RAINBOW TROUT FISHERIES IN SOUTH INDIA: CURRENT TRENDS AND FUTURE PERSPECTIVES

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Introduction

Rainbow trout (Oncorhynchus mykiss, Walbaum 1792) are coldwater species that belong to the family of Salmonidae. They are native to North America and have been introduced worldwide, except Antartica [1]. Rainbow trout have the capability to adapt to different aquatic habitats (rearing systems, reservoirs and natural waters) and have been introduced widely in other continents of the world such as Eastern Asia, Western North America, Central and Western Europe for aquaculture purposes [1]. Rainbow Trout was first introduced in the Ooty region of South India in the year 1863 [2]; this was followed by other coldwater regions of the Indian subcontinent.

Rainbow trout fisheries have flourished and expanded greatly in the Northern Himalayan regions and are available for commercial aquaculture. However they are neglected in the South Indian regions of Munnar, Ooty and Kodaikanal due to the absence of fisheries specialists and because of the lack of knowledge on trout fisheries and are currently in an endangered state [3].

Rainbow trout fisheries in the Indian scenario and its importance

Rainbow Trout fisheries in the North India first began in the year of 1900 in the Jammu and Kashmir State by Mr. F. J. Mitchell [4] and had arrived from Howeiton in Scotland.Currently, Trout fisheries in North India have become economically important, especially in the Himalayan regions and are in high demand. The fisheries department of the Jammu and Kashmir State government has achieved remarkable success in trout fisheries and has 59 trout rearing units in various districts (http://jkfisheries.in) and with one farm in the Kokernag region of the Anantnag district serves as the mother unit and is known as Asia's largest trout fish farm (Fig.1).

Fig. 1. A view of the trout fish farm in Kokernag of Kashmir, also known as "Asia's largest trout fish farm"

Further in Himachal Pradesh, trout fisheries have significantly contributed to the economic development of this state [5] and quality trout seeds are supplied to other north-eastern states such as Sikkim [6]. Trout farming has also flourished in the State of Arunachal Pradesh with hatcheries being established in this state. Adaptation of trout fisheries in the northern states of India has provided an excellent opportunity for game fishing and trout culture [3, 7]. Thus, trout fisheries have flourished in the North Indian regions and are economically viable. Although rainbow trout stocks are available in the high ranges of Munnar, Ooty and Kodaikanal[8, 9], the status of trout fisheries in South India is not fully developed [3].Rainbow trout was introduced in India by the British mainly for sport and recreational fishing and it is enjoyed by anglers who do game fishing India. Trout are reared in Indian uplands, and are contributing significantly to the revenue and economy of the people. Trout are a rich source of polyunsaturated fatty acids, accounting for 25 % of the total fatty acids [10] as such polyunsaturated fatty acids (linoleic acid (C18: 2n-6), docosahexaenoic acid (DHA; C22: 6n-3), arachidonic acid (AA; C20: 4n-6), and eicosapentaenoic acid (EPA; C20: 5n-3)) can be acquired only from the diet, therefore they play an important part of a healthy diet.Trout fisheries in India have become economically significant in the Himalayan regions and are known for producing table-sized trout [3].

Rainbow trout fisheries in Munnar

Trout Fisheries in Munnar was commenced by four Englishmen Koechlin, John Charles, Daisy Bell, and George Howlett of the Kanan Devan Hills Plantations (KDHP) Company in 1909 by introducing Brown Trout (Salmo trutta fario). This was initially successful, but further stocking operations with Brown Trout were not possible due to the First World War. In 1932, rainbow trout (Oncorhynchus mykiss) was introduced by A.W. John and a hatchery was established in 1941.

Though fisheries record are available in the 1930s and 1940s [11] and 1960s, but no data on trout fisheries are available until the 1970s [8]. However, the data after 1970 showed that rainbow trout have disappeared from a majority of the water bodies namely namely, Kaniamallay, Lakkam and Chokanad streams; Devikulam and Letchmi lakes; and Madupatty and Kundale reservoirs (Figs. 2a - f)due to illegal fishing, pollution, siltation, and animal intrusion. Currently, only one water body named as the Rajamallay Stream (Fig. 3a)is considered safe for the rainbow trout (Fig. 3b)for stocking and angling [3]. However, the rainbow trout in the Rajamallay Stream has been gradually decreasing after 1970, and are under continuous fishing pressure due to regular fishing. Moreover, local villagers and tribes are involved in illegal fishing. Furthermore, animal intrusion is also the reasonfor the decrease in stocks as wild otter packs often visit the stream for their meal because fish is their staple food [12]. All these criteria led to the reduction of stocks in the Rajamallay Stream. The rainbow trout stock in Iunnar is in an endangered state [3].

Conservative measures for future management of Rainbow trout fisheries in Munnar

Conservative measures are currently underway to help improve the trout fisheries in Munnar and some of them are as follows, fisheries experts from the Indian Council of Agricultural Research–Directorate of Coldwater Fisheries Research, India are frequently visiting the hatchery to help in the conservation of the trout stock. From 2020 onward, steps towards improvement of feed and water quality are being done to increase production. During 2018-2019, food pellets with improved nutritious value were formulated by ICAR–DCFR, Uttarakhand, India was fed and this gave excellent length and weight results to the fish. The strategy was adopted by the authorities of KDHP Company.

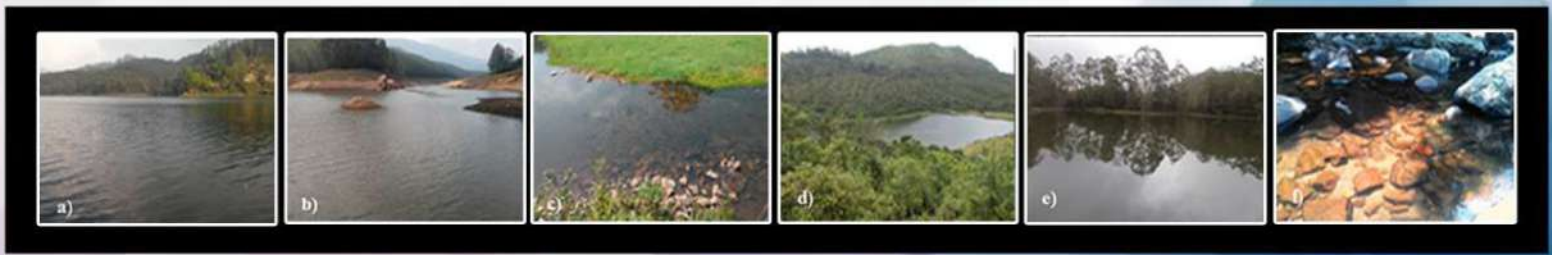

Fig. 2. Water bodies in Munnar once inhabited by Rainbow trout (Oncorhynchus mykiss); a)Kundale reservoir, b)Madupatty reservoir, c)Kaniamallay Stream, d)Letchmi Lake, e)Devikulam Lake, f)Lakkam Stream

Further training was given by ICAR - DCFR scientist's for hatchery workers on breeding, Hatchery management and feeding practices in February 2019 [13]. Efforts are currently being taken to increase the fingerling production for stocking. Construction of a new hatchery will help in the improvement of seed stocking operations. The commercialisation of the trout fish happens on a small scale and table-sized trout are sold at INR800 kg-1 to hotels and restaurants by the Munnar Supplies Association which is an authorized sales outlet of the KDHP Company [3]. On February 2021, nearly 8000 juveniles of rainbow trout were purchased from ICAR-DCFR Experimental Field Centre in Champawatand were released in the Rajamallay Stream [14], this will help in the conservation of the genetic diversity of the trout stock. Some of the other conservative measures that can be done towards conservation are, implementation of the recirculating aquaculture system needs consideration because low water levels are a persistent problem and the streams receive water mainly from the southwest monsoon [8].Angling rules and regulations need revision, with stringent action against destructive fishing.The KDHP Company should also take steps to restore all water bodies in which rainbow trout was previously found. The hill communities should also be educated on the conservation of the trout fish. Strict implementation of all the above factors can help flourish trout aquaculture in the High Ranges of Munnar in the future [3].

Rainbow trout stocks in Ooty

Trout introduction began in the Ooty region in the year 1863 by Francis Day who commenced by introducing of browntrout (Salmo trutta fario) and Loch Leven trout (Salmo levensis) in the 19th century, but it was a failure for four decades. In 1909, Henry. C. Wilson introduced rainbow trout from New Zealand and his attempts were successful and a hatchery was constructed in the Avalanche forest zone in 1910. Size and number decrease was noticed in 1913, indicating high fishing pressure. After this,In order to upgrade the stock, nearly five attempts were done and in 1920 rainbow trout were introduced from Kashmir for stock upgradation and this was followed by an introduction of four salmonid species from Japan in 1968 which consisted of golden rainbowtrout (Oncorhynchus mykiss aquabonita), brown trout, tiger trout (hybrid between brown trout and brook trout) and Sockeye salmon (Oncorhynchus nerka), out of all these releases, the golden rainbow trout established itself as the dominant strain in every anglers catch [2], while rest of the introduced species failed to establish itself. Another consignment of 10,000 eyed ova of albino rainbow trout was introduced from Japan in 1974, but had perished due to fungal infection, after this yellow bellied Shasta strain of rainbow trout was introduced from Munnar and hybrids were formed.

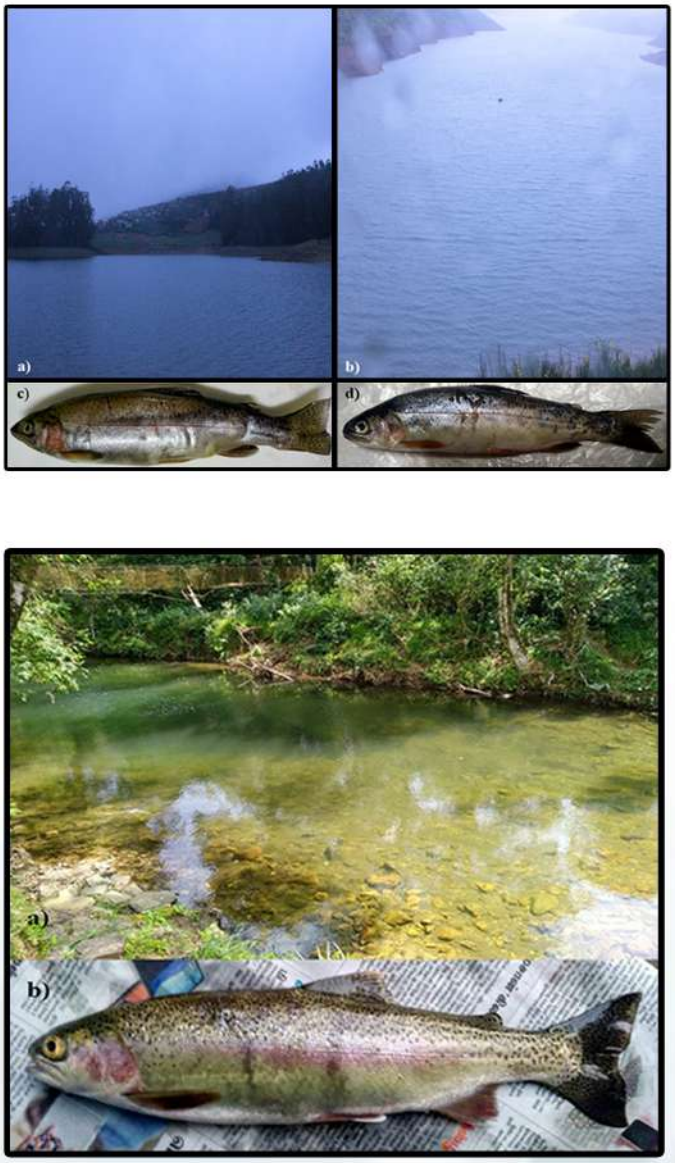

Fig. 3. a) Rajamallay Stream, current stocking habitation of the Rainbow trout (Oncorhynchus mykiss); b) Rainbow trout (Oncorhynchus mykiss) caught from Rajamallay Stream.

In 1997, the National Bureau of Fish Genetic Resources initiated a cross-breeding programme, by fertilizing the eggs of the wild spawners in Ooty with cryopreserved milt from Barot hatchery in Himachal Pradesh, but it failed due to untimely weather conditions with a poor success rate of 0.5% [2]. Though, trout fisheries got established in the Ooty region, but no reports are available after 1998. In 2015, fish biologists from Madurai Kamaraj University assessed the present status of trout fisheries in Ooty. It was found that after 2000, trout fishing activities have been banned to avoid fishing exploitation. The fisheries department of Tamil Nadu, Government of Tamil Nadu annually raise fingerlings from ripe brooders and has them stocked in the Avalanche Lake (Fig. 4 a) in small numbers but is majorly stocked in the Upper Bhavani reservoir (Fig. 4 b) of Ooty. Rainbow trout are now designated as 'wildlife fish' (importance of protection of rainbow trout is equivalent to that of the tiger) to save them from being poached. Commercialization of trout is not practised in Ooty. Production records from 2011 to 2019 showed that a total of 633,340 eyed ova were produced and the total number of fingerlings stocked was 462,350. The produced fingerlings have been stocked along with the wild brooders in the Upper Bhavani reservoir.In 2019, torrential rainfall and landslides caused massive damage to the hatchery and the Upper Bhavani reservoir which is the only stocking site on the reservoir wall, the repairing of the wall required the water and the entire trout stock to be flushed out. Thus, only a little stock is now available in the Upper Bhavani reservoir and similar situations persists in the Avalanche Lake andMukurthi reservoir. The rainbow trout stock in Ooty(Figs. 4c - d) is in an endangered state [15].

Conservative measures for future management of Rainbow trout fisheries in Ooty

Trout fisheries in Ooty hold ambient potential for growth, cultivation and farming, but are bred on a small scale. However, certain conservative measures can help in the sustainable development of this existing rainbow trout stock. There is a rising need for introduction of new rainbow trout strains which can make the population viable in the Upper Bhavani reservoir. Stripping and hatching sheds need construction along the banks of the Upper Bhavani reservoir, Avalanche Lake and Mukurthi reservoir, this can help in catching the brood fish and for quick fertilization of the eggs, thereby reducing the mortality.

Implementation of stringent action against poaching of trout fish must be done. The rainbow trout population in the Ooty region has high development potential [15]. Currently in 2022, the fisheries department of Ooty are taking proper steps towards the improvement of hatchery and are improving breeding procedures in the Upper Bhavani reservoir, Avalanche Lake and Mukurthi reservoir. Some of the other conservative measures that can be done are, introduction of new trout strains for genetic improvement of the stocks, Catch and release angling with supervision of the fisheries officials can be done for monitoring the trout population. Further maintenance of the hatchery premises using sanitary measures along with protection from animal intrusion (mainly by otters) is highly necessary. Cage culture of trout can also be implemented which can help in the employment and benefit of rural communities in Ooty [15].

Culture conditions for Rainbow trout

Rainbow trout can be bred artificially in specialized rectangular tanks called as "raceways" (tanks with free flow of water with an inlet and outlet) and can withstand temperatures upto 30°C. Adult broodersare first checked whether they are ready for spawning, i.ein female the belly is gently for release of eggs, in male for release of milt. Adults are anaesthetized in clove extract (so that they don't move around while handling). The female fish is then stripped for eggs completely, andthe eggs are placed in a bowl, and the male is stripped for milt and both the eggs and milt is mixed together and water is added to increase the sperm motility for fertilization. The fertilized eggs are then placed on flow through trays (trays with wooden sides and hollow glass rods like capillary tubes) and these trays are placed in hatching troughs which allows clear, cool and oxygenated water to pass through at 3-4 litres/min. Meanwhile before hatching, the dead eggs are removed in order to restrict fungal infection. Fungal infections can be controlled by using 37% formalin in the inflow water at a dilution of 1:600 for 15 minutes on an everyday basis, but should be stopped 24 hours before hatching time. The usual time taken for hatching is around 20 – 25 days.

After hatching, the trays are removed and are moved to shallow water with a depth of about 8-10 cm with a reduced water flow until they reach 'swim-up' stage, after which they reach the advanced fry stage and these and advanced fries are reared in fibreglass or concrete tanks and is fed with specially prepared starter feeds. As growth continues, dissolved oxygen is monitored, and the fish are moved to larger tanks and well-developed fingerlings are stocked in wild streams or lakes.

Need for conservation of rainbow trout

Rainbow trout play a vital role in the living of mankind and they need to be conserved for the reasons:

Nutritional Importance

Rainbow trout are a rich source of polyunsaturated fatty acids which makes upto 25 % of the total fatty acids of this fish [10] as they canbe acquired only from diet and cannot be synthesised by humans [16], and are also good in protein content and these trout fish can be considered asan important part of a healthy diet.

Medicinal Importance

This fish has medicinal value especially for patients with cardiac diseases, rheumatoid arthritis and nutritional deficiencies.

Economic Importance

In 2002, the trout industry generated about $9 million in economic output and created 201 jobs, and generated $3 and $0.9 million in North Carolina, USA [17].

Ecological Importance

Rainbow trout is sometimes used as a biological indicator for water quality in water purification facilities [18].

Adaptability

Rainbow trout can easily adapt and can be cultured in any cold and pollution free water environment around the world.

Rainbow trout in south india for future directions

Rainbow Trout have not received the importance and status as other aquaculture species in India have, this mainly because of the limited knowledge on trout fisheries to the general public. The availability and knowledge about Rainbow trout is limited only to the people residing in the Coldwater regions or hilly areas in North and South India, but it is also known to people who show great interest in sport and recreational fishery. Rainbow trout fisheries has reached phenomenal heights of growth and has greatly played a vital role in the economy of the fisheries departments of the northern states and in the lives of the public who have their living on trout farming. This is not the scenario in the South Indian regions and needs great efforts towards growth and sustenance, currently rainbow trout stocks have disappeared from most of the water bodies at Munnar and it is currently limited to the Rajamallay Stream of Munnar with the breeding operations in the Rajamallay Hatchery on a small scale. The scenario in Ooty is worrysome as the trout stock in the Upper Bhavani reservoir have been completely washed away and the hatchery too has been devastated due to the torrential rains and floods, thereby requiring reconstruction. Though remnant stocks are available in the Avalanche Lake and Mukurthi reservoir, breeding operations are not carried out here. The trout stocks in Munnar and Ooty are in an endangered state and suitable conservative measures are currently underway. Rainbow trout fisheries and cultivation can be an economic boon to the people of South India if fisheries specialists, scientists and authorities who can implement strong conservative actions towards protecting its habitats are available. If the other viable options that can help in the propagation and promotion of this salmonid species are considered, the fish will increase and flourish as it is seen in the Northern regions of India. The presence of clear water streams and ambient weather conditions have proved that they can sustain Rainbow trout life in the locations of Munnar and Ooty and it will continue to do so in the coming years also with efforts taken as proposed.

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