

# HISTORY OF TRANSPLANTATION AND INTRODUCTION OF FISHES IN INDIA\*

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*(With a text map and eight figures)*

## SYNOPSIS

The objects of transplantation of fishes in India and introduction of exotic species into the country are mentioned and in the light of these objects the fishes are grouped as (i) game fishes (ii) food fishes (iii) larvicidal fishes and (iv) ornamental fishes. The history of transplantation and introduction of these fishes is reviewed in the context of the results achieved. Instances of accidental transplantation are mentioned. In the light of the available data suggestions for further transplantation of fishes are given.

## INTRODUCTION

Though transplantation of food fishes from their natural habitat to nurseries and rearing ponds has been in vogue in India from remote times, the augmentation of the fish fauna by introduction of exotic forms and intrazonal transplantation of suitable autochthonous species for permanent establishment is of comparatively recent origin in this country. Most of the pioneering work in this field has been done by westerners, who, finding some of the upland waters similar to the rivers in their own country, tried to introduce their favourite varieties of fishes in them. The successful introduction of trout into certain hill-streams of India is an outstanding achievement of such efforts.

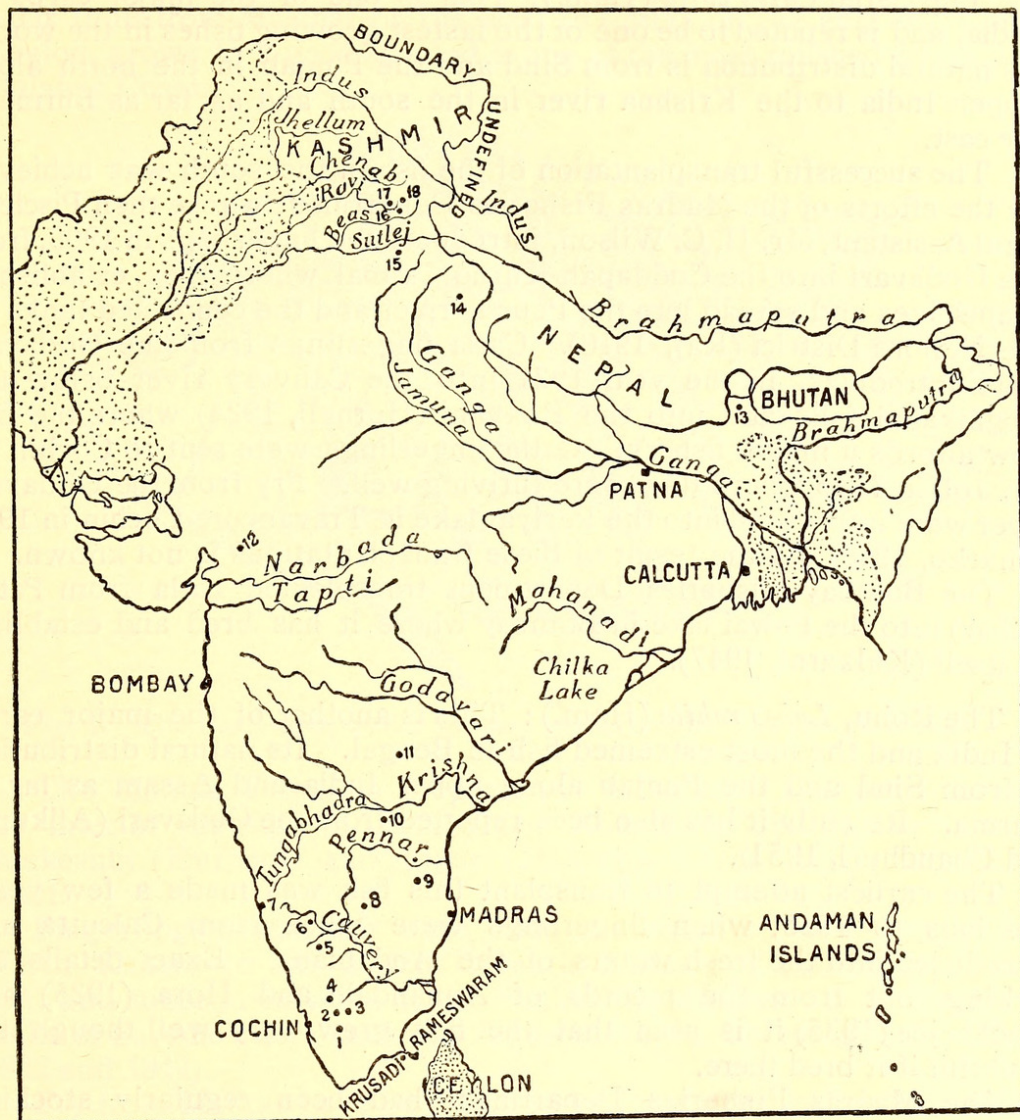
The Madras Fisheries Department was, probably, the first government organization to take up transplantation of fish, and its pioneering effort in this field is worth special mention. Though attempts to introduce or transplant food fishes into various localities were started over a century ago, it is only in recent years, when the food shortage in the country became acute, that these operations were intensified. While the establishment of game fishes and production of food fishes were the main objects of this work in India, another important object was the biological control of malaria. From early times ornamental fishes such as the exotic goldfish have been reared by aquarium keepers, and there exists a trade in these fishes in some of our big cities. The fishes that have been introduced or transplanted are here grouped as (1) game fishes, (2) food fishes, (3) larvicidal fishes and (4) ornamental

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\*Read at the Symposium on transplantation of fishes during the 3rd meeting of the Indo-Pacific Fisheries Council, Madras (February 1951), and published with the permission of the Chief Research Officer, Central Inland Fisheries Research Station, Barrackpore.



fishes, and a historical account of their transplantations and introductions with a brief discussion of the results achieved is attempted. Routine transplantation operations for rearing and harvesting purposes without the object of permanently establishing the species in regions where they are not autochthonous are not included in the account.



Outline Map of India showing the localities mentioned in the article.

*Key to the numbering* : 1. Periyar (Travancore) ; 2. High Ranges (Travancore) ; 3. Kodaikanal (Palnis) ; 4. Anamalais ; 5. Ootacamund (Nilgiris) ; 6. Mysore ; 7. Coondapur (South Canara) ; 8. Shevaroy (Salem) ; 9. Ippur (Nellore) ; 10. Sunkesula (Kurnool) ; 11. Hyderabad ; 12. Baroda ; 13. Darjeeling ; 14. Nainital (Kumaon Hills) ; 15. Simla ; 16. Kangra ; 17. Chamba ; 18. Kulu.

#### TRANSPLANTED FOOD FISHES—Autochthonous

One of the earliest recorded attempts at transplantation of fish in India, is of the Milk-fish, *Chanos chanos*, by Hyder Ali of Mysore during the latter part of the 18th century, from the sea to the Coondapur estuary in South Kanara (Thomas, 1870). Subsequently Thomas (op. cit.) transplanted some fish from the sea to the Karkal lake, but they failed to breed there.



An interesting but evidently unsuccessful attempt to transplant Hilsa *Hilsa ilisha* (Ham.) was made by Wilson (Nicholson, 1915). The eyed ova of this fish were transferred from the hatchery at the lower anicut in the Cauvery to the Ponnani river in Malabar, but there is no evidence of the fish having established itself there.

The Catla, *Catla catla* (Ham.): This is one of the major carps of India, and is reputed to be one of the fastest growing fishes in the world. Its natural distribution is from Sind and the Punjab in the north along upper India to the Krishna river in the south and as far as Burma in the east.

The successful transplantation of the fish in the south was achieved by the efforts of the Madras Fisheries Department whose then Piscicultural Assistant, Mr. H. C. Wilson, introduced the fingerlings in 1909, from the Godavari into the Cuddapah-Kurnool canal where they established themselves and spread into the Pennar river and the connected tanks in the Nellore District (Raj, 1916). Catla fingerlings from the Godavari were introduced in the year 1921 into the Cauvery river below the Hogaikanal falls and into the Bhavani (Hornell, 1924) where the fish now affords a major fishery. Catla fingerlings were sent to Cochin by Dr. Job in 1945 where they were thriving well. Fry from the Godavari river were introduced into the Periyar lake in Travancore-Cochin in 1947 (Chacko, 1948) but the result of these transplantations is not known.

The Bombay Fisheries Department transplanted catla from Patna (Bihar) into the Powai lake in Bombay where it has bred and established itself (Kulkarni, 1947).

The Rohu, *Labeo rohita* (Ham.): This is another of the major carps of India and the most esteemed fish in Bengal. Its natural distribution is from Sind and the Punjab along upper India and Assam as far as Burma. Recently it has also been reported from the Godavari (Alikunhi and Chaudhuri, 1951).

The earliest attempt to transplant this fish was made a few years previous to 1925, when fingerlings were taken from Calcutta and introduced into the fresh waters of the Andamans. Exact details are lacking, but from the records of Annandale and Hora (1925) and Mookerjee (1935) it is seen that the fish grew very well though it is doubtful if it bred there.

The Madras Fisheries Department had been regularly stocking several pieces of water in the State from 1944 to 1949 with fry obtained from Bengal and Orissa (Jaganadham 1946 and Thyagarajan & Chacko, 1950) and attempts were made to transplant the fish in the Cauvery also. Whether the fish has established itself there or not is not known. In Bombay, fry from Patna (Bihar) were introduced into the Powai lake along with *L. calbasu* (Ham.) where both are reported to have bred (Kulkarni, 1947).

The Mrigal, *Cirrhina mrigala* (Ham.): This is an important major carp of India distributed throughout upper India from North-west Provinces, the Punjab and Sind to Bengal and Assam and in upper Deccan and Burma.

The fry of mrigal have been introduced from Bengal regularly from 1943 to 1947 and from Orissa in 1949 into Madras waters including the Cauvery (Thyagarajan & Chacko, 1950) but the results of these transplan-



tations are not available. Mrigal introduced as fry into the Powai lake in Bombay from Patna (Bihar) is reported to have bred there (Kulkarni, 1947).

The Pearl-spot, *Etroplus suratensis* (Bloch) (Fig. 1): This Cichlid, distributed in brackish and fresh waters along the coastal tracts of Peninsular India from Malabar on the west to Chilka on the east coast, and in Ceylon, grows to a good size and is one of the most relished fishes of the Malabar Coast.

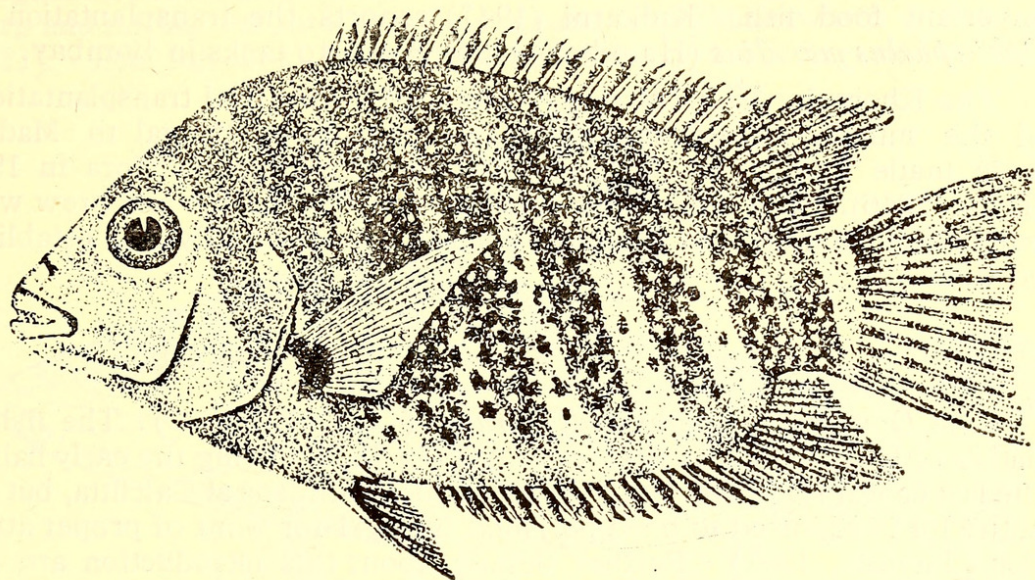


Fig. 1. The Pearl-spot, *Etroplus suratensis* (Bloch). (After Hornell).

The Madras Fisheries Department introduced the pearl-spot into the interior districts of Bellary and Anantapur and in the farms at Sunkesula (Kurnool) and Ippur (Nellore), where it has established itself.

Fingerlings of this fish have been transplanted successfully from North Kanara to the Mahim Creek in Bombay (Kulkarni, 1947) and in 1941 and subsequent years from Sunkesula, Madras, to the irrigation tanks of Baroda where they are reported to be breeding now (Moses, 1942 and 1944).

Fry from Madras have been introduced into the Bidyadhari area in Bengal (Jaganadham, 1946) and these have been reported to be breeding there (Job & Chacko, 1947). A total of 500 young fish were taken in 1942 from Madras to Hyderabad (Deccan) of which only a few survived. These commenced breeding in 1943 and the fish is now reported to have established itself there (Rahimullah, 1946).

This is perhaps the first or only Indian food-fish that has been transported to any foreign country. A consignment of pearl-spot was taken in 1922 from India to Mauritius via Colombo (Hornell, 1923). Over half of it reached safely, but it is not known whether the fish established itself there.

The Orange Chromide, *Etroplus maculatus* (Bloch): This cichlid, of more or less similar distribution and habitat as the pearl-spot, is of smaller size and hence is not of much economic importance. It is reared as an aquarium fish also and for this purpose has been introduced into several countries outside India.



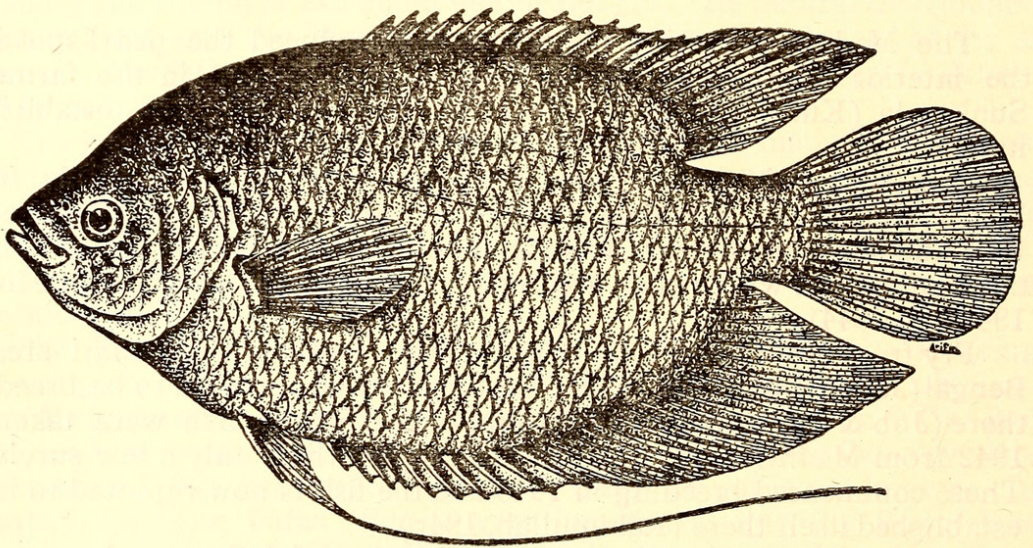
The Orange Chromide has been introduced by the Madras Fisheries Department into the Sunkesula (Kurnool) Farm and from there transplanted by the Bombay Fisheries Department to the Bandra Creek (Bombay) where it figures regularly in the fishermen's catches (Kulkarni, 1947). It was successfully transplanted from Madras to the Hyderabad State in 1943.

The Murrel, *Ophicephalus* spp.: In several parts of India where major carps are not available and tanks are seasonal, the murrel forms a very important food fish. Kulkarni (1947) reports the transplantation of *Ophicephalus marulius* (Hamilton) from Poona to tanks in Bombay.

The Khorsula, *Mugil corsula* (Hamilton): Two trial transplantations of the mullet, *Mugil corsula* (Hamilton), from Bengal to Madras were made by Dr. T. J. Job in 1944 and by Dr. S. L. Hora in 1945 (Basu, 1946). The fingerlings reached the destination and grew well, but as their number was small the species has apparently not established itself.

#### INTRODUCED FOOD FISHES—Exotic

The Gourami, *Osphronemus goramy* (Lacép.) (Fig. 2): The fish, a native of Indonesia, was first introduced in India during the early half of the last century and stocked in the Botanical Gardens at Calcutta, but the entire lot is reported to have perished by 1841 for want of proper attention (Thomas, 1881). Further details about this introduction are not available.



*Osphronemus goramy* Lac.

Fig. 2. The Gourami, *Osphronemus goramy* (Lacép.). (After Hofstede)

About the year 1865, Sir William Denison, the then Governor of Madras, imported some gourami from Mauritius and introduced them in the Government House ponds at Madras while some were taken to the Nilgiris (Raj, 1916). The fish bred in the tanks at Madras and it appears that the fry were distributed to some of the tanks in the neighbourhood, including the Red Hills tank. However, the condition of the stock in general was not satisfactory and a fresh consignment of about



200 fish was brought from Mauritius and Java in 1916. The fish has established itself in various parts of Madras State, from where it has been successfully transplanted to Bombay in 1937 (Kulkarni, 1943 and 1946), Baroda in 1941 (Moses, 1944), Mysore in 1942 (Bhimachar, *et al*, 1944) and Cochin and Hyderabad in 1945. Gourami was introduced in the Punjab but could not survive the low winter temperature there (Khan, 1946).

The Tench, *Tinca tinca* (Bloch) (Fig. 3): The tench was brought from England by Mr. MacIvor about the year 1870 along with the golden carp and introduced into the Ootacamund lake (Molesworth & Bryant, 1921). The fish bred in the lake and subsequently fingerlings were

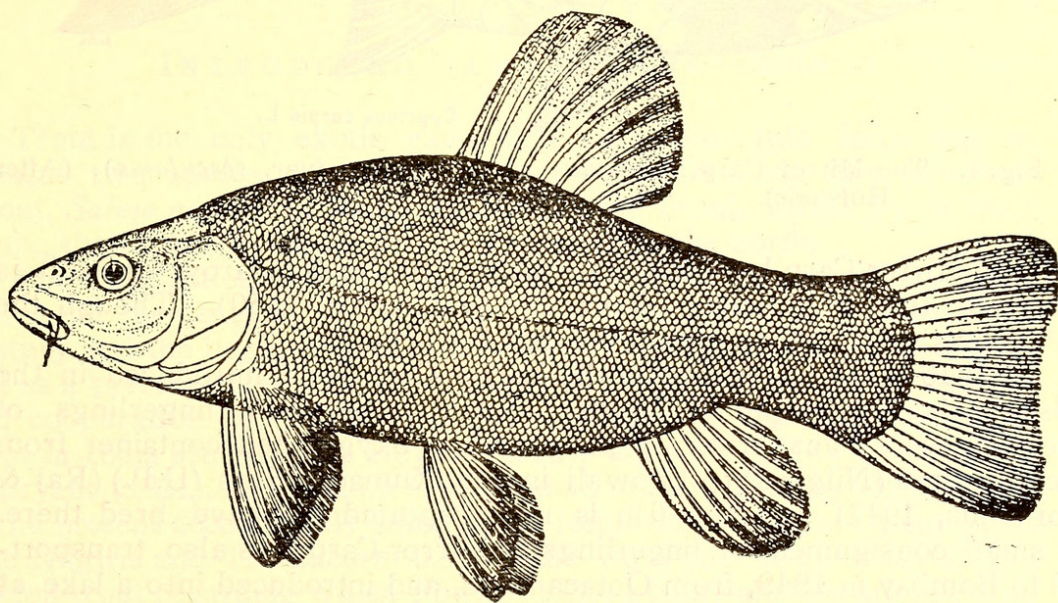


Fig. 3. The Tench, *Tinca tinca* (Bloch). (After Innes).

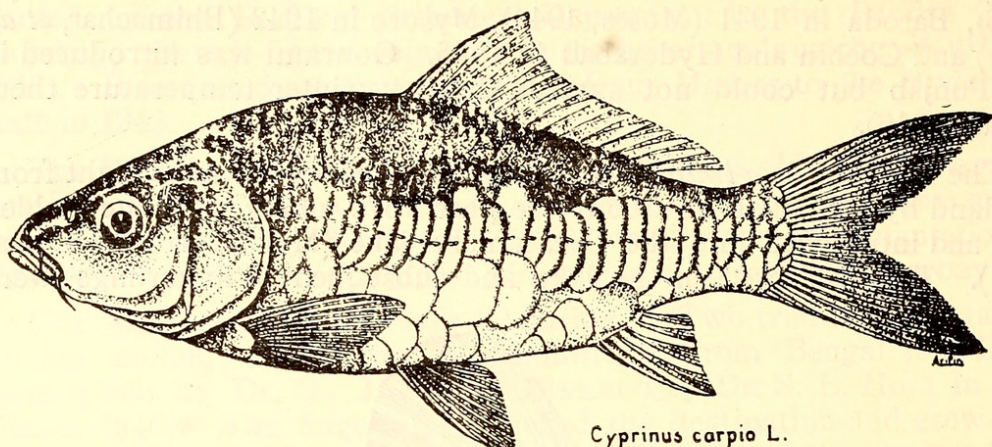
transplanted to some more ponds and lakes in the Nilgiris and the Shevaroy Hills. Its introduction in the lower elevations does not appear to have met with much success though it is reported to have bred in the Sunkesula farm, Madras (Hornell, 1923 and Tampoe, 1929).

The Crucian Carp, *Carassius carassius* (Linn.): This fish, also known as the Golden Carp, is a native of Central Europe from where it has been transplanted to various countries. MacIvor introduced it about the year 1870 along with the Tench into the Ootacamund lake where it bred well (Molesworth & Bryant, 1921). Subsequently it was transplanted to several ponds and lakes in the Nilgiris, Shevaroy and Kodaikanal. Attempts to transplant this fish to the plains did not meet with success.

The Common Carp, *Cyprinus carpio* (Linn.): Originally a native of China, this fish is now very widely distributed all over Europe, America and several other parts of the world. It was introduced in Ceylon from Prussia in 1914 and from there a consignment of 45 young fish was brought in 1939 by Dr. Sundara Raj, the then Director of Fisheries, Madras, and stocked in the Ootacamund lake where it thrived well and bred in three years. Three varieties of the common carp are distinguished, viz. the Mirror Carp (var. *specularis*) (Fig. 4), the Scale Carp (var.



*communis*) and the Leather Carp (var. *nudus*), and of these the first one is the most common.



*Cyprinus carpio* L.

Fig. 4. The Mirror Carp, *Cyprinus carpio* Linn. (var. *specularis*). (After Hofstede).

The Mirror Carp has been transplanted to the Shevaroyes where it is reported to be breeding (Ganapathi & Chacko, 1950). Though the fish grows well in the plains it has not bred there.

In 1946 some fingerlings of the Mirror Carp were introduced in the Ulsoor lake, Bangalore (Burton, 1948). In 1947 fingerlings of the fish were transported by plane in an oxygenated container from Ootacamund (Nilgiris) to Bhowali in the Kumaon Hills (U.P.) (Raj & Cornelius, 1947) and the fish is now reported to have bred there. A small consignment of fingerlings of Mirror Carp was also transported to Bombay in 1949, from Ootacamund, and introduced into a lake at Lonavla at an altitude of about 2,000 feet.\*

#### TRANSPLANTED GAME FISHES—Autochthonous

The Putitor Mahseer, *Barbus* (*Tor*) *putitora* (Ham.): The large-scaled carps of the subgenus *Tor* are known as mahseers and are the favourite among Indian game fishes. The Putitor Mahseer is found all along the Himalayas from Kashmir to the Darjeeling hills and probably further east as far as China.

The lakes of Kumaon hills were stocked with this fish by Sir H. Ramsay about the year 1858 (Walker, 1888). The Bhimtal, the Nakuchiatal and the Sathtal were stocked with fingerlings transported in earthen vessels from the Gola river and the Nainital with those from the Koli river. The fish flourished in all the lakes except Bhimtal, where a second attempt was made by him in 1878, with success. The fish took well to the confined waters and bred in the shallow areas of the streams that drain into the lakes. Edye (1922) stocked the Khurpatal on the Nainital-Kaladhungi Road in 1922. Raj (1945) has dealt with the present condition of the mahseer in the Kumaon lakes in detail.

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\* Annual Report of the Department of Fisheries, Bombay, 1943-49, p. 36.



The Khudree Mahseer, *Barbus (Tor) khudree* Sykes : Molesworth & Bryant (1921) have cited a report by Mr. Barlow to the effect that Pykara (Nilgiris) was stocked with mahseer before the introduction of trout. In the absence of further details it is to be presumed that the mahseer referred to is *B. (Tor) khudree* Sykes being the most common form found in that region at present.

Hornell (1923) reports about stocking the Kodaikanal waters (Palni Hills) with 162 mahseer fingerlings from the Tungabhadra in Kurnool. The species could either be *Barbus (Tor) khudree* Sykes or *B. (Tor) mussullah* Sykes, these being the mahseers available in the Tungabhadra. Information about the result of the transplantation is lacking.

### INTRODUCED GAME FISHES—Exotic

Trout is the only exotic game fish introduced into India and at present two species have established themselves, viz. the Rainbow Trout, *Salmo gairdnerii* Rich. and the Brown Trout, *Salmo trutta fario* Linn., the former in the south and the latter in the north.

The introduction of trout in India was achieved by the efforts of the European residents in the country during the latter half of the 19th century and the beginning of this century. Though the work commenced as a private enterprise, it subsequently received the active support and cooperation of the Government. Details of the introduction of trout in India are given by Howell (1916), Mitchell (1918), Molesworth & Bryant (1921), Skene-Dhu (1906 and 1918), and Mackay (1945); and in the present account only some of the important events are mentioned. The Nilgiris and Travancore trout came from the same stock as the Ceylon trout regarding which Fowke (1938) gives valuable information.

Introduction of trout in the Nilgiris (Madras): The first attempt to introduce trout in India was made by Mr. H. S. Thomas in 1863, but the consignment of ova he was bringing perished on the way (Day 1876). In 1866 Day (op. cit.) imported 6,000 ova and though most of them died a few days after reaching Ootacamund, the few that survived turned out to be the first trout to see life in Indian waters. After a few years' lull, attempts were again made by Mr. McIvor in 1837 and subsequently by himself and others till 1906. Some of the attempts resulted in failure, others being partially successful. Most of the consignments were of *Salmo fario* but trials with *Salmo gairdnerii*, *Salmo levenensis* and *Salmo fontinalis* were also made. All the successive attempts proved futile till the first decade of this century.

The credit for the ultimate permanent establishment of the trout in the Nilgiris goes to Mr. Wilson who organized the whole work on a scientific basis. He found the climate at Dodabetta, where the hatchery was located, unsuited for the Brown Trout. So he constructed a hatchery at Avalanche and concentrated on the establishment of the Rainbow Trout. All the available stocks of brood fishes were transferred and fresh consignments of ova were brought from Germany and New Zealand, and fingerlings from Ceylon. The Avalanche hatchery was a great success and the Rainbow Trout is now well established in the Nilgiris waters.

Introduction of trout in Kashmir: The introduction of trout in Kashmir was carried out independent of the attempts that were in



progress in the Nilgiris. The first shipment of ova was sent in the spring of 1900 as a present from the Duke of Bedford to the Maharaja of Kashmir in return for the Kashmir stags presented by the latter (Mitchell, 1918). The whole consignment, however, perished on the way on account of the heat. A second lot arrived in December of the same year and another followed in 1901. The ova were of Brown Trout and took very well to the Kashmir waters. Some ova liberated in the river Kalapani near Abbottabad flourished and bred there. A heavy flood in Kashmir in 1903 swept over all the brood ponds and hatcheries and this, instead of destroying the whole stock as was feared, resulted in providing more favourable conditions for their permanent establishment in the waters. Though both Rainbow Trout and Brown Trout were introduced, it was found that the latter is more suited to the cold Himalayan waters.

**Introduction of trout in the Punjab:** Trout was first introduced in the River Beas in the Kulu Valley (Punjab) in 1909 by Mr. Howell who brought about 23,000 eyed ova from Kashmir for the purpose (Howell, 1916). This stock established itself in the river and since then many lakhs of Brown Trout fry have been planted in the Beas and its tributaries and other streams in the Punjab (Tyson, 1941). The fish is now well established in Kulu and from there it has been transplanted to rivers and streams in Chamba, in the Kangra Valley and the Simla hills.

About 5,000 eyed ova of Rainbow Trout were introduced in Kulu waters from Kashmir in 1919. Though the fish spawned in 1922 and in subsequent years, it failed to give satisfactory results in view of its greater susceptibility to diseases than Brown Trout, and its culture therefore was abandoned (Khan, 1946).

**Introduction of trout in the Kumaon lakes and in the Eastern Himalayas:** Trout was first introduced in the lakes of the Kumaon hills in 1910 when a consignment of 10,000 ova was taken from Kashmir to the Bhowali hatchery, about 8 miles from Nainital. Another consignment was obtained in 1912 and fingerlings from these were stocked in various lakes such as the Nainital, Naguchiatal, Sathtal, Malwatal etc. (Skene-Dhu, 1918). Though the first stocking operations met with encouraging results it is doubtful if the trout has permanently established itself in the Kumaon hills.

Attempts made to establish trout in the Darjeeling Himalayas did not meet with success in view of the heavily silted condition of the rivers during floods and the precipitous nature of the valley with high waterfalls, whereas the fish has established itself in the Ha Valley in Bhutan at an elevation of 9,000 to 10,000 ft. (Hora, 1946). Further details about the above transplantations are not available.

**Introduction of trout in Travancore, Kodaikanal and other waters in South India:** The first consignment of trout ova for Travancore was obtained in 1909 from Howieton in Stirlingshire, Scotland (via Bombay) and this reached the High Range, Travancore, successfully. A second consignment was received in the same year via Colombo-Tuticorin, and another in 1913. All the above consignments comprised of ova of the Brown Trout. By this time culture of the Rainbow Trout was becoming a notable success in the Nilgiris and attention was turned to this species. Though the fry introduced into the waters of the High



Range showed phenomenal growth they failed to breed until a hatchery was located at Rajmally and the fish were liberated in the Eravikulam river, where they bred under natural conditions in 1937. Fresh stocks of Rainbow Trout were obtained from the Nilgiris and Ceylon and by 1941-42 the fish had firmly established itself in the High Range of Travancore. (Gopinath, 1942 and Mackay, 1945).

Streams in the Anamalais have been stocked with fingerlings of trout from the hatchery in the High Range, Travancore. The fish does not breed there due to the comparatively low elevation and consequent high temperature. As a result of the interest taken by Messrs. Crossley and MacTaggart two lots of trout ova were imported in 1894 by the Palni Game Association for stocking the Kodaikanal lake. Both the attempts resulted in failure (Skene-Dhu, 1906).

#### TRANSPLANTED LARVICIDAL FISHES—Autochthonous

Among the Indian larvicidal fishes, the cyprinodonts *Aplocheilichthys lineatus*, *A. panchax*, *A. blochii* and *Oryzias melastigma* (McCl.) are the most important; and these have been transplanted in several parts of the country for antimalarial work. Most of the transplantations are intra-regional and come under routine activities of public health departments of the States concerned, and the records are too numerous to be listed here.

#### INTRODUCED LARVICIDAL FISHES—Exotic

The Top Minnow, *Gambusia affinis* B. & G. (Fig. 5): This fish from North America has been introduced in various countries for larvicidal

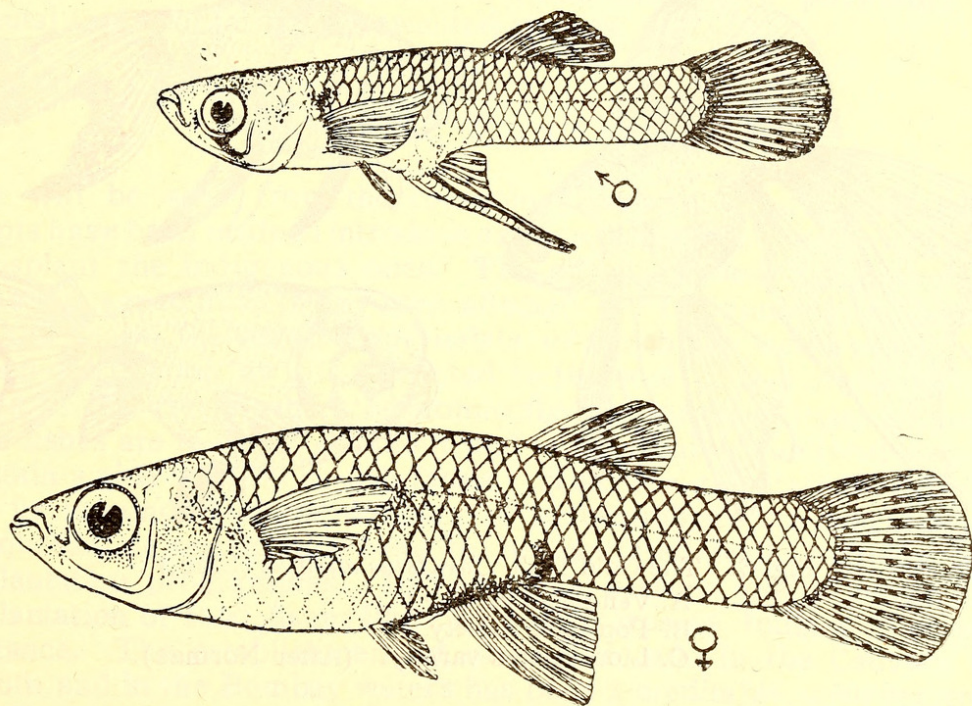


Fig. 5. The 'Top Minnow', *Gambusia affinis* (Baird and Girard). (After Prashad and Hora).

purposes. It was first introduced in India by Dr. B. S. Rao and Dr. Chandrasekhariah who brought an experimental consignment to Mysore



from Italy in 1928 (Gopinath, 1942). The attempt was a great success and the fish bred out of this stock was transplanted to several States, from Travancore in the south to the Punjab in the north. A consignment of young gambusia was brought from Ceylon in 1929 by the Madras Fisheries Department and stocked in the waters of Krusadai Island, and another was taken from Bangalore to Madras city in 1930 (Chacko, 1948). Both lots of gambusia bred well and have been distributed to different parts of the State.

**The Millions :** *Lebistes reticulatus* (Peters) : This is a native of South America and is known also as ' Barbados Millions '. A consignment was introduced by Major Selley into Madras in 1909, but was reported to have perished due to unsuitable climatic conditions (Prashad and Hora, 1936). However, in 1946 the fish was noticed thriving in the Rameswaram temple tank and from there it has now been successfully transplanted to various parts of Madras (Chacko, 1948).

#### INTRODUCED ORNAMENTAL FISHES

Records are not available showing the exact period of introduction of ornamental fishes into the country, but it is probable that this might have taken place at a very early date during the Buddhist period when India and China came into intimate contact with each other. During the Moghul period fish ponds and ornamental pools were popular in palace gardens, and in the residences of the aristocracy.

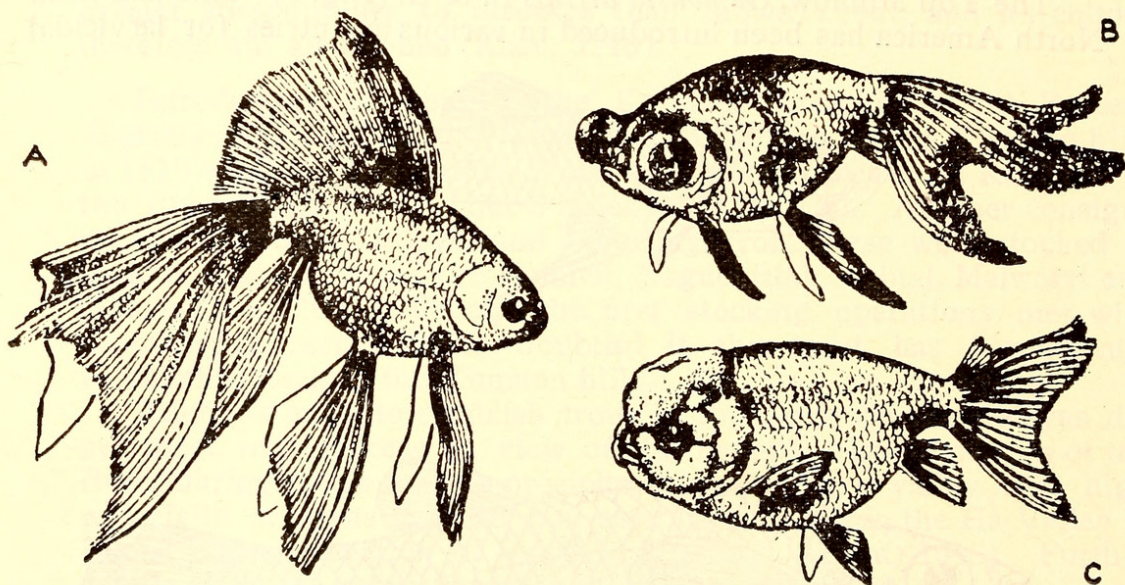


Fig. 6. The Gold Fish, *Carassius auratus* (Linn.) :

A. Veil-tailed variety ;

B. Pop-eyed variety ;

C. Lion-headed variety. (After Norman).

The commonest and the most popular ornamental fish is the Gold-fish, *Carassius auratus*, introduced from China. Other examples are the Angel-fish, *Pterophyllum scalare*, from South America ; the Fighting-fish, *Betta pugnax*, from Siam ; the White Cloud Mountain Minnow, *Tanichthys albonubes*, from China ; the Black Tetra, *Gymnocorymbus*



*ternetzi*, from Paraguay; the Flame Tetra, *Hyphessobrycon flammeus*, from Rio de Janeiro; the Pearl Gourami, *Trichogaster leerii*, from Siam; the Jewel Fish, *Hemichromis bimaculatus*, from Africa; the Chinese Paradise Fish, *Macropodus opercularis*, from China; the Red and Green Swordtail, *Xiphophorus hellerii*, from Mexico; the different colour varieties of Platies, *Platypoecilus maculatus*, from Mexico; the Liberty Mollies, *Mollienisia sphenops*, from Texas; the Cherry Barb, *Barbus titteya*, from Ceylon; the Negro Barb, *Barbus nigrofasciatus*, from Ceylon; and the Harlequin, *Rasbora heteromorpha*, from Sumatra and Singapore. Exact details about the introduction of these ornamental fishes are not available.

#### ACCIDENTAL TRANSPLANTATIONS

In the course of purposive introduction of species accidental introductions have also taken place, such as of *Rasbora daniconius* (Ham.) and *Oryzias melastigma* (McCl.) into the Andamans along with the fry of *Labeo rohita* (Ham.) (Mookerjee, 1935 and Herre, 1941). Species like *Ophicephalus gachua* (Ham.) found in the Andamans are considered to have been introduced accidentally by human agency (Mookerjee op. cit.). According to Annandale & Hora (1925), along with the fingerlings of *L. rohita* (Ham.) the fry of minor carps and certain Siluridae also might have been introduced into the Island.

As a result of the present fillip to the expansion of carp cultural activities in the different States (Job, 1951) and the consequent large-scale transportation of carp fry from the Gangetic and the Mahanadi systems of rivers to other parts of India there is a possibility of accidental transplantation of unwanted species.

#### GENERAL REMARKS

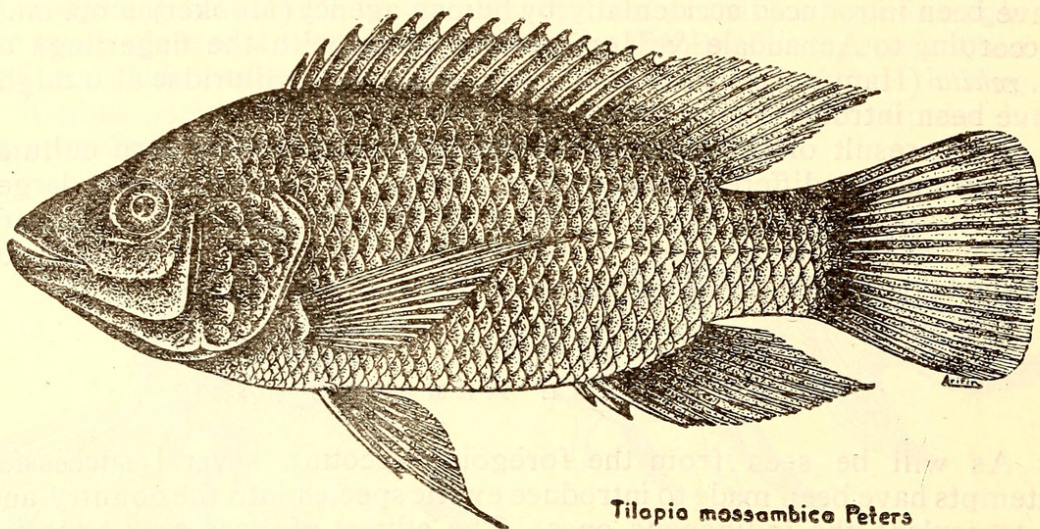
As will be seen from the foregoing account, several successful attempts have been made to introduce exotic species into the country and to transplant the indigenous ones. The advent of these exotic species does not appear to have in any way affected the indigenous fish fauna. Even the trout, the carnivorous habits of which are well known, has not been detrimental as it is restricted to the cool waters in the higher reaches of the rivers where economically important varieties of indigenous fishes are few. In Kashmir and in the Punjab, the trout waters still retain a rich indigenous fish fauna. However, this fact should not leave us unmindful of the dangers of indiscriminate transplantation. Strict quarantine restrictions have to be exercised while carrying out transplantation programmes. In view of the present food shortage the transplantation of food fishes like the major carps of India is of prime importance. The establishment of carps like catla in the Cauvery in the south and in the Bombay waters has been a creditable achievement, especially as it is a step towards regional self-sufficiency in the supply of carp fry for cultural operations. The result of the introduction of catla in Periyar lake in Travancore will be watched with interest and if the fish establishes itself in the Periyar system a suitable source of seed supply will be available for the region.



Among the fishes indigenous to India the pearl-spot ranks in importance next to the major carps in its suitability for transplantation and permanent establishment. The coastal districts of Orissa and Bengal appear to offer ideal conditions for introduction.

Another indigenous fish considered suitable is the Copper Mahseer, *Acrossochilus hexagonolepis* (McCl.). This fish grows to about 25 lb. and is distributed in the rivers of Assam and the eastern section of the Himalayas. Recently it has been reported from the Cauvery also. The fish breeds in semi-confined waters (Smith, 1944 and Hora, 1946) and its artificial propagation is reported to be easy (Ahmed, 1946 and 1948). Experimental transplantation of this could, therefore, be tried with advantage in waters where the major carps do not occur or when transplanted have failed to give satisfactory results. The small streams of the Andaman Islands appear to offer suitable conditions for the breeding of this fish, and it is likely that the Bengali settlers in the islands will find the Copper Mahseer a welcome substitute in the absence of the major carps.

The Tilapia, *Tilapia mossambica* (Peters) (Fig. 7) which is a native of South Africa, has given very encouraging results in some of the South-



*Tilapia mossambica* Peters

Fig. 7. The Tilapia, *Tilapia mossambica* Peters. (After Hofstede).

East Asian countries where it has been introduced in recent years. It will be desirable to consider the feasibility of introducing this fish in India also as an experimental measure.\* The usefulness of *Trichogaster pectoralis* (Regan) (Fig. 8) for introduction in paddy-fields, swamps and marshes requires to be studied. This fish is a native of Siam and is now well established in several parts of Malaya and Indonesia.

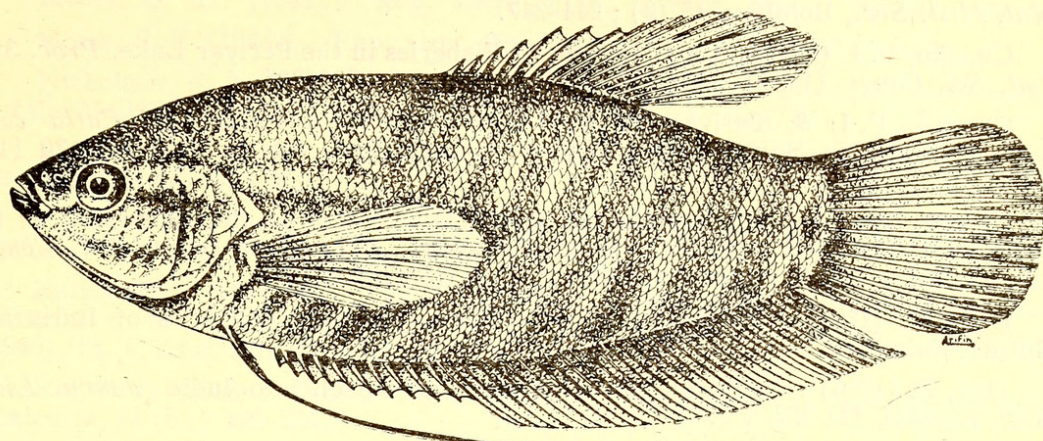
We have now in India a variety of fishes both indigenous and exotic suitable for culture in varying ecological conditions. The optimum

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\*After this paper was read at the Symposium we were informed by Dr. Nazir Ahmed that a consignment of *Tilapia* had recently been brought to East Bengal (Pakistan). The results of this transplantation are awaited with interest. If the fish gets established in East Bengal, its natural spread into the contiguous areas of India will be only a matter of time.



requirements of the species concerned, their response to the change in habitat etc. have yet to be studied in detail. With regional self-



*Trichogaster pectoralis* Regan

Fig. 8. The Sepat-Siam, *Trichogaster pectoralis* (Regan). (After Hofstede).

sufficiency in crop and seed as the aim, judicious transplantation and introduction of these fishes have to be planned and carried out throughout the country.

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\* A great deal of information obtained from the various Administration Reports of the Madras Fisheries Department is incorporated in the paper but only some important references are listed in the bibliography.



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