The Indian Himalayan region covers an area of about 595,000 km² from West to East between Nanga Parbat (8126m) to Namcha Barwa (7756m). This mountain system is bordered in the West by the famous Karakoram Range and Tibet plateau in the North. Four parallel longitudinal mountain belts namely the Shivalik, the Lesser Himalayas, the Greater Himalayas and Trans-Himalayas present discrete physiographic and geological features. There are 19 major rivers in the Himalayas of which Indus and Brahmaputra are the longest and each has a mountain catchment of about 1,60,000 km². Of the remaining 17 rivers, five belong to the Indus system of which the Beas and Sutluj have a total catchment of 80,000 km². Nine rivers namely, Ganga, Yamuna, Ram-Ganga, Kali-Sarda, Karnali, Rapti, Gandak, Bhagmati and Kosi have a catchment area of about 1,50,000 km² and belong to the Ganges system while Brahmaputra has a catchment area of about 1,10,000 km². Most of these rivers flow in deep valleys before they enter the plains. Besides these river systems, this region is rich in other water resources that are present in the form of rivulets, streams, lakes, ponds, tanks and reservoirs.

The varied aquatic habitats of the Indian mountainous region are quite rich in a variety of fishes. In terms of ichthyofauna, the Himalayan region may be classified into three zones. The headwater zone inhabited by rheophilic species of loaches and catfishes (Nemacheilus gracilis, N. stoliczkai and Glyptosternum reticulatum). The large stream zone, formed by joining of headwater streams, inhabited by species like Diptychus maculatus and Nemacheilus spp. There are different rheophilic species of snow trouts that inhabit the upper and intermediate stretches of this zone. Fish species like Barilius spp., Tor spp., Catfishes, Homalopterid fish and Snakeheads inhabit the slow moving meandering zone. In the mountain regions the fisheries resources are used as food and sport, while a few serve ornamental purpose. It is intriguing that the fish fauna in this region can withstand extreme cold as the high altitude lakes and rivers are generally frozen three to six months in a year.

Fish can play an important source of protein for the people living in the mountainous regions of the country besides fetching income for a section of the society. There is a tremendous scope for the development of low volume, high value fish like Rainbow Trout in the mountainous regions of the country. Fish and fisheries in the uplands has been christened as “Coldwater Fisheries.”
Dear Readers,

Fisheries play an important role in providing food and income globally. India is bestowed with a vast diversity of cold water resources (lakes, streams, rivers, reservoirs etc.) that harbours rich ichthyofaunal diversity comprising large populations of indigenous and exotic, cultivable and non-cultivable fish species constituting appx. 17% of the total fish fauna of the country. Across the Indian Himalayan region, the North–east Himalaya is remarkably rich in fish diversity. Apart from the natural water bodies there has been a tremendous increase in aquaculture activities. According to ICAR, presently coldwater sector contribute about 75,000 MT of fish production, which is about a meagre 1.5% of total inland fish production in our country that need to be enhanced substantially.

Articles contained in this Newsletter provide information on fish diversity, aquaculture techniques, diseases and other threats to cold water fisheries. Attempts have been made not only to conserve the ichthyofaunal diversity but also achieve socio-economic development and nutritional requirements of the people.

The term “Coldwater fish” subtly refers to the members of Salmonidae. However, under Indian perspective, members of the sub-family Cyprininae that inhabit streams, lakes and rivers receiving snow-melt water are also included. Coldwater fisheries resources present diversified and peculiar type of fish fauna. There are about 258 coldwater fish species of which 203 are recorded from the Himalayas while 91 Deccan plateau. Among these Snow-trout, Mahseer, Minor carps, Minnows, Loaches and Bariles constitute the indigenous species, while Rainbow Trout, Brown Trout, common and Silver carp are exotic.

The utilization of fishery resources in mountain regions is mainly from capture and culture fisheries. At present, the total fish production from upland areas contributes to nearly 1.5% of total inland fish production of India which is quite meager. Several constraints such as inaccessible and difficult hilly terrain, low productivity of upland waters, slow growth of fish species being cultured, low fecundity, lack of infrastructure for seed production, trained manpower, poor landing and marketing facility pose obstacles in the expansion of Coldwater fish production.

Indian Coldwater fishery sector is rapidly changing as more and more people are being attracted. This sector enables livelihood for a large section of economically underprivileged population living in the mountainous region of the country. Novel production technologies, higher economic growth, population explosion and shifts in dietary patterns are leading to enhanced production. As a consequence, besides a source of income, fish has become a commodity for trade too.

As fish constitutes an important source of animal protein for the people living in the hilly regions, selected fish species are being farmed by the local people in order to meet the nutritional needs and generate employment opportunities. Besides fish farming, other activities like ranching, sport and eco-tourism also fetch rich dividends for the locals. At present, several progressive farmers have started mono and composite fish culture in small ponds and a few of them have achieved considerably good production. The aquatic water bodies of this region are also enriched in ornamental fishes. Culture of ornamental fishes can also be a source of income for the people living in this region. Ornamental fish trade can fetch rich dividends both within the country as well as by export.

Coldwater fish farming is gaining momentum. Therefore, in order to enhance fish production, the vast natural resources of the Indian mountainous region need to be tapped and new prospects have to be explored. Intensification of fish farming may invite serious disease problems. Therefore in the direction of disease preparedness, information on microbial flora is also required and fish pathogens need to be identified. In this newsletter, some useful information on fish farming practices of Arunachal Pradesh, opportunities for Trout culture in Ladakh and culture of ornamental fish for providing food security as well as source of income is being provided.

Editors

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High Altitude Wetlands of Arunachal Pradesh

Climate Change Perspective…..

High Altitude Wetlands (HAWs) form extreme ecosystem with an adverse climate (low air temperature, higher ultraviolet radiation) and permafrost layer of diurnal and seasonal nature, fed by snow–melt, springs and precipitation. Freezing cum melting cycle, vertical mixing of water column and poor nutrient status are characteristic features of these water bodies. Remote sensing data generated by Space Application Centre, (ISRO) shows 1672 HAWs with a total area of 1,1864 ha in Arunachal Pradesh. These HAWs vary in size from 2.25–500 ha and are situated at an altitudinal range of 3000–5000m asl. They are present as wetland complexes and majorly distributed in Bhagajang Nagula, Thembang Bapu CCA and Pangchen Lumphoare. It is reported that Bhagajang wetland complex, situated South-west of Tawang has 20 lakes within altitudinal range of 4000–4400m asl. There are one hundred permanent alpine freshwater lakes at an altitude of 3505–420m in Nagula wetland complex, bordering Tibet and located north of Tawang. Impact of climate change on fragile ecosystem and unique climatic condition of HAWs as reported, revealed that that these high altitude water bodies are vulnerable to projected increase temperature from 0.9 °C ± 0.6 °C to 2.6 °C ± 0.7 °C during 2030s in Indian Himalayan Region (IHR). Similarly, Arunachal Pradesh state action plan on Climate Change has projected that the minimum temperature may increase from 1 °C-2.6 °C and 2.8 °C - 5 °C during 2030s and 2080s respectively. The impact of climate change on HAWs, its biodiversity and unique climatic condition cannot mar the potential of these water resources. These water bodies could be seen as an opportunity for harnessing potential of coldwater fisheries in the perspective of biodiversity and ecotourism in the country.

With an objective to study the fish diversity of these water bodies, besides feasibility of conservation of coldwater fish germplasm, water and soil samples were collected from selected HAWs in Tawang and analyzed for environmental parameters so as to record basic information. In our preliminary study, DO was 6.4–8.2mg/l, pH (5.8–7.2), conductivity (20–45 µs cm -1), NO3 (0.6–1.2 mg/l), PO4 (0.1–0.22 mg/l) and water temperature seasonally varied from 4 °C–15 °C. Further heavy metal concentration was also recorded to generate first hand data on their presence in such pristine water bodies possibly through soil erosion. The concentration of heavy metals (Cd, Hg, Fe, Se, Mn, Co, Pb, Cr, Zn and As) ranged 5 to <1 ppb. Since physico-chemical parameters are limiting factors for the existence of flora and fauna, the data recorded portray favorable ecological environment for conservation of Brown Trout and species of Schizothoracines in high altitude water bodies as a natural sanctuary. According to local fishers HAWs such as PTSO and Sanguster lake are inhabited by endemic species of Schizothoracine and Brown Trout (Fig. 1). State fisheries department, Tawang has also made an effort to release brown trout in PTSO lake to conserve their population (Fig 1e-f).

Fig 1e-f: Seed of Brown trout released by Department of Fisheries, Govt. of Arunachal Pradesh in HAWs for conservation

Other than conservation of coldwater fish germplasm, HAWs can also be used for the purpose of recreational fisheries. They can be stocked with Trout (Rainbow Trout and Brown Trout) because of their popularity for sport fishing and recreational fisheries. If water temperature is raised above 15 °C, which is not conducive for breeding of trout, stocking of sterile trout may serve the purpose of recreational fisheries. Development of eco-park, organizing events of sport fishing for recreation may attract tourist and create source of revenue generation and seasonal employment opportunity for local youth. Fisheries department has constructed concrete footpath and watch–shed encircling the PTSO lake for the tourists. One of our neighbor countries China has largely introduced coldwater fishes in high altitude water bodies for recreational and sport fishery. So, stocking of coldwater fish species in high altitude wet land may also provide opportunity for supplying fish as cheap source of protein to Indian Army deployed at Indo–China border, Bumla pass.

The unique climatic conditions provide ample scope for research on high altitude wetlands. Biotechnological potential of psychrophilic bacteria from the Antarctica, have shown that high proportion of cold-adapted bacteria from sea ice possess the ability to produce PUFA, such as Eicosapentaenoic acid (20:5 3; EPA) or Docosahexaenoic acid (22:6 3; DHA) essential for controlling cardiovascular diseases. Present commercial sources of EPA and DHA are restricted to marine fish and oils derived from algae. As commercial fish catch is in depleting condition and algal-derived oils require high investment of technology and expense compared to the prospect of bacterial fermentation, screening of bacteria in cold environment of HAWs for synthesis of a single PUFA may be advantageous over the fish and algal-derived oils as sources. Not only bacteria act as cell factories for production of PUFA, but they also offer scope for identification of gene and enzyme responsible for PUFA synthesis. In this regard, single PUFA synthesis from prokaryotes in cold climatic condition can be an interesting source for human nutraceuticals. Cold–active or cold adapted enzymes produced by bacterial isolates existing in high altitude may provide opportunities to study the adaptation of life to low temperature and the potential for industrial applications (leather processing, cleaning agents, degradation of xenobiotic compounds, cheese manufacture, fermentation, bakery, confectionery and meat tenderization). These wetlands also provide opportunity for glimpse of research on presence of UV-resistant phytoplankton, zooplankton and bacteria community in high altitude.

In short, in perspective of climate change and its impact, all we need to see the potential hidden in HAWs. Harnessing the potential of HAWs is imperative for conservation and preservation of biodiversity and livelihood security of hilly people.

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Among freshwater ecosystem of Indian Himalayas, lakes constitute major source of drinking water, recreation and fisheries development. They are considered as the centres of civilization and also contribute to socio-cultural, recreational and economy of the region. The dynamic nature of ecosystem plays an important role in maintaining the ecological, hydrological, biogeochemical and environmental balance of a region. Lakes help in the development of flora and fauna and also act as an excellent spot for the habitation of aquatic biota. Biodiversity of freshwater lakes provides valuable and irreplaceable service to mankind as they constitute storehouse of gene pool besides being unique ecosystems.

The Indian Himalayan region (IHR) spread over approximately 1, 26,249 ha has nearly 4,700 high altitude lakes mostly oligotrophic, fed by precipitation, snow-melt and springs. The lakes located in remote areas are characterized by pristine water that support a diverse array of flora and fauna. Unfortunately, freshwater lakes in the lesser part of IHR are being significantly degraded. The lakes of IHR can be grouped into: i) Lakes of Western Himalayas (e.g. Pangong Tso, Tsol Morari, Chantau, Noorichan, Chushul, Hanlay; Dal, Anchar, Wular, Haigam, Malgum, Haukersar, Kranchu, Surajtal, Chandra tal, Renuka, Chamera etc.); ii) Lakes of Central Himalayas (e.g. numerous lakes in Sikkim, Arunachal Pradesh, Assam, Meghalaya, Nagaland and Manipur). The lakes of IHR are home to several species of rare endemic fish species. Fish in these lakes support livelihood and food security of the local people. Wide-ranging Ichthyofauna inhabits in diverse aquatic ecosystem ranging from hot spring to cold-water with more than 270 fish species. Among these, cyprinidae, the most dominant, constitutes 93 species followed by Balitoridae (47 species) and Sisoridae (34 species). The important fish species that thrive in the western part of IHR are Schizothorax richardsonii, S. curvirostris, S. planiforns, S. micropogon, Schizothoracichthys ecosius; Labeo dero, L. dyocheilus, Crossocheilus latius, Puntius conchonius, Glyptothorax kashmiriensis.

The eastern part of IHR is a treasure house of biodiversity which harbours more than 200 fish species. The major fish species of this region are Abirichthys kempii, Acanthophthalmichthys pangia, Amblyceps apangi, Amblyceps arunachalensis, Anabas arunus, A. tetradenius, Anguilla bengalensis, Bangana dero, Barilius barila, Botia berthmorei, Channa punctatiss, C. striata, Catla catla, Clarias gariepinus, Chitala cichlusi, Chitala chitala, Cirrhinus mirzali, C. reba, Clarias batrachus, Colisa faciatus, Ctenopharyngodon idella, Cyprinus carpio, Danio dangalia, Devario acuticepsha, Esoxus danricus, Esoxus dentricus, Garra kempii, Gudusia chapra, Heteropneustes fossilis, Labeo dyocheilus, Lepidocephalichthys arunachalensis, L. manipurensis, Monopterus albus, M. chuchia, Nandus nandus, Neolisaichthys hexagonolepis, Notopterus notopterus, N. Chitala, Ompok pabda, Osteobrama belangerei, Pterocryptis indicus, Puntius sophore, Semiplotus manipurensis and Wallago attu etc.

The relationship between diversity of species and environment is important in exploring functional biodiversity. Impact on ecosystem due to change in biodiversity is quite pronounced in a freshwater ecosystem as compared with terrestrial. The patterns of fish taxa are varied along the geographical gradients driven by climatic factors as well as productivity of the water body besides elevation gradients. Mountain lakes are sensitive and respond rapidly to any changes therefore, resulting in serious consequences on the existence of endemic fish. Much of the organisms flourish in ultra-oligotrophic water bodies are low resilience to disturbance where a relatively small number of autochthonous species survive being sensitive to the introduction of allochthonous species. Thus, conservation of ‘sporadically trapped species in the environment of remote and uncontaminated lake is necessary.

Conservation of native biodiversity can amicably maintain the ecosystem. Extinction of indigenous fish species due to the introduction of exotics has been well established. The introduction of exotics in the water bodies of upland Himalayas without considering its possible consequences can cause severe adversity. Till date, about 14 exotic fish species have been introduced in the IHR. The important exotic fish species of the region are Hypophthalmichthys molitrix, H. nobilis, Ctenopharyngodon idella, Cyprinus carpio communis, C. carpio specularis, C. carpio nudus, Carassius carassius, Salmo trutta fario, Oncorhynchus mykiss, Gambusia holbrooki, G. affinis, Oosphronemus goramy. Exotic Trout were first species introduced by Mitchell in water bodies of IHR during 1900. In 1959, common carps were introduced in western Himalayas. In 1971, Silver Carp was accidentally released in this region. It is observed that silver carps had biological advantage over the Indian major carp. Some species of Schizothorax e.g. Pycobotobus and Gymnocypris are unique and more vulnerable to extinction. It is illustrated that introduction of common carps may negatively affect the endemic species like Schizo thorax and Mahaseer.

The rate of species loss is likely to be high in tropical and sub tropical lakes. Human settlements in the lesser part of IHR have steadily increased. In recent years, squalor in land use pattern in the region has intensified due to the high rate of urbanization, tourism and other anthropogenic activities. Hydro-electric projects and indiscriminate introduction of fish species have greatly contributed in this direction. Alteration in drainage flow, gross pollution and overfishing gravely threatens freshwater fishes. Water retention capacity of springs and streams have reduced due to damaged underground water resources. The groundwater reserves cannot be replenished by rains due to increasing surface runoff resulting in drying of a large number of perennial springs or streams that feed the lake. Siltation, dumping of garbage or intentional filling-up of lake's inflows has seriously affected recharging of these water bodies.

Thus, preservation of biodiversity remains a priority as pollution has amplified in magnitude by anthropogenic than natural causes. Introduction of exotic species and development of novel cultivable endemic species is an important modus operandi for the diversification in aquaculture. The impact of species released to a new environment and introduction of an exotic species should be critically evaluated. It is high time that strategic plans and policies for diversification of aquaculture with optimum utilization of aquatic resources are urgently required.

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Fish and Fisheries

Arunachal Pradesh.....

Fish is an essential food for the people of Arunachal Pradesh with an excellent source of vitamins, minerals, fats, essential amino acids and energy along with high consumer acceptability. The state is bestowed with vast aquatic resources in the form of 2,000 km of rivers, 2,500 ha of wetlands and lakes, 1,250 ha of ponds and mini barrages and 2,925 ha of rice – fish culture. The state is also reported to have more than 200 species of which many are coldwater species thriving at high altitude regions. Altitudinal regime of the state plays a dominant role in the distribution of fish species which may be categorized as foothills (upto 300 m msl), mid altitude zone up to 1200m msl (sub-tropical zone) and high altitude zone above 1200m msl or the alpine zone.Fish production from the state has shown an increasing trend in production in the past decade. But in spite of having vast fisheries resources, there still remains a gap between the production and demand which has to be met from other states like Andhra Pradesh, Bihar, and West Bengal. Moreover, the per capita availability of fish in the state is reported of 2.4 kg yr⁻¹ against the national requirement of 11 kg yr⁻¹.

Exotic Trout: The species of Trout available in the state are Brown Trout (Salmo trutta fario) and Rainbow Trout (Oncorhynchus mykiss). The favorable water temperature ranging from below freezing point to as high as 20 °C led to the establishment of the first Trout hatchery along Nuranang stream at 3660m msl in Tawang district, using Brown Trout seed from Jammu and Kashmir. The breeding season is during October to January and incubation period ranges between 90–120 days. Another hatchery with a production capacity of 50000–100000 numbers of eyed ova also has been established at Shergaon, West Kameng district, located at an altitude of about 1954m. Another regional coldwater hatchery complex comprising 300 ha is also established at Samtheng in West Kameng district.

Snow Trout: These fishes are important from taxonomic, evolutionary and zoogeographical view point. Their distribution is mainly restricted to mountain regions of Asia. Schizothorax richardsonii and Schizopyge progastus are commercially important indigenous snow Trout species found in several districts of the state. Unlike carps, these species have a very slow growth rate in capacity (30–40 g year⁻¹) and thus are not preferred for culture in ponds and tanks.

Mahseer: The groups of Mahseer in the state are mostly Golden Mahseer (Tor putitora), Tor Mahseer (Tor tor) and Chocolate Mahseer (Neolissocheilus hexagonolepis). These fishes are mostly concentrated in the Kamengriver along Bhalukpong, Daporijo in Upper Subansiri district, Namsai, Tezu in Lohit district and Roing in Dibang valley district. A hatchery has been established at Iduli in Roing for the purpose of commercial production of Mahseer. This fish is a major delight for the anglers.

Common carp fishery: Carp is a hardy fish with a wide thermal range of 4–30 °C. The species of common carp is mostly cultivated in mono and polyculture systems in ponds and tanks in mid to high altitudes due to its better food conversion ratio, high fecundity and easy accessibility of seed.

Rice cum fish culture: The culture of common carp in rice fields is popular in terraces of the Apatani Plateau at 1,564m msl of lower Subansiri district. Encouraging results of rice cum fish culture (earlier known as paddy cum fish culture) could be further promoted in the mid and high altitude areas such as Upper Subansiri (500m msl), Upper Siang (500m msl), East Siang (155m msl), West Siang (300m msl), West Kameng (1000m msl), Anjaw (1296m msl), Tirap (1278m msl) and Kurung Kumey (1004m msl) districts. Presently 1121 ha of land are under rice–fish farming in the state with a fish production of 150–200 kg ha⁻¹ per 3 months.

Composite carp culture: This is generally practiced with six recommended species namely Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Ctenopharyngodon idella and Cyprinus carpio. Culture of Indian major carps only or polyculture along with exotic carps at low to moderate stocking density with a yield of 4–6 tonnes ha⁻¹ is reported in the low altitude areas of the state.

Chinese carp culture: Three pronged Chinese carps namely Hypophthalmichthys molitrix, Ctenopharyngodon idella and Cyprinus carpio are taken as the candidate species for culture in pond fisheries at high altitudes. It has been possible to achieve a production range of 0.4–0.6 kg m⁻² below 20 °C at a stocking density of 3–4 fishes m⁻² with recommended supplementary diet in some parts of West Kameng.

Integrated fish farming: Adoption of integrated farming system often results in 3–4 fold increase in the farm production as well as income. Besides recycling of farm-based resources and increased cropping intensity, the system ensures continuous production of food crops, continuous money flow and better diet for farm families, employment generation and substantial reduction of risk factors through diversification of farming. The system also improves the nutrient status of the soil preserving its fertility on a long run. Some of the important integration models are fish cum poultry, fish cum duck, fish cum pig, fish cum rice and fish cum horticulture. Fish production levels up to 3–5 tonnes ha⁻¹ can be achieved without provision of supplementary feeding to fish under this type of integration.

Catfish culture: The most commonly cultured catfishes in the country are Magur (Clarias magur) and Singhi (Heteropneustes fossilis), which can also be of great potential for commercial cultivation in the foothills of the district considering the availability of huge resources in the form of ponds, swamps and derelict water bodies. These fishes can fetch a higher market value than the carps and can enjoy higher consumer preference.

Ornamental fisheries: Arunachal Pradesh has the advantage of having a mild climate, abundant natural waters and export facilities which makes this region a global spot for expansion of the trade to overseas market, which will earn valuable foreign exchange for the country and will also generate enormous employment opportunities for the local people.

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Bacterial Flora in Rainbow Trout Farms of Indian Himalaya

Rainbow Trout, (*Oncorhynchus mykiss*), is presently cultured in 82 countries, because of its fast growth and delicious taste. With ground-breaking effort made by British, it was introduced during nineteenth century and farming practices were established later on. Efforts from research institutes, university and state governments cumulatively helped in steady development of trout production infrastructure (Table 1 and Fig. 1) in Central, Northeastern, Northwestern and certain pockets of Southern India of India (Pandey and Ali, 2015). In the present aquaculture scenario of our country, this species is established as a prime cultivable coldwater fish species and rapidly gaining prominence.

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**Table 1. Status of trout infrastructure in India (Pandey and Ali, 2015)**

<table>
<thead>
<tr>
<th>S.No</th>
<th>State</th>
<th>Infrastructure</th>
<th>No. of Govt. farms</th>
<th>Hatcheries</th>
<th>Feed mills</th>
<th>Culture status</th>
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<td>Jammu &amp; Kashmir</td>
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<tr>
<td>3.</td>
<td>Uttarakhand</td>
<td></td>
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<td>3</td>
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<td>Govt. &amp; private sector</td>
</tr>
<tr>
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<td>Arunachal Pradesh</td>
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<td>Nil</td>
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<tr>
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<td></td>
<td>2</td>
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</table>

For successful establishment of Trout farming and increase in its production, it is imperative to carry out thorough investigation and develop a comprehensive data sheet of pathogenic microbial flora, their occurrence, seasonal distribution, prevalence in Trout and nature of sensitivity/resistance property of isolates to commercial antibiotics used. Scientific data generated on the subject would facilitate generating thought-out standpoint controlling challenges related to pathogenic microbial infections in trout health management. In this context, bacterial diversity of selected rainbow trout farms in Central, Northeastern and Northwestern Himalayan regions is extensively studied to document information on occurrence pathogenic flora in Trout culture.

Trout farms of Uttarakhand in Central Himalayan region signify presence of *Aeromonas hydrophila*, *Aeromonas veronii* (ichthiosmia), *Aeromonas popoffii*, *Aeromonas allosaccharophila*, *Pseudomonas fluorescense*, *Lactococcus garvieae*, *Citrobacter freundii*, *Escherichia coli*, *Micrococcus*, *Acidovorax facilis*, *Bacillus*, *Enterobacter*, *Brevibacillus agri*, *Shewanella*, *Morganela*, *Gamma proteobacterium* and *Hafnia alvei*. The ubiquitous presence of different species under genus *Aeromonas* is considered as commonly occurring opportunistic primary trout pathogens in all three seasons - summer, rainy and winter. The other major bacterial pathogen that have been frequently isolated along with *Aeromonas hydrophila* from moribund rainbow trout showing clinical symptoms of lesion in caudal peduncle region, tail, fin and gill rot (Fig. 2) is *Pseudomonas fluorescense*. Occurrences of secondary bacteria pathogens like *Escherichia coli*, *Micrococcus*, *Enterobacter*, *Shewanella*, *Morganela* and *Hafnia alvei* are also matter of concern in trout health management in farms of central Himalayan.

Analysis of microbial samples from trout farms of Sikkim in Northeastern Himalayan shows presence of more or less geographically diversified bacterial population in comparison to trout farms of central Himalayan. Identified bacterial flora is dominated by population of *Serratia*, *Pseudomonas putida*, *Micrococcus*, *Vagococcus*, *Hafnia alvei*, *Morganela*, *Rahnella aquatilis*, *Klebsiella*, *Pantoea*, *Pseudomonas*...
Fig. 2. Rainbow trout showing symptoms of disease development

veronii, Carnobacterium maltaromaticum, Carnobacterium divergens, Pseudomonas fluorescens, Yersinia, Erwinia and Corynebacterium sp. Carnobacterium and Corynebacterium are Gram positive bacteria, reported to cause pseudo kidney disease in rainbow trout and swelling of brain in carp. Genus Pseudomonas and Carnobacterium are considered as predominant groups in trout farms of Sikkim.

Large scale establishment of trout raceways and farming in Jammu & Kashmir and Himachal Pradesh has been successful due to its agro-climatic condition, topography and presence of huge perennial sources of snow-fed Himalayan rivers and streams. Based on hemolysis, virulence and serum activity study, some important bacterial pathogens isolated from trout farms of Jammu & Kashmir characterized by amplification of 16s rRNA, gyrB & rpoD gene are Aeromonas hydrophila, Aeromonas allosaccharophila, Aeromonas sobria, Hafnia alvei, Citrobacter freundii, Serratia sp., Pseudomonas fluorescense and Enterobacteriaceae. Himachal Pradesh being one of the major trout producing states, draws considerable attention for studying bacterial population and their diversity in trout farms. Isolates identified in lieu of bacterial population from different trout farms of Himachal Pradesh are Lactococcus garvieae, Citrobacter freundii, Proteus hauseri, Pantoea agglomerans, Erwinia rhapontici, Aeromonas hydrophila, Aeromonas veronii, Hafnia alvei, Pseudomonas fluorescens, Pseudomonas genticulata, Plantibacter, Escherichia coli, Lelliotia annigena, Microbacterium, Staphylococcus, Plegiomonas, Mollerella wisconsensis, Enterococcus casseliflavus, Enterococcus gallinarum, Caronobacterium divergens, Caronobacterium maltaromaticum, Bacillus firmus, Stenotrophomonas, Klouea and Paenibacillus. The predominant bacteria in few trout farms of Himachal Pradesh belonged to family Enterobacteriaceae. Antibacterial susceptibility test of Enterococci isolated from diseased eye (corneal opacity) of rainbow trout has shown resistant to Nalidixic acid (Na\textsuperscript{30}), Clindamycin (Cd\textsuperscript{3}), Lincomycin (L\textsuperscript{3}), Cephalexin (Cp\textsuperscript{30}), Polymyxin B (Pb\textsuperscript{30}), Amphotericin B (AP\textsuperscript{30}), Ceftazidine-\textit{Ca}\textsuperscript{30}, Cloxacillin Cx\textsuperscript{3}, Amphotericin B (AP\textsuperscript{30}), Oxacillin (O\textsuperscript{5}), Sulphamethoxy-pyridazine (St\textsuperscript{300}) and Meticillin (Met\textsuperscript{10}).

Precise data generated on bacterial germplasm of rainbow trout farms of Central, Northeastern and Northwestern Himalayan regions give ample chance to formulate location specific health management practices in rainbow trout farming. A strategic outlook envisages execution of proper prophylactic and therapeutic measures to control Lactococcus garvieae infection in rainbow trout farms of Uttarakhand and Himachal Pradesh showing typical symptoms lactococcosis; unilateral exophthalmia, inflammation and swollen vent, visceral petechial haemorrhages, focal haemorrhages and swollen liver. Being zoonotic in nature, occurrence of this pathogen has possible health implications, hence necessity of conducting awareness programme on zoonotic pathogens for trout handler/farmers is the need of the hour. Many times we ignore bacterial pathogens of lesser known occurrence in our culture environment. So research institutes and universities should focus on concept of emerging bacterial pathogens in aquaculture to develop scientific information on host-pathogen interaction and virulence mechanism. Data on occurrence of facultative pathogens in trout farms indicate that in adverse condition, they may cause possible disease outbreak leading to potential economic consequences for the trout farmers. Recorded antibiotic susceptibility data for primary, secondary and other potential bacterial pathogen of rainbow trout and its culture environment may help us to develop a quick decision support platform regarding efficacy of antibiotic treatment (dose and withdrawal period), in case there is any bacterial infection in rainbow trout culture practices. Genetic data developed on bacteria germplasm of trout farms of Indian Himalayan may serve as baseline information for future loss or addition new bacterial strain in the system.

Reference

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Prospects of Rainbow Trout Farming

Ladakh....

Coldwater aquaculture is well developed in the European countries but in India, the culture of cold water fish species is confined to the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and other states of North East. Rainbow Trout farming is popular as it is providing livelihood as well as food security to the people living in mountainous regions of the country. Farming of Rainbow Trout has enabled to earn rich dividends as rainbow trout being a delicacy is one of the most priced fish. It is intriguing that strict management practices can enable production of table size that can be harvested in a year and can fetch Rs 400–800 per kg. Besides the raw fish, the fish produce can also be utilized for value addition. It has been estimated that a farmer can earn a profit of Rs 1,00,000 per year from a raceway of 15m×3m×1m.

Rainbow Trout farming could be promising source of food as well a livelihood for the residents of Ladakh region. Ladakh, the world's highest cold desert is one of the most difficult terrain on earth with hostile climatic conditions. However, it has some promising areas for aquaculture around the rivers Sindhu or Indus, Suru, Dras, Shingo, Stod (Doda) Lungnak or Isarap Lingti and Zanskar. Streams and rivers which are snow fed, with highly oxygenated water that is ideal for rainbow trout culture. For popularization of trout culture in Ladakh, the Government of Jammu and Kashmir has established several rainbow trout farms. These well managed farms serve as technology demonstration units and are stretched across Diskit in Nubra Valley, Sindhu Ghat in Leh, Watka, Khachan, Damsna in Kargil sector while Khunda and Khandiyan in Drass sector. These farms provide technical know how to the local farmers for developing trout production units.

The Nubra valley has a tremendous potential for trout culture in the valley with a few perennial water sources. Trout Farm, Diskit lies over 34° 33.617ʹN, 77° 32.501ʹE at an altitude of 3128m asl (10260 feet). The farm has European as well American type of race ways for demonstration purpose.

Trout Farm Khaghanin Kargil sector lies over 34° 21.998ʹN, 75° 58.151ʹE at an altitude of 2881m asl (about 9540 feet). The unit was established in 1980 on the Kargil Damasna road and about 30 km away from Kargil district headquarters. The farm is located near the bank of river Suru and has seven raceways with a nearby perennial stream as the water source.

Trout farm Damasnain Kargil sector lies over 34°10.530’ N, 75°56.158’E at an altitude of 3190m asl (about 10465 feet). The farm was established in 1980 and is about 60 km away from Kargil district headquarters. The spring source of the water is Holocene (marshy spring). Rainbow Trout breeding was initiated at this farm in order to supply seed to those farmers who introduced trout farming. The farm is situated on the banks of river Suru near a famous picnic spot that faces the picturesque snow peak of Nun-Kun, the highest peak in the Himalayan range on Indian side of Line of Control.

Toutrearing unit in the village Khondiylas located in Drass sub division lies over 34° 26.049’N and 75°45.541’E at an elevation of 3156m asl (about 11340 feet). It is a rearing and a transit unit for trout seed that is transported to Kargil and Leh areas. The farm was established in August 2007 and has four raceways of 50’x7’x5’ feet. This unit has been instrumental in providing employment to the local youth by promoting rainbow trout culture.

The residents of Khundaat the foothills of Tololing range in Drass sector are also taking up trout farming. This small village at an altitude of 3076m asl (about 10000 feet) was severely affected during the Kargil war in 1999 is now flourishing as a couple of private trout raceways have been constructed by the locals with financial and technical assistance of State Fisheries Department. This village is now producing enough rainbow trout for local consumption which is quite useful during adverse winters when the temperature dips below -20°C.

Although there is a great potential of trout farming in Ladakh as the harsh climatic conditions and difficult terrains pose both challenges and opportunities. The transportation is difficult in Ladakh but on the other hand water from snow fed rivers is quite optimal in terms of quality. The low water temperature throughout the region is ideal for rainbow trout production. The produce can be served as a part of protein diet for the local residents as well as to the soldiers of the Indian Army deployed in several posts in this region. Locally produced rainbow trout could also be consumed during difficult winters when transportation of food material is difficult across the region due to snow fall and sub-zero temperatures. Rainbow trout is rich in omega-3 fatty acids that are known to be quite important for normal metabolism besides other health benefits.

With the efforts of ICAR-Directorate of Coldwater Fisheries Research, surveillance of important viral diseases was extensively carried out. Important viral like infectious pancreatic necrosis, viral hemorrhagic septicaemia that could pose serious threat to rainbow trout farming were investigated. It is interesting to note that so far there is no incidence of important viral disease in Ladakh as all the samples collected from different farms have tested negative for these diseases. In order to popularize rainbow trout culture in Ladakh, ICAR-Directorate of Coldwater Fisheries Research has been actively involved in developing rainbow trout raceways for enhancing fish production in Ladakh under Tribal Sub-Plan.

There is a great potential for rainbow trout production in Ladakh because of its conducive climatic conditions, the absence of fish viral diseases, availability of quality water, market demand and local population's interest in farming this fish.

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Snow trout in the Indian Himalaya

Distribution and Fishery Potential …..

The vast stretch of Indian Himalayan region, endowed with a number of rivers is home to diverse fish fauna. The rivers of these mountainous region support rich diversity of valuable and endemic cold water fishes that provide subsistence fisheries to the local inhabitants. Distribution of fish species in the Himalayan streams depends on the flow rate, nature of substratum, water temperature and availability of food which have contributed to the Ichthyofaunal diversity in the ecosystem. Some of the important group of fishes in the Indian sub-Himalayan region are Mahaseers, Schizothoracids, Minor Carps, Barils, Catfishes and exotic Trout.

Snow trout, belong to the family Cyprinidae, subfamily Schizothoracinae, have ubiquitous distribution in the Himalayan and sub-Himalayan regions of Indian subcontinent. They constitute an economically important group of food fishes of Coldwater region. Snow trout consist of 15 genera and over hundred species distributed all over the world. Seven genera and about 17 species of snow trout contribute to coldwater fishery in the Indian sub-Himalayan region. This group of fishes have a stream lined body, reduced scales, modifications of lower lips, short or complete absence of barbels and long caudal peduncle. Majority of the species belong to two genera: Schizothoracichthys and Schizothorax. These two genera have been broadly differentiated based on the shape of snout. Schizothorax spp. have a blunt snout and surculorial lip whereas Schizothoracichthys has a pointed snout without surculorial lip.

The major species are Schizothoracichthys escocinus, S. longipinnis, S. planifrons, S. micropogon, S. curvifrons, S. nasus, S. hugelli, S. labiatus, S. progastus, Schizothorax richardsonii and S. plagiotomus. Other genera commonly used for describing the species are Schizocypris (S. niger, S. micropogon) and Schizocypris stoliczkaei, Diplychus maculatus, Gymnocryptis biswasi and Ptychocharus conirostris. Snow trout have unique distributional pattern in Indian Himalayas as Schizothoracichthys escocinus, S. longipinnis, S. planifrons, S. micropogon, S. curvifrons and S. labiatus are endemic to Kashmir and Laddakh region, S. progastus has wide occurrence but have restricted distribution in the East. S. plagiotomus and S. richardsonii are found along the foot hills of Himalayas.

Fisheries in Himalayan water constitutes either subsistence or recreational fishery. Since mountain streams do not support high fish production, commercial fishery is quite limited. Fishing methods include nets, traps and poison which are generally used for catching fish in turbulent waters. Among different species of snow trout, Schizothorax richardsonii locally known as 'asela' has wide distribution in Indian Himalayas. This species alone contributes to 60-70% of the total fish catch from upland riverine systems. Schizothoracines migrate downstream to avoid extreme low temperature at higher altitudes during winters. They are mostly captured in large numbers in different streams of Indus and Ganga river system across Kashmir to Uttarakhand. Unfortunately, there is a quantitative and qualitative decline in natural fish population in Indian rivers and hill streams. The major threats to the coldwater fisheries are rapid environmental degradation, loss of habitats river impoundments, excessive and destructive method of fishing. This is creating enormous pressure on resources in general and fish stocks in particular. Therefore, due to their declining trend in different rivers and streams of Himalayas, IUCN has declared snow trout as a vulnerable species.

Life history traits, feeding and breeding biology of snow trout species have been widely studied. The feeding habit of snow trout is largely herbivorous and they are mostly periphytonic feeders. The reported maximum length and weight of different species varies from 25-60 cm and 1.5-5.0 kg respectively. The average number of egg laying in this group ranges between 10,000–40,000 per kg body weight of the fish, lowest being in S. niger and highest in S. escocinus. S. richardsonii has a total fecundity of 20,000–25,000 eggs per kg body weight. The spawning areas are characterized by shallow clear water, sandy and gravelly beds, with very feeble water flow. Spawning season also varies in different species and it was reported that it depends on the thermal regime at different elevations. The fish was observed to spawn at different elevations in different months of the year at a water temperature range of 18.0–21.5°C. It was observed that S. richardsonii and S. plagiotomus breeds during early summer while peak breeding season for S. niger extends from last week of February to mid of April while S. curvifrons breeds from May to July with a peak in June in Kashmir. The group as a whole exhibits slow growth pattern and generally attains maturity in two to three years of age.

Snow trout has some favourable cultivable traits such as eurythermal in nature, amenable to captive condition and accepts supplementary feed. Although a preferred food fish, aquaculture practices of this species is still not fully adopted due to slow growth and problems associated with developing appropriate feed. In India, initial success in artificial breeding of wild stocks of Schizothorax richardsonii, Schizothoracichthys escocinus, S. niger, S. micropogon, S. longipinnis, S. curvifrons has been achieved during 1980s in Kashmir, but a viable technology for seed production of these species particularly from the farm reared brood stock is still at initial stage of development. During late nineties similar success was achieved in Kumaon to breed S. richardsonii at field centre, ICAR-DCFRR Chirapani, Champawat. Induced spawning of some of snow trout species (S. richardsonii, S. niger) using synthetic hormones was carried out. Domestication and rearing of S. richardsonii has paved the way for producing seed under controlled conditions besides their culture under captivity. Thus, the aquatic resources in hills are quite valuable for the development of fishery for food, sport, recreation and employment. Mountain fish resource base is of great relevance which provides opportunities for the socio-economic development of unprivileged populations of the hills. It also to be remembered that the upland regions are fragile in nature therefore, it requires conservation besides utilization on a sustainable basis.

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टबमवन्य: नेपाली अध्ययन के साधन प्रजनन एवं पालन पोषण

आजीविका की समावाययाः

सजावटी मछलियों को उनके सुन्दर रंग, आकृति, और रचना के अनुसार “जीवन जेनर” कहा जाता है। कुछ श्रेणियों के मछली के मछली को पतन के प्रति स्वीकृति की है। इसका मुख्य कारण से ही मूलतः सजावटी मछलियों का पतन के प्रति स्वीकृति की है। सरंग पेड़ का रूप है। हैलमन्ट 1853 में नेडर ने यह दिखाया कि यह सजावटी मछलियों का पतन के प्रति स्वीकृति की है। सरंग पेड़ का रूप है। हैलमन्ट 1853 में नेडर ने यह दिखाया कि यह सजावटी मछलियों का पतन के प्रति स्वीकृति की है। अवकाशी बिजली का पालन एवं क्षेत्र के रूप में दिखाया जाता है। वह निषेध है कि हम नैसर्गिक जीवन में सजावटी मछलियों के पतन के प्रति स्वीकृति की है। इसका मानना है कि यह सजावटी मछलियों का पतन के प्रति स्वीकृति की है।

एक-दो नर का बुझा रहा, मांगते एक मछली से निकलने के निषेध में प्रयास पाए गए हैं। निषेध करने पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेध करने के पहले सभी क्षेत्र और क्षेत्रों में इसके प्रयास के निषेठ
News Section....

- A new species of a ground-dwelling lizard has been discovered in Gorgeon's Aarey Colony and Thane's Badlapur forested belts. The species, Cyrtodactylus Varadgirii or Girii's Geckoella, has been named after a Bengaluru-based scientist Varad Giri. It was discovered 130 years after the last such gecko was discovered.

- A team of Indian researchers led by Professor Anirban Banerjee from the Department of Biosciences and Bioengineering, IIT Bombay, and Dr. Deepak Modi from Mumbai's National Institute for Research in Reproductive Health unlocked the mechanisms by which preterm births occur. Preterm births signify the period between 28 and 32 weeks of gestation. They found that gram-positive Group B Streptococcus (GBS) bacteria produce small balloons called membrane vesicles. These vesicles contain toxins that destroy foetal and maternal cells. They also kill the collagen that keeps the cells together. The GBS bacteria are normally found in human vagina. Their numbers can shoot up in pregnant women. The GBS bacteria have been associated with premature rupture of amniotic membrane and preterm birth.

- A group of researchers discovered a new species of eel, Gymnothorax indicus, from the northern Bay of Bengal along the West Bengal coast. It is likely to be called Indian unpatterned moray. The eel was studied by the scientists at Sankarpur fishing harbour in West Bengal's Purba Medinipur district.

- Scientists from Massachusetts Institute of Technology have developed a new spectroscopic method to help the new Mars Rover to quickly and non-invasively identify rock and soil samples. The technique is based on improved way of interpreting the results of Raman spectroscopy, a common, non-destructive process used by geologists to identify the chemical composition of ancient rocks.

- A group of scientists at the University of Bristol developed a new stem cell-containing bio-ink that allows 3D printing of complex living tissues, known as bio-printing. Bio-ink contains a natural polymer from seaweed and a sacrificial synthetic polymer used in the medical industry. Seaweed polymer offers structural support when cell nutrients are introduced while synthetic polymer changes the bio-ink from a liquid to a solid as temperature is raised. Special bio-ink formulation was extruded from a retrofitted benchtop 3-D printer as a liquid that transformed to a gel at 37°C. The formulation allows construction of complex living 3-D architectures.

- Physicists working with the Large Hadron Collider beauty experiment (LHCb) have discovered new forms of matter, known as tetraquarks. The new particles have been named X(4140), X(4274), X(4500), and X(4700) after their respective masses, and each one has been found to contain a unique combination of two charm quarks and two strange quarks. This makes them the first four-quark particles found to be composed entirely of heavy quarks.

- Researchers at the Eli and Edythe Broad Center of Regenerative Medicine and Stem Cell Research at UCLA have succeeded in creating three-dimensional lung "organoids" by coating tiny gel beads with lung-derived stem cells and then allowing them to self-assemble into the shapes of the air sacs found in human lungs. The laboratory-grown lung-like tissue can be used to study diseases including idiopathic pulmonary fibrosis. Idiopathic pulmonary fibrosis is a chronic lung disease characterized by scarring of the lungs. The scarring makes the lungs thick and stiff, which over time results in progressively worsening shortness of breath and lack of oxygen to the brain and vital organs.

- A team of researchers from the United States and Madagascar has described a new, possibly microendemic, species of the snake genus Madagascarophis from the tsingy karst massif of Ankaranala National Park, the Malagasy Province of Antsiranana, and named it 'ghost snake' for its pale grey coloration and elusiveness.

- A team of scientists led by Dr. Carlos Perafán from the University of the Republic, Uruguay discovered new spider, scientifically named Kankuamo marquezi, in the Colombian mountain range Sierra Nevada de Santa Marta. It has been named after the famed Colombian novelist and 1982 Nobel Prize in Literature winner Gabriel García Márquez.

- Drs. Min Liu and Yuanjie Pang, along with a team of graduate students and post-doctoral fellows in Faculty of Applied Science & Engineering, University of Toronto's have developed a technique powered by renewable energies such as solar or wind. The catalyst derived stem cells and then allowing them to self-assemble into the shapes of the air sacs found in human lungs. The laboratory-grown lung-like tissue can be used to study diseases including idiopathic pulmonary fibrosis. Idiopathic pulmonary fibrosis is a chronic lung disease characterized by scarring of the lungs. The scarring makes the lungs thick and stiff, which over time results in progressively worsening shortness of breath and lack of oxygen to the brain and vital organs.

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**Fisheries Development in India the Political Economy of Unsustainable Development**

 Authored by: Dr. R. Korokandy
Published by: Kalpaz Publications | Year: 2008
ISBN-10: 8178356341;

**Fisheries Ecology**
The author provides a portrait of a society which is struggling to survive the traumas and changes of the Gorbachev years.

 Authored by: Paul Hart & T. J. Pitcher
Published by: Springer | Year: 1983

**Economics of Fisheries in India**
The book analyses the social, economic and environmental conditions of boat owners, boat labourers, female fish sellers and the cooperative fisheries societies.

 Authored by: P.A. Koli
Published by: Shruti Publications & Distributions | Year: 2012

**Fishery Products: Quality, Safety and Authenticity**
This holds true for companies and laboratories responsible for the processing of fish into various products, those responsible for researching safe new products, and departments within other companies supporting these functions.

 Authored by: Hartmut Rehbein & Jorg Oehlenschlager
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**Forthcoming events**

**National**

**4 December 2016**

“WRFER—International Conference on Forestry Food and Sustainable Agriculture (ICFFSA)”
Venue: New Delhi, India

**10 December 2016**

Venue: Dehradun, Uttarakhand, India

**25 December 2016**

“ISERD – 112th International Conference on Environment and Natural Science ICENS”
Venue: Pune, Maharashtra, India

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**International**

**3-5 December 2016**

“3rd International Conference on Environmental Systems Research (ICESR 2016)-Ei Geobase”
Venue: Dubai, United Arab Emirates

**25-27 December 2016**

“4th International Conference on Environment Pollution and Prevention (ICEPP 2016)”
Venue: Kyoto, Japan