacodynamics delves into how a drug interacts with a living organism, specifically focusing on its effects and the underlying mechanisms of action, which involve the drug's interaction with receptors responsible for its physiological effects.

Impact of Medicated Feed

Oral medications introduced into the environment are typically associated with organic matter like uneaten medicated pellets and feces. Water-soluble portions are released through gills and urine, dispersing into the water nearby, while organic-bound drug components tend to settle on the seabed or pond bottom. If the drug's absorption and breakdown rates are low, most of it is excreted unchanged via the liver and bile into the intestine. Particularly, when drugs bind readily to organic-rich particles, the resulting fecal matter may contain higher drug concentrations than the original pellets. Notably, there's a significant variance in stability among antibacterial agents found in marine sediments. Some like oxytetracycline, oxolinic acid, flumequine, and sulfadiazine remain stable, whereas sulfadimethoxine degrades partially, and ormethoprim, trimethoprim, and furazolidone completely degrade over time. Furazolidone and florfenicol, for instance, rapidly degrade in sediment, disappearing within days. Studies indicate that around 80% of antimicrobials used in aquaculture retain their effectiveness upon entering the environment. Research on teflubenzuron medication in salmon farms reveals significant variability in drug residues among wild fish species and even within species. In a separate study, barramundi fed garlic-enriched diets showed resistance to flatworm parasites compared to those on unenriched diets. Similarly, treating shrimp with oxytetracycline in feed upon early detection of necrotizing hepatopancreatitis exemplifies a targeted approach to bacterial diseases in crustaceans.

Conclusion

In summary, medicated feeds play a crucial role in managing bacterial diseases and parasitic infections in aquaculture. Success hinges on factors like accurate diagnosis, proper dosage calculation, and optimal administration techniques. Storage conditions and medication preparation methods are vital for maintaining efficacy and minimizing environmental impacts. While challenges persist, such as antibiotic bioavailability and environmental concerns, tailored strategies and ongoing research promise to refine these practices, ensuring fish health and sustainability in aquaculture operations. ■■■

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Probiotics in Aquaculture
Mechanisms, Applications, and Future Perspectives

"The choice of probiotics in aquaculture often depends on the specific needs of the aquatic organisms, the environmental conditions, and the desired outcomes, such as disease prevention, growth enhancement, or waste management."

Mechanisms, Applications, and Future Perspectives, Shubham Kanaujiya1, Anshika Pathak2, Shri Kant Yadav3 ...

Introduction

Probiotics are live microorganisms that confer health benefits when introduced into a host organism. It has the potential to revolutionize the industry by promoting the growth and well-being of aquatic species, enhancing disease resistance, improving water quality, and contributing to the overall sustainability of aquaculture practices. The importance of probiotics in aquaculture is underscored by several key factors. First and foremost, they offer a natural and environmental friendly alternative to many of the conventional practices used in aquaculture. In contrast to the use of antibiotics and chemicals, probiotics operate by harnessing the power of beneficial microorganisms to achieve desired outcomes. This approach not only reduces the environmental impact of aquaculture but also addresses concerns related to antibiotic resistance and chemical residues in seafood.One of the fundamental roles of probiotics in aquaculture is their capacity to enhance the digestive and immune systems of aquatic organisms. When administered through the diet or environment, probiotics

can optimize the gut microbial community, leading to improved nutrient absorption, feed utilization, and overall growth rates. This, in turn, can reduce the need for excessive feeding and increase the efficiency of aquaculture operations. Furthermore, probiotics have demonstrated their prowess in enhancing disease resistance in aquatic organisms. By colonizing the host's mucosal surfaces and competing with pathogenic bacteria, probiotics can effectively prevent or mitigate disease outbreaks. Probiotics play a critical role in improving water quality. They facilitate the breakdown of organic matter, reduce nitrogen and phosphorus levels, and help maintain a stable microbial balance in the water. This, in turn, mitigates the risk of harmful algal blooms and oxygen depletion, providing a healthier and more sustainable aquatic environment.

The selection of suitable probiotic strains, the optimization of administration methods, and the consideration of host-specific factors all play a pivotal role in ensuring their effectiveness. Furthermore, regulatory and economic factors may influence the widespread adoption of probiotics in aquaculture. This article aims to provide a comprehensive exploration of the role of probiotics in aquaculture. We will delve into the underlying mechanisms that make probiotics valuable in aquaculture, examining their diverse applications across different aquatic species.

2. Types of Probiotics Used in Aquaculture

Probiotics used in aquaculture can be categorized into several groups based on their microbial origin. Here, we explore the different types of probiotics commonly used in aquaculture:

- Bacterial probiotics
- Yeast probiotics
- Microalgae and phytoplankton
- Mixed probiotic formulations

1. Bacterial Probiotics

Bacterial probiotics are among the most widely used in aquaculture due to their diverse roles and applications. They can include various strains from different bacterial genera. Key examples of bacterial probiotics include:

1.1 Lactic Acid Bacteria

Lactic acid bacteria are known for their beneficial effects on the gut microbiota of aquatic organisms which produce lactic acid and other organic acids, creating a favorable gut environment. Examples: Lactobacillus, Streptococcus, and Pediococcusspecies.

1.2 Bacillus Species

These are spore-forming bacteria that can survive harsh environmental conditions and persist in the aquaculture systems. They are valued for their role in improving feed digestion, disease prevention, and promoting overall health. Examples: Bacillus subtilis and Bacillus licheniformis.

> "Probiotics offer a natural and environmental friendly alternative to many of the conventional practices used in aquaculture. In contrast to the often excessive use of antibiotics and chemicals, probiotics operate by harnessing the power of beneficial microorganisms to achieve desired outcomes"

1.3 Vibrio Species

Vibrio bacteria can have both beneficial and pathogenic strains. Beneficial Vibrio strains are used to outcompete and control the growth of harmful Vibrio species. Some probiotic Vibrio strains help with nutrient digestion and disease resistance in aquatic organisms.

2. Yeast Probiotics

Yeast-based probiotics offer unique benefits and can be included in the diet of fish and shellfish. Two well-known yeast probiotics are Saccharomyces cerevisiae, Candida utilis.

3. Microalgae and Phytoplankton

While less traditional than bacterial or yeast probiotics, microalgae and phytoplankton can serve as probiotic sources in aquaculture. They are rich in essential nutrients and can contribute to improved water quality and overall health of aquatic organisms.

They are often used to enrich the diet of larval fish and shrimp, providing essential fatty acids, vitamins, and other nutrients.

4. Mixed Probiotic Formulations

In many cases, fish farmers use mixed probiotic formulations that combine various bacterial strains, yeasts, and other beneficial microorganisms to create a more comprehensive probiotic treatment. The choice of probiotics in aquaculture often depends on the specific needs of the aquatic organisms, the environmental conditions, and the desired outcomes, such as disease prevention, growth enhancement, or waste management. Researchers and aquaculture practitioners continually explore and develop new probiotic formulations to optimize their use in the industry.

3. Probiotics Used in Aquaculture

The use of probiotics in aquaculture aims to enhance the overall health, growth, and disease resistance of aquatic species. This table provides an overview of some commonly employed probiotics in aquaculture as well as shedding light on their suitability for various aquatic species.

Probiotic	Suitable Aquatic Species	Description
Bacillus subtilis	Various fish and shrimp	Beneficial for gut health and disease prevention. Has a history of promoting growth and enhancing immunity in aquaculture.
Lactic Acid Bacteria	Various fish and shrimp	Includes Lactobacillus and Streptococcus species. Known for improving gut health, enhancing nutrient absorption, and disease resistance.
Bifidobacterium	Various fish species	Supports gut health and immune system. Considered beneficial for overall fish well-being in aquaculture.
Pseudomonas spp.	Various fish species	Probiotic and immunomodulatory effects, contributing to disease resistance in aquaculture.
Enterococcus faecium	Fish and shellfish	Contributes to gut health and disease resistance. Has been studied for its positive impact on aquaculture species.
Saccharomyces cerevisiae (Yeast)	Various fish and shrimp	Improves digestion, nutrient utilization, and disease resistance Commonly used as a feed supplement in aquaculture.
Shewanellacolwelliana	Pangasius catfish	Demonstrates growth promotion, immune enhancement, and disease resistance in Pangasius catfish aquaculture.
Vibrio spp.	Species susceptible to Vibrio infections	In some cases, probiotics are used to control pathogenic Vibrio species, promoting a healthier microbial balance in aquaculture.

4. Selection and Isolation of Probiotic Strains

The selection and isolation of suitable probiotic strains are crucial steps in developing effective probiotics for use in aquaculture. This process involves identifying and ensuring their safety and stability of desired microorgannism. Here are the key aspects of strain selection and isolation:

4.1 Criteria for Strain Selection

S.No.	Criteria	Description
1.	Environmental Compatibility	Well-adapted to aquatic environments; thrives in water conditions typical of the target application (e.g., pond, aquaculture system).
2	Survivability in aquatic conditions	Tolerates variations in water temperature, pH, and salinity; remains viable under conditions prevalent in aquatic systems.
3	Adaptations to host Organisms	Demonstrates an affinity for the host organisms in aquatic environments (e.g., fish, shrimp, or other aquatic species).
4	Pathogen resistance	Shows resistance to common aquatic pathogens; helps prevent and control diseases in the host organisms.

5	Immunomodulatory effects	Modulates the immune response of aquatic organisms positively, enhancing their overall health and disease resistance.
6	Production of Antimicrobial Compounds	Produces antimicrobial substances effective against aquatic pathogens, contributing to the protection of the host organisms.
7	Nutrient Utilization and Metabolism	Efficiently utilizes nutrients present in aquatic environments; contributes to nutrient cycling and overall ecosystem balance.
8	Compatibility with Aquaculture Practices	Compatible with common aquaculture practices and systems; integrates well into existing aquaculture operations.
9	Cost-Effectiveness for Aquaculture	Considers production costs and overall cost-effectiveness in the context of aquaculture operations.
10	Genetic Stability in Aquatic Conditions	Maintains genetic stability in the dynamic and diverse conditions of aquatic ecosystems.

5. Mechanism of Action

Probiotics exert their beneficial effects in aquaculture through various mechanisms. Understanding these mechanisms is crucial for optimizing their application and ensuring positive outcomes. Here are some of the key mechanisms of action of probiotics in aquaculture:

S.No.	Mechanisms of action	Description
1	Competitive Exclusion	It compete with pathogenic microorganisms for space and nutrients in the gut and aquatic environment and by outcompeting harmful microbes, probiotics prevent the growth of pathogens, reducing the risk of diseases.
2	Immunomodulation	It can stimulate the host's immune system, promoting the production of immune cells, antibodies, and other defense mechanisms, which helps aquatic organisms resist infections and maintain overall health.
3	Synbiotic Interactions	In some cases, combining probiotics with prebiotics can create a synbiotic effect. This synergy enhances the survival and effectiveness of probiotics in the gut.
4	Biofilm Formation	Some probiotics have the ability to form biofilms in the gut and on surfaces, which provide a protective barrier against pathogens and enhance the stability of probiotic populations in the environment.
5	Antimicrobial Metabolites	Probiotics can produce antimicrobial substances such as organic acids, bacteriocins and hydrogen peroxide which inhibit the growth of pathogens and maintain microbial balance in the gut and water.
6	Nutrient Transformation	Probiotic microorganisms can enhance the digestion and absorption of nutrients in the gut, leading to improved feed conversion efficiency and growth rates in aquatic species.
7	Detoxification	Some probiotics have the capacity to detoxify harmful substances or compounds in the environment.

6. Mode of application of probiotics

Probiotics exhibit diverse modes of application. Direct addition to water in aquaculture, dietary supplementation for animals and humans, and encapsulation to protect against environmental factors are prevalent strategies.

6.1 Direct Addition to Water

It is a common mode of application in aquaculture and agriculture. In aquaculture, probiotics can be added directly to the water in fish or shrimp ponds to promote a healthy microbial balance and enhance water quality.

6.2 Dietary Supplementation

Probiotics can be incorporated into the diet of fish as a form of dietary supplementation. The goal is to enhance the microbial balance in the digestive system, promoting overall health and improving nutrient absorption.

6.3 Encapsulated Probiotics

Encapsulation is a method used to protect probiotic organisms from harsh environmental conditions, such as stomach acid, during ingestion. This mode allows for the controlled release of probiotics in specific regions of the gastrointestinal tract, maximizing their effectiveness.

7. Benefits of Using Probiotics in Aquaculture

The use of probiotics in aquaculture benefits the overall health and productivity of aquatic organisms, as well as the sustainability of aquaculture practices. These benefits encompass various aspects of aquaculture management and include:

7.1 Disease Prevention and Control

Probiotics can prevent and control diseases in aquatic species by outcompeting pathogenic microorganisms and enhancing the host's immune response.

7.2 Improved Nutrient Digestion

Probiotics enhance the digestion and absorption of nutrients in the gut of aquatic organisms. This leads to better feed conversion efficiency and improved growth rates.

7.3 Enhanced Immune Response

Probiotics stimulate the host's immune system, leading to increased production of immune cells, antibodies, and other defense mechanisms. This enhanced immune response contributes to better disease resistance. This reduce the reliance on antibiotics in aquaculture

7.4 Stress Tolerance and Reduction

Probiotics help aquatic organisms cope with environmental stressors, such as temperature fluctuations, salinity changes, or handling stress. This results in reduced mortality and better overall health.

7.5 Environmental Sustainability

Probiotics can help improve the environmental sustainability of aquaculture systems. They contribute to better waste management by reducing the release of excess nutrients and pollutants into the surrounding water.

7.6 Improved Water Quality

Probiotics can help maintain a balanced microbial ecosystem in the water, reducing the risk of harmful algal blooms and promoting a healthier aquatic environment.

7.7 Cost Reduction

By improving growth rates and reducing the occurrence of diseases, probiotics can lead to cost savings for aquaculture operations.

7.8 Consistent Product Quality

The use of probiotics can lead to more consistent and high-quality aquaculture products, such as fish and shrimp, making them more marketable and valuable.

8. Limitations of using probiotics

There are limitations and challenges associated with probiotics application. Some of the limitations include:

1. **Species-specificity:** Probiotics may have species-specific effects, meaning that a particular strain or combination of strains that work well in one species of fish might not be as effective in another. Selecting the right probiotic for the target species is crucial for achieving positive results.
2. **Environmental factors:** Aquatic environments vary widely in terms of temperature, salinity, pH, and other parameters. Probiotics may not perform optimally under extreme environmental conditions, and their efficacy may be influenced by factors such as water quality and habitat.
3. **Survivability and stability:** Probiotics need to remain viable and stable during storage and transportation before reaching the aquaculture facility. Additionally, they must survive the harsh conditions of the digestive tract to exert their beneficial effects.
4. **Competition with native microflora:** In some cases, the introduction of probiotics may face competition from the existing microbial community in the aquaculture system. Native microorganisms may outcompete or limit the establishment of the introduced probiotic strains.
5. **Variable efficacy:** The effectiveness of probiotics can vary depending on factors such as the health status of the host, the presence of pathogens, and the overall management practices of the aquaculture operation.
6. **Limited understanding of mechanisms:** The mechanisms through which probiotics exert their beneficial effects in aquaculture are not always well understood. This lack of knowledge can hinder the ability to optimize probiotic use and predict their outcomes accurately.
7. **Regulatory challenges:** The regulatory framework for probiotic use in aquaculture may not be well-established in some regions. Approval processes, guidelines, and standards for probiotics in aquaculture may be lacking or insufficient, leading to uncertainties regarding their use.
8. **Cost considerations:** Probiotics, especially those containing specific strains with proven efficacy, can be expensive. The cost of incorporating probiotics into aquaculture practices may be a limiting factor for some producers, particularly in low-margin operations.

9. Challenges and Considerations

While the application of probiotics offers various benefits, there are challenges and considerations that need to be addressed, such as ensuring the viability of probiotics during processing, storage, and consumption. Additionally, understanding the interactions between probiotics and the host organism is crucial for optimizing their effectiveness.

The workshop on application of Drone Technologies in Fisheries held in Kochi

The Department of Fisheries, MoFAH&D, organized a Workshop on Application and Demonstration of Drone Technology in Fisheries and Aquaculture on 8th November 2024 at ICAR- Central Marine Fisheries Research Institute (CMFRI), Kochi, Kerala. Drones offer a range of applications to numerous challenges in the sector. The key critical areas of application of drones in aquaculture and fisheries are water sampling, identification of diseases and fish feed management. This will also useful for managing aquaculture farms, monitoring fish marketing, assessing damage to fisheries infrastructure and rescue operations during natural disasters. This includes other key activities such as precision fishing and stock assessment. Underwater drones, in addition, can monitor fish behavior in their natural habitats as well as signs of distress such as erratic swimming patterns.

Dr Grinson George, Director of CMFRI, welcomed the gathering and set the context for the one-day workshop. This was followed by opening remarks from Dr B K Behera, Chief Executive, NFDB, who highlighted various schemes and initiatives, encouraging stakeholders in the fisheries sector to take advantage of these benefits.

During the Inaugural address Shri George Kurian, Hon'ble Minister of State, Department of Fisheries and Ministry of Minority Affairs highlighted the initiatives taken by the department of Fisheries and the remarkable growth of India's fisheries sector, propelled by strategic investments and progressive policies over the past decade. He also announced the development of 100 climate-resilient coastal fishermen villages under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), with 2 crore allocated per village to enhance infrastructure and promote sustainable livelihoods. The Minister highlighted the role of drone technology in monitoring aquaculture farms and fisheries infrastructure, especially during disasters, and revealed plans to equip one lakh fishing vessels with transponders for real-time tracking, weather alerts, and communication, with an investment of 364 crores.

Ms. Neetu Kumari Prasad, Joint Secretary (Marine), addressed the gathering, highlighting the benefits of the flagship scheme Pradhan Mantri Matsya Sampada Yojna and reaffirming the Department of Fisheries' commitment to scaling up the fisheries sector. Dr. V V Suresh, Head Mariculture division and startup EyeROV Technologies pvt. Ltd. presented on the application of drone technology and its challenges in the fisheries sector. Following this the distribution of "Cadalmin BSF PRO" a specially formulated fish feed designed to support sustainable aquaculture practices to farmers was also held

The Workshop on Application and Demonstration of Drone Technology provided a unique platform to showcase innovative technological advancements, emphasizing the transformative role of drone technology in the fisheries sector to maximize its potential. Many fishermen, fisherwomen, scientists, entrepreneurs, students, and other delegates participated in the event.

Department of Fisheries organizes Investors' Meet 2024 in Andaman & Nicobar Island

Andaman Island : Investors Meet 2024: Investment Opportunities in Fisheries and Aquaculture sector of Andaman & Nicobar Islands on 14th November 2024 at Swaraj Dweep, Andaman & Nicobar Islands, organized by the Department of Fisheries, Ministry of Fisheries, Animal husbandry & Dairying; in the gracious presence of Union Minister of Fisheries, Animal Husbandry & Dairying (MoFAH&D) and Ministry of Panchayati Raj Shri Rajiv Ranjan Singh, Lieutenant Governor of Andaman & Nicobar Islands, Admiral D K Joshi, Minister of State for MoFAH&D and Ministry of Panchayati Raj, Prof. S.P. Singh Baghel, Minister of State for MoFAH&D and Ministry of Minority Affairs Shri George Kurian, Department of Fisheries, MoFAH&D Secretary, and Chief Secretary of Andaman & Nicobar Islands. It focus on investment in infrastructure, investor partnerships, training, and capacity-building to strengthen operations and boost global competitiveness in tuna fisheries

Investors from various parts of the country specializing in technologies related to Tuna Fishing and Seaweed also participated in the event namely such as Merchant Ventures Pvt. Ltd, Mumbai, Uday Aqua Connects Pvt. Ltd., Hyderabad, Sams Discus India, Mumbai, Aqualine Exports, Kerela, ANEMCO Pvt. Ltd., Sri Vijaya Puram, Sea6 Energy Pvt. Ltd., Bangalore, S Raja Rao Sea Foods, Sri Vijaya Puram, Joecons Marine Exports Pvt. Ltd., Goa, Nila Marine Export, Sri Vijaya Puram, Low Now Cargo Import Limited, Thailand, Babla Pearls, Mumbai, Continental Marines, Visakhapatnam, Garware Technical Fibres Ltd., Pune, Arbee Biomarine Extracts Pvt. Ltd., Mysore, Motherhood Foods, Banglaore, Jeelani Marine Products, Ratnagiri, Z A Food Products, Kolkata, Canares aquaculture LLP., Karnataka and Blue Catch, Mumbai.

The global tuna industry, valued at over $40 billion annually, plays a major role in the blue economy. The Andaman & Nicobar Islands represent a prime opportunity for this sector, with a vast 6 lakh square km Exclusive Economic Zone rich in high-value tuna species and an untapped oceanic potential of 60,000 metric tons. This includes 24,000 metric tons for Yellowfin and 2,000 metric tons for Skipjack, while current harvests stand at just 4,420 metric tons, leaving ample room for expansion. Strategically located near Southeast Asia, the islands offer efficient trade routes by sea and air, ideally positioning India to expand its tuna export capabilities. This engaging event was a landmark occasion, bringing fishers, fish farmers, entrepreneurs and other stakeholders, government officials, and enthusiastic participants together from the vibrant fisheries and aquaculture sector.

Union Minister of Fisheries inaugurates World Fisheries Day Celebrations, in New Delhi

To celebrate the contribution and achievements of fishers and fish farmers and other stakeholders and reinforce commitment towards sustainable and equitable development of the Fisheries sector the Department of Fisheries celebrated the World Fisheries Day 2024 with the theme India's Blue Transformation: Strengthening Small-Scale and Sustainable Fisheries today at Sushma Swaraj Bhawan, New Delhi. The event was graced by Chief Guest Shri Rajiv Ranjan Singh alias Lalan Singh, Union Minister, Ministry of Fisheries, Animal Husbandry & Dairying (MoFAH&D) and Ministry of Panchayati Raj along with Guests of Honour Shri George Kurian, Minister of State, MoFAH&D and Ministry of Minority Affairs and Prof. S.P. Singh Baghel, Minister of State, MoFAH&D and Ministry of Panchayati Raj. Ms. Vani Rao, Indian Ambassador to Italy, Rome, Mr. Manuel Barange, ADG and Director Fisheries Division FAO, Rome along with other dignitaries also graced the event.

Shri Singh, highlighted the achievements and challenges of the fisheries sector. The Union Minister congratulated the fishermen and fish farmers for their role in making India the second-largest fish producer globally, with around 30 million people involved in fish production across the value chain. He said that various initiatives by the department like the Blue Revolution and Pradhan Mantri Matsya Sampada Yojana (PMMSY), Pradhan Mantri Matsya Kisan Samridhi Sah- Yojana (PMMKSY) has supported boosting fish production in the country. As a result, fish production nearly doubled since 2014 to 17.5 million tons, with inland fishing now surpassing marine fishing, contributing 13.2 million tons. The Union Minister in his address highlighted the key challenges and solutions for the fisheries sector. He highlighted the issues like plastic pollution, carbon emissions from traditional fishing and water pollution, emphasizing the government's efforts to reduce plastics, improve water quality and promote eco-friendly practices. Shri Rajiv Ranjan Singh also discussed about the unorganized nature of the sector and the infrastructural gaps, stressing upon the need for reforms and initiatives like the Fisheries Infrastructure Development Fund (FIDF). He outlined a vision for a sustainable and economically empowering fisheries sector, focusing on modern techniques, policy integration, and long-term goals to ensure India's global leadership in fish production.

On this occasion, Shri Rajiv Ranjan Singh launched a series of landmark initiatives and projects aimed at transforming the fisheries sector and strengthening India's blue economy. These included the launch of the 5th Marine Fisheries Census for data-driven policymaking, the National Plan of Action on Sharks for sustainable shark management and India's endorsement to the Regional Plan of Action on IUU (Illegal, Unreported and Unregulated) Fishing to prevent illegal, unreported and unregulated fishing in the Bay of Bengal Region jointly in cooperation with Sri Lanka, Bangladesh and Maldives, the International Maritime Organisation-Food and Agricultural Organisation (IMO-FAO) GloLitter Partnership Project to combat marine plastic litter, and Standard Operating Procedures (SOP) for retrofitted LPG kits to promote energy-efficient, low-cost marine fishing fuels. Additionally, the New Single Window System (NSWS) by the Coastal Aquaculture Authority was launched to enable online registration of coastal aquaculture farms. A signed MoU was also exchanged to implement a framework for the Voluntary Carbon Market (VCM), harnessing carbon-sequestering practices in the sector. On this occasion, progressive States, Union Territories (UTs), districts, and individuals were honoured for their remarkable contributions to the growth of fisheries and aquaculture sector in India. Kerala received the award for the Best Marine State, while Telangana was recognized as the Best Inland State.

Fisheries Department to develop Tuna Cluster in Andaman & Nicobar Island

The Department of Fisheries under PMMSY notified the development of Tuna cluster in the Andaman and Nicobar Islands. The island has around with around 6.0 lakh square km of Exclusive Economic Zone (EEZ) rich in under-exploited sea resources, particularly Tuna and Tuna like high valued species, estimated at 60,000 metric tons, which offer a offers a prime opportunity for fisheries development. Coupled with effective administrative measures, the region is well-positioned to leverage its marine resources for economic growth. The notification of the Andaman and Nicobar Islands as a tuna cluster is expected to generate economies of scale, increase incomes, and accelerate organized growth in fisheries across the country. The initiative will help in focusing on critical investments such as organizing Investors Meetings to foster partnerships with tuna-fishing nations and implementing training and capacity-building programs, along with exposure visits for the stakeholders. Additionally, it will help in developing infrastructure for fish landing, processing and export connectivity that is essential for streamlining operations and enhancing India's global competitiveness in the sector. The Department of Fisheries has envisaged a strategic focus on cluster development across key areas, including Pearl, Seaweed, and Ornamental Fisheries; Reservoir Fisheries; Fishing Harbours; Saline Water Aquaculture; Cold Water Fisheries; Sea Cage Culture; Freshwater and Brackish-Water Fisheries; Deep Sea and Oceanic Fisheries; Organic Fisheries; Wetland Fisheries, and other areas tailored to specific sectoral and regional needs. Potential cluster locations are being identified with State Governments and Union Territories based on certain parameters like Fish culture, production trends, export earnings, number of fishing boats, engagement in fisheries activities, and existing fisheries infrastructure facilities. The Department of Fisheries has already identified three locations as priority areas for development that are Hazaribagh District in Jharkhand for pearl culture, Madurai District in Tamil for ornamental fisheries and UT of Lakshadweep for seaweed.

Uttarakhand earned the title of Best Himalayan and Northeastern State, and Jammu & Kashmir was awarded Best Union Territory. Among the districts, Kollam, Kerala, won the Best Marine District award, Kanker in Chhattisgarh was named Best Inland District while Darrang in Assam, received the Best Himalayan and Northeastern District award and Kulgam in Jammu & Kashmir, was honoured as the Best District in a Union Territory.

In individual and Cooperatives categories, Shri Ravi Kharvi from Karnataka was recognized as the Best Marine Fish Farmer and Shri Shiv Prasad Sahani from Bihar received the award for Best Inland Fish Farmer. The Best Marine Fisheries Cooperative/FFPO award went to the Mandovi Fishermen Marketing Cooperative Society, Goa, while Srijoni Min Unnayan Samabai Samiti Ltd., Assam, was honoured as the Best Inland Fisheries Cooperative/FFPO. Anmol Feed Pvt. Ltd., West Bengal, was acknowledged for its excellence as the Best Enterprise in the sector.

The event served as a unique platform to create awareness on the importance of healthy ocean ecosystems and sustainable fisheries practices. By fostering discussions among stakeholders, the event highlighted the need for collective action to ensure the long-term sustainability of marine resources while addressing challenges such as overfishing, habitat degradation, and climate change impacts.

In an interview with Aqua Post, **Chef Shailendra Singh,** Corporate Chef at Pride Hotel & Resorts, shares his perspectives on his experience as a chef with regards to seafood preparations and consumer preferences. He also explains various seafood delicacies that can cater to the taste buds of food enthusiasts. Furthermore, he emphasizes methods to prepare seafood dishes while retaining their natural flavors and maintaining a balance between technique and creativity.

Interview

Chef Shailendra

- **Give us a brief about yourself and your profile**

I am an innovative and multi skilled chef with strong backing of all cuisines. Worked for large hotel chains like Pride, Taj , Oakwood, Hyatt, Accor and Marriott's. 21+ years of professional cooking and kitchen management experience and believe in leading by example. Exemplify leadership qualities and professionalism, backed by a consistent, verifiable record of achievement. Have worked under the menu guidance of Chef George Blanc (Michelin star chef) at Carnival Cruise. Gone to Jakarta & Korea for food promotion and Training from Oakwood Premier Pune. From all the experience and skills, I have been able to successfully implement Indian culinary arena into Oakwood Seoul. Open many hotels restaurants including Oak Lounge, Bistro. Conceptualize Bistro, Oak Lounge into award winning restaurants by Times Food Guide, featuring number of articles in media to promote the footfalls. Conceptualized "FARM TO FORK" concept and execute exemplary. First one to introduce "HYDROPONICS" in hotel in Kathmandu. Conceptualized "HELP AGRO" to support the local and the farmers. Specialized in pre-opening, wellness, herbal, aphrodisiac food and menus.

- **When it comes to seafood, what is your view point on Seafood preparation?**

As a chef, my viewpoint on seafood preparation is rooted in a deep respect for the ingredients, the methods that best showcase their natural flavors, and the balance of technique and creativity. Here are the key points from a culinary perspective:

1. Understanding the Ingredient: Freshness is paramount in seafood preparation. Knowing the specific characteristics of each type of seafood is essential for proper handling and cooking. Each variety, whether it's delicate white fish or firm shellfish, has unique needs in terms of preparation and cooking time. Different seafood species have different peak seasons, and working with what's in season ensures better flavor, sustainability, and texture.

2. Techniques Matter: Seafood, especially fish and shellfish, is often best when treated with minimal cooking. Techniques like searing, grilling, steaming, poaching, and even raw preparations (like sushi or ceviche) bring out different elements of the seafood's character. Sous-vide are a modern technique I often use for cooking fish to perfect tenderness without overcooking. It's a controlled method that lets the fish

retain its delicate texture and moisture. They are quick to overcook, and I always pay close attention to the texture, aiming for that sweet, tender bite.

3. **Balancing Flavors:** I focus on simplicity and balance in seasoning. Seafood should shine as the star of the dish, and I use herbs, citrus, a touch of salt, and complementary ingredients like garlic, olive oil, or light broths to enhance, not overpower, the natural flavor. Acidity is an important element. A squeeze of lemon, a dash of vinegar, or light vinaigrette can bring out the best in seafood, adding freshness and cutting through richness. Texture is also a major consideration. A well-seared fish with a crispy skin can provide a beautiful contrast to the tender, flaky flesh. Similarly, when preparing shellfish, it's about achieving that perfect balance between tender and firm.
4. **Creativity with Pairings:** As a chef, I enjoy experimenting with diverse culinary influences. I blend traditional techniques with modern interpretations. Whether it's a Mediterranean-inspired grilled octopus, a Japanese-style miso-glazed cod, or a Southern-style shrimp and grits, I look for ways to infuse flavors and textures that complement the seafood while keeping its integrity intact. Pairing seafood with the right sides is an art in itself. For heartier preparations, a rich butter sauce or cream-based risotto might work.
5. **Sustainability and Sourcing:** Sustainability is a core principle in my kitchen. I focus on working with responsibly sourced seafood, ensuring it comes from fisheries that are committed to conservation efforts. This includes choosing wild-caught over farmed species when possible, and supporting sustainable aquaculture practices. Being a chef today also means being aware of overfished species. I aim to use a variety of lesser-known, sustainable fish to broaden people's palates and reduce pressure on endangered species.
6. **Respect for Raw Preparations:** Raw seafood preparations, like sushi, sashimi, and ceviche, require a high level of skill. Handling raw seafood involves understanding how to properly cut, store, and serve it safely to highlight its clean, pure flavors. I always ensure the freshest, highest-quality ingredients when preparing raw dishes, as these recipes rely on the ingredient's inherent flavor and texture.
7. **The Guest Experience:** Finally, as a chef, my ultimate goal is to create an experience that excites the senses. The delicate nature of seafood means that a light touch can elevate the dish from good to great. I want to bring out the best in the ingredients while delivering a satisfying and memorable experience for the diner.

■ **What are the best seafood items/dishes you would like to suggest our reader?**

As a chef, I would suggest a variety of seafood items and dishes that showcase the versatility, freshness, and unique flavors of seafood.

Here are some of the best seafood items and dishes I would recommend:

1. **Grilled Whole Fish (Mediterranean Style)**

❍ **Why it's great:** A simple yet elegant dish, grilling a whole fish (like sea bass, snapper, or branzino) enhances its natural flavors. The fish is often stuffed with fresh herbs like rosemary, thyme, and lemon slices, then drizzled with olive oil and grilled to perfection.

❍ **Why I recommend it:** Grilling brings out the best in fish, offering a crispy skin and tender flesh that's hard

to beat. This dish is also a great option for sharing, making it a perfect centerpiece for gatherings.

2. Seafood Paella (Spanish)

- **Why it's great:** A classic Spanish dish, seafood paella is made with a variety of shellfish and fish, including shrimp, mussels, clams, and squid, cooked with saffron-infused rice. The rich combination of seafood, rice, and aromatic spices makes this dish a standout.
- **Why I recommend it:** Paella is a celebration of seafood and rice, and it's versatile, allowing chefs to adjust ingredients based on availability. The complex flavors of saffron and smoked paprika combined with fresh seafood are always a crowd-pleaser.

3. Shrimp Scampi (Italian-American)

- **Why it's great:** Shrimp scampi is a flavorful pasta dish featuring succulent shrimp sautéed in a garlic butter sauce, often with white wine, lemon juice, and parsley, served over a bed of linguine or spaghetti.
- **Why I recommend it:** It's quick, easy, and packed with flavor. The buttery, garlicky sauce complements the shrimp perfectly, and the lemon adds a refreshing brightness. It's a comforting and satisfying dish that appeals to all seafood lovers.

4. Tuna Poke Bowl (Hawaiian/Japanese Fusion)

- **Why it's great:** This dish features fresh, raw tuna marinated in soy sauce, sesame oil, and spices, then served over a bed of rice with a variety of toppings such as avocado, cucumber, edamame, and seaweed.
- **Why I recommend it:** Poke bowls are a healthy, customizable option for seafood enthusiasts. The raw tuna provides a clean, fresh taste, and the combination of toppings adds texture and flavor, making it both satisfying and nourishing.

5. Crispy Fried Calamari (Italian)

- **Why it's great:** Lightly battered and fried squid rings, served with a zesty marinara dipping sauce or a squeeze of fresh lemon.
- **Why I recommend it:** Fried calamari is a popular appetizer, and when cooked properly, it offers a crispy, tender texture. It's a great starting point for a seafood meal, and the light batter enhances the natural sweetness of the squid.

6. Clams Casino (American)

- **Why it's great:** Clams casino are clams topped with a mixture of breadcrumbs, bacon, garlic, and herbs, then baked until golden and crispy.
- **Why I recommend it:** This dish is a perfect balance of salty, smoky, and savory flavors. The richness of the bacon and breadcrumbs complements the briny sweetness of the clams, making it a delicious and satisfying appetizer.

These dishes are not only diverse in terms of flavor profiles and techniques, but they also highlight the beauty and versatility of seafood. From raw preparations like poke and ceviche to cooked dishes like lobster rolls and grilled fish, these seafood options are perfect for different occasions, whether you're looking for something light, indulgent, or simple.

4. Please give us a brief recipie of a seafood dish you would like to suggest for this edition and also tell us about its cultural significance(if there is any)

Name Pan Seared Italian Shrimps

S.No	Ingredients	Weight Measure
1	Cleaned Shrimps	200 G
2	Chopped Garlic	40 G
3	Green Chilli	10 G
4	Dice Pepeprs	60 G
5	Chilli Flakes	5 G
6	6 Butter	30 G
7	Olive Oil	30 Ml
8	Parmesan Cheese	40 G
9	Parsleychopped	5 G
10	Lemon jucie	20 Ml
11	Basil Leaves	5 G
12	Dry White Wine	30 ML
13	Salt	10 G
14	Black pepper crushed	2 G

Method: Clean the shrimps (count 38 to 48) and keep it aside. Take a pan add butter and oil together warm it a little add chopped garlic in to it. Saute it till it get golden then add cleaned shrimps, chopped peppers, green chillies all seasoning, toss it add wine and finish it with lemon juice and parmesan cheese after closing the gas stove. All together cook it not more than 2 minutes by your watch, garnish with chopped parsley and basil leaves served hot.


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