

MISCELLANEOUS PUBLICATION
OCCASIONAL PAPER No. 39

Records of the Zoological Survey of India

**The Mahseer Fishes of India
— A Review**

By
T. K. Sen
and
K. C. Jayaram

Issued by the Director
Zoological Survey of India, Calcutta

THE MAHSEER FISHES OF INDIA
—A REVIEW

BY

T. K. SEN

AND

K. C. JAYARAM

RECORDS
OF THE
ZOOLOGICAL SURVEY OF INDIA

MISCELLANEOUS PUBLICATION

OCCASIONAL PAPER No. 39

THE MAHSEER FISHES OF INDIA
—A REVIEW

BY

T. K. SEN

AND

K. C. JAYARAM



Edited by the Director, Zoological Survey of India

1982

© Copyright, 1982 Government of India

Published in September, 1982

PRICE : Inland : Rs. 22.00
Foreign : £ 2.75 \$ 5.00

PRINTED IN INDIA AT THE BANI PRESS, 16, HEMENDRA SEN
STREET, CALCUTTA-700 006 AND PUBLISHED BY THE DIRECTOR,
ZOOLOGICAL SURVEY OF INDIA, CALCUTTA-700 012.

RECORDS
OF THE
ZOOLOGICAL SURVEY OF INDIA
MISCELLANEOUS PUBLICATIONS

Occasional Paper

No. 39

1982

Pages 1—38

CONTENTS

	PAGE
I. INTRODUCTION	1
II. ETYMOLOGY	1
III. TAXONOMY	2
A. VALID MAHSEER SPECIES OF INDIA	2
B. VALID SUB-SPECIES OF TOR	13
C. UNCERTAIN SPECIES OF MAHSEER	14
IV. BIOLOGY	17
V. BIONOMICS	29
VI. FISHERY	31
VII. SUMMARY	33
VIII. ACKNOWLEDGEMENT	34
IX. REFERENCES	34

I. INTRODUCTION

Anglers and sportfishing lovers all over India are familiar with the name Mahseer. India abounds in innumeral swift and fast flowing streams which provide ample opportunities for the anglers. Almost every part of the country with few exceptions has one or two areas which are exclusively patronised by these nature loving fishermen, who wait patiently for hours to feel the thrill of a fighting Mahseer. Almost all fishes which give such resistance to the anglers have come to be known as game fishes.

Among these, the carps of the genus *Tor* in particular get the distinction of being the *prime desiderata* of any fisherman and thus Mahseer have become popular.

The term Mahseer came to be used cursorily. No definite generic concept or definition of the fishes to be included under the term Mahseer was available for a long time. Hora (1936-1943) in a series of articles in the *JBSHS* consolidated the information known but subsequent to his last article (1942) much confusion has arisen and a vast array of fresh information had come to be known.

II. ETYMOLOGY

There has been quite some interesting opinions on the origin and derivation of the word mahseer. Lacy and Cretin (1905) observed the derivation of Mahseer from '*maha-sir*'—big-head—may be merely an attempt to give a meaning to the word. The derivation from '*maha-sheer*'—big-tiger—is fanciful, although the natives sometimes pronounce the word '*Mahaseer*'; it is merely the soft equivalent of the word. A third and a good derivation is from '*Massulah*', '*Mahasalka*'—meaning big scaled.

The mahseer is called in Bengal as '*Mahashol*' or '*Mahasol*', perhaps after the most common and popular food-fish '*Shol*' (*Channa striatus*). The mahseer has also got scales as big as the murrel, and hence the term Mahashol meaning big scales may have emanated. The scales of Mahseers are occasionally so big that they are often used as playing cards in some parts of India. Another derivation is from '*Matsya*', which is the Sanskrit word for '*fish*', and is used in the *Vedas*. As the mahseer is a sacred fish, preserved near many Hindu temples, it is

probable that the Brahmins called 'Fish' par excellence, pronouncing the word '*Mahsia*' Hora (1939) dealt with this point exhaustively and is of the opinion that mahseer is very likely a colloquial form of '*Mahasirasha*' or '*Maha-siras*', the bigness referring to the front part of the fish and not merely to its head or snout.

Mahseers are known by numerous vernacular appellations in different states of India and outside ; such as, *Putitor* (Goalpara) ; *Sahara* and *Turiya* (Purneah, Bihar) ; *Masal* (Kosi R., Bihar) ; *Kajra* (Daudnagar, Sone R., U. P.) ; *Burapatra*, *Junaga Peetia* (Assam) ; *Naharam* (Hindi) ; *Kukhiah* (Punjab) ; *Kurreah* (Sind, Pakistan) ; *Kendi*, *Bommin*, *Poo-meen-candee* (Tamil) ; *Peruval*, *Harale-minu*, *Hallaminu* (Karnataka, Canarese) ; *Meruval* (Malayalam) ; *Heragalu*, *Poo-meen*, *Peruval* (Telugu) ; *Kadchi*, *Barsa Masla* (Marathi) ; *Kuriah*, *Lela* (Sri Lanka) ; *Mahashol* (W. Bengal) ; *Sor-machha* (W. Nepalese).

III. TAXONOMY

For a number of years almost all carps with big scales and barbels and a large size with more or less similar morphological characters were regarded as mahseers. This was later restricted to more definitive features as below.

Carps with big scales, fleshy lips continuous at the angles of the mouth *with an uninterrupted fold or groove across the lower jaw*, two pairs of big barbels, lateral line scales ranging between 22 to 28, length of head equal to or greater or less than the depth of body are called taxonomically as true mahseers and included under the genus *Tor*. Hamilton (1822) first grouped mahseers separately and placed them under the genus *Cyprinus* and recognised three species of mahseers viz., *Cyprinus tor*, *Cyprinus putitora* and *Cyprinus mosal*. Later workers grouped these fishes under two distinct genera viz. *Barbus* by Cuvier in 1817 and *Tor* by Gray in 1834.

A. VALID MAHSEER SPECIES OF INDIA

Order	CYPRINIFORMES
Family	CYPRINIDAE
Genus	Tor Gray, 1834

1834. *Tor* Gray, *Ill. Ind. Zool.* Hardwicke, 2, p. 96 (type species, *Cyprinus tor* Hamilton = *Tor hamiltoni* Gray, monotypic).

1. **Tor tor** (Hamilton)The *Tor* mahseer

(Figs. 1 & 2 a, b)

1822. *Cyprinus tor* Hamilton, *Fish. Ganges*, pp. 305, 338 (type locality, R. Mahananda).
1834. *Tor hamiltonii* Gray, *Ill. Ind. zool.*, 2, pl. 36, fig. 1.
1839. *Barbus megalepis* McClelland, *Asiat. Res.*, 19, pp. 271, 337 (Northern parts of Bengal).
1839. *Barbus hexastichus* McClelland, *Asiat. Res.*, 19, pp. 269, 333, pl. 39, fig. 2 (Big rivers in the plains of India).
1878. *Barbus tor*, Day, *Fish. India*, p. 564.
1878. *Barbus hexastichus*, Day, *Fish. India*, p. 564.
1935. *Barbus tor*, Hora & Mukherjee, *Rec. Indian Mus.*, 37, p. 383 (Naga-Hills).
1941. *Barbus tor mosal*, Hora, *J. Bombay nat. Hist. Soc.*, 41, p. 784, pl. I & II, figs. 1-5 (Assam).
1941. *Barbus (Tor) tor*, Hora, *J. Bombay nat. Hist. Soc.*, 41, p. 518, pl. 1, 2, 3 text-fig.
1959. *Tor tor*, Misra, *Rec. Indian Mus.*, 57 (1-4), pp. 150-151.
1974. *Tor tor*, Menon, *A checklist of the Himalayan and Indo-Gangetic plains fishes*, Spl. Pub. (1) : *J. Indl. Fish. Soc. India*, p. 46.
1979. *Tor tor*, Kulkarni, *J. Bombay nat. Hist. Soc.*, 75(3), pp. 651-660.

Popular names : Tor mahseer, the deep-bodied mahseer, the famous red-finned mahseer, the large scaled *Barb*, Burapatra / Laopithia / Pukkiranga (Assam), Mahashol (W Bengal), Kudis / Kadchi / Barsa Masla (Marathi), Poo-meen-candee (Tamil), Kukhiah (Punjab), Naharam / Kajra / Turiya (Hindi), Peruval / Harale-minu (Canarese).

Fin formula : D. 12 (3/9) ; P. 19 ; V 9 ; A. 7-8 (2-3/5) ; C. 19 ; L. I. 22-27, L. tr. $4\frac{1}{4}$ / $2\frac{1}{2}$.

Description : Head slightly shorter than depth ; dorsal profile more sharply arched than ventral profile ; lips thick, fleshy, with continuous labial fold across the lower jaw ; eyes 3 to 4 times in total length ; snout pointed, jaws of about same length ; two pairs of barbels, maxillary ones slightly longer than rostral ones but shorter than eye ; interorbital space flat ; dorsal fin opposite to or slightly in advance of ventral fin, dorsal spine smooth, shorter than body depth, pectoral reaching pelvic as long as head excluding snout ; pelvic shorter, anal when laid flat not reaching caudal fin base, caudal deeply forked ; lateral line complete. Predorsal scales 9.

Colouration : Silvery green or greyish green dorsally with pinkish sides replaced by greenish gold above and light olive green below, lower fin reddish yellow.

Maximum size attained : 152.0 cm or 5 ft. (Misra, 1962).

Distribution : All along the Himalayas particularly freshwaters of Punjab, Haryana, Uttar Pradesh, Bihar, Darjeeling Dt. of W. Bengal, Assam, M. P., Pakistan, Bangladesh, Burma and China. Ganga and Narmada are its principal habitats (Kulkarni, 1979).

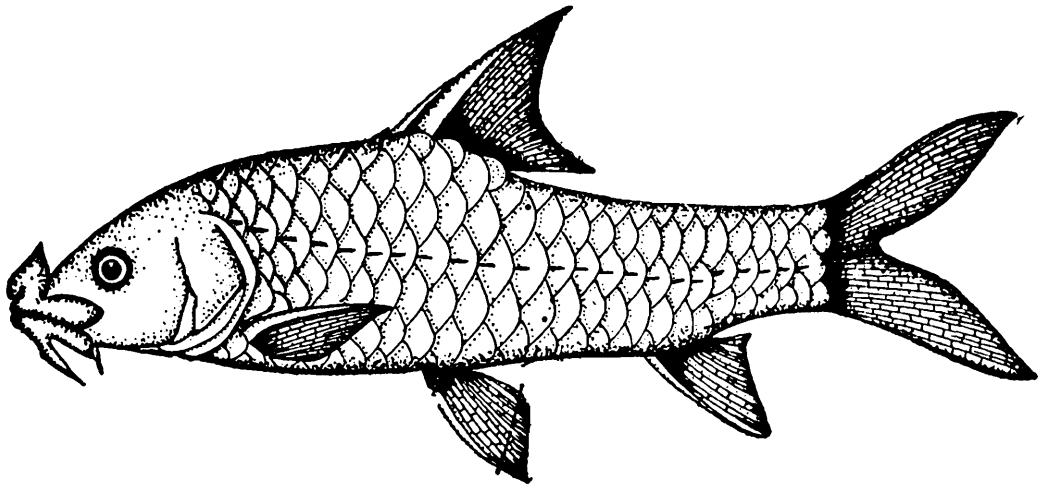


Fig. 1. Lateral view of *Tor tor* (Ham.)

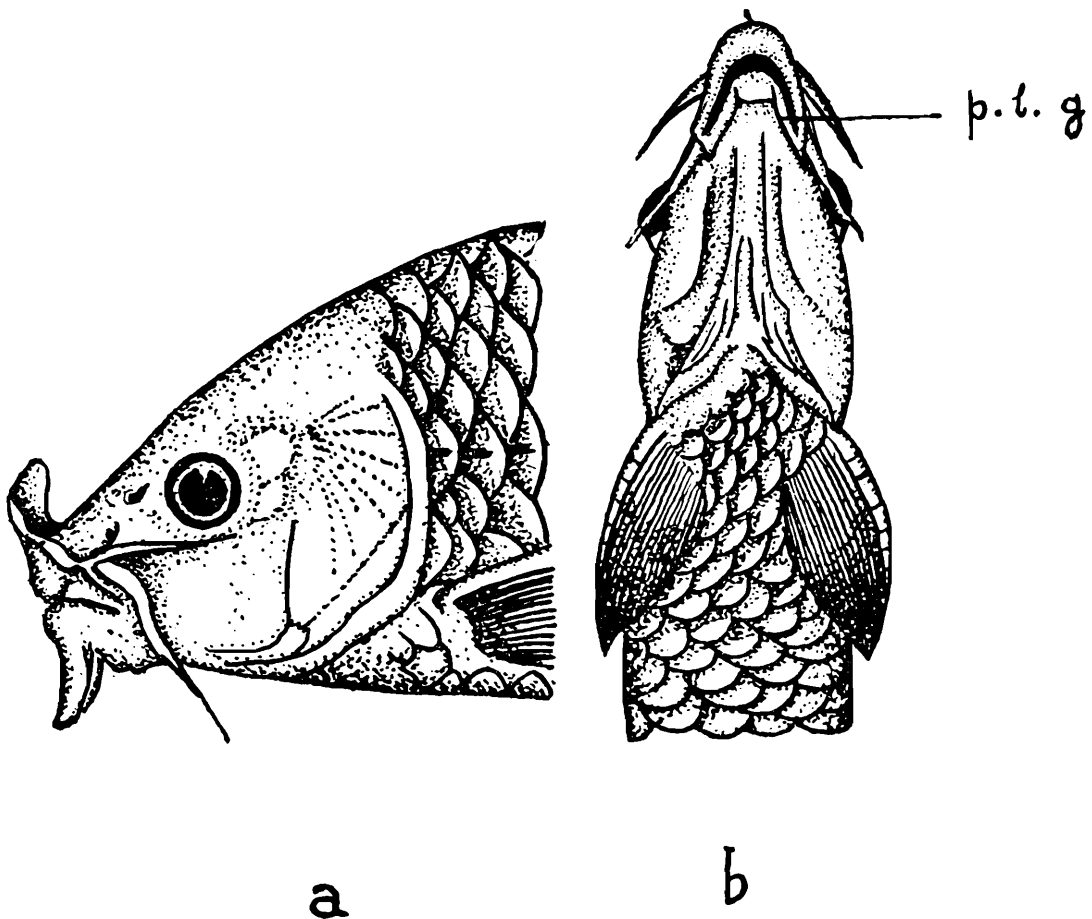


Fig. 2. Oral features of Mahseer

- 2.(a) Side view of head and forepart of body of a Mahseer, *Tor tor* (Ham.), showing hypertrophied lips extended.
- 2.(b) Ventral view of head and forepart of body of *Tor tor* (Ham.) showing continuous post-labial groove (p. l. g) and the enlarged lips with the median lobe of the lower lip.

2. **Tor putitora** (Hamilton)

The Putitor mahseer

(Fig. 3)

1822. *Cyprinus putitora* Hamilton, *Fish. Ganges*, pp. 303, 308 (type-locality : Eastern parts of Bengal).
1938. *Labeobarbus macrolepis* Hickel, *Fisch. Caschmir*, p. 60, pl. 10, fig. 2 (type locality : Kashmir).
1839. *Barbus macrocephalus* McClelland, *Asiat. Res.*, 19, pp. 270, 335, pl. 55, fig. 2 (type locality : Rapids of Upper Assam).
1868. *Barbus mosal*, Günther, *cat. Fish. Brit. Mus.*, 7, p. 130.
1936. *Barbus putitora*, Hora and Mukherjee, *Rec. Indian Mus.*, 38, p. 141.
1937. *Barbus putitora*, Shaw & Shebbeare, *Fishes of North Bengal*, pp. 39-41.
1939. *Barbus (Tor) putitora*, Hora, *J. Bombay nat. Hist. Soc.*, 41 (2), p. 272, 2 pls. and 2 figs.
1942. *Barbus (Tor) putitora*, Macdonald, *J. Bombay nat. Hist. Soc.*, 43, pp. 173-189.
1959. *Tor putitora*, Misra, *Rec. Indian Mus.*, 57 (1-4), p. 150.
1974. *Tor putitora*, Menon, *A check list of the Himalayan and Indo-Gangetic plains fishes.*, Spl. Pub. (1), *J. Indl. Fish. Soc. India*, p. 45.
1979. *Tor putitora*, Kulkarni, *J. Bombay nat. Hist. Soc.*, 75(3), pp. 651-660.

Popular names : Common Himalayan mahseer, Putitor mahseer, Sor-machha or Saar (Nepal), Mahashol (W. Bengal), Golden Himalayan Mahseer, Jungia (Mechi), Gray hound and Thick-lipped mahseer, Jongapithia, Junga Peetia, or Jongaputia (Assam).

Fin formula : D. 3/9 ; P. 19 ; V. 9 ; A. 2-3/5 ; C. 19 ; L. I. 25-28 ; L. tr. $3\frac{1}{2}$ / $2\frac{1}{2}$.

Description : Head 4 to 4.5, depth 5.5 to 7 times in total length ; eyes 3 to 5.3 times in head length ; lips thick with a continuous labial groove ; pronounced adipose extension of lips in larger fish present ; comparative length of head bigger than body depth ; two pairs of barbels more or less equal, as long as eye ; predorsal scales 9 ; dorsal fin origin midway between tip of snout and base of caudal, dorsal spine bony, strong and smooth, equal or slightly shorter than depth of body.

Colouration : Usually greenish above with light pinkish and silvery white below, a broad light greyish blue or purplish lateral line found generally in live specimens, fins yellowish with lower ones tinged with red, extreme redness of the lower fins sometimes associated with thick lips (Shaw, 1937).

Maximum size attained : 274.0 cm or 9 ft. (Misra, 1962).

Distribution : All along the Himalayas including Kashmir, U. P., Punjab, Haryana, Darjeeling Dt. of W. Bengal, Assam, Western Himalayas, Nepal, Eastern Himalayas, Pakistan, Bangladesh.

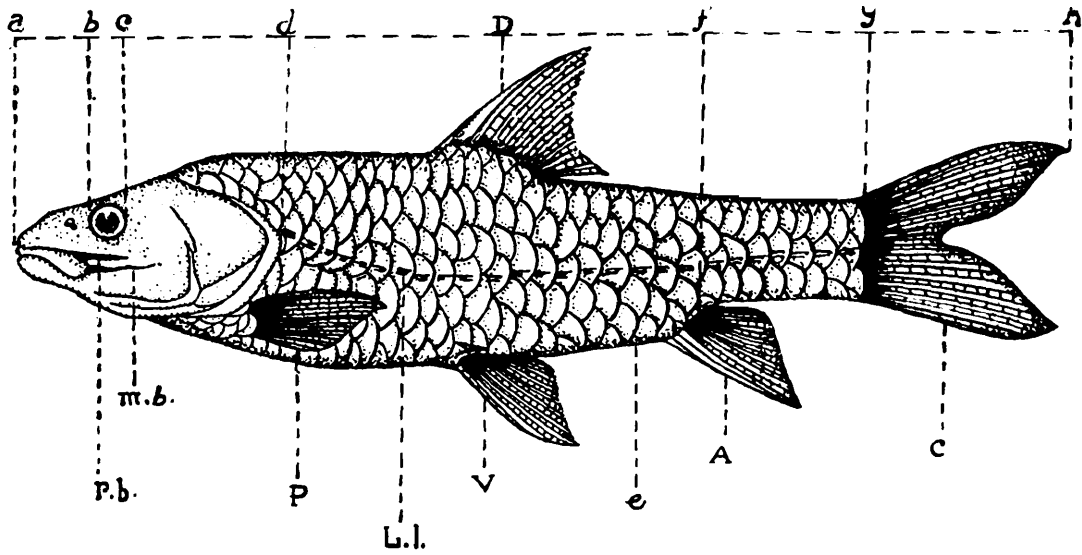


Fig. 3. The Putitor Mahseer—*Tor putitora* (Ham.) a—d=Length of head ; b—c=Diameter of eye ; a—g=Standard length ; a—h=Total length ; e=Anus ; a—b=Length of snout ; L. I.=Lateral line ; f—g=Caudal peduncle ; m.b.=Maxillary barbel ; r. b.=Rostral barbel ; p.=Pectoral fin ; V.=Ventral fin ; D.=Dorsal fin ; C.=Caudal fin ; A.=Anal fin.

3. *Tor mussullah* (Sykes)

The Mussullah mahseer

(Fig. 4)

1838. *Barbus mussullah* Sykes, *Proc. Zool. Soc. London*, p. 154 (type-locality—'Seroor' or 'Sirur', Ghod river, Maharashtra).
 1840. *Barbus mussullah* Sykes, *Ann. Mag. Nat. Hist.*, 4, p. 56.
 1849. *Barbus megulepis*, Jerdon, *Madras Journ. Lit. & Sci.*, 15, p. 311.
 1869. *Barbus macrocephalus*, McClelland, *Ind Cyp.*, pp. 270, 335, pl. 44, fig. 2.
 1944. *Barbus (Tor) mussullah*, Hora, *J. Bombay nat. Hist. Soc.*, 44, pp. 1-8.
 1959. *Tor mussullah*, Misra, *Rec. Indian Mus.*, 57(1-4), p. 149.
 1979. *Tor mussullah*, Kulkarni, *J. Bombay nat. Hist. Soc.*, 75(3), pp. 651-660.

Popular names : High-backed mahseer of Deccan, the Bawany mahseer, the Mussullah mahseer, the Deccan mahseer, Musundi mahseer (Marathi), etc.

Fin formula : D. 4/9 ; A. 3/5 ; P. 16 ; V. 9 ; C. 19 ; L. I. 26-27 ; L.tr. $4\frac{1}{2}/3\frac{1}{2}$.

Description : Head 4.6, depth 3.5 to 3.7 in total length ; eye diameter about 6 times in head length ; head length much less than body depth ; fleshy lips with continuous labial fold ; predorsal scales 10 ;

barbels 2 pairs, maxillary barbels longer than rostrals ; dorsal origin midway between snout lips and caudal fin base, opposite to pelvic origin ; dorsal spine strong, smooth as long as head excluding snout.

Colouration : Upper parts of body covered with large coarse silvery scales with blue and red reflections tinged with yellow ; young ones rather silvery at sides shot with pinks, fins reddish grey with bright streaks.

Maximum size attained : 121.9 cm or 4 ft. (Misra, 1962).

Distribution : Freshwaters of Peninsular India ; Krishna and Godavari rivers are its principal river systems (Kulkarni, 1980).

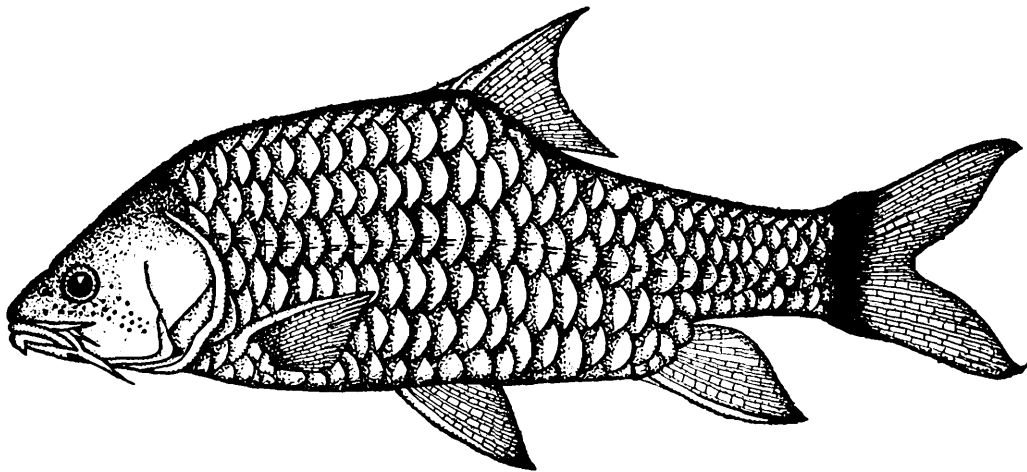


Fig. 4. Lateral view of Mussullah Mahseer, *Tor mussullah* (Sykes)

4. *Tor khudree* (Sykes)

The Yellow mahseer

(Figs. 5 & 6a, b)

1838. *Barbus khudree* Sykes, *Proc. Zool. Soc. Lond.*, p. 159. (type locality—Mutta—Mulah or Mota Mola river, 8 miles east of Poona).

1943. *Barbus (Tor) khudree*, Hora, *J. Bombay nat. Hist. Soc.*, 44 (1), pp. 1-8.

1959. *Tor khudree*, Misra, *Rec. Indian Mus.*, 57 (1-4), p. 149.

1979. *Tor khudree*, Kulkarni, *J. Bombay nat. Hist. Soc.*, 75(3), pp. 651-660.

Popular names : Yellow mahseer, 'Irraham' (Hydrabad), 'Arrayam' (Telugu), Peela-mahseer, Deccan mahseer, Pu-meen (Telugu), Hora paleya/Lehella (Sinhalese).

Fin formula : D. 4/9 ; P. 15 ; V. 10 ; A. 8 ; C. 19 ; L. I. 25-27 ; L. tr. $4\frac{1}{2}/3\frac{1}{2}$.

Description : Head 4.5 to 4.7 ; depth 4.3 to 4.6 times in total length ; diameter of eye 5.5 to 7 times in head length ; sides and suborbital region tuberculated ; thick, fleshy lips with continuous labial fold ; pronounced adipose extension of lips in larger fishes ; 2 pairs of barbels longer than eye ; dorsal profile more sharply arched than ventral

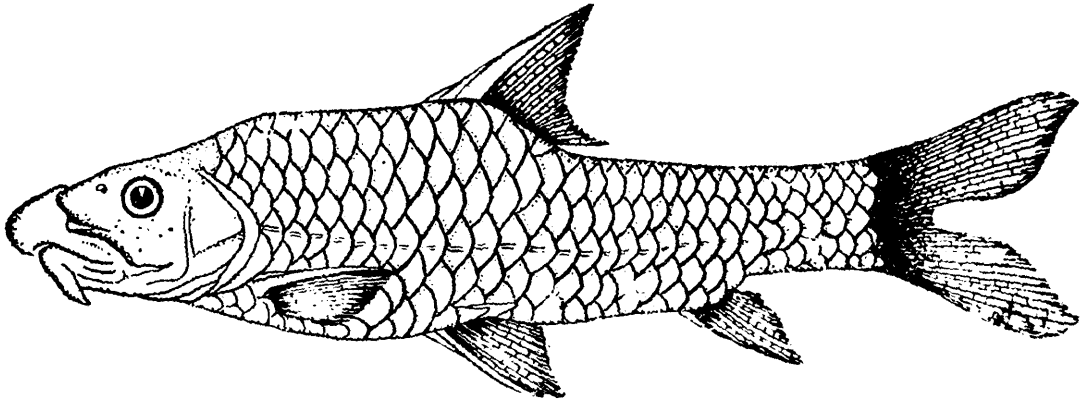
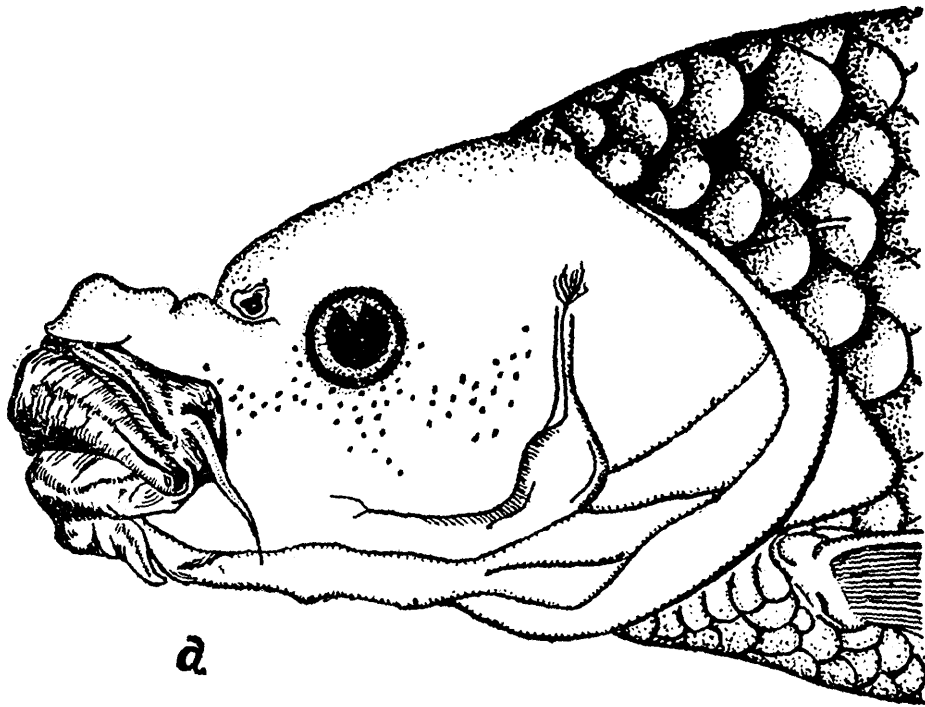
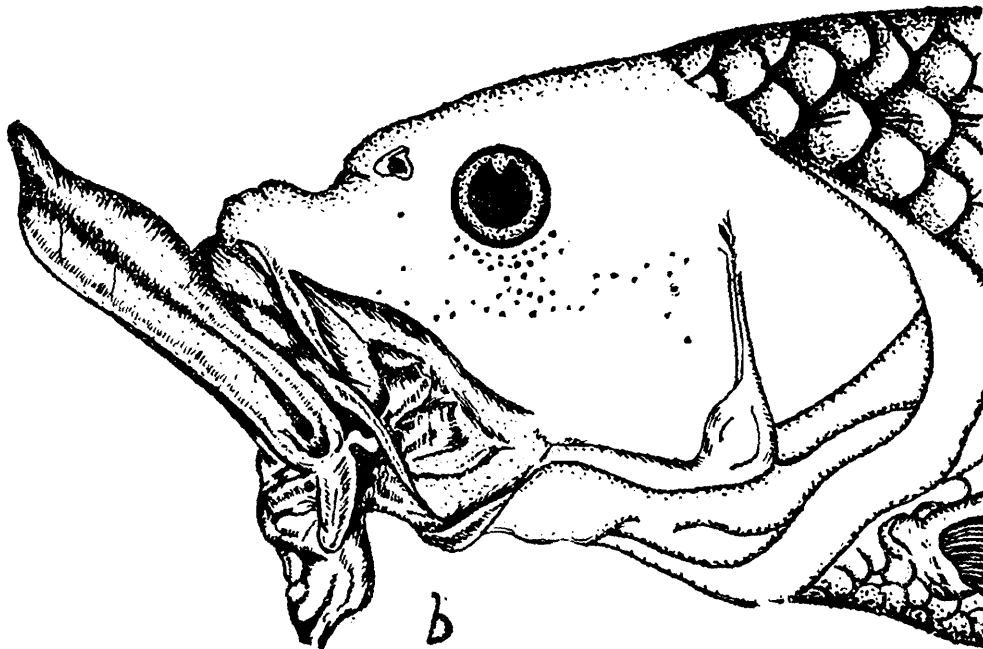


Fig. 5. The Khudree Mahseer--*Tor khudree* (Sykes)



a



b

Fig. 6. Head and anterior part of body of *Tor khudree* (Sykes) showing hypertrophied lips. (a) shows lips and mouth closed (b) lips and mouth protruded.

profile ; dorsal origin opposite to pelvic fin origin, dorsal spine strong, smooth about as long as head without snout.

Colouration : Dark-olive green superiorly becoming creamy, yellowish white below ; fins often tinged with yellowish pink, generally bluish grey.

Maximum size attained : 144.7 cm or 4 ft. 9 inches (Misra, 1959).

Distribution : Freshwater of Orissa and Peninsular India. This fish has become rare in rivers Bhima, Krishna, Koyana and Cauvery except at a few temple sanctuaries at Dehu and Alandi on the Indrayani river and in some reservoirs (Kulkarni, 1979). Its range of natural distribution is the entire peninsular India, south of river Tapi.

5. *Tor mosal* (Hamilton)

The Copper mahseer

(Figs. 7 & 8 a, b)

1822. *Cyprinus mosal* Hamilton, *Fish Ganges*, pp. 306, 388 (type locality—Kosi river).
 1943. *Barbus tor mosal*, Macdonald, *J. Bombay nat. Hist. Soc.*, 44, pp. 185-191.
 1953. *Tor mosal mahanadicus*, David, *J. Zool. Soc. India*, 5(2), pp. 245-247.
 1979. *Tor mosal*, Kulkarni, *J. Bombay nat. Hist. Soc.*, 75(3), pp. 652-660.

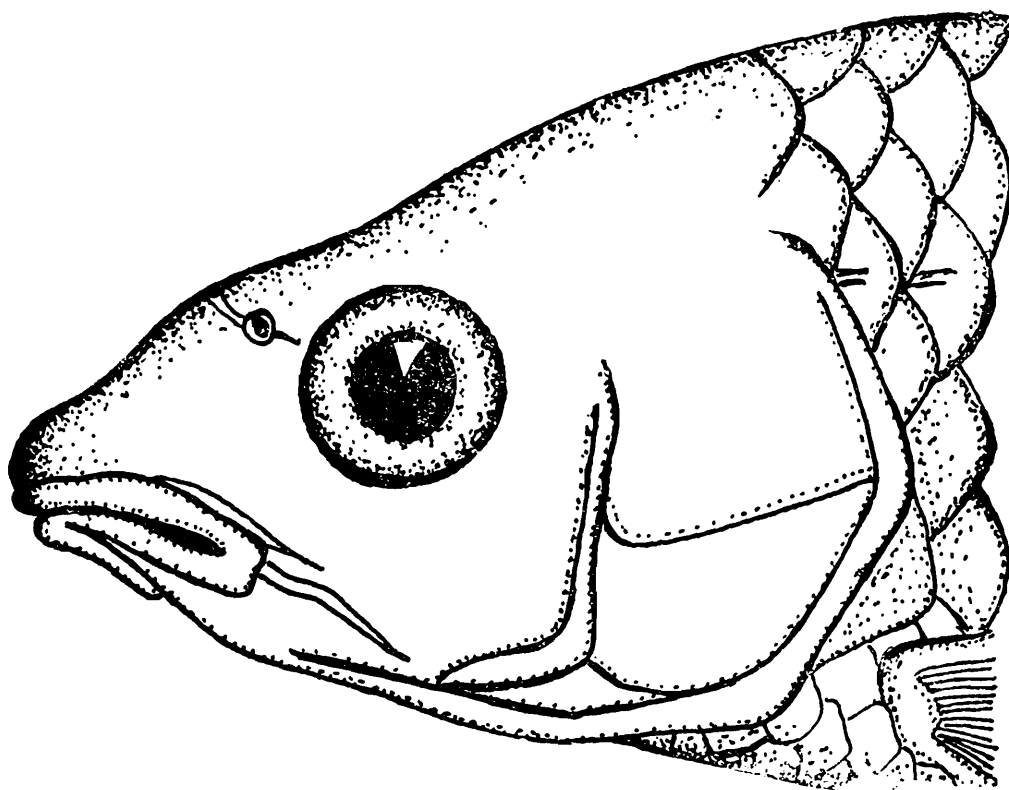


Fig. 7. The Mosal Mahseer (Head)—*Tor mosal* (Ham.), a Burmese species with larger eye-diameter (3.3-4.2 in length of head).

Popular names : Mosal Tor, Copper mahseer, Yellow mahseer.

Fin formula : D. 4/8-9 ; P.17 ; V 8-9 ; A. 3/5 ; C. 19 ; L.I. 23-26 ;
L. tr. $3\frac{1}{2}/3\frac{1}{2}$.

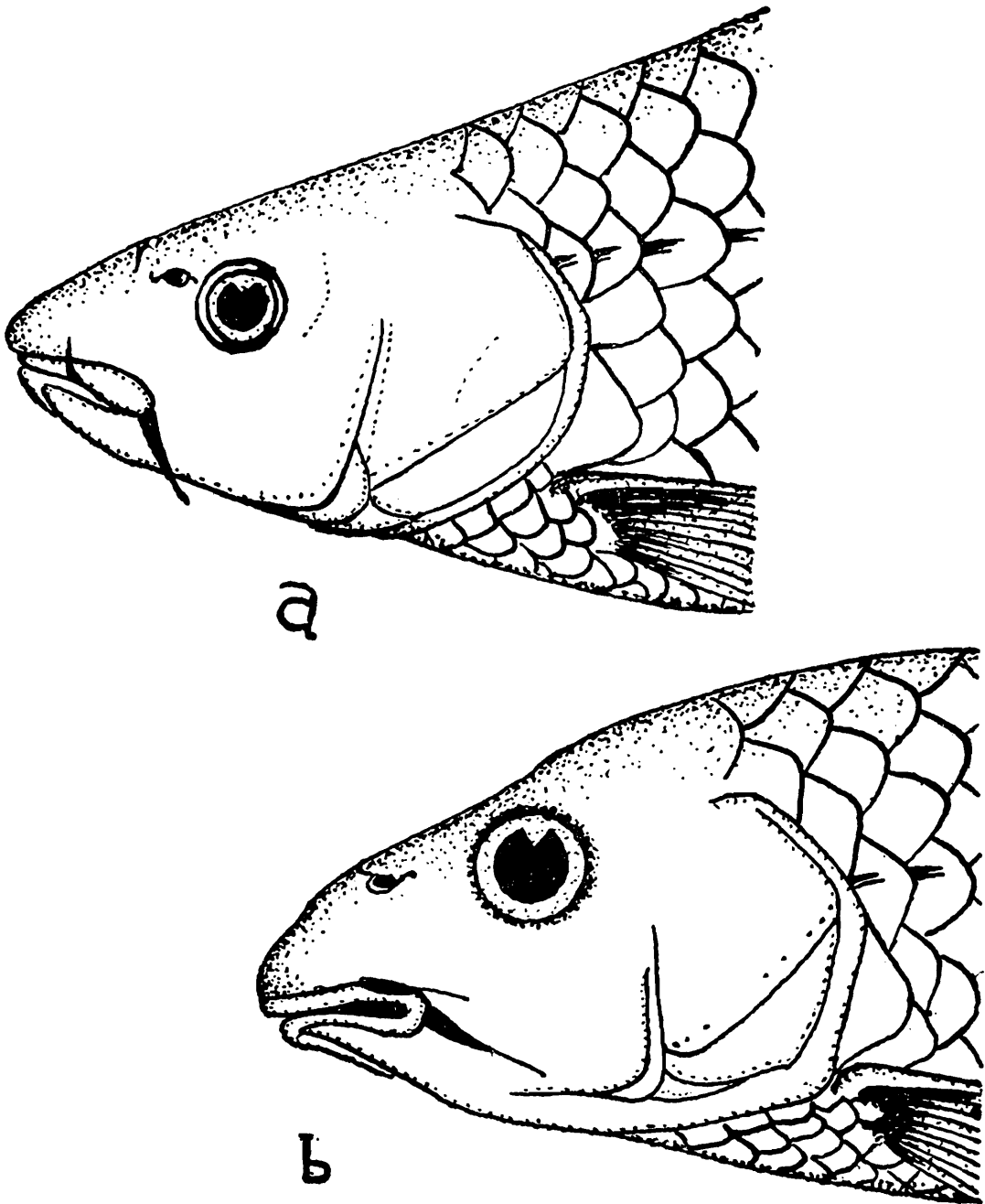


Fig. 8. (a) Showing remarkably small size of eye in: *T. m. mahanadicus* David in comparison with
(b) much bigger size of eye in *T. mosal* (Ham.)

Description : Head 5 to 6, depth 4.5 to 5 times in total length, head more or less equal to body depth ; diameter of eye 3.3-4.2 in head length, lips with continuous labial fold, pronounced adipose extension of lips in larger fishes ; 2 pairs of barbels ; dorsal fin almost opposite to pelvic fins but slightly towards caudal base.

Colouration : Delicate yellowish shade below (Macdonald, 1944), more yellowish colour than gold ; deep blue fins except caudal fin, which

has a red tinge ; dorsal fin reddish orange and other fins yellowish orange (David, 1953).

Maximum size attained : Grows to average weight 11 kg (Macdonald, 1943b).

Distribution : It is strictly speaking a Burmese form and very rarely found in Himalayan waters. In India it occurs in rivers in and around Himalayas, Sikkim and Assam (Jhingran, 1975) ; Mahanadi basin is its principal river system in India (Kulkarni, 1979) ; besides originally, the Burmese water.

6. *Tor progeneius* (McClelland)

The Jungha

(Fig. 9a, b)

1839. *Barbus progeneius* McClelland, *Asiat. Res.* 19, pp. 270, 334, pl. 56, fig. 3 (great rivers in the plains of India).

1936. *Barbus progeneius*, Hora, *Rec. Indian Mus.*, 38 : 328-330.

1942. *Barbus (Tor) progeneius*, Hora, *J. Bombay nat. Hist. Soc.*, 42, p. 526, pl. and text-figs. 1-3 (Assam).

Popular name : Jungha, Junga, Junga-Peetia, Junghapithüa or Jongapittia—Assamese, Manipuri.

Fin formula : D. 12 ; P. 16 ; V. 9 ; A. 7 ; C. 19 ; L. I. 26 ; L. tr. 3/3.

Description : McClelland (1839) has defined this species as 'Length of the head to that of the body as one to three ; scales large and rounded posteriorly ; twenty six along each lateral line, and six from the base of each ventral to the dorsum. Fins short... 'the head is long and much compressed, the mouth is narrow and small, and from the lower lip a fleshy appendix is extended, by which it is distinguished from the neighbouring species'. The long, compressed and short fins are very characteristic of this species ; dorsal spine less developed ; length of head almost equal to depth of body. In the adult form the median lobe of the lower lip is reflected backwards and the middle portion is produced into a tongue like flap ; tip of snout fleshy and produced into a semicircular flap ; upper lip fleshy but not projected ; continuous labial fold.

Colouration : Silvery green or greyish dorsally with sides slightly pinkish and white below ; a black streak behind the gill-openings in the younger forms.

Maximum size attained : Hora (1936) collected 6 specimens from Naga-Hills ranging from 113 to 710 mm in length.

Distribution : North-Eastern Himalayas in Assam, Naga-Hills and Manipur.

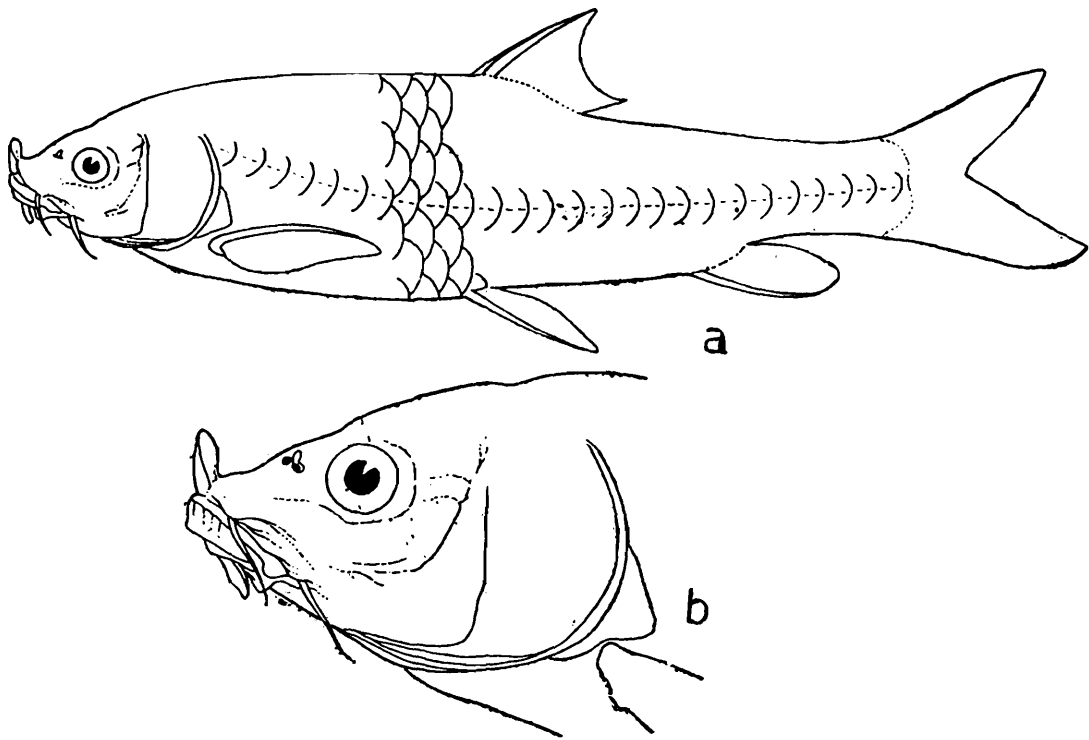


Fig. 9. (a) Lateral view of *Tor progeneius* (McClelland)

(b) Lateral view of head and anterior part of body of the species illustrated in figure 9(a), showing the nature of the hypertrophied snout and lower lip. The upper lip is fleshy, but not hypertrophied.

Remarks : The popular Assamese name 'Jungha' implies to its distinct chin or long beard in allusion to the singular fleshy appendage on the lower jaw. The labial fold is uninterruptedly continuous which is the typical *Tor* character.

This species has so far been not recognised as a separate valid species and regarded a synonym of *T. tor* or other closely allied *Tor* species probably due to its lower-lip character which is produced into a median fleshy lobe in the adult form. However, *T. progeneius* can be distinguished from *T. tor* by its (1) length of head (3 times) (2) long compressed head and short fins (3) dorsal spine less developed (4) upper lip fleshy but not produced as in *T. tor* (5) length of head almost equal to depth of body and (6) a black streak behind the gill-opening in the younger forms.

B. VALID SUB-SPECIES OF TOR

1. **Tor khudree longispinis** (Günther)

1868. *Barbus longispinis* Günther, *Cat. Fish.*, VII, p. 132.

1955. *Tor khudree longispinis*, Munro, *Marine & Freshwater Fishes of Ceylon*, p. 43.

Popular names : Mahseer (Sri Lanka); Hora-palerya/Lehetta (Sinhalese), Pumeen (Telugu).

Fin formula : D. 4/9 ; A. 3/5 ; P. 1/15-17 ; L. I. 23-24 ; L. tr. $3\frac{1}{2}/2\frac{1}{2}$.

Description : Body profile same like that of *T khudree* ; predorsal scales 8-9, pre-ventrals 13-14, complete lateral line ; rostral barbels extend to eye, maxillary barbels longer ; the males smaller than females and with larger labial flaps.

Colouration : Head and back olivaceous with tinge of blue and bronze reflections, lighter below, dorsal and caudal fins olivaceous, other fins orange.

Maximum size attained : 11 kg in weight (Munro, 1955).

Distribution : It is most common in hill streams of Sri Lanka and regarded as good game fish for sportsmen.

2. **Tor khudree malabaricus** (Jerdon)

1849. *Barbus malabaricus* Jerdon, *M. J. L. and Sc.*, p. 312.

1878. *Barbus malabaricus*, Day, *Fish. India*, p. 569, pl. 138, fig. 6.

1944. *Barbus (Tor) khudree* var. *malabaricus* Macdonald, *J. Bombay nat. Hist. Soc.*, 44, (3), p. 527.

1979. *Tor khudree malabaricus*, Kulkarni, *J. Bombay nat. Hist. Soc.*, 75 (3), pp. 651-660.

Popular name : Malabar Carp.

Fin formula : D. 12-13 (3-4/9) ; P. 17 ; V. 9 ; A. 8 (3/5) ; C. 19 ; L. I. 24 ; L. tr. 4/4.

Description : Head $4\frac{2}{3}$ to 5, depth $4\frac{1}{2}$ to $4\frac{1}{4}$ in total length ; eye-diameter 5 times in head length ; dorsal and abdominal profiles almost equally and moderately convex ; interorbital space slightly convex ; upper jaw longer, lips thick, with complete lower labial fold and with a median lobe ; 2 pairs of barbels, maxillary reaching hind edge of eye, rostral pair shorter ; dorsal origin anterior to origin of ventral with concave upper edge.

Colouration : Bluish becoming white on the abdomen, fins generally blue, eyes red, sometimes it is brown with red dorsal, pectoral and ventral fins.

Maximum size attained : 'Attains atleast 18 inches in length' (Day, 1878).

Distribution : South Kanara down the Western Ghats stretching to Travancore hills.

3. *Tor mosal mahanadicus* David

(Fig. 8a, b)

1953. *Tor mosal mahanadicus* David, *J. Zool. Soc. India*, 5(2) : 245-247 (type locality—Hirakud stretch of Mahanadi river in Orissa).

1975. *Tor mosal mahanadicus*, Jhingran, *Fish and Fisheries of India*, p. 221.

Fin formula : D. 4/9 ; P. 17 ; V. 8-9 ; A. 3/5 ; C. 19 ; L. I. 25-27 ; L. tr. $3\frac{1}{2}/3\frac{1}{2}$.

Description : Length of head often more than height of body ; diameter of eye 4.5 to 7 times in head length.

Colouration : Greenish yellow back (iridescent) with silvery sides and white abdomen, a light grey band from opercle to base of caudal, dorsal fin either green or blue, never orange or red as in *Tor mosal* (Ham.), other fins pinkish or orange or light yellow without spots, golden opercle.

Distribution : Mahanadi river near Hirakud stretch, Orissa. Not so far known from any other river system even in Orissa.

Remarks : According to Dr. A. G. K. Menon's assumption, this subspecies, will most probably, be, *T. Khudree mahanadicus* and not *T. mosal mahanadicus* as described by David (1953) ; considering *T. mosal's* non-availability in Indian waters and its Zoogeography. We have not synonymised accordingly due to some prevailing confusions to be studied in details in future.

C. UNCERTAIN SPECIES OF MAHSEER

1. *Barbus hexastichus* McClelland

1839. *Barbus hexastichus* McClelland, *Asiat. Rec.*, 19, pp. 269, 333, pl. 39, fig. 2.

1878. *Barbus hexastichus* Day, *Fish India*, p. 565, pl. 136, fig. 4.

Remarks : It is a confused species due to some similarities with *T. tor* with which it has been synonymised by Menon (1974). Prominent *Tor* characters in this species are not very sound and represent very poorly, 'lips moderately thick, the lower one without or with a badly developed lobe, but having a shallow and continuous fold' (Day, 1878). It is popularly known as Labura in Assam, found in the

rivers on the Himalayas, Kashmir, Assam, Sikkim, growing to 3 feet in length. It cannot be included under *Tor*. We have studied the specimens in our collection in detail and found to be not a *Tor* species.

2. *Barbus dukai* Day

1889. *Barbus dukai* Day, *Fauna Brit. India* fish., 1, p. 306.

Remarks : It is not a Mahseer or *Tor* species but confused with mahseer due to its big sized scales, lateral line scales 28-29, colour, big size, sporting nature etc. The typical *Tor* character, *the continuous lower labial fold is interrupted in this species*. We have also studied these specimens in our collection in details and found to be not a *Tor* species.

The type locality being Tista river in Darjeeling District, W. Bengal ; it is also found in the foot-hills of Terai and Duars, attains 13 cm in length. It is popularly known as Bhorkol or Buluk (Nepalese), Katli (Lepcha), Kantasi (Assamese).

3. *Barbus neilli* Day

1878. *Barbus neilli* Day, *Fish. India*, p. 569, pl. 140, fig. 4.

Remarks : It is taken as mahseer due to its big scales, continuous labial fold, lateral line scales, size and body shape. It is closely related to the Peninsular form, *Tor khudree* regarding its head length ($4\frac{1}{2}$ times), thick fleshy-lips, lateral-line scales (24-26), colour pattern and locality. But at present we are neither synonymising it with *T khudree* nor treating it as a separate *Tor* species due to some confusions still remaining to be examined in future. It was first recorded by Day (1878) from Tungabhadra river from South, a Peninsular form, weighing '38 lbs' and measuring '22 inches' in length.

4. *Barbus chilinoides* McClelland

1878. *Barbus chilinoides*, Day, *Fish. India*, p. 563, pl. 134, fig. 5.

Remarks. It is another confused species due to the presence of some *Tor* characters. It cannot be regarded as a *Tor* species because of the following features—lateral line scales 32-35, head length, elongated body, overhanging snout, longer upper jaw, depression across the snout, moderately thick lips and lower lip without a lobe.

MATERIAL STUDIED

1. *Tor khudree* (Sykes)

2exs., 165-180 cm., Godavari river, S. India ; 5.10.78., W J. Rainboth ; 4exs., 190-205 cm., Bombay, 1959, S. B. Setna ; 2exs.,

250-260 cm., Sundargarh, Orissa ; 5.4.73, T. K. Sen ; 4exs., 110-115 cm., Madanpur-Rampur, Orissa ; 1973, T. K. Sen ; 1ex., 290 cm., Bonaigarh, Orissa ; 6.4.73, T. K. Sen.

2. *Tor mussullah* (Sykes)

4exs., 250 cm., Cauvery river, Madras ; 1980, K. C. Jayaram ; 4exs., 90-150 cm., Kistna river, Satara Dt., Bombay, C. D. McIver.

3. *Tor tor* (Ham.)

2exs., 270-290 cm., Inle. S. Shan States ; 1exe., 220cm., Nagla Nainital, U. P., 11.2.1907, Mus. Coll. Hodgart ; 2exs., 110-120 cm., Simla Hills, H. P., F. Day ; 3exs., 165-170 cm., Dehra Dun, U. P., S. L. Hora ; 1exe., 55 cm., Siju Cave, Garo-Hills, Assam ; S. W. Kemp and B. N. Chopra ; 6exs., 90-230 cm., Manipur, 5.2.53, A. G. K. Menon.

4. *Tor putitora* (Ham.)

9exs., 55-110 cm., Nainital, U. P., 22.8.39., E. O. Shebbeare ; 1ex., 35 cm., Tawi River, Jammu ; 22.10.64., R. Tilak ; 1ex., 180 cm., Murri, F. Day ; 1ex., 110 cm., Punkhadi, Punjab, Punjab Fisheries Deptt. ; 3exs., 115-135 cm., Jammu, 3.10.64, R. Tilak.

5. *Tor progenius* (McClelland)

4exs., 159-306 cm., Manipur, 5.2.53, A. G. K. Menon.

6. *Tor mosal* (Ham.)

1ex., 225 mm., Lon Kin, N. Burma, H. C. Raven—The Vernay—Hopwood upper Chindwin Expd.

D. KEY TO THE SPECIES OF GENUS *TOR*

- | | | |
|---|--------|--------------------------------------|
| 1. Head length more than 5 in total length | ... | 2 |
| —Head length less than 5 in total length | ... | 3 |
| 2. Eye-diameter 3.2-4.2 in head length, L. 1. scales 23-26, length of head equals to depth of body | ... | <i>T. mosal</i> (Ham.) |
| —Eye-diameter 4.5-7 in head length, L. 1. scales 25-27, head length more than depth of body | ... | <i>T. mosal mahanadicus</i>
David |
| 3. Head length greater than depth of body, dorsal spine smooth and strongly developed, snout not tuberculated, L. 1. scales 25-28, length of head 4-4.5 in total length, thick lips | ... .. | <i>T. putitora</i> (Ham.) |
| —Head length not greater than depth of body, dorsal spine may or may not be strongly developed, snout may or may not be tuberculated | ... | 4 |

- | | | |
|--|--------|--|
| 4. Length of head equal to depth of body, L. 1. scales 25-27 | ... | 8 |
| —Length of head shorter than depth of body | ... | 5 |
| 5. Eye-diameter 3-4 in head length, snout not tuberculated, L. 1. scale 22-27 | ... .. | <i>T. tor</i> (Ham.) |
| —Eye-diameter in head length more than 4, snout may or may not be tuberculated, length of head 4.6 in total length. | ... | 6 |
| 6. L. 1. scales 26-27, pre-dorsal scales 10, eye-diameter about 6 in head length, snout tuberculated, length of head less than depth of body | ... .. | <i>T. mussullah</i> (Sykes) |
| —L. 1. scales 23-24, predorsal scales 10 | ... | 7 |
| 7. Head length 4.5-4.7 in total length, predorsal scales 8-9, L.1. scales 23-24, males smaller than females, males with larger labial flap | | <i>T. khudree longispinis</i>
(Günther) |
| —Head length 4.7-5 in total length, rostral barbels short, not extending to eye, L.1. scales 24, eye-diameter 5 in head length, upper jaw longer, thick lips | ... .. | <i>T. khudree malabaricus</i> (Jerdon) |
| 8. A black streak behind gill-opening, tip of snout fleshy and produced into a semicircular flap, L. 1. scales 26, length of head almost equal to depth of body, dorsal spine less developed, long compressed head, fins shorter | ... .. | <i>T. progeneius</i> (McCll.) |
| —No black streak behind gill-opening, tip of snout not fleshy, tuberculated, L. 1. scales 25-27, length of head equal to depth of body, eye-diameter 5.5-7 in head length | ... .. | <i>T. khudree</i> (Sykes) |

IV BIOLOGY

1. REPRODUCTION

The commonest form of reproduction is that females discharge enormous number of eggs and the males milt in shoals during spawning and the discharged eggs are fertilised externally. Migratory breeding preparations and courtship procedures are very active in mahseers. Macdonald (1943) observed during the floods that mahseer ascends considerable heights to gain the upper reaches of the river travelling long distances for fresh feeding grounds and for the purpose of spawning. There they lay their eggs in sheltered rockpools, not in the manner of the salmon, all at a time, but a batch of eggs at a time, repeating the process several times in the year, unlike popular Indian carps *Labeo rohita* (Ham.), *Labeo calbasu* (Ham.), *Labeo gonius* (Ham.), *Catla catla*

(Ham.), *Cirrhina mrigala* (Ham.) etc., where spawning takes place once in a year during the monsoon rains in June-July (Khan, 1939). Mahseers particularly *Putitora* mahseers spawn *thrice* in a year, firstly in winter months in January-February, secondly, in May-June, when the snow melts and rivers are swollen, and thirdly, from July to September, when the rivers are flooded with South-West monsoon (Khan, 1939) rains. It is for this reason that mahseer fry of all ages are seen throughout the whole year. Sehgal *et al.* (1972) observed two breeding seasons, one during May-June and the other during August-September based on their studies on the collection of fertilised eggs and hatchlings of *Putitora* mahseers from Baner stream in Himachal Pradesh.

The controversial views of Thomas (1897) that mahseer lays egg a day for many days, 'just like a fowl lays an egg a day for many days', are not appropriate ; as in the case of mahseer, all eggs contained in the ovaries seem to be laid out at the spawning time, leaving the ovaries completely vacant. At the approach of the next spawning season the ova reappear, increase in size, the ovaries swell and the eggs are again laid, thus repeating the process thrice during the three spawning seasons in a year. It may be said that mahseer does not lay its eggs in three batches, but all at a time during each spawning season (Khan, 1939).

It is an extraordinary thing that mahseers are never seen in the act of spawning. When the rivers are low and clear it would not be difficult to observe them. The period, during the end of June to the beginning of September, is believed to be the best period for the mahseer to propagate its species. After the rains, all mahseers tend to collect together in the deepest pools along the foot-hills where the mountain streams move out from narrow place to wider plains and join the big rivers. During December-January and early February, when the weather is again cold, they will be found gathered together in deep water for warmth (Conway, 1943). Actual egg-laying and fertilisation has not been seen except reports, which describe the embracing act as same like that of Rohu but in transparent water below the surface (Kulkarni, 1979). Breeding mechanisms in mahseers varies from species to species depending on the local ecological factors :

Tor tor (Ham.)

Migratory habits of this species are well known. It spawns at the beginning of rains or just before. This species has a prolonged breeding season which begins in July-August and continues up to December with the maximum breeding height from July to September. It has been

observed that younger ones breed earlier in the season than the older ones (Jhingran, 1975). Ova diameter studies have revealed that an individual *Tor* mahseer breeds in three spurts of spawning at intervals of 2-3 weeks in between two acts and as soon as the last batch of ova are shed the ovary becomes again mature and get ready for the next spawning during the ensuing season (Karamchandani *et al.*, 1967). It has been further observed that *Tor* mahseer, as a general rule in Punjab, migrates towards the headwaters at the onset of the south-west monsoon and down stream when the rain diminishes. It has also been reported by some workers that the three spawning are associated with spates. Some workers doubt whether there is any existence of definite spawning season of *Tor* mahseer in Punjab and North Bengal. (Jhingran, 1975). According to Beavan (1877) 'the fish lays eggs in several batches for a long period mainly during May and August'

***Tor putitora* (Ham.)**

The *Putitor* mahseer is said to spawn three times in a year. In Punjab these seasons are (i) January-February, (ii) May-June and (iii) July-September. It migrates from the main rivers to the tributaries during August-September and the spent fish returns in October-November (Jhingran, 1975). The fry of this species hide themselves behind rock boulders near the bank. The fingerlings prefer mid-streams for faster currents, hiding beneath stones and sometimes running in shoals. It has been reported that bigger fry prefer deeper pools of the major streams (Jhingran, 1975).

***Tor khudree* (Sykes)**

Spawning in this species is greatly induced by the south-west monsoon rains in the Periyar river in South India at the end of May. As a result of this, *khudree* mahseers move up the river from the near by lake, and spawning takes place during July-August. The river is also in spate at the beginning of North-East monsoon during October and early November. The presence of large number of clear and gravid fishes reveal that the Deccan mahseer 'spawns between June and December, seven months of the year, which is considerably more elastic than the period June-August mentioned by Dr Kulkarni (1954)' (Lovatt, 1956). It can also breed below the reservoir, under forced and confined conditions when it cannot move up and cross the dam (Mahmood, *et al.*, 1950).

Tor mussullah (Sykes)

Breeding habits of this species are reported to be more or less similar as that of *Tor khudree* (Sykes).

Tor mosal (Ham).

Nothing is known definitely about its breeding behaviour.

Tor progeneius (McClelland)

Breeding habits of this species are reported to be more or less similar to that of *Tor tor* (Ham.).

2. SEX and SEXUAL DIMORPHISM

Fleshy protuberance and hypertrophied lips (Fig. 6a & 6b) have been reported to have a sexual significance but have not been reliably tested. The presence or absence of tubercles on the snout is regarded as a secondary sexual character in mahseers. However, the most significant characters are the gonads which occur as a pair of elongated light coloured strap shaped bodies lying one on each side of the intestine and lodged into the groove between air-bladder and abdomen. Each gonad is like a quill-like bag containing eggs (Macdonald, 1943). Sex identification is only possible when ripe females show a fully bulged and soft abdomen with a slightly swollen pinkish vent. If the abdomen is slightly pressed the mature females and males will discharge eggs and milt respectively. Other sex determining characters in *T. khudree* during breeding are that the females having peculiar obliquely protruding base of anal fin out of the ventral profile curve and the length of pectoral fin in male (Jhingran, 1975). Hora and Mukerjee (1936) observed sexual dimorphism in *T. putitora*. In males, the lips are fleshy and the lower one is projected backwards into fleshy appendages. In case of females, the lips are of normal type and the lower lip does not form an appendage and the snout is rather pointed. Sexual dimorphism is also present in case of *T. mussullah*. It is found that in the males the tubercles on the snout are more numerous and prominent, while in the females only a few small tubercles are present on the sides of the snout (Hora, 1943). The males are smaller than the females with large labial flaps in case of *T. khudree* and *T. khudree longispinis* (Munro, 1955).

3. EGGS

Mahseer eggs are bright lemon yellow in colour measuring 2.8-3.2 mm. in diameter (Kulkarni, 1971). Eggs of *T. tor* and *T. khudree* are heavy,

demersal and full of yolk. Diameter of *T. khudree* egg is slightly larger than *T. tor*, i.e., 3.2 mm and 2.8 mm respectively (Kulkarni, 1980). Embryonic developmental stages of *T. tor* larva within the egg capsule are almost same as that of *T. khudree* (Kulkarni, 1980). Desai (1970) observed the size of ovarian eggs of *T. tor* varying from 1.0-2.22 mm. and orange in colour. This variation, according to Kulkarni (1980), is due to the fact that they are yet to pass through the final maturation stage necessary for proper fertilisation. Jhingran (1975) observed that breeding spurts in mahseers can be indicated by the study of their ova diameter. Mahseer eggs take about 72-85 hours to hatch out in water between 22°-26°C temperature (Kulkarni, 1979 & 1980). The semiquiescent stage for the hatchings is 6-7 days (Kulkarni, 1979). (Fig. 10).

4. OVULATION

It is reported that rain, flood, and physico-chemical factors greatly induce mahseers to ascend their spawning grounds and stimulate themselves in sexual plays. Internal secretion of pituitary hormone is greatly responsible for ovulation and for the changes in eggs which make them translucent. The behaviour of mahseer indicates that it is probably the pituitary sex hormone which is directly responsible for ovulation.

5. SPAWNING TEMPERATURE

Mahseer eggs hatch out in water having 22°-26°C temperature (Kulkarni, 1971). *T. tor* eggs hatch out in water after 72-85 hours in water temperature of about 24°C (Kulkarni 1980). It has been observed that *Tor putitora* eggs need water temperature of about 22.2°-23°C before spawning. Spring temperature in the hills is generally found to be around 17.7°C and that is why in March mahseers are never found to spawn. In April-May the temperature generally rise to 25.5°C and all the mahseers caught during this period are invariably in spawn. Some tributaries like Ramaran heat up very slowly due to its forest clad banks and run fairly cool upto the end of May. This river flows into the great Rangit valley in N. Darjeeling which runs cold like Teesta, due to melting of snow in the upper region. Longdale (1944) caught some mahseers from this junction on 25th May, 1942 but none of them were found in spawn ; he again collected some mahseers on 2nd June in the same year which were found to be slightly in spawn and mahseers caught on 20th June were found in full spawn.

6. GROWTH

Breeding biology, growth, early and post larval developmental stages of the different mahseer species have been more or less studied by many workers. They are Thomas (1897), Khan (1939), Cordington (1939), Hora (1943), Macdonald (1948), David (1953), Qasim & Qayyum (1961), Lal & Chatterjee (1962), Karamchandani (1967), Sukumaran (1969), Desai (1970, 1972 & 1973), Sehgal (1972), Chaturvedi (1976), Kulkarni (1971, 1979 & 1980). Of the different species of mahseers, the larval developmental stages of four have been so far studied and reported viz., *T. tor*, *T. khudree*, *T. putitora* and *T. mosal mahanadicus* by Desai (*T. putitora*, *T. tor* & *T. khudree*. 1972 & 1973), Karamchandani (*T. tor*. 1967), David (*T. mosal mahanadicus*. 1953), Kulkarni (*T. khudree*, *T. putitora*, 1971, 1979 & 1980), Tripathi (*T. putitora*, 1978), Das (*T. putitora*, 1978), Chaturvedi (*T. tor*, 1976), Khan (*T. tor*, 1939), Cordington (*T. tor*, *T. putitora*, *T. khudree* & *T. mussullah*, 1939) of which, Kulkarni (1971, 1979 & 1980), Desai (1972 & 1973) and Karamchandani (1967)'s papers are specially valuable for their extensive work on breeding and developmental biology of *T. tor*, *T. khudree* and *T. putitora*. David (1953) studied and described the variation, bionomics and early larval developmental features of mahseers collected from Mahanadi river near the Hirakud stretch in Orissa and established a new subspecies *Tor mosal mahanadicus*. Kulkarni (1971, 1979 & 1980) studied and described in detail the embryonic developments and early larval stages, artificial fertilization of eggs of *T. khudree* and *T. putitora* collected from Lake Walwhan near Lonavla in Maharashtra. He also investigated in detail (1980), for the first time, matured eggs, its developments and early hatchlings and larval stages of *T. tor* in one of the Hydel lakes of the Tata Electric Companies at Lonavla. Karamchandani (1967) studied the early development, maturity growth-rate, fecundity and larval behaviours of *T. tor* collected from the Narmada river in M. P. Khan (1939) studied and described the developments of sex organs of *T. tor*. Cordington (1939) studied and described spawning biology, its seasons etc., of Indian mahseers. Chaturvedi (1976) studied the spawning biology of *Tor* mahseers of Udaipur lakes and streams. Tripathi (1978) studied the artificial breeding biology of *T. putitora*. Das (1978) studied in details the biology of the Kumaon mahseer, *T. putitora*. Desai (1970, 1972 & 1973) studied in detail the three stages of *T. putitora* collected from the Narmada river at Hoshangabad, M. P. and compared it with that of the larvae of *T. tor* collected from the Narmada river. He also made observations in the maturity, fecundity, larval developments and fishery

biology of *T. tor* collected from the Narmada river during monsoon period in July-August. In this mixed collection of larvae of *T. putitora* and *T. tor*, it was observed that larvae of *T. putitora* were found much less compared to that of *T. tor*. It was further observed that the pro-larvae of both the species had big yolk sac. The three larval stages were conspicuously different in their body proportions as compared to the corresponding stages of *T. tor*. These three stages looked slender with longer heads. The stages measured 9.02, 10.36 and 11.30 mm. in total length and their development was found to be identical with the first three stages of *T. tor* measuring 8.74, 9.50 and 10.74 mm. in total length. It was evident from this variation with regard to total length that these stages correspond to bigger variety of mahseer. The only mahseer, other than *Tor tor*, available in the Narmada river, at Hoshangabad, is *Tor putitora*, which is slender in form and grows more than *Tor tor* (Misra, 1962).

The larval stages of all the valid mahseer species *T. tor.*, *T. putitora* and *T. khudree* show very close affinity in general appearance and body contour. The striking similarities between these three species during their larval stages is the presence of a *big yolk sac* which appears to be the characteristic feature of prolarva of the genus *Tor*.

*Comparison of larval stages (First, second and third) of
T. putitora, T. tor and T. khudree (Desai, 1972)*

First stage

Distinguishing characters

	<i>T. tor</i>	<i>T. putitora</i>	<i>T. khudree</i>
Total length (T.L.)	8.74	9.02	11.00
T.L./Length of head	5.5	6.0	8.5
T.L./Height of head	5.5	8.5	9.2
T.L./Height of body	6.0	6.7	5.5

Common characters in the larvae of the three species

Yolk-sac present. Median fin fold is continuous. Dorsal fin is demarcated without formation of rays in it. Rudimentary rays are evident in caudal fin, caudal fin truncate in shape.

Second stage

Distinguishing characters

	<i>T. tor</i>	<i>T. putitora</i>	<i>T. khudree</i>
Total length (T.L.)	9.5	10.4	12.6
T.L./Length of head	5.0	5.5	6.5
T.L./Height of head	6.4	7.6	7.7
T.L./Height of body	5.8	7.2	5.5

Common characters :

Dorsal fin further demarcated with the formation of 7-8 rays. Anal fin region slightly demarcated without indication of rays in it. Appearance of fork in caudal fin.

*Third stage**Distinguishing characters*

	<i>T. tor</i>	<i>T. putitora</i>	<i>T. khudree</i>
Tor length (T.L.)	10.7	11.3	—
T.L./Length of head	4.8	5.0	—
T.L./Height of body	6.6	7.4	Unknown

Kulkarni (1980) studied and observed the three larval developmental stages of *T. tor* larva of 15 days old hatchling stage. He first collected young hatchlings of *T. tor* from Narmada river near Hoshangabad M. P., in November, 1973 and reared these hatchlings into Walwhan lake at Lonavla upto July, 1978 attaining 1.75 kg body weight and 540 mm total length with distinct orange yellow caudal fin. Efforts were then made to breed them artificially by the stripping method. The first egg was hatched out in water after 72 hours and the remaining fertilised eggs after 79 to 85 hours in water temperature of 24°C.

Reported growth in total length of the valid tor species

<i>T. tor</i>	<i>T. khudree</i>	<i>T. putitora</i>	<i>T. mussullah</i>	<i>T. mosal</i>
1,524 mm (5 ft.) (Misra, 1962), 1.5 m (Jhingran, 1975).	1,447 mm (4 ft. and 9 inches) (Misra, 1962), '50 lbs weight' (Hora, 1943), 1.5 m (Jhingran, 1975).	2,743 mm (9 ft.) (Misra, 1962), 2.75 m. (Jhingran, 1975).	1,219 mm (4 ft.) (Misra, 1962), 1.2 m. (Jhingran, 1975).	'55 to 75 lbs' body weight ; 1.524 mm. (5 ft.) (McDonald, 1943).

Kulkarni (1979) observed that *T. khudree* egg takes about 27-35 days to attain the length of 30-35 mm and 6-8 months to reach fingerling stage, i.e., 8-9 cm in length (Fig. 10). According to Thomas (1897), the size of the mahseer depends much on the size of the river in which it is found, possibly on other circumstances also with which we are not acquainted, but certainly on the size of the river.

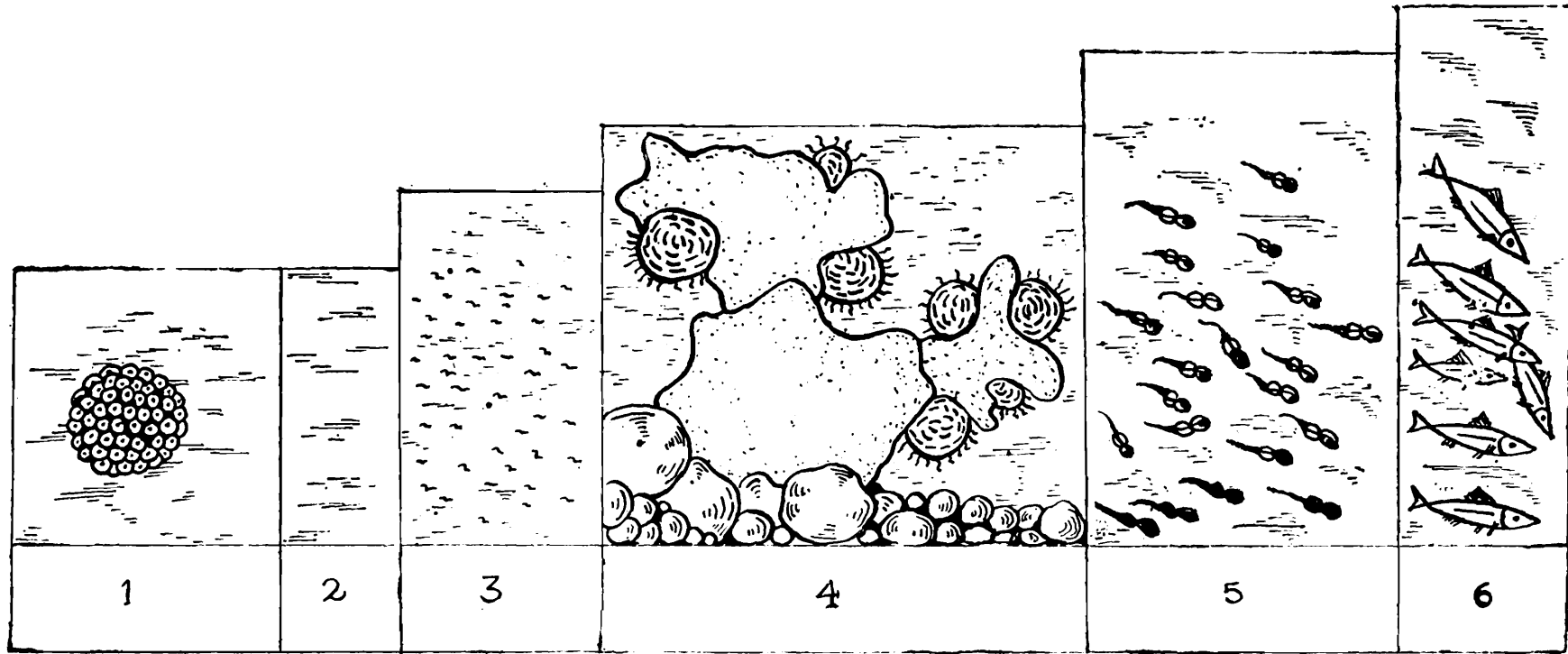


Fig. 10. Diagrammatic views showing the six developmental stages of *T. khudree* (Sykes) from fertilised eggs to fingerling stage (Based upon the observations made by Kulkarni, 1971 & 1979).

1. Showing cluster of fertilised eggs measuring 2.8-3.00 mm in diameter in water temp. 22°-26°C.
2. Hatching period being 80 hrs.
3. Hatchlings.
4. Showing semiquiscent stage—hatchlings remain attached like clustered balls with rocks or stone corners for 6-7 days with their flickering tails around the periphery.
5. Showing 30-35 mm sized larvae within a period of appxly. 30 days.
6. Showing fingerlings (8-9 cm length) within a period of 6-8 months.

Distinguishing characters T. mosal and T. m. mahanadicus

Eye-diameter in length of head	...	...	3.3-4.2	4.5-7
Lateral line scales	...	...	23-26	25-27
Head length	...	...	Head length equals the depth of body.	Head length often more than the depth of body.
Colour	...	...	More yellowish than gold, dorsal fin reddish orange and other fins orange yellow.	Back iridescent greenish yellow, sides silvery, abdomen milky white ; a light grey band from opercle to caudal fin base ; dorsal fin green or blue (not red or orange) ; all other fins pink, orange or light yellow without spots ; golden opercles.

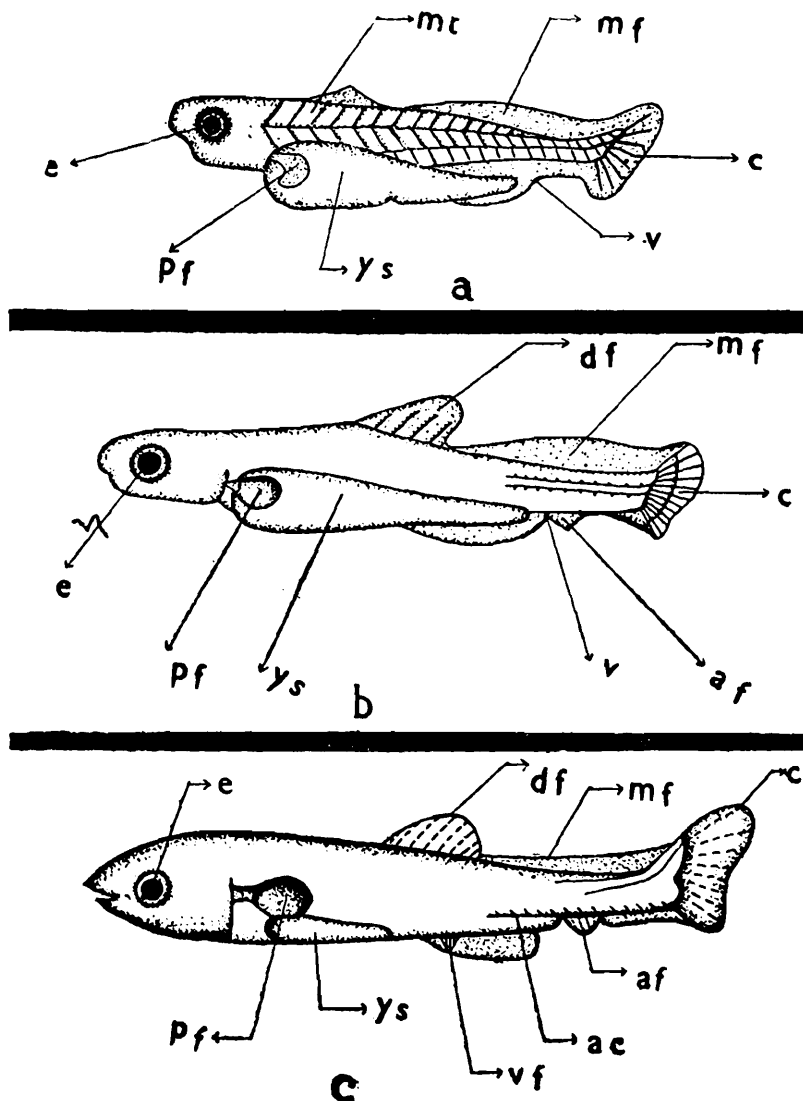


Fig. 11. Diagrammatic views of three larval stages of *Tor putitora* (Ham.) showing a, b, c, stages of development at 9.02 mm, 10.36 mm and 11.30 mm respectively. e=eye ; mt=myotomes ; mf=median fin ; c=caudal fin ; v=vent ; ys=yolk sac ; pf=pectoral fin ; df=dorsal fin ; af=anal fin ; ac=alimentary canal ; a=first stage ; b=second stage ; c=third stage.

7. FECUNDITY

Fecundity in mahseers is comparatively low as compared to other popular carps. Karamchandani (1967) calculated fecundity of 30,420 ova for *T. tor* of 625 mm. in total length and Desai (1973) recorded 42,6000 ova for a 657 mm. female of the same species. Kulkarni & Ogale (1979) counted 20,000 ova from a 630 mm. *T khudree* weighing 3.6 kg. from one of the Lonavla lakes in Pune district. This is very low as compared to *Catla catla* (1,33000 av.) and *Labeo rohita* (2,61,000 av.) per kg. of body weight (Sukumaran, 1969).

According to Jhingran (1975), the relationship of fecundity (F) with total length (L) and weight of fish (W) and weight of ovary (WO) for *Tor tor* are found to be controlled by the equation given below :

$$\log F = 1.9749 \log L - 1.0384, \quad (1)$$

$$F = 14.29 W + 1297 \quad (2)$$

$$F = 198.52 WO + 277 \quad (3)$$

The length weight relationship of the Narmada mahseer, *Tor tor*, has been found to be very near to the formulae given below in respect of two sexes :

$$\text{Male } \log W = 2.9851 \log L - 4.9647$$

$$\text{Female } \log W = 3.0522 \log L - 5.1263$$

The above relationships show a high degree of correlation in males ($r=0.96$) and females ($r=0.99$) (Jhingran, 1975).

Calculated fecundity of *T tor* (After Karamchandani, 1967)

Total length (mm)	Calculated fecundity
290	6,677
330	8,616
375	11,090
425	14,200
475	17,690
525	21,560
575	25,800
625	30,420
675	35,410
725	40,780
750	43,610

8. MORTALITY

Mortality is reported to be heavy in mahseers.

The semiquiescent stage of *T. khudree* (Kulkarni, 1979) is extended to six days instead of the normal 3 days in case of other carps. During this period the hatchlings do not swim freely but remain at the bottom mostly crowded together in large numbers in corners and crevices with their heads rolled away from light and tails vibrating. In this condition they are largely eaten up by predatory animals and thus are regarded as the most critical stage of their life and since this stage is prolonged, mortality is very heavy. It is assumed that *T. tor* and *T. putitora* have got the similar hazardous semiquiescent stages in their life history and face the same heavy mortality. In Nainital hills in U. P., stripping of matured ripe *T. putitora* was attempted by Tripathi (1978). The eggs were fertilised but heavy mortality was reported.

9. MATURITY

The typical mahseer of anglers in northern India attains its first maturity in the size range 270-290 mm (Jhingran, 1975). The younger ones have been observed to breed earlier in the season than the older ones.

10. AGE DETERMINATION

The condition of the scales and otoliths is said to have direct indications in determining the age of the fish. Definite growth rings on the cycloid scales of mahseers, if detected properly, can indicate the age of the fish. The ear sac containing the otolith is a bony concretion and increases in size during the entire span of life of the fish, each year adding two layers, a light one formed in summer and a dark one in autumn and winter. The number of pairs of layers represent the age of the fish (Macdonald, 1943). However, definite techniques to calculate the age of mahseers have not yet been reported.

11. ARTIFICIAL BREEDING

Artificial breeding by pituitary hormones (induced breeding) in mahseers have been attempted by many fishery biologists like other carps but met with very limited success (Kulkarni, 1979).

However, in recent years considerable work has been done on artificial breeding of mahseers by many fishery biologists of which the

works of Kulkarni (1971, 1980), Kulkarni and Ogale (1979), Desai (1970, 1972), Tripathi (1978), Karamchandani *et al.* (1967) deserve attention.

V. BIONOMICS

A. FOOD

The mahseer is noted to be an intermittant as well as bottom feeder. Thomas (1897) in his famous book 'Rod in India' has discussed its food and feeding habits. It takes aquatic weeds of all sorts, some taken intentionally, some when grabbing at the insects that live on them, seeds of Dhup (*Vateria indica*) of West coast, the seeds of many other trees also which hang over the river when it is forest clad, bamboo seeds, rice thrown by man, unhusked rice or paddy washed out from the fields, crabs, small fishes, earthworms, water-beetles, grasshoppers, small flies, water or stone crickets, shrimps, snails etc. It is a fish of varied tastes—'he will take small fish with the same readiness as he will worm and paste, a fig or berry on the surface, or a frog on the bottom, leaves and flying ants, weeds and small fish' (Macdonald, 1943). Sehgal (1971) observed that fry and fingerlings of mahseers of the size range between 25-130 mm subsist on algae belonging to the families Bacillariophyceae (46.98%), decayed organic matter (22.28%), green algae (13.33%), insects (10.21%), rotifers (1.42%), blue-green algae (1.38%), protozoans (0.76%) and fish (0.41%).

It has been reported that food and feeding habits of mahseers vary from species to species under various ecological conditions and stages of their developments.

B. FEEDING HABITS OF DIFFERENT TOR SPECIES

(1) *Tor tor* (Hamilton) : It feeds on insects, shrimps, stone-cricket, molluscs, small fishes and aquatic weeds. It has been observed that it takes algal filaments, gastropods, sand and gravels (Lal & Chatterjee, 1962). Its elementary canal is comparatively much convoluted and much longer than that of *Tor putitora*. The length of intestine is equal to 6 times in its total length (Lal & Chatterjee, 1962).

(2) *Tor putitora* (Hamilton) : Scanty information is available on food of *T. putitora* (Hora, 1939 ; Qasim & Qayyum, 1961 ; Lal & Chatterjee, 1962 and Bhatnagar, 1964). However, green filamentous algae and other water plants, slimy matter of encrusting rocks, insect-larvae etc. have been recorded from the stomach contents of *Putitor*

mahseer (Macdonald, 1943). The alimentary canal is considerably short, being 6 times in its total length (Lal & Chatterjee, 1962).

(3) *Tor khudree* (Sykes) : Feeds on green vegetable matters, insects, shrimps, small fishes etc. Also 'debris' has been found in its stomach as food (Rajan, 1965). It is also a foul feeder—'It has been found to feed on, during rains (Ghod river, Sirur), surplus municipal sewage, fresh buffalo dung etc. (Suter, 1942).

(4) *Tor mussullah* (Sykes) : Besides its usual food matters viz., vegetable matters, insects, molluscs, it is also a foul feeder feeds on, during rains, municipal sewage, fresh buffalo dung etc. (Suter, 1942).

(5) *Tor mosal* (Hamilton) : Nothing is known distinctly regarding its food. It is not very common in Indian waters (a Burmese form) but is said to be mainly leaf-eating. It is more common in Burma than in the Himalayas. A wide spread belief prevails among Burmese people that mahseer caught in streams which flow through certain evergreen forests are poisonous, if eaten. Mahseers when caught from such streams are called 'ngatauk'. The poisonous effect is said to be due to the fish eating the fruit of the 'kalaw, (*Tarnktogenos kerzzii*) tree. If anybody, eats a mahseer from such a stream, it has a delirious effect as the name 'ngatauk' signifies 'Ngafish' 'tauk' = to be giddy. Two streams where the mahseers are 'poisonous' in this way are the Kodan and the Nankamu in the upper Chindwin District. Mahseers of such streams, which are edible, are tasty and are locally called 'Nganangyaung'. The oil derived from the fruits of the 'Kalaw' trees has valuable medicinal properties in the treatment of leprosy (Hopwood, 1934).

(6) *Tor progeneius* (McClelland) : Reported to be more or less same as that of *Tor tor* (Ham.)

It has been observed that the food taken by the mahseers on the surface of the water varies greatly with that taken under it and at the bottom. It has been found from the proportionate quantities of food taken by them to be most favourite, are the crabs, molluscs and fishes (Thomas, 1897). The four fine and distinct feelers or barbels by the side of the mouth—are indication of a bottom feeder. As the fish grows the teeth are shed individually as they become worn and replaced by fresh growing pharyngeal teeth.

The juveniles and adults of *T. tor* mahseers have been reported to depend on food organisms common to both of them but in varying quantities as shown in the table below (Jhingran, 1975). When juvenile, it is insectivorous, but becomes herbivorous when it reaches to its adult

stage. Besides barbels, the protrusible and suctorial mouth (hypertrophied) of the fish and presence of large quantities of mud, sand and debris in its guts are clear indication of its bottom feeding habits.

*Proportionate percentage of food of juvenile and adult Tor tor
in river Narmada (After Karamchandani, 1967)*

<i>Main food item</i>	<i>Adult</i>	<i>Juveniles</i>
Macro-vegetation	41.7%	4.7%
Molluscs	10.5%	21.9%
Filamentous algae	12.3%	2.8%
Insects	8.0%	53.8%

VI. FISHERY

1. GAME FISH

Mahseers are extremely popular all over India particularly along the Himalayan foot-hills of northern and eastern India both as a game as well as food fish. According to Jhingran (1975), it is one of the most important game fishes of India. Thomas (1897) and Macdonald (1943, '44 and '47) have narrated, in detail their sporting and fighting nature and the use of rod to hunt them in their famous works 'The Rod in India' and 'Circumventing the mahseer and other sporting fishes in India' respectively. Hora (1939, '40, '41, '42 & '43), Hora & Misra (1941), Hora & Nair (1943) have described important game fishes of India including the mahseers.

2. FISHING GROUNDS

Rivers and streams fed by perennial snow-melt water with beds covered by rocks and sheltered stones having shallow depths, currents and low temperature are considered to be the most favourable fishing grounds for mahseers. It enters into side streams or torrential river-branches for spawning purposes and returns to main stream or river when the waters begin to subside during summer time.

3. FISHING SEASONS

In the northern India, the best fishing season for *T. tor* and *T. putitora* is from February to April for the large rivers and October and early November for the small rivers which are not affected by snow-melt waters. Early hot weather is popularly known as the best. In Bombay, Central India, the best time is when the 'snow begins to clear after the monsoon floods, and the best sport being obtained early in the

season before the water has run low, after which the larger fishes are mostly in deep pools and are not easily found (Khan, 1939). But as the *T. mussullah* and *T. khudree* are mostly peninsular forms, the most popular fishing seasons are S. W and N. E. monsoon oriented months i. e., from July to August and from November to December.

4. FISHING EQUIPMENTS

Drag, gill, drift, purse, cast and scoop nets ; traps, rods, with hooks and lines are generally used for catching mahseers. As it is a very popular game fish, various kinds of hooks and lines are used by anglers. The most popular fishing baits are paste balls or pellets made of wheat-flour ('atta') and gram-powder ('chattu').

5. PRESENT FISHERY STATUS OF MAHSEERS IN INDIA

The famous sport-fish of India, the mahseers are greatly threatened today in India according to the recent (1976) report of the National Commission on Agriculture on 'Fisheries'. It stated "It has been reported that there has been a general decline in the mahseer fishery due to indiscriminate fishing of brood fish and juveniles and the adverse effects of river valley projects". It has further recommended "extensive survey and detailed ecological and biological investigations". Whatever may be the commercial catches of mahseers, present sport-fishing reports of these fishes by anglers all over the country indicate its gradual decline particularly the larger ones (Sehgal, 1972). The commercial fishery of *T. putitora* in the upper Himalayan regions and U. P. mainly consists of individuals either ascending streams for breeding purposes or the spent ones returning to their perennial pools (Sehgal, 1972). In M. P., particularly in the Narmada river near Hoshangabad and in Tapi near Barhanpur (Karamchandani, 1967), landings of *Tor tor* (Ham.) have been reported to be declining in recent years compared to the catches made 12-years ago. *Tor khudree* (Sykes) in Maharashtra rivers viz., Bhima, Krishna, Koyana etc., is now-a-days a rare catch except from a few temple sanctuaries at Dehu and Alandi on the Indrayani river and in some reservoirs. In Rajasthan lakes, and Chambal river between the Gandhi-Sagar and Rana Pratap Sagar reservoirs, the mahseers though occurring in plenty, their fishery status has not yet been determined due to the absence of previous catch data.

In the south, it is the same declining picture. Cauvery river, one time famous home of large mahseers (*T. khudree* and *T. mussullah*)

has been reduced to a mere stocking river with fingerlings of Deccan mahseer, *Tor khudree* (Sykes) from Lonavla (Maharashtra). The main causes of the decline are reported to be (1) use of explosives (2) wanton killing of brood fish in the spawning season (3) ecological changes in the riverine systems of the country and the (4) continued construction of dams and reservoirs on rivers and streams shattering their migratory routes. (Kulkarni, 1979).

VII. SUMMARY

The celebrated mahseer which is the most popular game fish amongst the anglers in India occupies a prestigious position amongst all other carps in view of its size and sporting behaviour. It is found in the snow-fed streams and rivers of India particularly along the Himalayan foot-hills. The generic concept and true specific status were in confusion for many years until the late Dr S. L. Hora attempted to clarify the same in a series of articles. Despite this many erroneous misidentifications crept into literature, the information regarding their habitats, habits, bionomics, reproductive behaviour and biology were scattered in several publications. In order to codify all such available information this review was prepared.

The etymology of the name mahseer was found to have been interpreted in several ways and the correct possible interpretation has been presented. The existing taxonomic confusion and the limitations of the genus *Tor* has been clarified. All the valid species referable to *Tor* have been described with complete synonymy, fin-formulae, popular-names, colour-patterns, maximum-size attained, range of distribution and all other necessary details of the fish. The systematic position of *Tor progeneius* (McClelland) has been clarified for the first time. A Key for all the known species is also given together with adequate illustrations drawn by the senior author himself. The position of the species doubtfully referred to *Tor* has also been discussed. For each species known information regarding their biology, breeding behaviour, migratory habits, courtships, spawning habits, seasons and temperature ; sex and sexual dimorphism, ovulation, hatching, growth, comparative larval developmental stages, fecundity, maturity, age-determination, artificial-breeding etc., have been dealt with in this review. For the first time most compact and elaborate bibliography on mahseers ranging 1822 form 1980 is furnished.

The food and feeding habits and other details of bionomics have been dealt with under a sub-heading fishery, the fishing seasons,

equipments used, fishing grounds, present fishery status of mahseer etc., are given.

VIII. ACKNOWLEDGEMENT

The authors are thankful to Dr B. K. Tikader, Director, Zoological Survey of India, for kind facilities and interest.

IX. REFERENCES

- ANNANDALE, N. 1919. The Fauna of certain small streams in the Bombay Presidency. V. Notes on Freshwater Fish mostly from the Satara and Poona Districts. *Rec. Indian Mus.*, **16** : 134-137.
- BEAVAN, R. 1877 Handbook of freshwater fishes of India, London.
- CONWAY, CAPT. C. W. S. 1943. Sunlit waters. Thacker & Co. Ltd. Bombay (3rd edit.)
- CORDINGTON, K. and DE, B. 1939. Notes on the Indian Mahseer. *J. Bombay nat. Hist. Soc.*, **46** : 336-344.
- CHATURVEDI, S. K. 1976. Spawning biology of *Tor mahseers*, *Tor tor* (Ham.) *J. Bombay nat. Hist. Soc.*, **73** (1) : 336-344.
- DAVID, A. 1953. On some new records of fish from the Damodar and Mahanadi river systems. *J. Zool. Soc. India*, **5** (2) : 243-254.
- DAVID, A. 1953. Notes on the bionomics and some early stages of the Mahanadi mahseer. *J. Asia. Soc.*, Calcutta, **19** : 197-209.
- DAY, F. 1878. *The Fishes of India*, London, pp. 556-582.
- DAS, S. M. and PATHANI, S. S. 1978. Studies on the biology of the Kumaon Mahseer (*Tor putitora*). Adaptation of the Alimentary tract to feeding habits and body weight. *Indian J. Anim. Sci.*, **48** (6) : 461-465.
- DESAI, V R. 1970. Studies on the fishery and biology of *Tor tor* (Ham.) from river Narmada. 1. Food and feeding habits *J. Indl. Fish. Soc. India*, **2** : 101-102.
- DESAI, V. R. 1972. Notes on the early larval stages of *Tor putitora* (Ham.) *J. zool. Soc. India*, **24** (1) : 47-51.
- DESAI, V. R. 1973. Studies on the fishery and biology of *Tor tor* (Ham.). Maturity, Fecundity and Larval development. *Proc. India. Nat. Sci. Acad.*, **19** : 228-248.
- GRAY, J. E. 1834. *The illustrations of Iadian Zoology, Chiefly selected from the collection of General Hardwicke*, **2**, p. 96.

- HORA, S. L. & MUKERJI, D. D. 1936. Fish of the Eastern Doons, United Provinces. *Rec. Indian Mus.*, Calcutta, **38** (2), pp. 133-146.
- HORA, S. L. 1936. Fish of the Naga-Hills. *Rec. Indian Mus.*, **38** (1) : 328-330.
- HORA, S. L. 1937. The game fishes of India. 1. The Indian Trout. *J. Bombay nat. Hist. Soc.*, **39** (2) : 199-210.
- HORA, S. L. 1939. The game fishes of India : VIII. The Mahseers or the large-scaled Barbels of India. 1. The Putitor Mahseer, *Barbus (Tor) putitora* (Hamilton). *J. Bombay nat. Hist. Soc.* **41** (2) : 272-285.
- HORA, S. L. 1940a. The Game fishes of India. XI. The Mahseers of the large-scaled Barbels of India. 4. The Bokar of the Assamese and Katil of the Nepalese, *Barbus (Lissochilus) hexagonolepis* McClelland. *J. Bombay nat. Hist. Soc.*, **42** (1) : 78-88.
- HORA, S. L. 1940b. The game fishes of India IX. The Mahseers or the large-scaled Barbels of India. 2. The *Tor Mahseer*, *Barbus (Tor) tor* (Hamilton). *J. Bombay nat. Hist. Soc.*, **41** (3) : 518-525.
- HORA, S. L. 1940c. The game fishes of India. X. The Mahseers or the large-scaled Barbels of India. 3. The Mosal mahseer, *Barbus (Tor) mosal* (Hamilton). *J. Bombay nat. Hist. Soc.*, **41** (3) ; 784-794.
- HORA, S. L. 1941a. The game fishes of India. XIII. The Mahseers or the large-scaled Barbels of India. 6. The Jungha or the Assamese *Barbus (Tor) progenius* McClelland. *J. Bombay nat. Hist. Soc.*, **42** (3) : 526-572.
- HORA, S. L. 1941b. The game fishes of India. XIV. The Mahseers or the large-scaled Barbels of India. 7. The black Mahseer with notes on other colour varieties. *J. Bombay nat. Hist. Soc.*, **42**(4) : 803-815.
- HORA, S. L. 1942. The game fishes of India. XV. The Mahseers or the large-scaled Barbels of India. 8. On the specific identity of Syke's species of *Barbus* from Deccan. *J. Bombay nat. Hist. Soc.*, **43** (2) : 163-169.
- HORA, S. L. 1943a. The game fishes of India. XVI. The Mahseers or the large-scaled Barbels of India. 9. Further observations on Mahseers from the Deccan. *J. Bombay nat. Hist. Soc.*, **44**(1) : 1-8.
- HORA, S. L. 1943b. Specific identity of the Record Mahseers. *J. Bombay nat. Hist. Soc.*, **44**(2) : 303-304.

- HORA, S. L. & MISRA, K. S. 1941. The game fishes of India. XII. The Mahseers or the large-scaled Barbels of India. 5. The extra Indian distribution of the Bokar of the Assamese and Katil of the Nepalese, *Barbus (Lissochilus) hexagonolepis* McClelland. *J. Bombay nat. Hist. Soc.*, **42** : 305-319.
- HOPWOOD, S. F. 1934. Effect on Mahseer on eating the fruit of the Kalaw Tree (*Tarnktogenos kerzii*). *J. Bombay nat. Hist. Soc.*, **37**(3) : 743-745.
- HAMILTON, B. 1822. *Fish Ganges*, pp. 303-388.
- JERDON, T. C. 1840. *On the freshwater fishes of Southern India. Madras, J. Litt. and Sci.*, **15**, pl. 2, pp. 302-346.
- JHINGRAN, V G. 1975. *Fish and Fisheries of India*—Delhi : Hindusthan Publishing Corporation, XV + 954 pp.
- KARAMCHANDANI, S. J. & PISOLKAR, M. D. 1967. Survey of fish and fisheries of the Tapti River. *Bull. Cent. Indl. Fish. Res. Instt. Barrackpore*, **4** : 1-29.
- KARAMCHANDANI, S. J., DESAI, V R. & PISOLKAR, M. D. 1967. Biological investigations on the fish and fisheries of Narbada river. *Bull. cent. Indl. Fish. Res. Instt.*, **19** : 1-39.
- KULKARNI, C. V 1954. Comments on spawning of Rohu at Powai Lake. *J. Bombay nat. Hist. Soc.*, **52**, p. 634.
- KULKARNI, C. V. 1971. Spawing habits, eggs and early development of Deccan Mahseer, *Tor khudree* (Sykes). *J. Bombay nat. Hist. Soc.*, **67** : 510-521.
- KULKARNI, C. V. 1980. Eggs and early development of *Tor* Mahseer Fish. *J. Bombay nat. Hist. Soc.*, **77**(1) : 70-75.
- KULKARNI, C. V. & OGALE, S. N. 1979. The present status of mahseer (Fish) and artificial propagation of *Tor khudree* (Sykes). *J. Bombay nat. Hist. Soc.*, **75**(3) : 651-660.
- KHAN, H. 1924. Observations on the breeding habits of some freshwater fishes in the Punjab. *J. Bombay nat. Hist. Soc.*, **29** : 958-962.
- KHAN, H. 1939. Study of the sex organs of Mahseers (*Barbus tor*). *J. Bombay nat. Hist. Soc.*, **40** : 653-656.
- LAL, M. B. and CHATTERJEE, P. 1962. Survey of Eastern Doon fishes with certain notes on their biology. *J. Zool, Soc. India*, **14** (1-2) : 230-243.
- LACY, G. H. & CRETIN, E. 1905. *The Angler's Handbook for India*, 4th Edn. pp. 2, 3 (Calcutta).

- LONGDALE, S. W. K. 1944. A note on the breeding habits of Katli *Barbus (Lissochilus) hexagonolepis* Mcl. *J. Bombay nat. Hist. Soc.*, **19**, 89-90.
- LOVAT, J. D. 1956. The spawning of Carps. *J. Bombay nat. Hist. Soc.*, **54**(1) : 197.
- MENON, A. G. K. 1974. A check-list of Fishes of the Himalayan and the Indo-Gangetic Plains. *J. Indl. Fish. Soc. India*, spl. Pub. (1) : 45-47.
- MACDONALD, A. ST J. 1942-44. Circumventing the Mahseer and other sporting fish in India and Burma. *J. Bombay nat. Hist. Soc.*, **42** (2) : 173-189 ; **44**(1) : 38-59 ; **42**(2) : 185-205 ; **44**(3) : 322-354 ; **44**(4) : 520-535.
- MAHMOOD, S. & RAHIMULLAH, R. 1950. Fish survey of Hyderabad State. *J. Bombay nat. Hist. Soc.*, **47** : 102-111.
- MUNRO, I. S. R. 1955. *The Marine and Freshwater fishes of Ceylon*, Deptt. Ext. Affairs, Canberra, p. 43.
- MISRA, K. S. 1962. An aid to the identification of the common commercial fishes of India and Pakistan. *Rec. Indian Mus.*, **57** (1-4) : 149-156.
- QASIM, S. Z. & QAYYUM, A. 1961. Spawning frequencies and breeding seasons of some freshwater fishes with special reference to those occurring in the plains of Northern India. *Indian J. Fish.* **8** (1) : 24-43.
- RAJ, B. S. 1945. The decline of the Mahseer fisheries of the Kumaon Lakes and possible remedy. *Proc. Nat. Inst. Sci. India*, **3** : 341-345.
- RAJAN, S. 1965. Food of some hill-stream fishes of South India. *J. zool. Soc. India* : **17** (1 & 2) : 8-15.
- SEHGAL, K. L. 1972. Cold water fisheries development in India for sport profit. Silver Jubilee Volume. *Cent. Indl. Fish. Res. Inst.* pp. 125-131.
- SHAW, G. E. & SHEBBEARE, E. D. 1937. The Fishes of Northern Bengal. *J. Royal. Asiat. Soc. Bengal (Science)*, **3**(1) : 34-44.
- SPENCE, R. & PRATER, S. N. 1932. Game fishes of Bombay, the Deccan and the Neighbouring Districts of the Bombay Presidency. *J. Bombay nat. Hist. Soc.*, **36** : 29-64.

- SUKUMARAN, K. K. 1969. Growth, maturation and fecundity of cultivated fishes, U. N. D. P. Regional *Semi. Indu. breed. cult. fish.* Calcutta, **5** : 53.
- SYKES, W. H. 1840. On the Fishes of the Deccan. *Ann. Mag. nat. Hist.* **4** : 54-62.
- SYKES, W. H. 1841. On the Fishes of the Deccan. *Trans. Zool. Soc.*, London, **2** : 349-378.
- TILAK, RAJ. 1967. The fishes of the river Tawai and its tributaries (Jammu State) with some notes on ecology. *Rec. Zool. Surv.*, **65** (1-4) : 183-277.
- TRIPATHI, Y. R. 1978. Artificial breeding of *Tor putitora* (Ham.), *J. Indl. Fish. Soc. Indi.*, **9** : 161.
- THOMAS, H. S. 1897. *Rod in India*, London.