

INTRODUCTION OF TROUT INTO TANGANYIKA TERRITORY.

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Trout having succeeded so admirably in the neighbouring territory of Kenya, it was decided by a few keen fishermen in the Usambara District of Tanganyika Territory to try the experiment there. To the late Major Sandwith of Magamba Estate in the West Usambaras, the credit is due, for it was he who first suggested the introduction of trout and subscribed a large part of the necessary funds. The writer, helped by a few friends, attended to the actual business, built the hatcheries and generally conducted operations throughout. Early in 1926 a very small hatchery was made on a tributary of the Mkussu Stream on Major Sandwith's estate. The capacity of the hatchery was some 5,000 ova at the most. The Mkussu stream, which it was intended to stock, drains a well forested tract of the West Usambara Mountains between altitudes of 6,500 feet at its sources and 1,200 feet at its confluence with the Mkomazi River on the plains at the foot of the Usambara Escarpment. There are nine major falls on the stream, varying in height between about 40 and 190 feet of sheer drop. Between these falls the reaches have for the most part an easy gradient. For many miles the stream flows slowly in a deep and narrow bed through swampy lands. In such it meanders to an extraordinary extent greatly increasing the available fish containing and fishable water. On other reaches there is a rapid fall over a rocky bed with many runs and pools. The water is well broken and aerated in these reaches as well as at each of the major waterfalls, a condition which as regards oxygen content counteracts the effect of a quiet swampy course in other reaches. The total length of the main stream measured in its prevailing directions would be some 30 miles, but taken over its actual meandering course this distance can safely be doubled.

The climate of the West Usambara Mountains is cool and moderately wet. The average shade temperature is 60°F. with extremes of approximately 30°F.—75°F. Two rainy seasons prevail, the longer in March, April and May and the shorter in October, November and early December. Water temperatures vary from 51°F. in the cold months of June to September to about 62 or 63°F. in December-February. The water is normally rather peaty and, though no chemical analysis has been made, it can safely be assumed to contain much CO₂ and to have a high acidity. But neither condition appears to be in the least harmful to rainbow trout, though their effect on the brown trout is doubtful. In regard to the natural food supplies of the Mkussu River,

unfortunately little definite knowledge exists. Much careful investigation is required and an entomological survey would be invaluable. Certain it was, however, that a large number of fresh water crabs inhabited the stream and examination of the stream bed as well as of the stomach contents of many trout shows the presence still of fairly abundant and varying aquatic insects. Frogs in the adult stage are common, but their spawn and tadpoles have seldom been observed. Presumably the frogs breed in small pools and swamps by the stream side and migrate to it only as adults.

Long reaches of the stream were in dense forest, but the heavy shade was lightened artificially by judicious clearing with the result that these dark reaches, so poor in insect life, have been much improved by the presence of water weeds and a more luxuriant fringing growth along the banks.

Such then briefly is the nature of the water stocked. As for the stocking itself, little need be said. The first attempt was with Fario. Three thousand ova were received from the Solway Fisheries, Dumfries N.B., on March 11th, 1926. The hatchery mentioned above was only completed on the day the ova arrived in Magamba and on testing the water temperature it was found to be in the region of 70° owing to the sun-warmed flume boards, filters and troughs. The hatchery, therefore, could not be used and resort was had perforce to placing a hatching trough with boats directly in the stream itself anchored down with pegs. The ova arrived at 11 p.m. and a shivering trio sat out for three hours thawing up eggs from the travelling box temperature of 42°F. to that of the stream at the moment, namely 58°F., a good fire at a distance and much bottled beer made this vigil more tolerable. This lot of ova was unlucky from the start. In a few days the stream came down in flood and covered them with a brown peaty deposit, which it was most difficult to remove. The first alevins emerged 4½ days after incubation recommenced and hatching ceased on the 6th day thereafter. The water temperature during this time varied between 55° and 60½°F. owing to periodic flooding, and for the same reason the stream was very dirty and the ova seriously injured by heavy deposits. On the 17th of March the hatchery had become serviceable with a comparatively clean water supply at a temperature of 62°. The mortality among alevins had been great, but the remaining few together with unhatched ova were removed to the hatchery. Much dropsy of the yolksacks and deformity appeared among these alevins.

Out of this consignment of 3,000 ova only some 57 fry were obtained! The yolksacks were absorbed from 9 to 10 days after hatching and the fry were first clearly seen to feed 4 days after absorption, though they must actually have been feeding before this. The food consisted of fowl's liver and eggs hard boiled and finely grated. Crabs were caught, boiled and their flesh finely grated. This food was readily

devoured. The hatchery was too dark, an error in construction, which rendered accurate observation of the stock most difficult. The next lot of ova to be received was of rainbow (*Salmo irideus*). Little better success attended them, for it was found that the ova had been badly packed all on one tray between heavy layers of wet moss and a large percentage was already crushed and dead, probably by vibration during the train and lorry transit.

On April 6th, 1927, a further consignment of Fario arrived, the number of which was never ascertained but could not have been above 3,000. These were well packed and travelled unscathed the 80 miles of railway. The water temperature was $60\frac{1}{2}$ °F. Few losses were sustained. On May 28th a second lot of rainbow ova arrived and without due notice. In consequence the box was deposited on the Railway Station platform at an altitude of 1,200 feet above sea level and at a shade temperature of 90°F. It remained there from 4 p.m. till 12 noon the next day. During some of this time the box was exposed to the direct rays of the sun. It speaks well for the packing that these ova were intact and hatched successfully, although subjected to such trying conditions. The temperature on opening the box was found to be 46°F., that of the stream in the hatchery was 58°F. There was insufficient ice to keep the temperature down for long enough evenly and slowly to equalise the temperatures of the travelling box and hatchery water. Some ova commenced to hatch within 5 minutes of opening the box—they would have begun hatching on the trays, had the transfer been any longer delayed. Despite the rough and drastic treatment experienced by these ova, the hatch was very successful, and the fry developed strongly in the hatchery and when set out eventually in the river continued to do so without any apparent weakness resulting from the treatment. Fish of this lot grew to 2 lbs. 8 oz. in 22 months from the egg.

The hatchery thus contained almost even aged brown and rainbow trout fry. The brown were first put out into a pond close to and fed by a flume from the Mkussu and were regularly fed there. A rent was made one night in the grating at the entrance of the pond and most of the fry escaped prematurely into the river. The rainbow were transferred to this pond after a few weeks in the hatchery and fed daily on boiled crab flesh and ox liver.

In all 1,700 brown trout and 1,457 rainbow fry escaped or were put out into the stream and no other stock was added until June, 1931, four years later.

As usual the mixture of Fario and rainbow in the water was no success as far as the former are concerned. The Fario, it has been observed, remained more or less in the reaches where they were set out, but their travelling tendency has been upstream. The rainbow have travelled equally upstream and down. An insurmountable fall put an

end to their upstream journey after some 2½ miles. But down-stream they have travelled about 5 miles, going unhurt over a 90-foot waterfall and a narrow race rushing at an angle of 45° through a rocky channel about 50 yards long into a deep wide pool below.

The Fario have never been happy and do not appear to have propagated their kind, though certainly hen fish have been taken in ripe spawn and cocks in milt. No Fario fry or fingerlings have ever been taken or observed. Some people claim to have observed hybridization, but the writer has not yet seen any evidence of this. Most of the Fario caught are sorry starvelings with tremendous hungry looking heads and soft emaciated bodies. But there are exceptions, e.g. a beautiful 3-pound cock fish in perfect condition was taken last July. This was certainly one of the old pioneers.

The rainbow encountered perfect conditions in a virgin stream, abundance of food and complete freedom from natural enemies. Angling began in earnest about 12 months after the rainbow were planted. By the end of the second year it was common to take 2 and 3 lb. fish in perfect condition.

Observation appears to show that, although the fish spawn in any month between June and January even into February, there is a period of greatest spawning activity in the months of August-November when the water temperatures are coldest and the volume of flow at its lowest. A close season was originally prescribed by law as well as restrictions as to size and numbers of trout to be killed. But the stock increased so rapidly that all attempts at preservation by regulating the activities of anglers were abandoned after four years when the problem became one of increasing food supplies and reducing the numbers of fish rather than attempting to augment them. The relation between natural food supplies and fish stock is as marked here as it is in Kenya. The fresh-water crab, so plentiful before the advent of the trout, has practically disappeared from the reaches in which fish are most plentiful.

It may be noted here that recently the Mkussu Angling Association has been adopting the following measures aimed at increasing food supplies in its water. Small log dams are thrown across the stream at places where one bank is low and already somewhat swampy. The water overflows into the reedy low-lying land and inundates it. The object in view is to promote the breeding of insects, which will have direct connection with the stream over the flooded bank. These dams hold up the water very well and provide deep shelter for the trout. Below each is a good swirling current, which aerates the water.

Thin poles or logs are laid across the stream just touching the surface in sluggish places. Floating refuse and white scum collect at these poles, which at once become a much appreciated resort for the fish. They are also death traps, as the angler generally takes a good trout at each pole.

The third measure consists of actually collecting the fresh-water crabs in large numbers in streams and swamps untenanted by trout and liberating them alive in the dammed reaches of the trout stream. These crabs had eggs in the month of July and young in August—September carried between the body and tail folded inwards to support them.

It is intended also to rake over the redds in reaches where overcrowding is most noticeable and thus reduce numbers.

The year 1928 saw heavy long rains in April and May. The Mkussu came down in spate seven feet over its normal level and produced powerful currents, which doubtless carried some of the young fish far down stream, leaving them, on the flood subsiding, in unpopulated reaches, where, being well spread out and encountering quantities of food, they developed very rapidly.

Microscopic examination of scales does not appear to be very informative as to the life history of the trout in the Usambaras. It is recognised, however, that the observer may be at fault and incapable, through lack of experience, of recognising the characteristic signs or of correctly interpreting them. The scales of a few three year old fish seemed to show spawning marks, while only occasionally is definite zonation to be observed, denoting, it is thought, the successive periods of food plenty and scarcity. Attempt was made to correlate this zonation with the periods of the short and long rains, but without much success. Only in the cases of trout found singly in pools far down stream in 1929 did the scales relate the owners' history. These fish were spawned in the upper reaches and for a time lived with numerous others in keen competition for the available food supplies. The floods of April, 1928, transported some of them to rich feeding grounds enjoyed without competition. The scales show a zone of narrow rings at the centre followed immediately by a far wider zone of broad rings. No sign of spawning marks is seen. One such fish was a cock of 18 inches long with a girth of $15\frac{1}{2}$ inches and the small and short lower jaw characteristic of the henfish.

The year 1929 marked the height of the Territory's prosperity and the Legislative Council readily agreed to vote a small sum for further stocking operations to be conducted by Government. An allocation of £200 was made to the Forest Department for a permanent hatchery to be erected on the Mkussu River near Lushoto. This was duly erected and ready to receive ova by January, 1931, and a consignment of 20,000 Rainbow ova was hatched. Operations were partially successful. The water temperature at the time was unfortunately on the warm side, being about $61\frac{1}{2}$ °F., and in consequence mortality among ova and alevins was nearly 50%.

It was from fry resulting from this hatching that the trout were spread to the West Kilimanjaro area, where there are a number of small streams suitable for them and a fair population of Europeans.

Moving fry from the Lushoto hatchery to West Kilimanjaro proved no simple business. Aeroplanes were out of the question owing to lack of landing grounds. The hatchery at an altitude of 5,000 feet is 27 miles by road from the railway station at 1,200 feet. Mombo, the railway station on the Tanga line, is a distance of some 140 miles from Moshi. The whole of this length of line runs through low-lying hot country. From Moshi to the Ngare Nairobi North River, the one chosen for the first stocking, is about 50 miles over roads at the time very bad in parts.

Several attempts were made to move fry and by bitter experience a method was finally evolved, which proved very successful. The fry were starved for 24 hours, then placed in thick flannel bags inside 8-gallon milk-cans. In one can of this capacity as many as 500 $1\frac{1}{4}$ inch fry or 100 3-4 inch fish were placed. Aerators were used. They consisted of steel cylinders fitted with valve, rubber piping, pressure gauge and tap. The air was forced through filter candles into the water cans. This idea proved highly efficacious in breaking up the air into millions of minute bubbles, so that the oxygen was readily absorbed by the water. Ice was also necessary to regulate the water temperature and smart staff work was necessary to ensure the ice supply would be on the train on which the fish were to travel and immediately obtainable when the train arrived. Fortunately the mail train ran at night in the coolest hours. The General Manager, himself a keen fisherman, arranged for a four berth 1st class compartment in the centre of the bogey for the cans' accommodation and two people travelled with the fry taking turn to watch thermometers and aerators throughout the night. The jolting of the lorry next morning between Moshi station and West Kilimanjaro was the most trying time for the fry, but this was where the thick flannel bags came in and prevented injury to the small fish when the water was violently hurled from side to side of the cans. Arrived at the Ngare Nairobi, the temperature discrepancy between river water and can water was found to be between 10 and 11°F., necessitating very gradual equalization.

One incident of considerable interest occurred. Five hundred 4-inch fish were being transported to stock a reservoir in the Ngare Nairobi area. Wooden troughs had been installed at the place fed by water from the bottom of the said reservoir by a pipe and tap. On arrival at the troughs the fish were apparently in excellent health being lively and actually feeding on small pieces of ham and bread crumbs. The water temperatures in troughs and cans were identical so the fish were emptied straight from cans into troughs. During the first five minutes 49% died, during the ensuing hour 15% and during the next 19 hours a further 1%. After much consideration the writer inclines to the view

that deaths were due to asphyxiation. The water in the cans was over-aerated by the efficient apparatus while that in the troughs issuing as it did from the bottom of the deep reservoir contained less than a normal oxygen content of 2 p.p.m. The truth of this theory might have been tested by shutting off the aerators until the fish were beginning to show signs of distress from asphyxiation and then turning them out into the troughs. It is understood that trout gradually accustomed to water of low oxygen content will withstand much lower contents than fish suddenly transferred from normal oxygen conditions to water of low oxygen content.

In this way some 500 fry were successfully planted in the river during June and July, 1931. By the latter month of 1933 the river was full of trout. The original stock had spawned freely and themselves reached a weight of 2 lbs. and over. The majority of fish in July were of a half-pound average down stream. The writer took 50 such in three hours. All were in fine condition. This stream, unfortunately, is a rapid mountain torrent running mostly in a precipitous rocky gorge and liable to most sudden and violent flooding. A rise of eight feet in two hours is common in the long rains. The food supplies are doubtless meagre and rapid deterioration of stock is to be expected. But the importance of having stocked this stream lies in the fact that it now forms a nucleus and supply base for fry and fingerlings for stocking the neighbouring waters of Moshi and Arusha Districts. The writer, helped by the local Forest Officer, last July successfully transported 128 fry to the Ngeraragua River, 12 miles to the east. This is a better trout stream of easier gradient flowing through forest reserve and open plain between European farms. Judging by the speed of increase in the Ngare Nairobi River, it is safe to expect good fishing in the Ngeraragua two years hence.

There are beautiful streams emerging from the south slopes of Kilimanjaro, among them the Weru Weru and Kikafu. The volume of water is great and pools deep and long, but the temperatures soon increase with loss of altitude while irrigation furrows are numerous, as also, it is feared, are the eels and giant kingfishers. It is probable, however, that the rainbow trout will succeed in them. If this is the case, the angling will be of the highest quality.

Further attempts to stock waters in Tanganyika Territory have been made, notably that of an Association of fishermen at Usa in the South Meru area of Arusha. This association flew 2,000 fry by air from Kenya to Arusha and succeeded in planting them in the Usa River. But this stock, which developed well initially, now appears to have been lost. Much of it doubtless has served as fish manure for coffee trees, having escaped down the irrigation furrows into the coffee plantations. A more probable explanation of the disappearance is the high alkalinity of the Meru Mountain waters.

This paper cannot be ended without a mention of Tanganyika's Southern Highlands, south from Iringa to Mbeya and into the Livingstone Mountains to Rungwe and Tukuyu. There is in this lovely region great scope for introduction of trout. The streams are legion and they are cold and long, some ideal for Fario. The Rufirio River flowing out of the Livingstone Mountains will, it is hoped, before long rival Kenya's Gura. Residents in the Southern Highlands have already formed an association with which Government will co-operate to make a fisherman's paradise of this attractive country.

Since writing the above there have been important further developments as regards introduction of trout into these Southern Highlands.

The Mbeya Planters' Trout Association last August succeeded in hatching out some rainbow as a first experiment. Three thousand ova were posted up from Stellenbosch, South Africa, by air mail. The box of ova was a simple, single-sided, wooden one without any insulation or devices for preserving the contents either against heat or mechanical injury. The box was shaken out of one of the mail-bags at the post office and tumbled along the floor! In view of this and lack of suitable hatching apparatus, it is surprising that even a low percentage hatch took place. It sufficed to prove that, given better conditions, rainbow can be easily introduced.

Funds both from private subscription and Government grant are to be available in 1934, when serious work will begin in two separate hatcheries, to stock the fine streams of Dabaga, Mufindi, Njombe, Tukuyu and Mbeya. The writer had the opportunity of making a preliminary reconnaissance of three of these streams, the Kiwira of Rungwe-Livingstone origin and the Ruhudje and Hagafirio on the Ubena Plateau. All three are unsurpassed by anything in the way of potential or existing trout water in Eastern Africa. So Tanganyika, it is hoped, will soon be entering into friendly rivalry with Kenya.

Morogoro,
November 7th, 1933.