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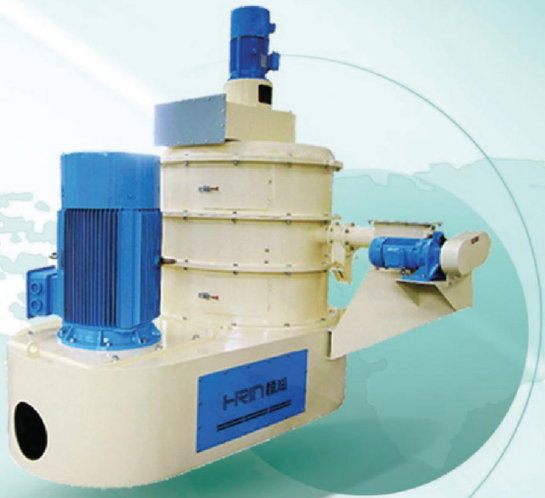
Inside...

Professional Feed Machinery Manufacturer



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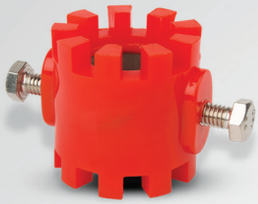


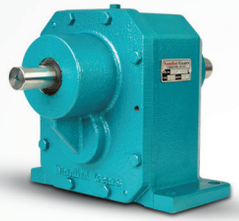
Spiral Stopper

Bevel Gear Box

2 HP Motor

Spiral

Worm Shaft & Wormwheel



Spiral (Helical) Gear Box

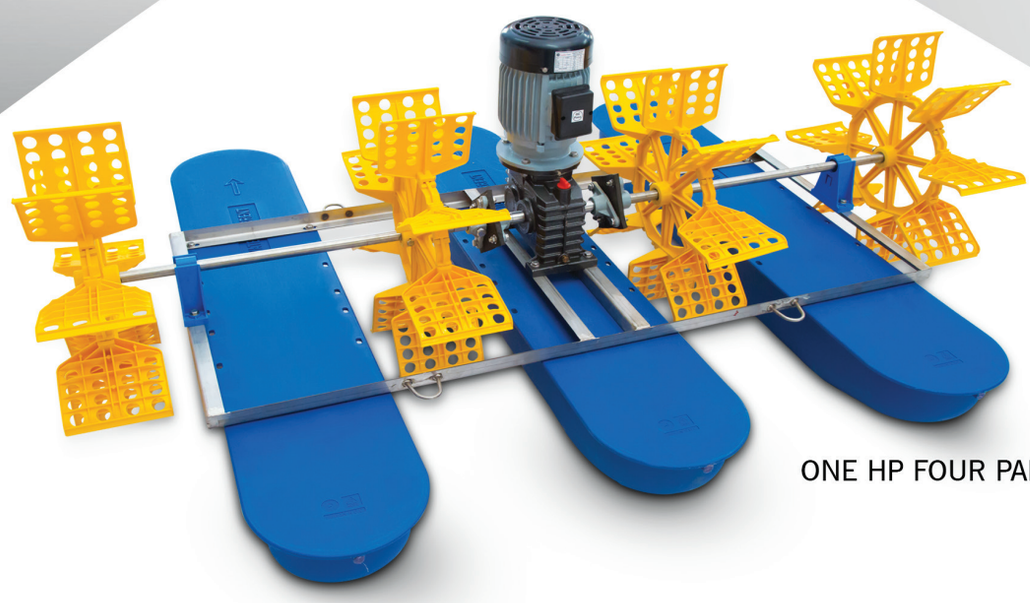
1 HP Gear Box

Paddle Wheel

Long Arm Gland

2 HP Gear Box

2 HP Out Put Shaft



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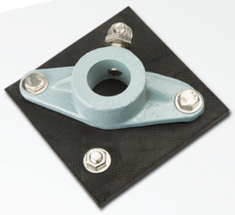
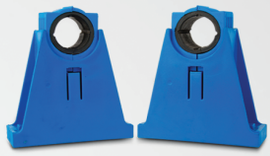
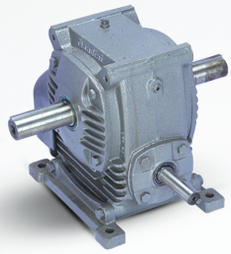


Spiral Gear Box Movable Joint



Bearing Stand For Spiral



Long Arm Gear Box

Movable Joint

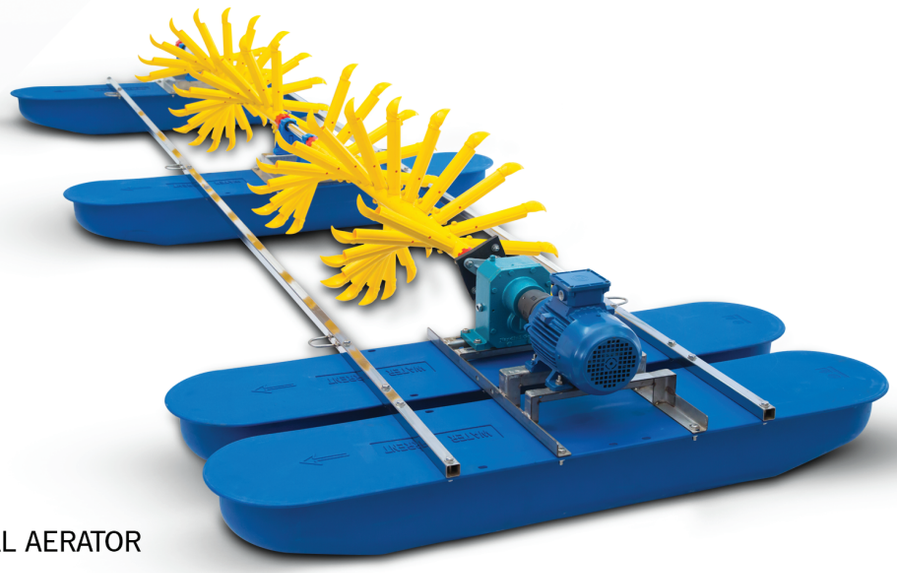
Paddle

Float

1 HP Motor

2 HP Motor

HDPE Cover



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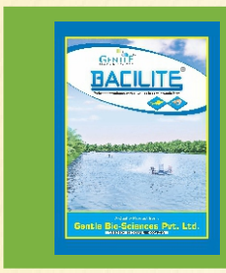

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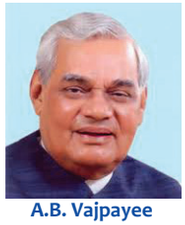
India is set gain the top slot in farmed shrimp production, overtaking China in 2019-20

M.A. Nazeer

Dear Readers,

The October 2018 issue of ***Aqua International*** is in your hands.

Aqua International expresses its deep sorrow at the demise of Mr Atal Bihari Vajpayee, the Former Prime Minster of India and the great son of India on August 16, 2018 due to age-related illness. During his tenure as Prime Minister, Vajpayee sought to improve diplomatic relations with neighbouring countries like Pakistan, travelling to Lahore by bus to meet Prime Minister Nawaz Sharif. After the 1999 Kargil War with Pakistan, he sought to restore relations through engaging with President Pervez Musharraf, inviting him to India for a summit at Agra.



A.B. Vajpayee

Vajpayee was conferred India's highest civilian honour, the Bharat Ratna by the President of India, Pranab Mukherjee in 2015. Vajpayee's birthday, 25 December, was marked as Good Governance Day.

Policies: Vajpayee's government introduced many domestic economic and infrastructural reforms, including encouraging the private sector and foreign investments, reducing governmental waste, encouraging research and development and privatisation of some government owned corporations. Among Vajpayee's projects were the National Highways Development Project and Pradhan Mantri Gram Sadak Yojana. In 2001, the Vajpayee government launched the Sarva Shiksha Abhiyan campaign, aimed at improving the quality of education in primary and secondary schools.

Aqua International

Our Mission

Aqua International will strive to be the reliable source of information to Aquaculture industry in India.

AI will give its opinion and suggest the industry what is needed in the interest of all in the industry.

AI will strive to be The Forum to the Stakeholders of the industry for development and self-regulation.

AI will recognize the efforts and contribution of individuals, institutions and organizations for the development of Aquaculture industry in India through annual Awards presentation.

AI will strive to maintain quality and standards at all times.

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In the News section, you may find news about - India is set gain the top slot in farmed shrimp production, overtaking China in 2019-20, said Ravi Kumar Yellanki, president, Society of Aquaculture Professionals.

"We have already overtaken China in shrimp exports last year, but are on par with regard to farmed shrimp production. Next year, we will overtake China [on this count] too," he said

The U.S. Food and Drug Administration refused 5.6 percent of shrimp imports in August due to banned antibiotics. This was the second highest number of entry lines refused for antibiotic contamination this year," said the Southern Shrimp Alliance in a statement. In addition, the FDA refused two entry lines of shrimp for salmonella in August, it reported; both shipments were from India. The FDA has now refused 62 entry lines of shrimp for salmonella through the first eight months of 2018, of which the vast majority originate from India, SSA said.

CLFMA's 51st Annual General Meeting was held and the new leadership team took charge for the period 2018-20. Speaking on the occasion, the outgoing Chairman Mr B. Soundararajan expressed his appreciation and conveyed best wishes to the new team led by Mr S. V. Bhave, Managing Director, Berg and Schmidt India Pvt Ltd, who got elected as the new Chairman.

In India, safety of edible fish and shellfish has gained prominence with progress of time.There is a need to implement certain safety norms, carry out stringent checks at regular intervals and conduct awareness campaigns to educate fish producers, sellers and consumers on the harmful effects of traces of banned antibiotics and formalin in fish and shellfish used at production and preservation stages and other issues. With this background, Confederation of Indian Industry (CII Eastern Region), Kolkata, WB organized 'The Fisheries Conclave: Maximizing Production and Ensuring Safety' recently at Hotel Hindustan International, Kolkata.

Congress President Mr Rahul Gandhi, who is on a two-day tour of flood-hit parts of Kerala, said recently that, if voted to power, his party would set up a separate Ministry for Fisheries. He said this, while speaking in Alappuzha in Central Kerala, at a reception accorded to fishermen who had ferried their boats to the worst-affected areas and plunged themselves voluntarily into rescue operations.

Field biologists from the East Godavari Riverine Estuarine Ecosystem (EGREE) Foundation have spotted 'Pondicherry shark', an endangered species protected under the provisions of the Wildlife (Protection) Act, near the Kumbhabhishekam landing point in the city. This is for the third time that it was spotted in the East Godavari River Estuarine Ecosystem region after 2007 and 2016.

Readers are invited to send their views and comments on the news and articles published in the magazine which would be published under "Readers Column". Time to time, we shall try to update you on various aspects of Aquaculture industry. Keep reading the magazine regularly and update yourself. Wish you all fruitful results in your efforts.

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India may overtake China in farmed shrimp production

'Many producers planning to expand capacity'

Chennai: India is set gain the top slot in farmed shrimp production, overtaking China in 2019-20, said Ravi Kumar Yellanki, president, Society of Aquaculture Professionals.

"We have already overtaken China in shrimp exports last year but are on par with regard to farmed shrimp production. Next year, we will overtake China [on this count] too," he said

China's output falls

While the shrimp production target for the current year stands at 7 lakh tonnes, India might end up producing 6.5 lakh tonnes, on par with China. Last year, India produced 6 lakh tonnes, he said. Shrimp production in China declined after the outbreak of the Early Mortality Syndrome (EMS) disease, he added. While India was not impacted by the disease, countries such as Thailand, Vietnam, Malaysia and Mexico were largely affected. "But China kept inflating its production numbers by adding imports from Vietnam," he noted.

"Next year, we will definitely overtake China as farmed shrimp production is on the wane. Their farmers suffered huge losses and this dissuaded them from getting into production," said Ramakanth V. Akula, CEO, The Waterbase Ltd. (TWL), a leading shrimp feed manufacturer.

Huge tracts of land were available to host brackish water for cultivation, he said adding,"India has 15 lakh hectares suitable for brackish water, but only 10% of it [1.5 lakh hectares] is being used for shrimp production. Farmgate prices are increasing. Also, several shrimp producers are planning to expand capacity".

Last year, India exported 4.02 lakh tonnes of Vannemei shrimp, an increase of 22% in quantity and 25% in value terms.

The company also plans to augment its shrimp feed production capacity either through greenfield or brownfield project.

"India needs good quality seeds. To sustain the momentum, we are setting up a ₹22 crore hatchery in Nellore in two phases," he said. In the first phase, it would produce 250 million post larvae seed Vannemei shrimp. The trial runs are on and commercial productions would commence by October 2018. The second phase would also have similar capacity. The new plant might come up in Andhra Pradesh in two years. Based in Chennai, TWL is a leading acquaculture company promoted by Karan Chand Thapar Group. The company focusses on manufacture and marketing of shrimp feed, farm care products, processing of shrimp and producing post larvae of Vannemei shrimp. Last year, the company posted a revenue of ₹342 crore. Dwelling on the current year's performance, he said a significant increase in raw material costs not only contracted the margins, but also impacted the operational profitability of the firm.

Courtesy: The Hindu

More shrimp imports refused over antibiotics, salmonella in USA

The U.S. Food and Drug Administration refused 5.6 percent of shrimp imports in August due to banned antibiotics.

Through August, there have been a total of 33 shrimp entry lines refused for reasons related to banned antibiotics.

"This was the second highest number of entry lines refused for antibiotic contamination this year," said the Southern Shrimp Alliance in a statement.

In addition, the FDA refused two entry lines of shrimp for salmonella in August, it reported; both shipments were from India. The FDA has now refused 62 entry lines of shrimp for salmonella through the first eight months of 2018, of which the vast majority originate from India, SSA said.

The shrimp shipments that were refused due to banned antibiotics were from Royale Marine Impex Pvt. Ltd. in India (four entry lines refused) and Edhayam Frozen Foods PVT Ltd. in India (one shipment), because it was contaminated with chloramphenicol, which was deemed poisonous by the Division of Southwest Imports.

OceanBest (M) Sdn. Bhd. in Malaysia also had one line refused for veterinary drug residues or "unsafe additives."

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AQUATICA

Change of Guard: New Leadership team elected for CLFMA of India

S.V . Bhave, Berg & Schmidt India, elected the Chairman

New Leadership Team of CLFMA of India for year 2018-20
from left: Rajeev S. Murthy, S.V. Bhave,Neeraj Kumar Srivastava, Divya Kumar Gulati and Naveen Pasuparthy

Mumbai: CLFMA of India is the apex organization and the voice of the country's dynamic livestock sector. The 51-year old industry association is recognized as one among the highly reputed in India. CLFMA OF INDIA is well recognized by livestock farmers, Central and State Governments, government departments, Agricultural Universities, Veterinary Colleges and also National Research Institutes in India as well as outside the country.

CLFMA's 51st Annual General Meeting was held and the new leadership team took charge for the period 2018-20. Speaking on the occasion, the outgoing Chairman Mr B. Soundararajan expressed his appreciation and conveyed best wishes to the new team led by Mr S. V. Bhave, Managing Director, Berg and Schmidt India Pvt Ltd, who got elected as the new Chairman.

Mr B. Soundararajan mentioned that CLFMA is well respected and well recognised in the Livestock industry. CLFMA is the pioneer organization and voice of the sector, which actively works to protect the industry's interest through policy and regulatory advocacy.

"It was my great pleasure and honour to serve as the Chairman of CLFMA of India for the last two years during which the organization made significant progress in terms of 3 I's - "Image, Impact & Income". I am sure under the able stewardship of a visionary leader like Mr S V Bhave, CLFMA will continue to grow to newer heights. I wish the new Office Bearers and the Managing Committee Members all the success." commented Soundararajan.

CLFMA OF INDIA has over 230 members representing diverse sub - sectors of animal protein value chain including feed manufacturing, poultry, dairy and aquaculture business, animal nutrition and health, veterinary services, machinery and equipment, processing, distribution and retailing of meat and ancillary services such as banking.

Following Office Bearers were elected for the period 2018 – 20:

Chairman :

Mr S. V. Bhave, Berg and Schmidt India Pvt Ltd

Dy. Chairman :
Mr Rajeev S. Murthy,Godrej Agrovet Limited

Dy. Chairman :
Mr Neeraj Kumar Srivastava, Novus Animal Nutrition (India) Pvt Ltd

Secretary :
Mr Divya Kumar Gulati, Nurture Aqua Technology Pvt Ltd

Treasurer :
Mr Naveen Pasuparthy, Nanda Feeds Pvt Ltd

Immediate Past Chairman :
Mr B. Soundararajan, Suguna Holdings Pvt Ltd

The other members of the Managing Committee for 2018 – 20 comprises of:

1. Mr Sujit Komarla : Komarla Feeds
2. Mr Vijay Bhandare : Bhavani Agrovet Pvt Ltd
3. Mr Sumit Sureka : Shivshakti Agro (India) Ltd
4. Mr Anil M: KSE Limited
5. Mr Ramakanth V akula : The Waterbase Ltd
6. Mr Lakshmanan : Shanthi Poultry Farm Pvt Ltd
7. Mr Suresh Deora : S. A. Pharmachem Pvt Ltd
8. Dr Saikat Saha : Evonik India Pvt Ltd
9. Dr Devender Hooda : Huvepharma SEA (Pune) Pvt Ltd
10. Dr Sujit Kulkarni : Biomin India
11. Mr S. Kannan : Suguna Foods Private Limited
12. Mr Nakul Vakil : Cremach Private Ltd
13. Mr Abhay Shah : Spectoms Engineering Pvt Ltd
14. Mr Nissar Mohammed : Coastal Exports Corporation
15. Dr Vijay Makhija : DSM Nutritional Products India Pvt Ltd
16. Mr Balaram Bhattacharya : Indian Herbs Specialities Pvt Ltd
17. Mr Ramkutty : Niswin Enterprises

Mr S. V Bhave, the new Chairman of CLFMA of INDIA, acknowledged the critical role and valuable contributions of the immediate past chairman, Mr B. Soundararajan and his predecessors who played the vital role in building the organization all along the past five decades.

"The new team of CLFMA has an apt mix of experienced professionals. We will strive to uphold the reputation and the legacy of CLFMA and work committedly towards its growth in the years to come", concluded Mr S V. Bhave.

Fisheries Conclave organized at Kolkata

Dignitaries in the Fisheries Conclave
From Left: A.K. Banerjee, Ravi Inder Singh, C.N. Sinha and Subrata Mukherjee.

Kolkata: In India, safety of edible fish and shellfish has gained prominence with progress of time.There is a need to implement certain safety norms, carry out stringent checks at regular intervals and conduct awareness campaigns to educate fish producers, sellers and consumers on the harmful effects of traces of banned antibiotics and formalin in fish and shellfish used at production and preservation stages and other issues. With this background, Confederation of Indian Industry (CII Eastern Region), Kolkata, WB organized 'The Fisheries Conclave: Maximizing Production and Ensuring Safety' on28th August, 2018 at Hotel Hindustan International, Kolkata. This conclave brought different stakeholders like professional fishermen, progressive fish farmers from different districts of WB, fish traders, exporters, reputed fish feed and fish health product manufacturers together.

In the inaugural session on 'Fishery as an Instrument of Inclusive Economic Development', Mr Amit Saraogi, Chairman, CII Eastern Region Agriculture and Food Processing Sub-committee and MD, Anmol Feeds Pvt. Ltd highlighted the contribution of fish farming to rural economy, consumption of fishes in WB (15.6 kg/capita compared to 9kg/capita at national level), aquaculture as the most-profitable business and way to self-sufficiency in fish production, adoption of modern aquaculture technology and shift to modern practices, 60% return on investment can be achieved in six months following extensive method and 100% achieved in same period with improved pelleted fish feed. Mr Saraogi mentioned that if investment of Rs 7,00,000 is made in 1 acre fish pond in WB, profit of Rs 4,20,000/- can be achieved in six months. Raw material based farming (mustard oil cake and de-oiled rice bran) should be converted to modern approaches. CII is committed to growth of fish production in WB.

Subrata Mukherjee, Director of Fisheries, WB making presentation

Mr Soumajit Das, WBCS (Exe.), Managing Director, State Fisheries Development Corporation, WB discussed about maximizing aquaculture resources, policy of introducing scientific fish feed which WB Government is distributing to fish farmers, accreditation of fish hatcheries as an important step, improving quality of fishes, introduction of new commercially-important fish species like cobia, milkfish, silver pompano, grouper, Amur carp in addition to Vietnam koi and Ompak pabda in aquaculture systems in WB. For Indian major carps, it takes 10-11 months to attain maturity stage (750-800gm) and IMC production is not economically viable in many parts of WB. IMC dependency has to be reduced. Economic return is high in cases of GIFTTilapia or pangas catfish farming. A paradigm shift/change is needed in fish culture practices. In the 'Moyna model' of fish farming, stocking of advanced fingerlingsresulted in much improved growth. According to Mr Das, safety of fish depends upon the management practices followed during pond preparation in fish farms, good quality fish seed, use of cold chain, solar refrigerator, refrigerated vehicles, change in fish packaging technology.He also spoke on on-line cold chain marketing technology,

West Bengal Fisheries Minister Chandranath Sinha addressing the CII conclave.

fisheries in agri-allied sector as second biggest source of economy, inclusive growth and fisheries in social upliftment.

Mr Subrata Mukherjee, WBCS (Exe.) Director of Fisheries, WB spoke on role of Government of WB in maximizing fish production and ensuring safety. He highlighted different schemes in freshwater and brackishwater sectors implemented at Block level, selection of beneficiaries and inputs' distribution, training to fish farmers on use of improved fish feed, awareness programmes for fish farmers about misuse of antibiotics and other issues, proper use of medicines in fish ponds in recommended dosage. Mr Mukherjee also spoke on utility of observing ban period for Hilsa ilisha,

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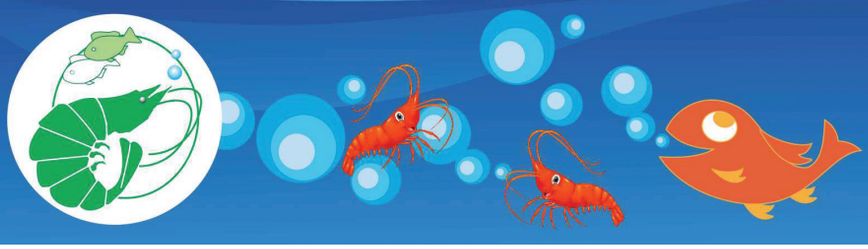

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safety measures for marine fishermen and insurance aspects, shrimp farmers must get the right price for their produce, cost of farming has to be reduced. We were informed that 17.4 lakh tonne of fish was produced in WB in 2016-2017. In 'Moyna model', 150gm fishes are stocked in 4-5ha water bodies and desirable big-sized fishes could be produced. Small newly-excavated ponds are being utilized with fish seed and feed in Jal bharo Jal dharo programme in different districts. For production of IMC fingerlings, source of fish seed (spawn and fry stage) must be traced out. Steroids must never be introduced into fish medicines for quick growth of fishes.

Mr Ravi Inder Singh, speaking

With endeavour of WB Government, deficit in fish production can be met and high quality fishes provided to consumers, safety of fishermen must be looked into and their income should be increased.

Mr Ravi Inder Singh, IAS, Principal Secretary, Department of Fisheries, WB emphasized on the fact that an 'enabling environment' for development of fisheries sector must be ensured. Research should be focused on creating infrastructure, fish for export and retail market, creation of 'enabling environment' for stakeholders, SPF seeds are now available for prawn and shrimp farmers, stop in misuse of antibiotics will lead to increase in production. Creation of infrastructures on fish markets, fish landing centres, establishment of cold chains are included in Government policy.Combined effort of Government and organizations (MPEDA, other NGOs) is needed; NGO members must follow GMP (Good Management Practices) in export-oriented and other aquaculture activities.Mr Singh hoped that more discussion with fish farmers is needed and such Conclave must be marked as 'issue-resolving exercise' - certain issues should be flagged up that needs further deliberation and discussion.

Mr Chandranath Sinha, Minister-in-Charge, Department of Fisheries mentioned about emergence of livelihood-generating commercial aquaculture and means of sustenance of many families in villages, new candidate species introduced in freshwater culture systems, establishment of cold chain and ice plants in landing centres, status of availability and existence of small indigenous fishes (SIFs) in different districts of WB, steps undertaken for their revival. Mr Sinha stated that WB has eight times more water bodies (in area) in comparison to that in Andhra Pradesh and those should be properly utilized, proper application of improved fish feed, production of two crops and

Mr Amit Saraogi speaking

one crop in a year for SIFs and major carps respectively from fish ponds, those should be brought under fish culture as many as possible. Many village ponds are not properly utilized due to conflicts/disagreement among its co-sharers for division- these may be leased out to progressive fish farmers. Often ponds are illegally filled up for construction purposes but if fish culture is done properly, it will ensure a high return. Species like silver pompano, cobia and others attain marketable size in short period, their farming is profitable with high demand in hotels and hatcheries can be set up for these fishes. More amount of farmed shrimp produce should be meant for local markets, laboratories have been set up at Block level for pond soil and water testing, selection of right fish species for farming in appropriate environment, establishment of fish hatcheries in hilly areas of WB and supply of seeds, means of raising standard of life of fish farmers. All speakers provided a deep insight into potential and prospects of aquaculture in WB.

Mr A. K. Banerjee, Co-chairman, CII AFP Subcommittee mentioned that a policy paper will be prepared by CII on shrimp farming in WB. Crop insurance can be introduced in fisheries/ aquaculture. Many fish and prawn farmers have to take imprest money from local money-lenders for large-scale farming and finance has become a major impediment for farmers. Eleven speakers who spoke in the two technical sessions were Mr E. Narayana from Anmol Feeds Pvt. Ltd; Mr Bishal Acharjee from IFB Agro Industries Ltd; Dr Bipul Kumar Das, Dean, Faculty of Fishery Sciences, WBUAFS on Fisheries to Aquaculture: a Paradigm Shift; Mr Ajoy Deb Mondal from Oriental Insurance Comp. Ltd; Dr Uttam Kumar Sarkar, Principal Scientist, ICAR-CIFRI, Barrackpore on Fisheries Enhancement in Indian Reservoirs: an avenue for entrepreneurship and employment; Mr Dipankar S. Halder from Jalongi.com; Mr A. Lahiri from MPEDA; Mr Mohammad Asif from IB Group; Mr Siddhartha Misra from Kolkata Municipal Corporation; Mr Rajarshi Banerjee from Seafood Exporters Association of India, WB and Dr Uttam Kumar Panja, Joint Director of Fisheries (IPU Cell), WB. News communicator Subrato Ghosh participated in the entire programme attentively.

Separate ministry for fisheries, if voted to power: Rahul

Thiruvananthapuram:

Congress President Rahul Gandhi, who is on a two-day tour of flood-hit parts of Kerala, said recently that, if voted to power, his party would set up a separate Ministry for Fisheries.

He said this, while speaking in Alappuzha in Central Kerala, at a reception accorded to fishermen who had ferried their boats to the worst-affected areas and plunged themselves voluntarily into rescue operations.

Congress President Rahul Gandhi interacting with flood-affected people of Chengannur, Alappuzha, Kerala.

'Their voices will be heard'

"The moment a Congress Government comes to power at the Centre, we are going to create a ministry for fisheries," Rahul said, adding that the fishers, whom he chose to address as God's own army, will have their own ministry.

"A separate ministry will help to understand and look after the problems of the fishermen. Their voices will be heard at the national level," Rahul added.

He went on to suggest that the Indian Coast Guard utilise the services of fishermen for future rescue operations. "When Kerala needed fishermen, you stood up to the challenge," he said while thanking them.

"Three thousand fishermen saved 70,000 lives. This is not a small thing. Both farmers and fishermen have helped build this country," he added.

Earlier on Tuesday morning, Rahul arrived at the Thiruvananthapuram International Airport from London after completing a tour to Europe and visited a relief camp at Chengannur in Alappuzha.

He was accompanied by Ramesh Chennithala, Leader of the Opposition in Kerala Assembly; Oommen Chandy, KC Venugopal, Mukul Wasnik, Congress Working Committee members; and MM Hassan, President, Pradesh Congress Committee.

Relief camp visit

From Alappuzha, the Congress president took off to Kochi and visited relief camps and the flood-ravaged areas at Aluva, Chendamangalam and Chalakudy.

Rahul is scheduled to stay overnight at Kochi and proceed to Kozhikode in the north of the State on Wednesday morning.

He will visit flood-hit areas and relief camps in Wayanad before returning to Delhi later in the day.

Courtesy: The Hindu

Sea food waste prevents steel corrosi Chitosan-based agent shows over 90% efficiency

Mild steel used in wide range of industries easily develops rust and the corrosion causes huge economic loss every year. As chemical corrosion inhibitors are detrimental to the environment, there is an urgent need to develop green inhibitors. Now, researchers from Indian Institute of Technology (BHU), Varanasi, have successfully produced a chitosan-based corrosion inhibitor that shows over 90% efficiency.

Chitosan

Chitosan is a natural polysaccharide found in the shell of crab, shrimp and also in the cell wall of fungi. "As the solubility of chitosan in water is poor, polyethylene glycol (PEG) was incorporated to it and a novel PEG-crosslinked chitosan was developed.

The inhibitor blocks the active sites on steel available for corrosion thereby mitigating corrosion, says Quraishi (standing)

PEG is non-toxic and has been approved by the FDA even for internal consumption," says Vandana Srivastava from the Department of Chemistry of the institute and first author of the paper published ChemistrySelect.

Mild steel was immersed in a corrosion-inducing solution of hydrochloric acid containing different concentration of chitosan. PEG ranging from 50-200 mg/L for six hours. The novel inhibitor was found to form a thin film on the metal surface.

"We studied the precise chemical mechanisms and found that the inhibitor is adsorbed as a thin film on the steel surface. The inhibitor blocks the active sites on steel available for corrosion thereby mitigating corrosion," explains M.A. Quraishi from the institute and corresponding author of the work.

Weight loss studies and electron microscopy imaging showed that a maximum inhibition of 93.9% was achieved when the concentration of the treated solution was 200 mg/L.

Smooth surface

"Usually when steel is treated with anti-corrosive agents there is a change in its surface and it tends to get rough. But our inhibitor did not alter the surface. In fact, there was a significant improvement in the surface smoothness," Prof. Quraishi adds. "The shells of the shrimps are usually discarded as waste and if we can use them and develop such eco-friendly products it will be a good way to convert waste material to a useful application."

Courtesy: The Hindu

Participatory Management Councils to play crucial role in fisheries management

Venkatesha Pathi, Director of Fisheries speaking at the two-day workshop being held at the CMFRI.

Kochi: The participatory management councils, one of the new amendments of Kerala Marine Fisheries Regulation Act (KMFRA), will play a crucial role in revamping the fisheries management system in the state, according to experts. Marine scientists who spoke at the workshop on scientific management of marine fisheries, Kerala held at the Central Marine Fisheries Research Institute (CMFRI) observed that the proposed management councils will ensure involvement of all the stakeholders including fishermen in management and policy formation in the sector.

Dr Sunil Mohamed, Principal Scientist at the CMFRI said the councils would open a platform for dialogues and discussions to take decisions on a particular issue in democratic way. "This participatory management will address the requirements for sustainability, equity and efficiency in fisheries and coastal resources management.

The participatory management council, which was included in the amendment of KMFRA following a proposal from the CMFRI, will be functioned as a 3-tier system– village, district and state. The council will have representations of fishermen, government officials, boat owners, boat builders, fish traders, NGOs, scientists, etc.

Through the implementation of these councils, fishermen would be empowered to become active members of the fisheries management team, balancing rights and responsibilities, and working in partnership rather than antagonistically with the government, Dr Sunil Mohamed said.

He also said that intensive public awareness is requited to effectively implement Minimum Legal Size (MLS) regulations to curb juvenile fishing. "Consumer awareness is crucial in implementing the MLS regulation properly", he said adding that implementing the same would increase the economic efficiency of the fishery besides affording protection to juvenile fishes and allowing them to grow in weight and length.

During his introductory remarks, VenkateshaPathi, Director of Fisheries said scientific approach is essential for a better fisheries management in Kerala. "The fisheries department has allocated special funds for adaptive research in this regard", he said. The two-day workshop is organised by the department of fisheries.

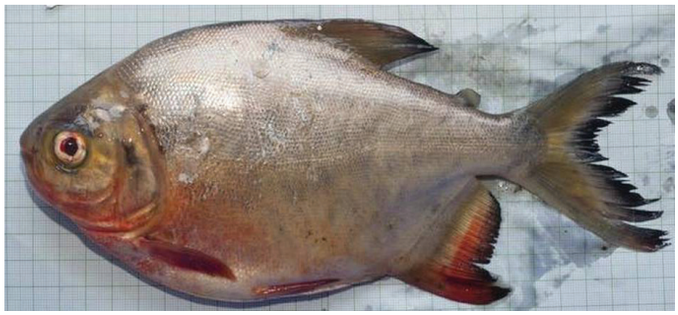
Dr T V Satyanandan, Dr Leela Edwin, Dr T M Najmudeen, Dr Dinesh Cheruvattu, Ignatius Mandro and Thajudheen spoke on the occasion.

Fisheries department officials from all the districts are attending the workshop which will conclude on Wednesday.

Floods Trigger Influx of Alien Fish Species in Kerala

Thiruvananthapuram: The catastrophic floods that caused widespread havoc throughout the State last month have also released several alien species of fish into waterbodies, raising a threat to the endemic aquatic ecosystem and biodiversity, scientists have reported.

A joint research team which carried out a rapid assessment of the impact of the floods on waterbodies, has documented the presence of 11 alien species, including the alligator gar (Atractosteus spatula), arapaima (Arapaima gigas), arowana, giant gourami, grass carp, kissing gourami, (Helestoma temminckii), koi carp, gold fish (Carassius auratus), shark catfish also known as Malaysian vaala, red-bellied pacu (Piaractus brachypomus) and three-spot gourami and four alien invasive species namely the East African catfish, common carp, tilapia (both cultivated and ornamental varieties) and sucker catfish.



The researchers from the University of Kerala, Kerala University of Fisheries and Ocean Sciences (KUFOS) and the National Institute of Advanced Studies (NIAS), Bengaluru, have established that the alien species had escaped in large numbers from flooded commercial and ornamental fish farm.

According to Mr Rajeev Raghavan of KUFOS and the South Asia Coordinator of the IUCN's Freshwater Fish Specialist Group, the proliferation of alien species poses a serious threat to the freshwater ecosystem of Kerala, consider a global gotspot for fish diversity, with about 200 freshwater species of fish, about 30 percentage of them endemic. The scientist have called for ban on the imports and farming of alien species like the arapaima and alligator gar.

Courtesy: *The Hindu*

NFDB Sponsored Skill Development Programme held on Pre-processing and Drying of Fish

Release of training manual Dr A.K. Mohanty, Dr Ravishankar C.N., Dr Renal, Lecturer, KOLA and Dr Manoj P. Samuel

Kochi: National Fisheries Development Board, Hyderabad sponsored Skill Development Program (SDP) on "Pre-processing and drying of fish" was conducted at ICAR-CIFT during 4 to 6 September 2018. The training program was attended by 25 participants from all over Kerala, of which 17 belonged to the training organization under Kerala Institute for Local Administration (KILA) - Extension Training Centre, Mannuthy and remaining were entrepreneurs interested in solar fish drying.

The program was inaugurated by Dr Ravishankar C.N., Director, ICAR-CIFT in the presence of Dr A.K. Mohanty, Principal Scientist and Nodal Officer and Dr Manoj P. Samuel, Course Director, SDP, officials of KILA, Mannuthy, Heads of Divisions and staff of ICAR-CIFT. The training program covered areas related to pre-processing, drying, quality evaluation, packaging of dried fish and fishery waste management. Participants were also given an opportunity to visit and acquaint with the Agri-Business Incubation process of CIFT developed technologies.

Training in progress

A visit was arranged to the dry fish market at Chambakkara, owned by an incubate of ICAR-CIFT. A B2B meet was conducted with the empanelled list of manufacturers of ICAR-CIFT solar dryers and participants who were interested to establish solar fish dryer.

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Endangered 'Pondicherry shark' spotted near Kakinada

Kakinada: Field biologists from the East Godavari Riverine Estuarine Ecosystem (EGREE) Foundation have spotted 'Pondicherry shark', an endangered species protected under the provisions of the Wildlife (Protection) Act, near the Kumbhabhishekam landing point in the city. This is for the third time that it was spotted in the East Godavari River Estuarine Ecosystem region after 2007 and 2016. Scientifically known as Carcharhinus hemiodon, it belongs to the Carcharhinidae family with a growth of 3.3 feet. Field biologists Mahesh Babu and Ganesh Pallela, during their routine survey, spotted it on Saturday and Sunday They sent the details to Anil Mohapatra, scientist from the Zoological Survey of India, for confirmation and got a positive response. Zoologists have been trying to trace the species in the other parts of the country since 1979. Known as 'Pala Sora' in the local parlance, the 'Pondicherry Shark' is on the verge of extinction even according to the conventional fishermen.

They, however, are unaware of its conservation status which is on a par with the tiger. "The two we have found are of the length of 1.5 feet and 2.4 feet respectively and they are not fully grown. We doubt whether the fisher folks are selling the fish whenever they trap it," they say. Scientific info The only scientific information available about the species comes from 20 specimens collected from fish markets across the IndoPacific region. It is identified by its black tips of dorsal, pectoral and Tai fins. The front teeth are distinctly serrated at the base and smooth at the tip. Divisional Forest Officer (Wildlife) Anant Shankar, also the additional CEO of the EGREE Foundation, says the department in association with the foundation is working with the fishing communities and various line departments in bringing down the trade in such species. "Conservation of such species is only possible through community mobilisation and stewardship," he says.

Endangered species: The 'Pondicherry Shark' spotted on the Kakinada coast.

Courtesy: *The Hindu.*

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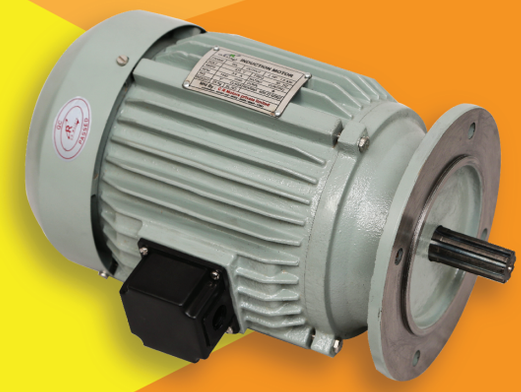

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Surat to host 33rd edition Aquaculture Expo 2019

The quality and standard of forthcoming Expo at Surat will be a level ahead

Surat: NRS Publications, publishers of *Aqua International*, the national English monthly magazine on aquaculture sector in India, are organizing the 33rd edition of ***Aquaculture Expo 2019***, an exhibition and conference on aquaculture sector at Surat, Gujarat, India on 10 & 11 January 2019. The venue for the Expo is Surat International Exhibition & Convention Center (SIECC), Sarsana, Khajod Chokdi, Sachin Magdalla Road, Surat, Gujarat.

The main objective of the Expo is to bring awareness among aquaculture farmers on shrimp, fish, crabs and other species culture and various products, technology and services available to get better yield and results in aquaculture.

There will be presentations on topics like Quality Seed, Pond & Water Management, Bio-security, Diseases, Harvesting and Post Harvesting Management, Marketing etc in the conference to be held on the occasion. Aqua International so far organized 32 exhibitions and conferences on aquaculture since 1994 in different parts of the country, said Mr M.A Nazeer, chief executive of the expo and Editor, Aqua International.

He invited all categories of the industry to take part in the forthcoming expo with stalls, which are allotted on first come, first served basis. The Stall Rental Rate is Rs 36,000 each stall. Please add GST at 18% on the above tariff.

The payment for the stalls may be arranged through a bank draft or at par cheque favouring **"NRS Events"** payable at Hyderabad, India. Payment may also be sent through online transfer to: NRS Events, Account No: **C/A 50200030770881,** IFSC Code: HDFC0002826, Brach Code: 2826, GST No: 36ABMPM6671L1ZY, HDFC Bank Limited, Road no 12, Banjara Hills, Hyderabad, Telangana, India.

Advantages of Farmers' participation in the Expo

- Farmers can directly talk to the companies, who exhibit their products in the stalls and know about the products and their usefulness in shrimp, fish culture and other species.
- Companies (Exhibitors) can meet farmer-customers and get the feedback on their products and their performance as well as services. This will enable the companies/ manufacturers to know farmers' feedback and suggestions to further improve quality of their products and services.
- Every product exhibited in Aquaculture Expo and every word spoken in the Inaugural Session >> and in the Conference are meant for farmers and to the benefit of the culture.
- Farmers can also interact with experts on various aspects and get solutions for various problems in aquaculture.
- This Expo is a very good opportunity to the enterprising people, who would like to take up aquaculture as a profession.
- The Expo is a good platform for buyers and seller – as well as – Service providers and Receivers.
- Plan your visit and update your knowledge and contacts in aquaculture, stated the chief executive of Aquaculture Expo.

Dr Gopalakrishnan, Dr Imelda Joseph Receive Rajbhasha Award for Best Article in Hindi

CMFRI Director Dr A.Gopalakrishnan and Mariculture division Head Dr Imelda Joseph receiving the Rajbhasha Guarav award from the Vice President of India Venkaiah Naidu.

Kochi: Dr A Gopalakrishnan, Director of Central Marine Fisheries Research Institute (CMFRI) and Dr Imelda Joseph, Head of Mariculture division of CMFRI received the 'Rajbhasha Gaurav' 'award instituted by the Ministry of Home Affairs for the best articles in Hindi. Vice President Venkaiah Naidu presented the award at a function held in New Delhi in the presence of Minister of Home Affairs Rajnath Singh.

The article titled 'mariculture technologies for doubling of income of fishermen', which was jointly authored by Dr Imelda Joseph and Dr A.Gopalakrishnan, won the second prize in all India level. The article was originally published in 'Matsyagandha', an in-house Hindi magazine of the CMFRI.

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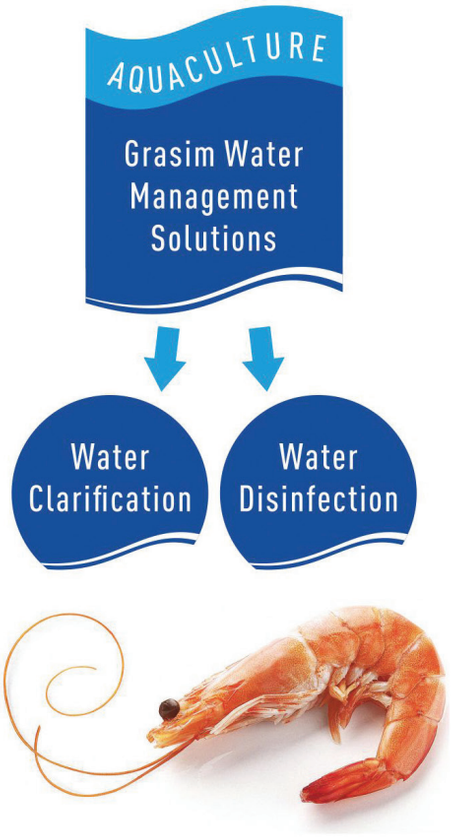

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Pangas catfish seed production and exemplary fish breeder Sri Babul Majumdar

Pangasianodon hypophthalmus - a commercially important fish

In India, West Bengal (WB) is the leading fish seed producing state and North 24 Parganas district is the hub of production centre of fry stages of major carps and economically important cultivable catfishes. Recently greater thrust has been given to production of the pangas catfish Pangasianodon hypophthalmus (Pangasius sutchi is a synonym of P. hypophthalmus) fry by fish breeders in commercial scale hatcheries in this district. It grows to almost 1kg in four months and a minimum harvest of 12000kg/ha/year is achievable from culture ponds. According to National Fisheries Development Board (Govt. of India) estimates, its farming has increased since 2004 due to the commercial importance and there is growing interest among fish farming community in Krishna and West Godavari districts of Andhra Pradesh (AP) to take up its culture in a larger extent, thus paving way for demand for its seed. About 300-500 million P. hypophthalmus seed is produced every year in WB (Source: W. S. Lakra and A. K. Singh, 2010. Risk analysis and sustainability of Pangasianodon hypophthalmus culture in India, Aquaculture Asia, Volume XV No. 1: Page 34-37). P. hypophthalmus exhibits remarkable growth rate even in semi-clean grow-out ponds. Much enthusiasm has arisen among fish breeders in North 24 Pgs, WB for artificial spawning of P. hypophthalmus.

Exemplary and three-times national awardee fish breeder Mr Babul Majumdar in North 24 Pgs is producing P. hypophthalmus fry in a large scale since 2002. He was able to introduce this fish to AP and other parts of India after his 34 years struggle in fish seed breeding and rearing business. It has been found that there is a shift of culture practice from major carps to pangas catfish in considerable areas in AP. The culture production of P. hypophthalmus ranges from 7 tonnes/ha/year to 20 tonnes/ha/year and the average production is found to be higher than carp production in same areas.

Advanced fry of P. hypophthalmus

Brief profile of Mr Shri Babul Mazumder

Mr Babul Majumdar, aged 64 years, is proprietor of Majumdar Fisheries at Vill. Sibdaspur, P.O. Salidaha, Block Barrackpore-I, PS Naihati (via Kanchrapara), Dist. North 24 Parganas. Mr Majumdar is a successful progressive fish breeder, with expertise in pangas catfish and rupchanda and his biography is a lesson to those who desire to accept aquaculture as their profession for income generation to support livelihood (Source: P. P. Chakrabarti and others, 2012. Pabda seed production and culture, ICAR-CIFA Publication: Page 29). He had to face poverty since his childhood days. After 1978, during his daily travel from one village to another for artificial insemination of cows, he used to observe regular fish catch in village and their sale. He was attracted towards fishery and influenced to accept this practice for his livelihood support. He received training in pisciculture from District-level fishery training centre at Barasat town in this district, visited different places in WB where scientific fish culture was in vogue extensively, went to Bankura district for learning fish breeding techniques, obtained training from Freshwater Fisheries Research Station, Kulia, Dist. Nadia, also necessary guidance from renowned fish breeder Late Nilu Ghosh in Naihati area. Gradually he started fish culture activity and got seriously involved in rearing and grow-out pond management practices.

Author with Mr Babul Majumdar

Mr Majumdar initially purchased carp spawn from Lalgola in Murshidabad district and Bankura and reared them in his ponds. He planned for developing hatchery of his own for production of spawn. He initially started breeding fishes in hapa enclosures and produced spawn sufficient for stocking in his culture ponds. After continuing this activity upto two years, in 1985, he achieved considerable success of monetary benefit and started carp hatchery by learning the technique from Mr Ghosh. Today, in 2018, he has come up at a highly successful stage through his persistence and untiring efforts with a motto to achieve success in fish culture, which had been his source of inspiration. Presently, he is running fish seed production as a large scale business enterprise and has become a leading

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fish seed producer in India.

In July 2011, an article was published about Mr Babul Majumdar with the title 'Untiring efforts never failing attitude made a poor farmer to reach a height of successful progressive fish farmer' in the booklet Aquaculture Innovators, brought out by ICAR-CIFA, Bhubaneswar. It was authored by experienced scientists of ICAR-CIFA Regional Centre, Kalyani. Mr Majumdar is undoubtedly a fish farm innovator, and his innovative ideas and management practices in freshwater aquaculture have been descriptively documented in this booklet. In total seed farm area of 60 bigha (1980 decimal) at Majumdar Fisheries, there are total 16 well-maintained fish ponds, with 12 nursery ponds and 4 brood stock ponds. Area of his fish culture ponds range from 8 decimal to 100 decimal. His rearing ponds are located outside this hatchery-cum-nursery pond premises at a distance of 6km. Seventeen concrete circular egg hatching-cum-incubation pools (familiar Chinese model) and fifteen rectangular cement cisterns (with water exchange facilities, for temporary maintenance of brood stock and seed fishes) have been constructed here, which are all running efficiently. The entire fish seed production unit is equipped with modern technologies.

Recognitions received

Mr Majumdar was felicitated by West Bengal University of Animal and Fishery Sciences. In addition to this, he received felicitation from ICAR-CIFA, Bhubaneswar on 10th July 2011 on National Fish Farmers' Day and Aquaculture Innovators Meet 'for successful adoption of freshwater aquaculture technologies for enhancing fish farm productivity and providing leadership to the farming community'; was felicitated by ICAR-CIFE Kolkata Centre on National Fish Farmers' Day 2013 for his commendable achievement in fisheries and aquaculture; received Certificate of Appreciation from ICAR-CIFA on 18th August, 2012 'for his meritorious contribution towards aquaculture productivity by adopting and popularizing Pabda Ompak pabda breeding and culture in West Bengal'; received ICAR-CIFRI Platinum Jubilee Award in March 2018 'for outstanding achievement in fish and fisheries and supporting livelihood to vast community, which is a step towards doubling income of farmers by 2012' and at the same time delivered Platinum Jubilee lecture; received felicitation from ICAR-CIFA on 10th July 2009 on National Fish Farmers' Day 'for his efforts in adopting CIFA technologies in the field of carp seed production for enhancing fish farm productivity'; received Young Fish Farmer Award from ICAR-CIFRI, Barrackpore on 10th July, 2002.

In March-April 2019, most likely Mr Majumdar will receive the prestigious Jag Jivan Ram Innovative Farmer Award from Ministry of Agriculture, Govt. of India. Mr Majumdar was invited to ICAR-NBFGR, Lucknow in November 2016 to discuss about the prospects, conditions of farming, merits and demerits of farming of Piaractus brachypomus in freshwater ponds, which he introduced in WB. Mr Majumdar was an invitee in the one-day Scientists-Fish entrepreneurs' workshop (interactive discussion-cum-awareness programme) organized at ICAR-CIFA Kalyani Centre on 17th July, 2017.

Induced breeding of P. hypophthalmus

Presently, as seen in the end June during the visit, artificial spawning and seed production (fry, advanced fry) of P. hypophthalmus only is conducted in this farm. Mr Majumdar is concentrating on this fish only as there is great demand of its early stages outside WB. From March, brooders are maintained for two months prior to breeding operation. P. hypophthalmus attains sexual maturity and becomes ready for induced breeding at 4+ years of age. In broodstock ponds with high stocking density, fishes attain less weight at 4 years of age, but in ponds with comparatively lesser stocking density, fishes attain a higher body weight at this age. Normally 1500kg brooders can be maintained in every 8-9 decimal pond. It does not require much space.

Release of milt from male

Stripping of ova from female

Mixing of milt and ova

For the P. hypophthalmus (and also for P. brachypomus) brooders, 250kg whole dry yellow peas (which we eat as dried yellow peas curry at home) is boiled and fed to the fishes every morning. Ground nut oil cake is used at evening time. For every 1500kg broodstock of P. hypophthalmus, 25kg boiled dry yellow peas is used as feed every morning and 20kg GNOC every evening. Males weighing 1000-2000gm and females 2500-3000gm are considered suitable for induced breeding. For females, an interval of 4.5-5.0 hours is maintained in between first and second injection, pituitary extract is used as the inducing agent. The first and second doses of injection are 1mg/kg and 14mg/kg body weight respectively. The single dosage for male fish is 0.5mg/kg body weight, applied at the time of second dose to female. Stripping for release of gametes is conducted on the 6th hour of second injection to female at 38-40°C water temperature and in between 7.0-7.5 hours at 33-34°C temperature. Wet stripping method is followed both for P. brachypomus and P. hypophthalmus.

Injected male and female brooders are kept

separately in cement tanks. During artificial spawning and stripping of P. hypophthalmus, milt of 2 males is used to fertilize ova obtained from 3 females in enamel tray. Even sufficient milt of one male does work efficiently. In order to remove adhesiveness of ova and ensure effective fertilization, the fertilized eggs are treated, rinsed and washed with buffalo milk or a mixture of urea and tannic acid. But normally the sieved yellow clayey soil obtained from Bankura district, devoid of sand completely, is used. At the beginning of the season, in March-April, a dosage of 1mg/kg body weight is applied to males. If dosage to males is increased, fluidity of milt increases (becomes thinner) which is undesirable. It will not be able to cause fertilization of ova. Fertilized eggs obtained from 5-6 females are kept in a single hatching-cum-incubation chamber. After 20 hours of incubation period, larvae hatch out. The 16-17 days old P. hypophthalmus fry are harvested from rearing pond and maintained in rectangular cement cisterns of dimension 15 feet x 20 feet. Those are reared for next 5-8 days and these attain saleable size by then.

Some features of pond management

The cherry plum fruit chebulic myrobalan Terminalia chebula extract is used in P. hypophthalmus ponds. It destroys dense mass of green algae in fish ponds and also turbidity of ponds caused due to mud particles can be eliminated. Upon application of chebulic myrobalan, mud particles coagulate and settle at bottom of pond. When required, it is applied @ 20kg/33 decimal water body. A mixture of soap 'LifeBuoy' brand and mustard oil is used in P. hypophthalmus nursery ponds. Besides killing aquatic insects, since mustard oil has fat content, application of it enriches zooplankton population in ponds. Soap is first boiled in huge iron kadhai utensil over furnace, thereafter oil is added. A mixture of 5kg soap and 15 kg oil is applied in every 33 decimal pond, 48 hours prior to spawn (P. hypophthalmus) stocking. Depth of his nursery ponds is 3.0-3.5 feet.

After 2-3 crops, nursery ponds are sundried, dust Mohua oil cake @ 25kg/33 decimal is applied over the earth. On the same day, mohua oil cake soaked in water in previous night is sprayed over the dry pond earth. On the next morning, lime $CaCO_3$ solution is applied @ 20kg/33 decimal. The pond is allowed to remain in this condition the whole day, and water is filled in during evening. When water is let into nursery ponds, before spawn stocking, it is sieved through fine-meshed bolting silk cloth (hapa enclosure is constructed with such cloth at one end of the ponds and water is poured in here first); in this process larger zooplankton of Copepoda group (Cyclops sp., Diaptomus sp.) is trapped and are not allowed to enter into nurseries. Otherwise these will predate upon spawn after stocking.

Mr Majumdar stated that for Labeo bata and Puntius javanicus, spawn are stocked in earthen nurseries on 120th hour of second injection to females, but for P. brachypomus, P. hypophthalmus and

Matured Pangas catfish

Ctenopharyngodon idella, it is stocked on 96th hour. P. hypophthalmus spawn obtained from hatching-cum-incubation chambers is first kept in hapa enclosures in cement tanks, then stocked in nursery ponds. On 10th day, these small fry (advanced spawn) are harvested from nurseries and stocked in rearing pond. At the time when P. hypophthalmus fry weigh 250mg (4000 pieces/kg), those are harvested from rearing pond and stocked in those rectangular cisterns, maintained for a brief period before sale. Four borewell submersible pumps are used here as water source. Drawn-out water is stored in one pond, oxygenation is provided here at a high rate and water is continuously agitated by traditional but effective aeration device. This water is allowed to flow into overhead tank, next it flows down into the hatching-cum-incubation units, used water finally flows into different ponds.

Feed for growing spawn

The 4-day old stage is stocked into nursery ponds @ 6-9 lakh / pond. On the 9-10th day of stocking, these are harvested from nurseries and stocked in rearing pond (bigger in size) @ 4-5 lakh / pond. From 9-10th day, liquefied form of GNOC is fed to the advanced spawn two times a day. An amount of 8kg GNOC is used for every 2,00,000 spawn (10-days stage) daily in rearing pond. From 10th day, dry rice polish (5-7kg in each pond) is fed to advanced spawn of P. hypophthalmus. For every 3000nos. of spawn (10-days stage), 10-15kg rice polish is used everyday.

For the first ten days after stocking, powdered milk suspension is used (@ 4kg/82 decimal pond everyday and 3kg in smaller nurseries) in morning and evening in nurseries where P. hypophthalmus spawn are stocked. From same time, minced tubifex worm is applied in the ponds @ 3kg/33 decimal pond. A mixture of GNOC (50kg), dust shrimp feed (Rs 95/- / kg; 40kg) and AgriMin. Feed supplement (40kg) is allowed to compost in cement cisterns; then it is applied @ 7-8kg/65 decimal pond. It is used considering the condition of pond water, not used routinewise. Transparent and thin extract of chebulic myrobalan is used in nursery ponds @ 60-70kg/65 decimal water body. Thick

extract of the same is used in P. hypophthalmus brooders' pond.

The 10-days stage is propagated in rearing pond for next 6-7 days, which is a large pond of 650 decimal located at a distance of 6km from this campus. In each of the large rectangular cement cisterns, before sale, the 16-17 days old fry are fed 30-35kg tubifex worms, 10kg pelleted shrimp feed and lumpfulls of dust-type commercial feed daily. In addition to tubifex worms, pelleted feed (1mm dia) is used. In each such cistern, 3-4 quintals of P. hypophthalmus fry are stocked. Seeds weighing 250-1000mg (20-24mm) are supplied to Andhra Pradesh by air and sold @ Re 0.40-0.50 / piece; larger ones of 45-50mm size are sold at renowned Rajendrapur-Battala fish seed market in North 24 Parganas @ Re 0.70-0.80 / piece.

End note

Mr Babul Majumdar has been thoroughly trained by ICAR-CIFA, Kalyani in breeding and rearing of O. pabda. He is now capable of selling pabda seeds in the market @ Rs 3/- / piece. Deep-layer ground water is required for breeding and seed production of O. pabda, and it must be completely iron-free, Mr Majumdar opined. It attains 50-60gm in one year. In one of his brood stock pond of 2.5 bigha (82 decimal), he is maintaining 10-12 tonnes of brood fishes comprising Indian major carps and P. brachypomus. In one of his nursery pond of 3 bigha (100 decimal), he stocked 20,00,000nos. spawn of P. hypophthalmus and those were being maintained (9-10 days stage as on 30th June 2018) under proper condition. Every management aspect is cautiously and meticulously looked into by Mr Majumdar and his workforce; there are 35 male and 5 female workers in this farm. Since 2007, P. brachypomus seeds are produced here. According to Mr Majumdar, brooders and spawn of P. brachypomus cannot be reared in chebulic myrobalan extract treated water.

Mr Majumdar has installed Closed-circuit television camera in different places in his farm. He is working on seed production of economically-important cultivable freshwater fishes for the last 38 years. In last 14 years, many trainees and State Government officers from different parts of India, who come for weeklong training at ICAR-CIFA Kalyani Regional Centre, have visited this farm and undergone demonstration of different facets of induced breeding and fish seed production. Dignitaries including Dr S. Ayyappan, Former DG, ICAR; Dr P. Jayasankar, Former Director, ICAR-CIFA; Dr J. K. Sundaray, Director, ICAR-CIFA; Mr Kiranmoy Nanda, Former Minister of Fisheries, Government of WB; Minister of Fisheries, Government of Tripura; Scientists of ICAR-CIFA Kalyani and Rahara Regional Centres have visited Mr Babul Majumdar's hatchery. Author is truly grateful to Mr Majumdar and Mr Jafar Ali, elderly farm employee for entertaining author at hatchery site and patiently explaining different activities pertaining to induced breeding and seed production of P. hypophthalmus.

'Omni-Channel' Shrimp Tech Platform looks to Modernize Indian Sector

Omni-channel" shrimp platform Aquaconnect is ready to take the next step in its ambitious plans towards making the Indian aquaculture sector simpler and more modern for rural farmers. The Chennai, Tamil Nadu-headquartered project is now hiring business analysts to "develop strategies for our Omni-channel marketplace", as well as "digital assistants" to help farmers with technology adoption, CEO Raja Manohar told its stated mission is to simplify the shrimp farming business experience for farmers in rural India, according to an investor brief shown. "Our Omni-channel marketplace provides quality and affordable inputs to the shrimp farmers. Also we provide them market access to sell their harvested shrimp." Aquaconnect also locates good quality post larvae from the hatcheries; procures other inputs such as feed, chemicals and probiotics at optimum prices; and creates a transparent and accessible export market for their harvest, it claims. "Increasingly, hatcheries, input providers and processors prefer to work with Aquaconnect as we help them reduce the dedicated sales force and associated operational cost," said Raja Manohar. Currently Aquaconnect works with around 3,000 farmers in Tamil Nadu and parts of Andhra Pradesh, and has completed 100 paid deals, he said 65 hatcheries and 15 exporters are also on board. "We recently won a contract from [one of the] world's largest feed companies, worth about $72,000, to launch their farm management tool in India," he said. This has not yet been announced publicly, and so he could not confirm the company, he said. However, Dutch aquafeed firm Nutreco has recently invested in Indian start up Eruvaka, which aims to use the "internet-of-things" and mobile technology to help aquaculture farmers increase productivity.

Aquaconnect has identified a number of challenges in the Indian Shrimp sector, including supply chain inefficiency; a lack of transparency in the market place; exploitative middlemen; and a lack of formal financial access. As well as supplying farmers, it hopes to help educate them using its website "for tech-savvy farmers", a multi-lingual toll-free number, and digital assistants "on the ground". It plans to take service fees on aquaculture inputs, and sees an overall market potential for Aquaconnect of $558 million, based on a three-crop cycle per year. It believes it can serve some 2,200 farmers in Tamil Nadu; 5,00 in Gujarat, on the west coast; and a huge 42,000 farmers in Andhra Pradesh.

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Micro-Algae Culture Techniques and its Importance in Aquaculture

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Introduction

Phytoplankton are the micro-algae, which used as the basic food of almost all the animals in aquatic ecosystem. Most of them are unicellular. They are the primary producer of organic matter in aquatic habitats. The scope of micro-algae as a possiblesource of protein food-was recognized in the middle of the 20th century. In the past, the main attention was on Single Cell Protein (SCP) production for human consumption and later many new applications have evolved including waste-water treatment, nutrient recycling, closed life-support systems, aquaculture and the bio-conversion of solar energy. In recent years, there has been renewed interest in producing Single Cell Protein by mass culturing the unicellular micro-algae such as diatoms (species of Chaetoceros and Skeletonema) and Nannoplanters (species of Isochrysis, Chlorella and Tetraselmis) for feeding the larvae of crustaceans, molluscs and fishes, as the success of any hatchery operation depends mainly on providing the required species of microalgae. The larvae of prawns and fishes prefer diatoms as their basic food while the larval molluscs live on the nannoplankton flagellates, measuring less than ten microns. For rearing shrimp larvae species of Chaetocerosand Skeletonemaare used. Species of Isochrysis, Pavlova, Dicrateriaand Chromulinaare used as feed for the larvae of pearl and edible oyster, mussels, clams and sea cucumbers and mixed diatom cultures and nannoplanters are given for the juveniles and adults. The various aspects of the micro-algae culture are: isolation of required species, identification, and preparation of culture media, stock culture maintenance, indoor and outdoor mass culture and harvest and preservation of the culture.

Highlight Points

Microalgae or microscopic algae produce in either freshwater or marine systems. They are the primary producers in the oceans that convert water and carbon dioxide to biomass and oxygen in the presence of sunlight. Now, cultured microalgae is used as direct feed for humans and land-based farm animals.Micro-algae are an important food source in the rearing of all stages of marine bivalve molluscs (clams, oysters, and scallops), the larval stages of some marine gastropods (abalone, conch), larvae of several marine fish species and penaeid shrimp, and zooplankton.

Further, for rearing marine fish larvae according to the "green water technique" algae are used directly in the larval tanks, where they are held to play a role in stabilizing the water quality, nutrition of the larvae, and microbial control.It is a potential candidate for biofuel production. So the culture of micro algae is very important for aquaculture development. The different factors play important role in the culture condition of algae which are discussed here in details.

Phytoplankton comprises the base of the food chain in the marine and the freshwater environment. Therefore, micro-algae are indispensable in the commercial rearing of various species of marine animals as a food source for all growth stages of bivalve molluscs, larvae of crustacean species, and very early growth stages of some fish species. Algae are furthermore used to produce mass quantities of zooplankton (rotifers, copepods, and brine shrimp) which serve in turn as food for larval and early-juvenile stages of crustaceans and fish. Further, for rearing marine fish larvae according to the "green water technique" algae are used directly in the larval tanks, where they are held to play a role in stabilizing the water quality, nutrition of the larvae, and microbial control.

Major classes and genera of cultured algal species

Today, more than 40 different species of micro-algae, isolated in different parts of the world, are cultured as pure strains in intensive systems. There are eight major classes and 32 genera of cultured algae currently used to feed different groups of commercially important aquatic organisms.

Requirement for Algal Production:

Physical and chemical conditions

The most important parameters regulating algal growth are nutrient quantity and quality, light, pH, turbulence, salinity and temperature. The most optimal parameters as well as the tolerated ranges are species specific and a broad generalization for the most important parameters is given in Table 2.2. Also, the various factors may be interdependent and a parameter that is optimal for one set of conditions is not necessarily optimal for another.

Table No. 1 Major Classes and genera of micro-algae cultured in aquaculture:

CLASS	GENUS	EXAMPLE OF APPLICATION
Bacillariophyceae	*Skeletonema*	PL,BL,BP
	Thalassiosira	PL,BL,BP
	Phaeodactylum	PL,BL,BP,ML,BS
	Chaetoceros	PL,BL,BP,BS
	Cylindrotheca	PL
	Bellerochea	BP
	Actinocyclus	BP
	Nitzchia	BS
	Cyclotella	BS
Haptophyceae	*Isochrysis*	PL,BL,BP,ML,BS
	Pseudoisochrysis	BL,BP,ML
	dicrateria	BP
Chrysophyceae	*Monochrysis (Pavlova)*	BL,BP,BS,MR
	Tetraselmis (Platymonas)	PL,BL,BP,AL,BS,MR
Prasinophyceae	*Pyramimonas*	BL,BP
	Micromonas	BP
Cryptophyceae	*Chroomonas*	BP
	Cryptomonas	BP
	Rhodomonas	BL,BP
Cryptophyceae	*Chlamydomonas*	BL,BP,FZ,MR,BS
	Chlamydomonas	BP
Xanthophyceae	*Olisthodiscus*	BP
Chlorophyceae	*Carteria*	BP
	Dunaliella	BP,BS,MR
Cyanophyceae	*Spirulina*	PL,BP,BS,MR

Note: PL, penaeid shrimp larvae; BL, bivalve mollusc larvae; ML, freshwater prawn larvae; BP, bivalve molluscpostlarvae; AL, abalone larvae; MR, marine rotifers *(Brachionus)*; BS, brine shrimp *(Artemia)*; SC, saltwater copepods; FZ, freshwater zooplankton.

- A generalized set of conditions for culturing micro-algae (modified from Anonymous, 1991).

Parameters	Range	Optima
Temperature (°C)	16-27	18-24
Salinity ($g.l^{-1}$)	12-40	20-24
Light intensity (lux)	1,000-10,000 (depends on volume and density)	2,500-5,000
Photoperiod (light: dark, hours)		16:8 (minimum) 24:0 (maximum)
pH	7-9	8.2-8.7

Culture Media

For the successful culture of micro-algae, various chemical culture media have been used depending on the type of organisms cultured and their growth phases. Since the micro-algae require nutrients such as nitrates and phosphates, roughly in a ratio of 10: 1 (N:P) for normal growth, and reproduction, the culture media used in the laboratory should have sufficient quantities of these elements besides other growth promoting substances including trace metals and vitamins. Since the diatoms require silica for building up the cell walls, the culture media should have a silicate source besides nitrates, phosphates, chlorides and trace metals. Similarly, for the nanoplankton flagellates such as species of Isochrysis, Dicrateria, Pauloua, trace metals and vitamins are required for their growth. Commercially available nutrient solutions may reduce preparation labour. The complexity and cost of the above culture media often excludes their use for large-scale culture operations. Alternative enrichment media that are suitable for mass production of micro-algae in large-scale extensive systems contain only the most essential nutrients and are composed of agriculture-grade rather than laboratory-grade fertilizers

Light

As with all plants, micro-algae photosynthesize, i.e. they assimilate inorganic carbon for conversion into organic matter. Light is the source of energy which drives this reaction and in this regard intensity, spectral quality and photoperiod need to be considered. Light intensity plays an important role, but the requirements vary greatly with the culture depth and the density of the algal culture: at higher depths and cell concentrations the light intensity must be increased to penetrate through the culture (e.g. 1,000 lux is suitable for erlenmeyer flasks, 5,000-10,000 is required for larger volumes). Light may be natural or supplied by fluorescent tubes. Too high light intensity (e.g. direct sun light, small container close to artificial light) may result in photo-inhibition. Also, overheating due to both natural and artificial illumination should be avoided. Fluorescent tubes emitting either in the blue or the red light spectrum should be preferred as these are the most active portions of the light spectrum for photosynthesis. The duration of artificial illumination should be minimum 18 h of light per day, although cultivated phytoplankton develop normally under constant illumination.

pH

The pH range for most cultured algal species is between 7 and 9, with the optimum rangebeing 8.2-8.7. Complete culture collapse due to the disruption of many cellular processescan result from a failure to maintain an acceptable pH. The latter is accomplished by aeratingthe culture (see below). In the case of high-density algal culture, the addition of carbondioxide allows to correct for increased pH, which may reach limiting values of up to pH 9 during algal growth.

Aeration/mixing

Mixing is necessary to prevent sedimentation of the algae, to ensure that all cells of the population are equally exposed to the light and nutrients, to avoid thermal stratification (e.g. in outdoor cultures) and to improve gas exchange between the culture medium and the air. The latter is of primary importance as the air contains the carbon source for photosynthesis in the form of carbon dioxide. For very dense cultures, the CO_2 originating from the air (containing 0.03% CO_2) bubbled through the culture is limiting the algal growth and pure carbon dioxide may be supplemented to the air supply (e.g. at a rate of 1% of the volume of air). CO_2 addition furthermore buffers the water against pH changes as a result of the CO_2/HCO_3 - balance. Depending on the scale of the culture system, mixing is achieved by stirring daily by hand (test tubes, erlenmeyers), aerating (bags, tanks), or using paddle wheels and jet pumps (ponds). However, it should be noted that not all algal species can tolerate vigorous mixing.

Temperature

The optimal temperature for phytoplankton cultures is generally between 20 and 24°C, although this may vary with the composition of the culture medium, the species and strain cultured. Most commonly cultured species of micro-algae tolerate temperatures between 16 and 27°C. Temperatures lower than 16°C will slow down growth, whereas those higher than 35°Care lethal for a number of species. If necessary, algal cultures can be cooled by a flow of cold water over the surface of the culture vessel or by controlling the air temperature with refrigerated air- conditioning units.

Salinity

Marine phytoplankton are extremely tolerant to changes in salinity. Most species grow best at a salinity that is slightly lower than that of their native habitat, which is obtained by diluting sea water with tap water. Salinities of 20-24 g.l-1 have been found to be optimal.

Algal culture techniques

Algae can be produced using a wide variety of methods, ranging from closely-controlled laboratory methods to less predictable methods in outdoor tanks. There are three basic types of phytoplankton culture which will be described in the following sections-

Batch culture

The batch culture consists of a single inoculation of cells into a container of fertilized seawater followed by a growing period of several days and finally harvesting when the algal population reaches its maximum or near-maximum density. In practice, algae are transferred to larger culture volumes prior to reaching the stationary phase and the larger culture volumes are then brought to a maximum density and harvested.

According to the algal concentration, the volume of the inoculum which generally corresponds with the volume of the preceding stage in the upscaling process, amounts to 2-

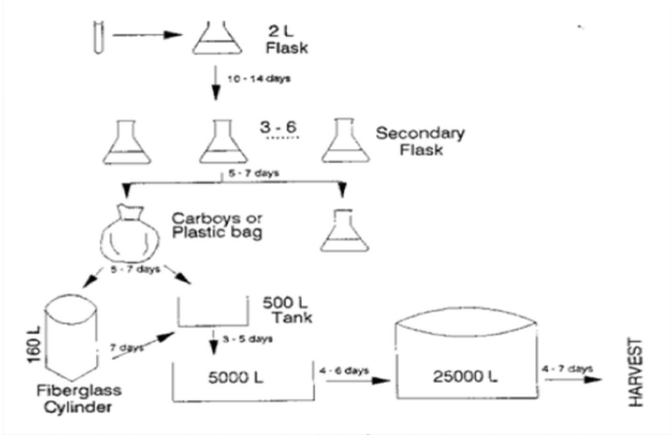

Fig: An inoculation schedule for the batch technique.

10% of the final culture volume. Where small amounts of algae are required, one of the simplest types of indoor culture employs 10 to 20 l glass or plastic carboys, which may be kept on shelves backlit with fluorescent tubes. Batch culture systems are widely applied because of their simplicity and flexibility, allowing to change species and to remedy defects in the system rapidly. Although often considered as the most reliable method, batch culture is not necessarily the most efficient method. Batch cultures are harvested just prior to the initiation of the stationary phase and must thus always be maintained for a substantial period of time past the maximum specific growth rate. Also, the quality of the harvested cells may be less predictable than that in continuous systems and for example vary with the timing of the harvest (time of the day, exact growth phase).

Another disadvantage is the need to prevent contamination during the initial inoculation and early growth period. Because the density of the desired phytoplankton is low and the concentration of nutrients is high, any contaminant with a faster growth rate is capable of outgrowing the culture. Batch cultures also require a lot of labour to harvest, clean, sterilize, refill, and inoculate the containers.

Continuous culture

The continuous culture method, i.e. a culture in which a supply of fertilized seawater is continuously pumped into a growth chamber and the excess culture is simultaneously washed out, permits the maintenance of cultures very close to the maximum growth rate. Two categories of continuous cultures can be distinguished:

- Turbidostat culture: - In which the algal concentration is kept at a preset level by diluting the culture with fresh medium by means of an automatic system.
- Chemostat culture: - In which a flow of fresh medium is introduced into the culture at a steady, predetermined rate. The latter adds a limiting vital nutrient (e.g. nitrate) at a fixed rate and in this way the growth rate and not the cell density is kept constant.

Laing (1991) described the construction and operation of a 40 l continuous system suitable for the culture of flagellates, e.g. *Tetraselmissuecicaand Isochrysisgalbana*. The culture

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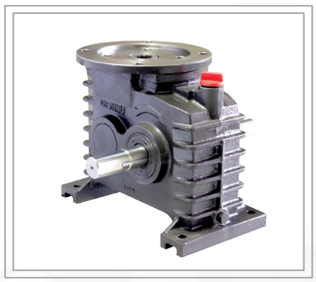

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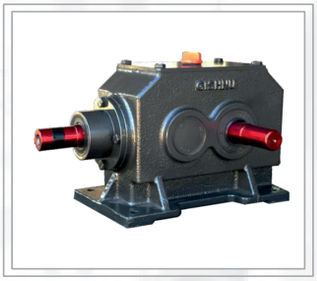

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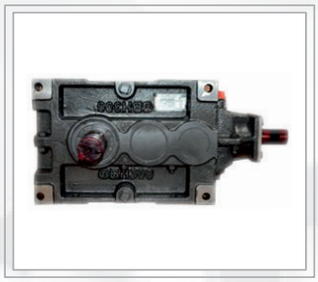

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vessels consist of internally-illuminated polyethylene tubing supported by a metal framework (Fig. 2.11.). This turbidostat system produces 30-40 l per day at cell densities giving optimal yield for each flagellate species (Table 2.8.). A chemostat system that is relatively easy and cheap to construct is utilized by Seasalter Shellfish Co. Ltd, UK. The latter employ vertical 400 l capacity polyethylene bags supported by a frame to grow *Pavlova lutheri, Isochrysisgalbana, Tetraselmissuecica, Phaeodactylumtricornutum, Dunaliellatertiolecta, Skeletonemacostatum.* One drawback of the system is the large diameter of the bags (60 cm) which results in self-shading and hence relatively low algal densities.The disadvantages of the continuous system are its relatively high cost and complexity. The requirements for constant illumination and temperature mostly restrict continuous systems to indoors and this is only feasible for relatively small production scales. However, continuous cultures have the advantage of producing algae of more predictable quality. Furthermore, they are amenable to technological control and automation, which in turn increases the reliability of the system and reduces the need for labor.

Semi-continuous culture

The semi-continuous technique prolongs the use of large tank cultures by partial periodic harvesting followed immediately by topping up to the original volume and supplementing with nutrients to achieve the original level of enrichment. The culture is grown up again, partially harvested, etc. Semi-continuous cultures may be indoors or outdoors, but usually their duration is unpredictable. Competitors, predators and/or contaminants and metabolites eventually build up, rendering the culture unsuitable for further use. Since the culture is not harvested completely, the semi-continuous method yields more algae than the batch method for a given tank size.

Algal production in outdoor ponds

Large outdoor ponds either with a natural bottom or lined with cement, polyethylene or PVC sheets have been used successfully for algal production. The nutrient medium for outdoor cultures is based on that used indoors, but agricultural-grade fertilizers are used instead of laboratory-grade reagents (Table 2.5). However, fertilization of mass algal cultures in estuarine ponds and closed lagoons used for bivalve nurseries was not found to be desirable since fertilizers were expensive and it induced fluctuating algal blooms, consisting of production peaks followed by total algal crashes. By contrast, natural blooms are maintained at a reasonable cell density throughout the year and the ponds are flushed with oceanic water whenever necessary. Culture depths are typically 0.25-1 m. Cultures from indoor production may serve as inoculum for monospecific cultures. Alternatively, a phytoplankton bloom may be induced in seawater from which all zooplankton has been removed by sand filtration. Algal production in outdoor ponds is relatively inexpensive, but is only suitable for a few, fast-growing species due to problems with contamination by predators, parasites and "weed" species of algae. Furthermore, outdoor production is often characterized by a poor batch to batch consistency and unpredictable culture crashes caused by changes in weather, sunlight or water quality.

Harvest And Preservation Of The Culture:

Harvest should be done during the exponential phase of growth of the micro-algae after determining the cell concentration. If the culture has entered the declining or stationary phase, the metabolites will be more and the cells may not be in healthy condition. The rearing larval organisms may not show the expected growth if fed with this algae. The maintenance of the culture and constant supply of the same whenever required is a problem in the hatchery, especially during adverse weather conditions. Preservation of the algal either by freezing or by drying could be done so that during adverse condition, the hatchery operations may be successfully conducted. For freezing or drying, the culture has to be flocculated either by adding lime or adjustii1.g the pH using sodium hydroxide. After knowing the quantity of the culture to be flocculated, measure the volume of sodium hydroxide solution needed to flocculate to get one degree rise in pH. Suppose the pH of the culture is 8.4, raise to 9.4 by adding sufficient quantity of sodium hydroxide solution. After vigorous stirring, leave the culture for one hour. After one hour, the algal mass deposited at the bottom of the tank has to be collected in a bucket by decanting the clear water. Then bring the pH of culture to the original level by adding sufficient quantity of dilute hydrochloric acid. Now the algae are ready for freezing or sun-drying. Drying of the algae can be done by pouring the mass in white enamel trays and keeping the same in bright sun-light. If the algae have dried up thoroughly, scrap the powder from the tray and keep it in glass bottles. Before freezing the algal mass in polythene bags few drops of preservatives like glycerol or dimethyl sulphoxide are to be added. The frozen algae may not have the same protein content as in the live condition. Whenever adverse conditions arise, the frozen algae can be utilized for rearing the larval organisms.

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Biofloc and its Significance in Farming of Shrimps

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Introduction

Biofloc is one of a recent technology, which shows several benefit over other farming technologies. In India very few farmers applied biofloc technology in their farming and hatchery systems, especially in shrimp hatchery. There are approximately 260 shrimp hatcheries in our country at present, of this nearly 200 hatcheries are in the state of Andhra Pradesh, remaining 60 hatcheries only fall in rest of the states like Tamil Nadu, Odisha, Gujarat, and Karnataka.

The term 'floc' is designated as flocculation of organic matter`s present in the medium at the level of higher concentration of particulate biomass (Aquacop 1975; Guillaume et.al.,1989). Biofloc defined as macro aggregates like diatoms, microalgae, excess feed, faecal pellets, and remains of dead organisms, exoskeleton, bacteria, protest and invertebrates (Jatoba et al., 2014 and Hargreaves, 2006). Biofloc system is much profitable in farming as well as hatchery practices than the normal semi-intensive culture-based system. This system offers efficient use of water, reduced feed cost, and improved biosecurity, reduce the risk of crop loss due to the outbreak of bacterial and viral diseases. There are two biofloc technologies primarily used in shrimp cultivation they are in-situ and ex-situ biofloc system (Avnimelech and Lacher, 1999).An In-situ biofloc system is currently in operation, whereas ex-situ biofloc system is under developing condition. In the in-situ biofloc system, biofloc were formed in culture pond along with the shrimp. With the proper maintenance and management, ammonia level in the water can directlyassimilated by microorganisms and converted as microbial protein.Over these benefits, there is a demand for oxygen due to the utilization of oxygen by both micro and macro agregates and culture animal. In the case of ex-situ biofloc system, effluent water is treated by using the biological reactor, which results in the production of biofloc and the produced biofloc is used as an ingredient in shrimp feed. Normally biofloc is rich in protein, which helps to replace fish meal either partially or fully by biofloc as a source of protein. When biofloc is used as a shrimp diet, the animal shows positive responses like improved growth rate and health conditions.

There are three basic reasons why biofloc is inevitable technology in shrimp hatcheries as well as in shrimp farming. The reasons could be, may produce more aquaculture products without increasing the usage of the natural resources like water and land(Avnimelech, 2009).It helps to develop sustainable aquaculture system without affectingthe natural environment (Naylor et al., 2000). And this system willprovide an equitable cost/benefit ratio to improve economic and social sustainability(Avnimelech, 2009).

Biofloc production

There are two methods of biofloc production. One is in-situ (production of biofloc in the culture pond itself) and another one is ex-situ (produced from out of the culture pond) biofloc production. When C/N ratio is maintained above 10:1 (optimally 12:1)in the culture water the boifloc is produced within 5 or 6 days(Wu-Jie Xu et al., 2015). C/N ratio is one of the deciding factors in the process of biofloc production. Apart from this DO (dissolved oxygen) is also a deciding factor. Because the microbial aggregates in the floc may usesthe higher level of oxygen for their accumulation and produce higher level of CO_2, which may cause decrease in pH. To overcome this problem $NaHCO_3$ is added to the culture system at optimal lavel (Wu-Jie Xu et al, 2015). Initially,biofloc is green in color due to the accumulation of autotrophic organisms like filamentous microalgae, then itslowly turns into brown color which predominance in heterotrophic bacteria. The color may vary based on the addedcarbon source. Generally heterotrophic bacterial accumulation is much more rapid than the accumulation of nitrifying bacteria (Hargreaves, 2006).

Need of aeration and aerators in biofloc production

Aeration is one of the prime management activity for the production of biofloc. Aeration controls the quantity of biofloc production. In the culture system of shrimp with biofloc, the demand for oxygen may double then the other commercial systems. Aeration not only provides oxygen to the culture system, it also helps to maintain the micro and macro aggregates in suspension. This process will minimize the settlement of excess feed (uneaten feed) at the bottom. If there is no settlement of suspended matters, there will not sludge formation at the bottom of pond. For the production of 'floc' the water should always be in circulation which enhances the suspension growth of heterotrophic bacteria and microalgae.

Highlight Points

- **Biofloc system reduces the water usage comparatively with other commercial systems.**
- **System will not harm the natural environment (Eco-friendly method of shrimp farming).**
- **Formed flakes act as a protein rich feed for culture animal, hence it will reduces the feed cost.**
- **Cultured animal shows improved health condition.**

Carbon source

Biofloc technology is mainly used to improve

the water quality through the addition of extra carbon to the culture system. The added carbon is used to synthesise the new heterotrophic bacterial cells by the assimilation of ammonium and extra inorganic nitrogen, which may reduce the ammonium and nitrogenous waste in the culture water. Some of the carbon sources are listed below(Felix and Sudharsan, 2004; Makela et al., 1998).

- Tapioca
- Sugarcane Molasses (contains glycine betaine, act as attractants in aquaculture)
- Tapioca by-product
- Rice Bran
- Plant cellulose
- Dextrose
- Glucose
- Glycerol

Calculation of carbon requirement

Here, I have given the model calculation to find out the carbon requirement of the culture system and how much carbon needs to be supplied in the shrimp larval rearing system to produce biofloc, (Eg. Total area of larval rearing tank is 10 m2 and stocking density is 150 no's/m2).

For the post larvae of shrimp (PL7) the feeding rate will be 21.1% (according to FAO) of total biomass. At this stage Shrimp weigh approximately 0.1g. The stocking density of PL is 150 no's/m2 in the hatchery. The feed required is 31.6g. Take a feed with 25% of protein but the protein requirement at earlier stage of shrimp is higher than the later stage. In general 1g of protein consists of 16% of nitrogen(Craig and Helfrich, 2002). So 31.6g of feed consist of 7.91g protein, of which 16%(1.26g) is nitrogen. An average 75% of feed nitrogen ends up in the water through uneaten feed and animal excretion (Piedrahita, 2003). So nitrogen level in the pond water after assimilation by animal is 0.94g. Minimum requirement of C/N ratio for the microorganism to form aggregate is10:1(Avnimelech, 1999). So 9.4 g of carbon is required to maintain the C/N ratio at 10:1. This calculation is for one day (PL7), accordingly the carbon requirement will be calculated for each day.

Biofloc as shrimp feed

Shrimp feed cost more than 40-50% of the working capital(Bender et al., 2004).There are several commercial feeds available for shrimp with different nutritional composition. The composition of nutrients in the feed is based on the ontogenic development of shrimp. For example, in the initial stage the requirement of protein is very high, in later stages it may reduce. Normally in shrimp feed, the fish meal is used as a protein source. For the production of the fish meal low- value fishes/ trash fishes are used, due to this reason the demand on trash fish has been increased, as well as the value of trash fish also increased. As a result, the cost of feed has been increased. To overcome this problem, there is a need to find out the better alternative without compromising the nutritional quality of shrimpfeed.

Here, the biofloc technology came as a revolution in shrimp farming. The biofloc is produced when the C/N ratio is inoptimal level. The produced biofloc consist of microalgae, diatom, heterotrophic bacteria, etc. Normally, heterotrophic bacteria utilize carbon and ammonia(Nitrogenous waste) for the synthesis of new cells. Therefore the water quality has maintained. The optimal level of biofloc in culture water is 15ml/l. The biofloc is rich in protein (30% of dry matter), carbohydrate (18% of dry matter), ash (31% of dry matter), lipid (4% of dry matter), and moisture (12%)(Helena Khatoon et al, 2016). If the biofloc technology is used for shrimp culture nearly half of the feed cost mayreduce, because the animal(shrimp) directly feed the biofloc (Crab, 2010; Crab et al., 2007, 2009, 2010a).which shows several advantages over commercial feed like increased production, improved health condition, maintain good water quality totally biofloc gives the biosecurityto the culture system(Mishra et al., 2008).

Some of the research and field experimental findings shows that BFT (Biofloc Technology) will reduce more than 20%of the rational feed application. BFT normally improves the growth rate of shrimp, this indicated that biofloc might possess a 'growth factor'. Cultured shrimp shows full gut for the entire day throughout the culture period & the protein conversion ratio is twice as efficient as normal conventional shrimp culture system. And biofloc improves enzymatic and hormonal activity. If water contains 5 ml/l of floc, it might be said that 1 ha pond may contain approximately 700 kg of feed. The bacterial biomass which is produced by the biofloc system contains approximately 61% of crude protein.

Control of inorganic nitrogen by biofloc

When carbon source is applied to the culture system atrequired level bacteria which are present in the water utilizes organic carbon and search nitrogen for cell growth & multiplication. The main purpose of adding carbon source (Carbohydrate) is to immobilize the nitrogen (organic or inorganic nitrogen) present in the water generated by animal excretion and degradation of excess feed. Based on the level of carbonaceous substrate this immobilization will be mooted. Proper monitoring of TAN (Total Ammonia Nitrogen) will give the clear cut idea about how much of carbon should be addedto the culture system in order to minimize the level of TAN.

Our culture system is mainly based on feed to get a maximum production with minimal inputs. But nearly 75% of provide protein in the form of feed may unutilized by an animal and remains in the form of inorganic nitrogen in the water column. Here, the BFT plays a major role to convert inorganic nitrogen to microbial protein by the bacterial community (Avnimelech, 1999). Nitrogen is an important building block of microbial cells, because protein is the major component of the microbial cell.

Disease control effect of biofloc

Most of the emerging fish farmers or shrimp farmers normally go for higher stocking density (>100 nos/m^2) to get more yield. But the result is not more yield. In other words they are facing loss of culture due to the outbreak and spreading of viral and bacterial diseases. Normally overcrowding leads to the easy spreading of deadly disease. The recommended stocking density is 60 nos/m^2. Even some of the experienced shrimp farmers go for 50nos/m^2. Because they know that overcrowding leads to over stress, outbreak and spreading of diseases, depleting the quality of water. But in the biofloc

system though the stocking density is very high, the disease outbreak is less common. That is the main advantage of biofloc. Biofloc provides complete biosecurity to the culture system. One of the greatest challenges faced by the shrimp farmer is how to neglect the outbreak of viral diseases like WSSV, AHPND(Escobedo-Bonilla et al). Since WSSV was first identified during 1994-1995 and now it is 12-13 years till now the effective control measures for WSSV is yet to be developed. But we know that the outbreak is due to lack of biosecurity in culture systems.

In the presence of biofloc system, shrimp or fish shows improved immune response and less susceptibility to the occurrence of bacterial and viral disease. If the immune system get activated, it fights against the infective agents when it is invaded in to the animal body. Shrimp have only innate immune response system they don't have an adaptive immune system and immunological system. So they don't have antibodies. The research was conducted by National Fisheries Research and Development Institute, Incheon, The Republic of Korea on shrimp PL's growing in biofloc systems. They found that the presence of prophenoloxidase 1 (proPO1), prophenoloxidase 2 (proPO2), prophenoloxidase activating enzyme (PPAE), serine proteinase 1 (SP1), masquerade like-serine proteinase (mas) and Ras-related nuclear protein (Ran) was high in PL's of shrimp grown in the biofloc (Kim et al). These are all the components of the innate immune system. The recent research found that, the presence of antiseptic agents like short chain fatty acids (SCFA) or poly-B-hydroxy butyrate (PHB) produced by biofloc community. These components effectively acts against the *Vibrio* sp.

Microbiology of biofloc

When shrimp or fish cultured with the biofloc system it may contact with wide varieties of micro-organisms. Normally in biofloc systems, 1 ml of water may harbor 106 - 109 cells. Biofloc is mainly consisting of bacteria, algae, protozoa, and zooplankton. By using molecular pro-sequencing technology researcher found that biofloc system contains 1000 - 2000 different bacteria.

Future areasof study

- Use of microbial protein in aquaculture
- Whether protein pool is available for any fish and shrimp species.
- Proper selection and positioning of aerators.
- Integration of biofloc with existing culture systems like aquaponics, raceways, polyculture.
- Determining the impact of different carbon sources on biofloc characteristics.
- Identification of beneficial bacteria from biofloc.

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Immense Potentiality of Bacterial Biofilm as Commercial Vaccine in Indian Aquaculture

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Abstract

Due to the tremendous intensification, increasing stocking densities in aquaculture give rise to high stress levels in cultured organisms which in turn make fish more vulnerable to infection. Prevention of disease outbreaks is therefore essential to prevent serious economic losses and thus the development of drugs for aquaculture species is imperative. The application of new and novel strategies to develop effective vaccines is indispensible in sustainable aquaculture health management. The bacterial biofilm-based oral vaccine development is a recent technology developed by the Indian scientists. Conventional planktonic bacterial cell or Free cell (FC) oral vaccines give poor and inconsistent immune response and protection in fish mainly due to their destruction by enzymes in stomach or foregut before reaching the immune responsive lymphoid organs. Biofilms (BF) are known for their resistant nature to antibiotics, antibodies and phagocytic cells due to a protective glycocalyx layer. Unlike in natural environment, here in our laboratory bacteria was made to go into biofilm mode by providing them with minimum of media and harsh environment in the form of shaking 120 strokes/ min. The biofilm thus produced, inactivated and delivered orally demonstrated good humoral and protective response in herbivore carps, omnivore catfish (*Clarias batrachus*), carnivore fish (*Channa striatus*) and tiger shrimp (*Penaeus monodon*). Till now, no known vaccines are being commercialized or marketed in India despite the fact that market attractiveness is very high. Biofilm based oral vaccines efficacy has been proven in institutional research experiments, now it is high time to produce on a large commercial scale for the development and marketing of this vaccines in India which are very important to reduce

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the disease loss in fish culture in this country and elsewhere.

Key words: Aquaculture health management, bacterial biofilm, free cell, protective response

Highlight Points

- **Due to the tremendous intensification in aquaculture activities, the need for effective disease control measures is of prime concern.**
- **Bacterial biofilms is a novel antigen for oral vaccination in aquaculture.**
- **Several advances have been made in developing biofilm-based oral vaccines for fish.**
- **Biofilm vaccine is considered as simple, cheap and ideal technique for mass administration.**
- **Bacterial biofilms are excellent immunostimulating agents for shrimp as they express several other antigenic proteins and are also resistant to gastric enzymes.**
- **With its outstanding success in institutional research experiments, it is expecting that by the end of 2019 biofilm vaccines will be available on commercial scale as several drug companies came forward to take the product for marketing.**

Introduction

Aquaculture is a steadily growing industry world over. The number species and new technologies are increasing in aquaculture industry for rising production. Intensification has come up as a boon to meet the increasing food demand. However, diseases are stumbling block, causing huge economic looses imposed by incidences and outbreaks of infectious diseases on account of high mortality in farmed fishes and commercial aquaculture systems. Literature suggested that 54.9% bacterial pathogens, 22.6% viruses, 3.1% mycotic agents, and 19.4% parasitic agents are responsible for periodical disease outbreaks in fish cultures (Dhar *et al*., 2014). To control bacterial and other diseases, antibiotics and drugs were used indiscriminately. Antibiotic has already raised lots of criticism over its negative impact on living biota may lead to antibiotic-resistant pathogen. Vaccination is becoming an increasingly important part of aquaculture, since it is considered a cost effective method of controlling different threatening diseases.

Concept of vaccination and the pioneers'

Intentional administration of a harmless or less harmful form of a pathogen to induce a specific immune response that protects the individual against later exposure of the same pathogen is called vaccination. The word "vaccination" originated from the work of Jenner (1796) who inoculated a boy with infectious material from cowpox in order to induce immunity to smallpox. He called the process "vaccine inoculation". Later Louis Pasteur (1881) suggested that the word "vaccination" should be a general word for preventive inoculation of microorganisms as a tribute to the work of Jenner.

The first report of disease prevention using vaccines is probably by Snieszko who published a paper in 1938 about protective immunity in carp immunized with *Aeromonas punctata*. Their paper was written in Polish which reduced –unfortunately- the availability elsewhere in the world. The first report in English was written by Duff in 1942, who showed protection against *Aeromonas salmonicida* in trout immunized by parenteral inoculation and by oral administration. Fish vaccination in India, first attempt was made by Karunasagar and his team in 1991 (Karunasagar *et al*., 1991). The first vaccine for aquaculture, a vaccine for prevention of ERM/ yersiniosis in salmonid fish, was licensed in USA in 1976. The first viral vaccine for fish was produced by a Czechoslovakian company (Bioveta) in 1982.

Vaccines success in Norwegian Salmon Industry

The introduction vaccines in Norwegian Salmon Industries has demonstrated a significant impact on the reduction of antibiotics from 50000 kg in 1987 to 1000-2000 kg in 1997, while at the same time the production increased from 50 000 tonnes to 350 000 tonnes (Brudeseth *et al*., 2013). The development of a sustainable industrialised aquaculture industry depends on the development and implementation of vaccines and vaccination regimes that makes the disease situation predictable and manageable under intensive production.

Vaccines for industrial scale fin-fish farming

Vaccines are available for more than 17 species of fish and protect against more than 22 different bacterial diseases and 6 viral diseases. Vaccines are available in more than 40 countries (Fig. 1).

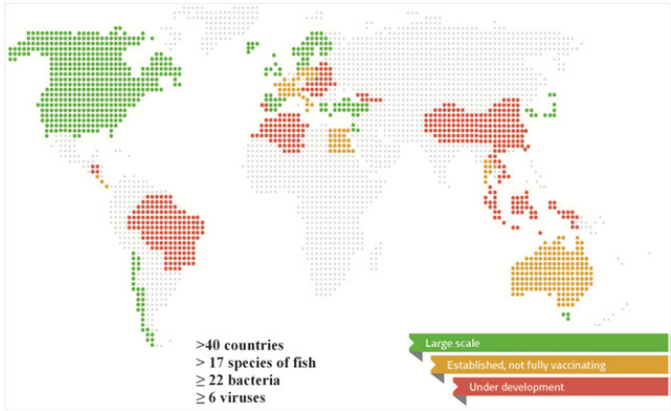

Fig. Countries according to the use and implementation of fish vaccination. Green shows countries where vaccination is commonly used. Yellow are countries where vaccination is used, but not fully implemented. Red are countries where fish vaccination is under development. From Brudeseth et. al., 2013

Importance of oral vaccines in aquaculture

Depending on the age and size of the fish, commercial vaccines are administered either orally (by mixing with the feed), by immersion (dip or bath) or by injection through the intraperitoneal (i.p.) or intramuscular (i.m.) route. Vaccine by injection route although very effective in terms of immune response and long term protection but it has some side effects including tissue inflammation, adhesion and necrosis. On the other immersion vaccination required high production costs. Oral vaccines are an attractive alternative

to reduce the stress on the fish during immunization. Due to the ease, simplicity and practical applicability oral vaccination became the choice of antigen delivery. However, attempts to orally vaccinate against different bacterial diseases have either yielded mild and short lived or inadequate responses. One of the important factors for the inconsistency and poor response to oral vaccination is the digestive degradation of antigens in the foregut, before the vaccine reaches immune-responsive areas in the hind-gut and other lymphoid organs.

Need for biofilm oral vaccines in aquaculture

To protect oral antigens from the gastric destruction several strategies were evaluated, such as encapsulated antigen microspheres, enteric coated vaccine and bioencapsulation of vaccine in live feed, these are complex, costly and impractical method. In this respect biofilm vaccines would be the best alternative way for oral route of vaccination. Biofilm cell produce adhesive exopolymeric substance, which is called glycocalyx, offer protection to antigen from gastric destruction.

Designing of biofilm-based vaccines

Unlike in natural environment, here in laboratory condition bacteria was forced to go into biofilm mode by providing them with minimum of media (0.225% TSB+ 0.3% Chitin flakes) and harsh environment in the form of shaking 120 strokes/ min. Biofilm was produced on the chitin flakes later the supernatant was decanted and the chitin flakes were washed thrice in the same flask with sterile phosphate buffer saline (PBS, pH 7.2) to remove free cells. Biofilm cells on chitin were then heat inactivated at 100 0C for 50 min before incorporating in the feed.

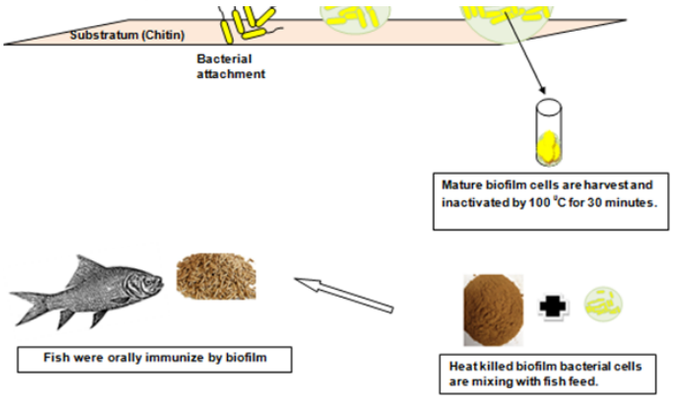

Fig.2. Attachment and growth of bacterial biofilm on the substrate and its application as oral vaccine candidate for aquaculture species

Efficacy of biofilm vaccines in aquaculture

Over the 20 years, the vaccine research has been oriented towards safer and more effective vaccine preparation from a normal inactivated bacterial vaccine to the biofilm vaccine (Azad et.al., 1997). Various researches conducted in the preparation of biofilm of *Aeromonas hydrophila* and *Vibrio alginolyticus* and its use as oral vaccine under the direct supervision of renowned Indian scientist and ICAR (Indian Council of Agriculture Research) Emeritus Professor Dr. K.M Shankar at the Laboratory of Aquatic Health Management, College of Fisheries, Mangalore have shown promising outcome in teleost fishes like catla, rohu, common carp, catfishes like *C. batrachus, C. striatus* and also from crustaceans tiger shrimp (*P. monodon*).

The hypothesis was proposed and substantiated first by Azad et al., (1997, 1999). They promoted a virulent A. *hydrophila* isolate to form biofilm on chitin flakes and successfully utilized it as oral vaccine in catla, rohu and common carp. Biofilm vaccinated carps had significantly higher antibody titre and protection than free cell vaccinated fishes. Advantage of biofilm and free cell vaccines when studied by antigen localization employing monoclonal antibody based immunefluorescence, indicated that biofilm antigen compared to free cell antigen retained for longer time in larger quantities in gut and other lymphoid organs like kidney and spleen. The protective nature of glycocalx was believed to be protecting biofilm from gastric hydrolysis as free cells showed a quicker clearance from lumen of hindgut within 6h of vaccine uptake compared to biofilm, which remained for 48h following oral delivery. In addition to that, biofilm might represent a more immunogenic material as seen to have induced higher antibody and protective immunity, altogether making it as a better vaccine carrier in oral immunization regime, keeping this background biofilm of *A.hydrophila* was evaluated for oral vaccination of walking catfish (*Clarius batrachus*). Serum agglutinating antibody titre and relative percent survival (RPS) following challenge were found to be significantly higher in catfish fed with BF vaccine compared to that with free cell vaccine. Another study with C. striatus, a carnivorous fish model, fed with biofilm (BF) and free cell (FC) of A. hydrophila with the dose of 1010 cfu/fish/day and 20 duration. They observed BF vaccinated fish upon challenge had significantly higher relative per cent survival (88) than that with FC (29.6).

Biofilm of V. *alginolyticus* to study preliminary immune response in tiger shrimp (*Penaeus monodon*) and the study showed that biofilm cells were superior to free cell in stimulating the non-specific immune response of *Penaeus monodon*. As shrimp has no specific memory, they need a continuous stimulation with immunostimulants to maintain the immune response and show resistance against various infections. Bacterial biofilms are excellent immunostimulating agents as they expressed several proteins and are also resistant to gastric enzymes. A study has demonstrated the use of biofilm of *V. alginolyticus* administered orally to *Penaeus monodon* showed an increased innate immune response challenged against *V. alginolyticus* and WSSV indicating the efficacy and nonspecific cross protection.

Conclusion

Biofilm cells probed to be effective as oral vaccination of fin and shellfishes. It can be considered as simple, cheap and ideal oral vaccination technique for bulk administration. Production of Biofilm vaccines and its efficacy has been proven in institutional research experiments and it is expected that the biofilm vaccine will available in the market by 2019 in India as commercial production was undertaken by the aqua drug company.

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Minor Carp: A Novel Way for Species Diversification of Fresh Water Aquaculture in India

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Introduction

India is second largest producer of fish, next to china. Indian fisheries has made great strides during last decades with the production levels increasing from 750,000 tonnes of fish in 1950-51 to 10.79 million tons in 2014-2015, of which the contribution from the inland sector is around 7.21 million tons (66.82 % of the total) compared to 3.58 million tons (33.17 %) from the marine sector. The contribution of fisheries to the gross domestic product (GDP) and agriculture GDP has been estimated to be 0.9 and 5.17 %, respectively. The average national fish production levels from tanks and ponds have increased significantly from 600 kg/ha during the 1970's to 2,900 kg/ha in the 2014-2015. Earlier, it was mention that the freshwater aquaculture in India is mainly carp-based. It is the backbone of the Indian aquaculture. India is known as carp country due to rich diversity of carps. The carps together contribute to more than 87% of total aquaculture production. One of the possible ways for realization of the higher profit is through introduction of high valued species into the carp culture system. India has a rich biodiversity potential cultivable fish fauna of minor carps and barbs having regional market preference. Intercropping of minor carps in the conventional carp polyculture and culture of minor carps in seasonal ponds have been introduced in the farming sector of certain states (Rajasthan,Maharashtra, Gujarat,Madhya Pradesh etc.) and have proved to be more rewarding. The minor carps are belongs to Cyprinidae family and have commercial importance.

Minor carps that can diversify the traditional aquaculture include Reba (*Cirrhinus reba*), Bata (*Labeo bata*), Sarsi (*Labeo rajasthanicus*), Pengba (*Ostreobram belangeri*), Fringe-lipped carp (*Labeo finbriatus*), Labeo dussumieri, *Labeo boggut* and Cauvery carp (Labeo kontius) etc. These species can make scope for diversifying of farming systems and yet to be exploited. These carp species to be considered as alternatives to the major cultured carp species, for diversification in freshwater aquaculture. The systematic detail about some commercially important minor is given below-

Highlight Points

- **Minor carp can grows faster than Indian major carp during their initial stage and they can be easily culture in tank, pond, cage and pen.**
- **They can adopt artificial feed so it is easy to culture them.**
- **They have higher market value and demand in regional area and they can be culture along with the Indian major carp so the earning is high for the farmer.**
- **They can be marketed at lower size (100-300g).**
- **Culture of minor carp can be beneficial in for the seasonal water bodies where the water is available for few months.**

Reba carp

Reba carp, Cirrhinus reba is an important food fish belong to cyprinidae family and Order *Cypriniformes*, which is distributed over Indian sub-continent found in the Gangetic regions in North and Cauvery River systems in South, although it is not available in the Malabar River systems. It is locally known as bhagna bata, raik or tatkini, and considered as one of the most important indigenous minor carp species. The natural production of Reba has declined considerably due to increased fishing pressure and various anthropological activities leading to siltation, aquatic pollution, and loss of natural habitat for spawning and growth. Reba carp mainly inhabits in rivers and clear streams but is also found in tanks, canals, ponds, beels and inundated fields. It is primarily plankton feeder but also feeds on detritus, mud, vegetables, crustaceans and insect larvae. It takes herbivorous feeding habit. The fish mature after one year at 22-25 cm in length. Spawning season of Reba carp is April to August with peak spawning occurring during the monsoon season. Induced breeding has been attempted on the species. Relative fecundity of Reba carp was documented between 2.0-2.5 lakh egg kg-1 body weight of female. Nursing technology of reba has beed standardised (Keer et al., 2018). No attempts have been made for commercial scientific culture of this species in India. Reba is vulnerable and threatened species in India and Bangladesh so it is need to maintain this fish population as well as its conservation and rehabilitation. The initial growth rate of the fish is very fast more than catla. Its flesh is oily, tasteful and people would like to eat due to its lucrative size, high nutrition, attractive flavour and less spines. All these qualities allure the farmers to consider the fish as a potential species for the diversification of aquaculture.

Bata carp

Bata carp (*Labeo bata*),A minor carp commonly called as 'Bata'. Distribution of this fish is throughout northern India. It is also found in the Cauvery, Krishna, Godavari river systems of peninsular south India and the freshwater bodies of West Bengal, Orissa, Uttar Pradesh, Bihar and Assam. They are also available in the upper stretches of the

Ganga, Yamuna and Bramhaputra rivers. Bata is considered an esteemed food fish and cultured along with other major carps in India. It is found in tanks, rivers, reservoirs, jheels, beels and moats. It grows 20-25 cm in pond and 40-60 cm in large tanks and reservoirs. It is also a slow growing fish, reaching 20-22.5 cm length in 9-10 months, and the growth rate of this species decreases markedly after two years in age. It is herbivorous fish, adults are bottom dwellers but frequently move in all zones of the water column for feeding and breeding purposes. It attains maturity in two years but under favourable conditions it can mature in the first year. The average length of the matured fish in both sexes is around 20 cm and 100- 125 g in weight. They are also highly fecund ranging from 300,000 to 450,000 eggs per kg body weight. *L. bata* breeds early in the monsoon and its spawning season is very short. Bata fish is very tasty and prefer by the consumer. It is widely cultured in bheries in the Sunderban areas of West Bengal.

Dero carp

Labeo dero,it is a minor carp and forms a commercially important food fish in upland waters in Northern India. This fish is commonly known as "Kursa Bata". Flesh of this fish is well flavoured and highly esteemed as food. It is widely distributed all along the Himalayan rivers particularly in the Sutlej, Beas, Ravi, Baner, Tawi and Jhelum. It is mainly restricted in the upper reaches of the river. The fish prefer to come down to lower stretches of the river to avoid the cold during winter months. It is distributed mainly in the States of Arunachal Pradesh, Punjab and Jammu and Kashmir. It is also observed in the Mahanadi river system in Orissa. It is a herbivorous fish, feeding on soft aquatic vegetation and periphyton. It also feeds by licking off algal growth from rocks and hard surfaces. It is highly fecund ranging from 67, 288 (330 g fish) to 700,000 (1.35 kg fish). It breeds early during the monsoon over a very short breeding period. It is relatively slowgrowing, reaching a maximum size of 1.5 kg in weight and 50 cm in length. The fertilized eggs are non–adhesive, demersal and 2.9 – 3.2 mm in diameter. Culture and seed production of this fish is not being realized in India till now.

Sarana (Sarpunti)

Sarana *(Puntius sarana)* is an esteemed food in eastern region of the country. It is commonly known as "sarana" or "sarpunti". It is widely distributed in the Gangetic river system. Sarana is omnivore and eats submerged vegetation and molluscs. One peculiar feature of this species is that the rate of feeding is very high during the peak breeding season of the fish. Maturity of the fish comes at the end of first year when it is 17-25 cm in length. It spawn once in year and pre monsoon breeder. The fecundity of the species varied from 60,000 to 225,000 depending on the size of the fish. The fish does not grow beyond 30 cm length and 800-900 g weight. It is exclusively freshwater and cannot withstand even very low-saline water. It dies immediately in any adverse physiological condition of soil or water. It is also easily susceptible to protozoan diseases.

Sarsi

Labeo rajasthanicus, usually known as sarsi, is one of the important minor carp, native to South Rajasthan. Among the carp, it is a very important alternate carp species for diversification in freshwater aquaculture in India and it has high market value in some region of Rajasthan. This species has potential for inclusion in composite culture (Lal et al., 2015). It has been reported from the two isolated rivers, Tidi and Chambal and also from Jaisamand Lake. Occurrence of *L. rajasthanicus* was recorded from rocky substrates with shelter and higher depth (5-20 m), having low water velocity.

Pengba

Osteobrama belangeri (Family: Cyprinidae), Locally known as pengba in Manipur. It is one of the indigenous medium carps of Manipur and has been declared as State Fish of Manipur in 2007. It is an omnivorous freshwater species cultured traditionally in earthen ponds. They are particularly suitable for NE region of India due to relatively smaller marketable size and excellent consumer acceptability. Very few nutritional studies have been carried out on this species. Captive breeding technology has been developed for pengba by using different type of inducing hormone. Fecundity of pengba is 237237 to 268138 (weight of female 419.53±11.48 g) gaverage number of age per female. Pengba is an economically important aquaculture species and have high market value in Manipur.

Advantages of alternative minor carp over the Indian major carps

1. Minor carp grow faster than IMC in initial stage. The marketable size of the fish is small (100-300 g) compared to 700-800 g in major carps.
2. Minor carp can compete with Indian major carps for composite fish culture.
3. They are suitable for integrated fish culture systems.
4. Mostly minor carp's habitat is river, they live in riverine condition and they are very hardy fish.
5. More than one crop can be easily harvested when culturing minor carps.
6. They are small in size and suitable for high stocking density culture.
7. Minor carps can be cultured in pens and cages.
8. Most of the minor carps are omnivores/herbivores and can easily digest the plant protein source. Therefore, the different plant based agro-industry by-products, which are rich in protein and are abundantly available in our country, can be used for low-cost feed formulation of these species.
9. They are suitable for short duration culture in seasonal water bodies so farmer can get his returns in a shorter duration as compared to Indian major carps.
10. Mostly minor carp are very tasty and have commercial value, consumer preference is more towards minor carp.

References

Alternate carp species for diversification in freshwater aquaculture in India K. N. Mohanta, S. Subramanian1 , N. Komarpant1 and S. Saurabh2 1

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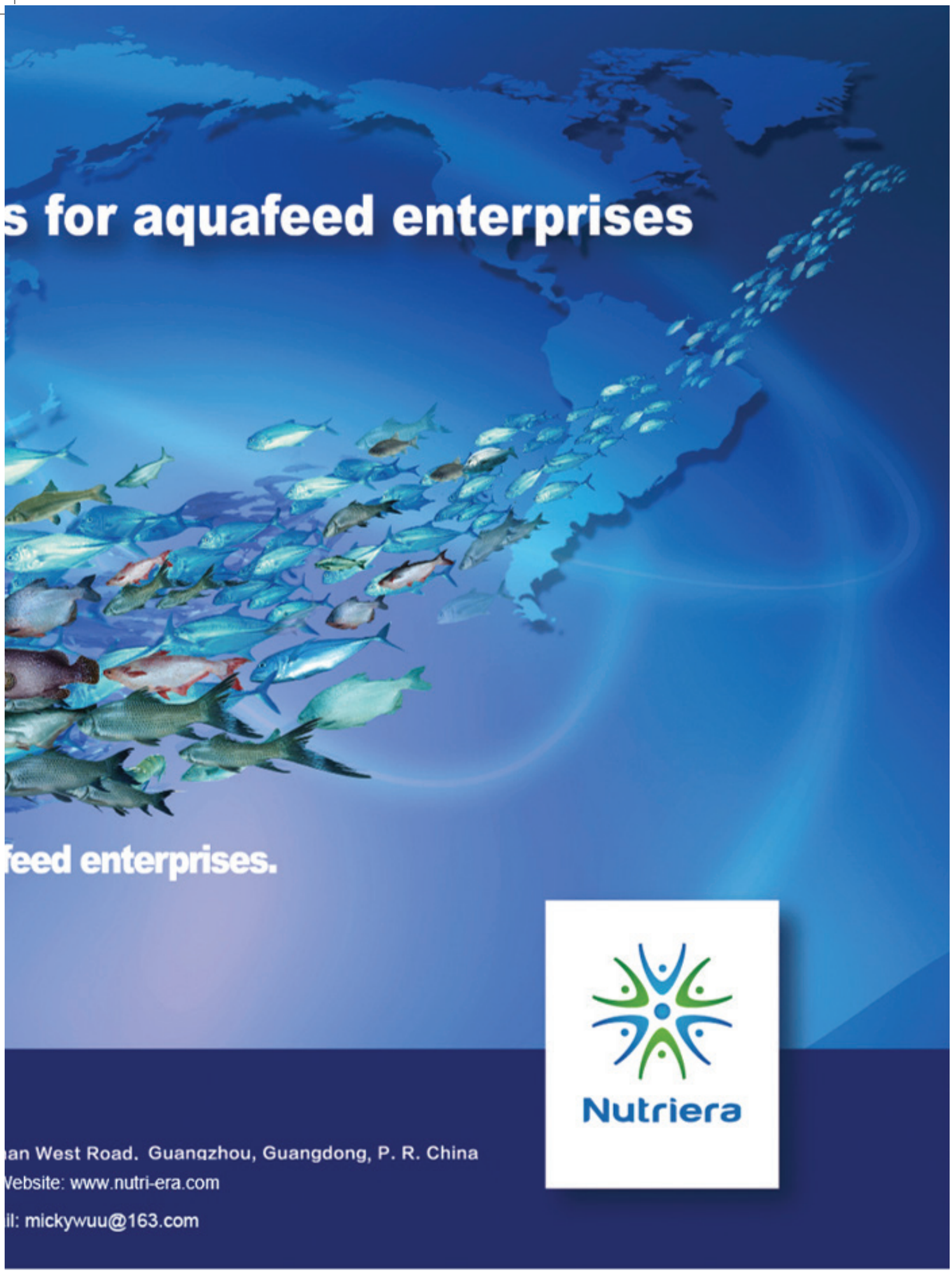

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