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# SYSTEMATIC STATUS OF *BARILIUS BENDELISIS* HAMILTON (CYPRINIDAE : PISCES)

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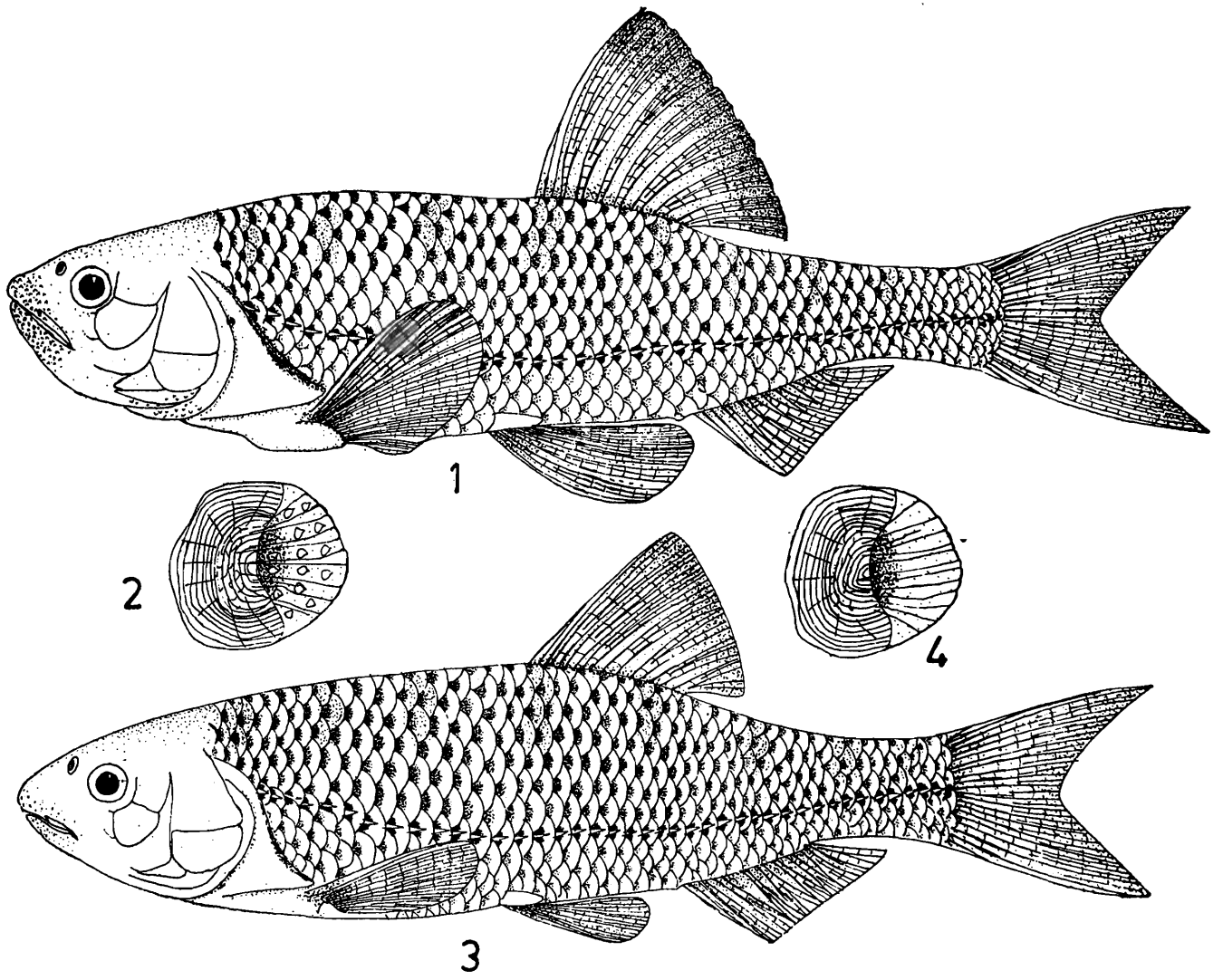
(With 8 Text-figures)

## INTRODUCTION

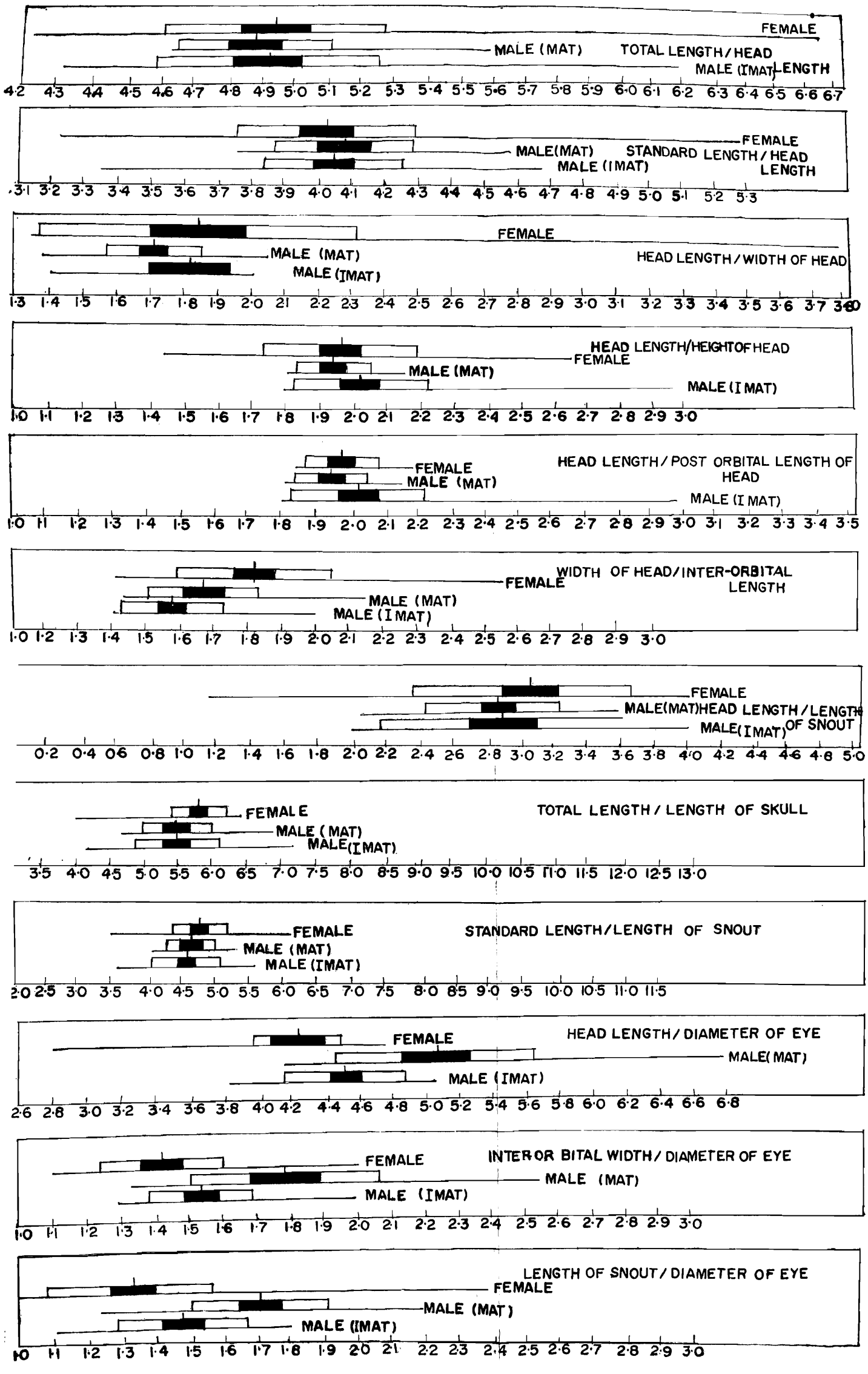
Hamilton (1807, 1822) described *Barilius bendelisis*, *Barilius cocsa* and *Barilius tila* under the genus *Cyprinus* Linnaeus and since then various authors have treated these texa at different levels (Day, 1878 ; Hora, 1921, Hora and Mukerji, 1936 ; Tilak, 1971 ; Menon, 1963, 1974). As such the systematic status of these texa has remained in a state of confusion. These fishes are widely distributed in the streams and rivers along the base of hills and are economically important. In this paper it is proposed, therefore, to study the material of these texa in detail and evaluate their taxonomic status.

## HISTORY

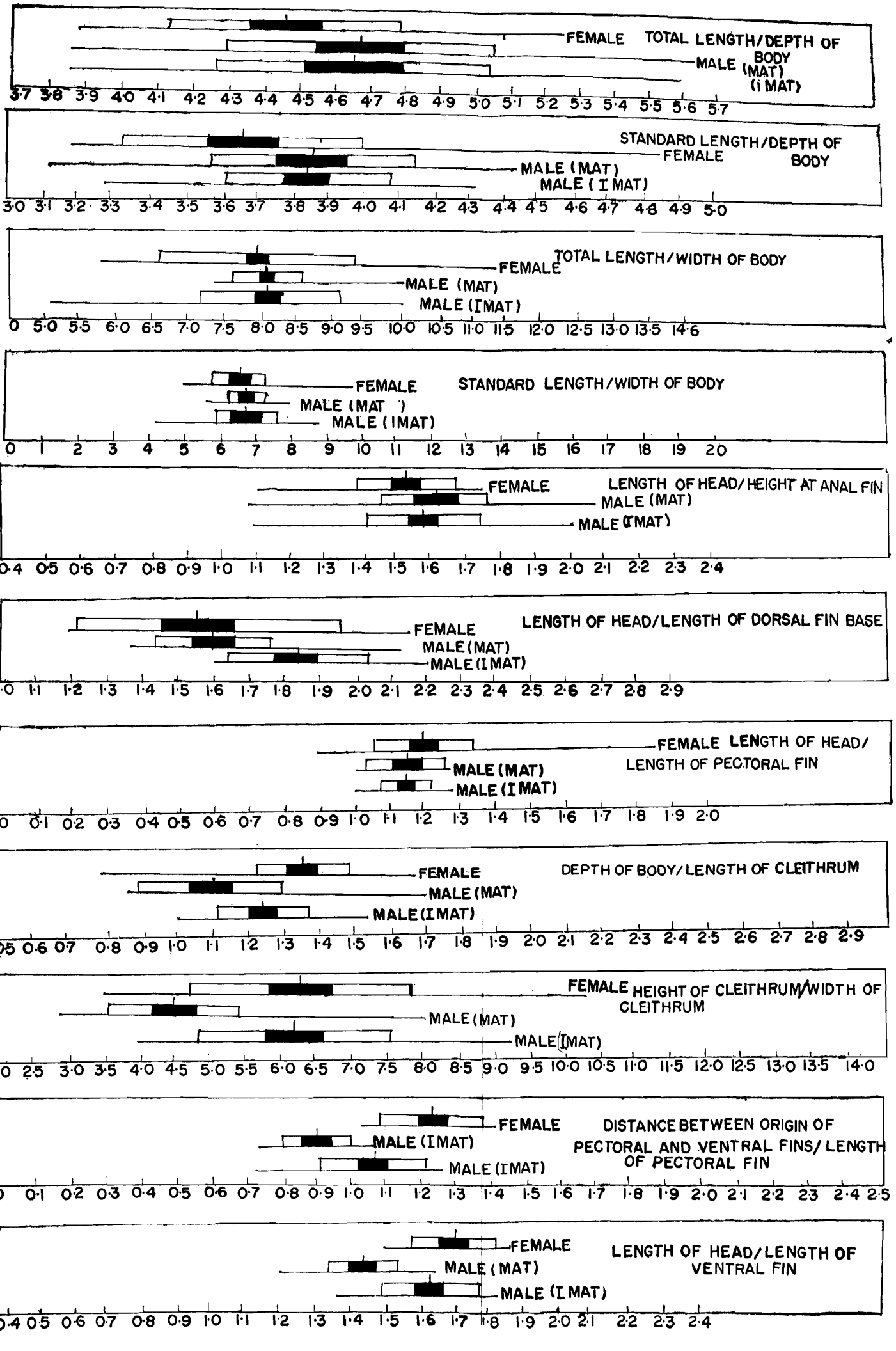
Hamilton (1807), during his journey to Mysore, described *Cyprinus bendelisis* from the rivers of Mysore. Hamilton (1822) further described three more species allied to *C. bendelisis* viz *C. cocsa* from the northern rivers of Bengal and Bihar, especially the Mahananda and, *C. chedra* and *C. tila* from northern rivers of Bengal. Since then, the taxonomic status of *B. bendelisis* has been in great confusion. Day (1878) considered *C. tila* as synonym of *B. bendelisis*, and *cocsa* and *chedra* as subspecies of the latter. Incidentally, Day (1878) found *chedra* type of specimens with very stiff outer pectoral rays. Hora (1921) was probably influenced by the treatment of Day (1878) and, recognising *B. bendelisis chedra* Hamilton as a valid taxon, remarked "The paired fins are broad and well expanded and most of the outer rays in this have become stiff. The chest is flattend and the scales in this region are poorly developed. There are characteristic muscular pads in front of the bases of the pectorals. The open pores on the snout are absent". Hora and Mukerji (1936) tried to correlate the specially developed pectoral with digging in sand or holding on to the rocks in rapids. Sehgal (1974) probably followed Hora (1921) and Hora and Mukerji



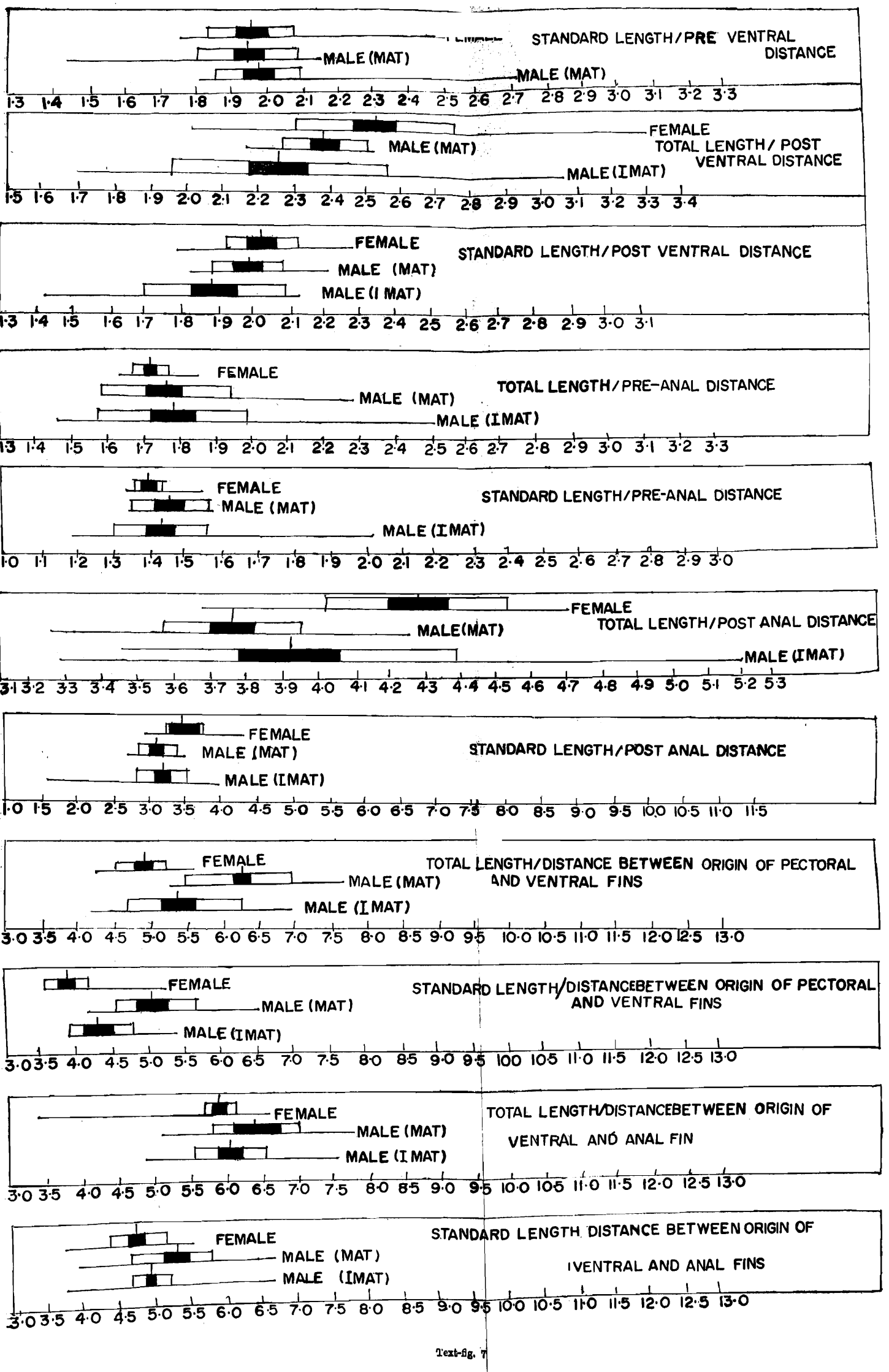

Text-figs. 1. Lateral view of the breeding male of *Barilius bendelisis* Hamilton.
2. A subdorsal scale of breeding male of *Barilius bendelisis* Hamilton.
3. Lateral view of the female of *Barilius bendelisis* Hamilton.
4. A subdorsal scale of the female of *Barilius bendelisis* Hamilton.


FEMALE
MALE (MAT)
MALE (IMAT)
TOTAL LENGTH / HEAD LENGTH
4·2 4·3 4·4 4·5 4·6 4·7 4·8 4·9 5·0 5·1 5·2 5·3 5·4 5·5 5·6 5·7 5·8 5·9 6·0 6·1 6·2 6·3 6·4 6·5 6·6 6·7
FEMALE
MALE(MAT)
MALE (IMAT)
STANDARD LENGTH / HEAD LENGTH
3·1 3·2 3·3 3·4 3·5 3·6 3·7 3·8 3·9 4·0 4·1 4·2 4·3 4·4 4·5 4·6 4·7 4·8 4·9 5·0 5·1 5·2 5·3
FEMALE
MALE (MAT)
MALE (IMAT)
HEAD LENGTH / WIDTH OF HEAD
1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3 3·4 3·5 3·6 3·7 3·8
HEAD LENGTH/HEIGHT OF HEAD
FEMALE
MALE (MAT)
MALE (IMAT)
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0
FEMALE
MALE (MAT)
HEAD LENGTH / POST ORBITAL LENGTH OF HEAD
MALE (IMAT)
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3 3·4 3·5
WIDTH OF HEAD/INTER-ORBITAL LENGTH
FEMALE
MALE (MAT)
MALE (IMAT)
1·0 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0
FEMALE
MALE(MAT)
MALE(IMAT)
HEAD LENGTH / LENGTH OF SNOUT
0·2 0·4 0·6 0·8 1·0 1·2 1·4 1·6 1·8 2·0 2·2 2·4 2·6 2·8 3·0 3·2 3·4 3·6 3·8 4·0 4·2 4·4 4·6 4·8 5·0
FEMALE
MALE (MAT)
MALE(IMAT)
TOTAL LENGTH / LENGTH OF SKULL
3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0
FEMALE
MALE (MAT)
MALE (IMAT)
STANDARD LENGTH/LENGTH OF SNOUT
2·0 2·5 3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5
FEMALE
MALE(MAT)
MALE (IMAT)
HEAD LENGTH / DIAMETER OF EYE
2·6 2·8 3·0 3·2 3·4 3·6 3·8 4·0 4·2 4·4 4·6 4·8 5·0 5·2 5·4 5·6 5·8 6·0 6·2 6·4 6·6 6·8
FEMALE
MALE (MAT)
MALE (IMAT)
INTEROR BITAL WIDTH / DIAMETER OF EYE
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0
LENGTH OF SNOUT / DIAMETER OF EYE
FEMALE
MALE (MAT)
MALE (IMAT)
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0

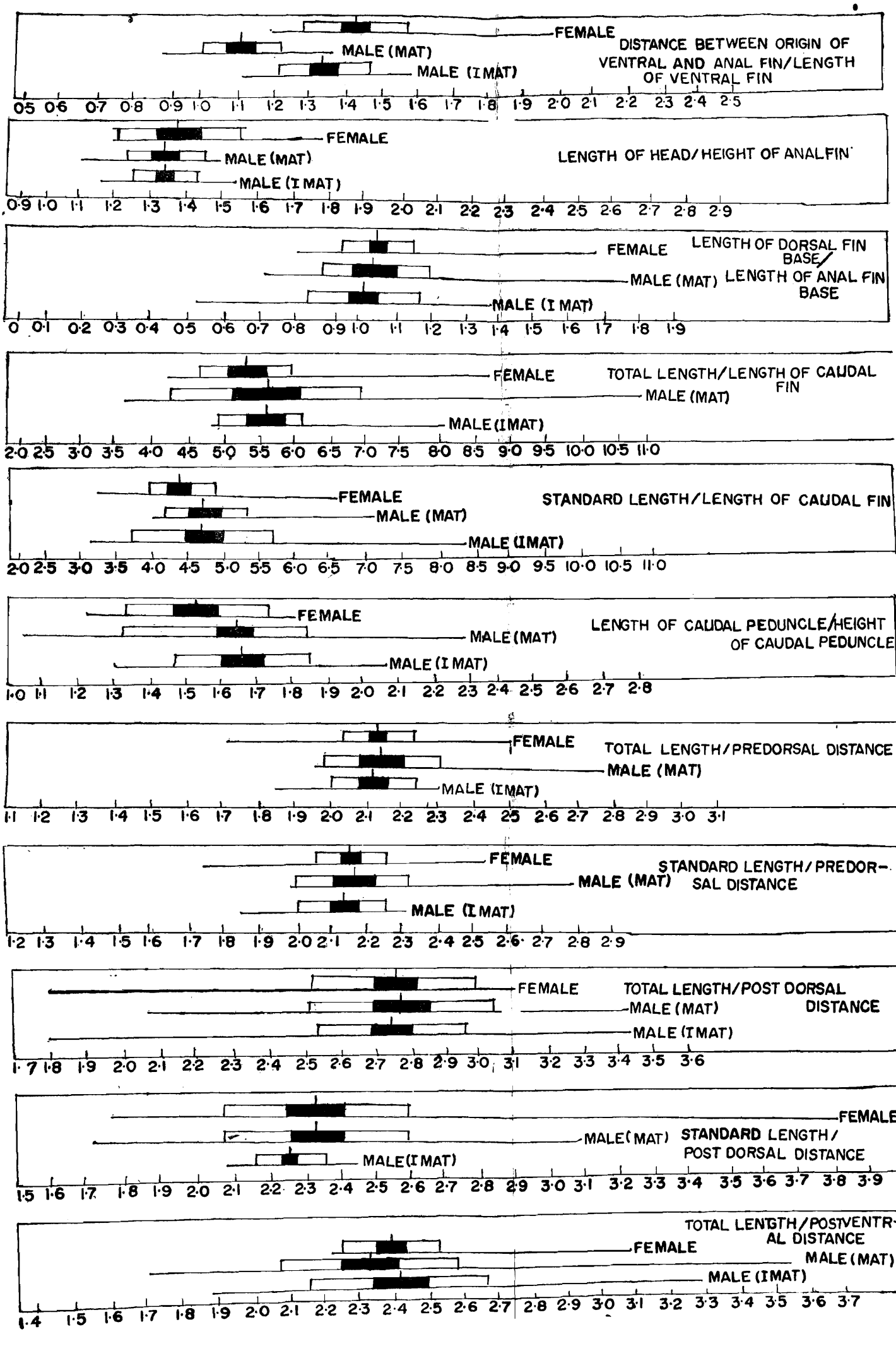
Text-fig. 5


FEMALE
MALE (MAT)
MALE (I MAT)
TOTAL LENGTH/DEPTH OF BODY
3·7 3·8 3·9 4·0 4·1 4·2 4·3 4·4 4·5 4·6 4·7 4·8 4·9 5·0 5·1 5·2 5·3 5·4 5·5 5·6 5·7
STANDARD LENGTH/DEPTH OF BODY
3·0 3·1 3·2 3·3 3·4 3·5 3·6 3·7 3·8 3·9 4·0 4·1 4·2 4·3 4·4 4·5 4·6 4·7 4·8 4·9 5·0
TOTAL LENGTH/WIDTH OF BODY
0 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0 13·5 14·6
STANDARD LENGTH/WIDTH OF BODY
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
LENGTH OF HEAD/HEIGHT AT ANAL FIN
0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4
LENGTH OF HEAD/LENGTH OF DORSAL FIN BASE
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9
LENGTH OF HEAD/ LENGTH OF PECTORAL FIN
0 0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0
DEPTH OF BODY/LENGTH OF CLEITHRUM
0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9
HEIGHT OF CLEITHRUM/WIDTH OF CLEITHRUM
2·0 2·5 3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0 13·5 14·0
DISTANCE BETWEEN ORIGIN OF PECTORAL AND VENTRAL FINS/ LENGTH OF PECTORAL FIN
0 0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5
LENGTH OF HEAD/LENGTH OF VENTRAL FIN
0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4

Text-fig. 6


STANDARD LENGTH/PRE VENTRAL DISTANCE
MALE (MAT)
MALE (MAT)
1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3
FEMALE
MALE (MAT)
MALE (IMAT)
TOTAL LENGTH/ POST VENTRAL DISTANCE
1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3 3·4
FEMALE
MALE (MAT)
MALE (I MAT)
STANDARD LENGTH/POST VENTRAL DISTANCE
1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1
FEMALE
MALE (MAT)
MALE (IMAT)
TOTAL LENGTH/PRE-ANAL DISTANCE
1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3
FEMALE
MALE (MAT)
MALE (IMAT)
STANDARD LENGTH/PRE-ANAL DISTANCE
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0
FEMALE
MALE(MAT)
MALE (IMAT)
TOTAL LENGTH/POST ANAL DISTANCE
3·1 3·2 3·3 3·4 3·5 3·6 3·7 3·8 3·9 4·0 4·1 4·2 4·3 4·4 4·5 4·6 4·7 4·8 4·9 5·0 5·1 5·2 5·3
FEMALE
MALE (MAT)
MALE (IMAT)
STANDARD LENGTH/POST ANAL DISTANCE
1·0 1·5 2·0 2·5 3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5
FEMALE
MALE (MAT)
MALE (IMAT)
TOTAL LENGTH/DISTANCE BETWEEN ORIGIN OF PECTORAL AND VENTRAL FINS
3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0
FEMALE
MALE (MAT)
MALE (IMAT)
STANDARD LENGTH/DISTANCEBETWEEN ORIGIN OF PECTORAL AND VENTRAL FINS
3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0
FEMALE
MALE (MAT)
MALE (I MAT)
TOTAL LENGTH/DISTANCEBETWEEN ORIGIN OF VENTRAL AND ANAL FIN
3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0
FEMALE
MALE (MAT)
MALE (IMAT)
STANDARD LENGTH DISTANCE BETWEEN ORIGIN OF VENTRAL AND ANAL FINS
3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0 11·5 12·0 12·5 13·0

Text-fig. 7


FEMALE
MALE (MAT)
MALE (I MAT)
DISTANCE BETWEEN ORIGIN OF VENTRAL AND ANAL FIN/LENGTH OF VENTRAL FIN
0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5
FEMALE
MALE (MAT)
MALE (I MAT)
LENGTH OF HEAD/HEIGHT OF ANALFIN
0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9
FEMALE
MALE (MAT)
MALE (I MAT)
LENGTH OF DORSAL FIN BASE/ LENGTH OF ANAL FIN BASE
0 0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9
FEMALE
MALE (MAT)
MALE (I MAT)
TOTAL LENGTH/LENGTH OF CAUDAL FIN
2·0 2·5 3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0
FEMALE
MALE (MAT)
MALE (I MAT)
STANDARD LENGTH/LENGTH OF CAUDAL FIN
2·0 2·5 3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5 8·0 8·5 9·0 9·5 10·0 10·5 11·0
FEMALE
MALE (MAT)
MALE (I MAT)
LENGTH OF CAUDAL PEDUNCLE/HEIGHT OF CAUDAL PEDUNCLE
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8
FEMALE
MALE (MAT)
MALE (I MAT)
TOTAL LENGTH/PREDORSAL DISTANCE
1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1
FEMALE
MALE (MAT)
MALE (I MAT)
STANDARD LENGTH/ PREDORSAL DISTANCE
1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9
FEMALE
MALE (MAT)
MALE (I MAT)
TOTAL LENGTH/POST DORSAL DISTANCE
1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3 3·4 3·5 3·6
FEMALE
MALE (MAT)
MALE (I MAT)
STANDARD LENGTH/ POST DORSAL DISTANCE
1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3 3·4 3·5 3·6 3·7 3·8 3·9
TOTAL LENGTH/POSTVENTRAL DISTANCE
FEMALE
MALE (MAT)
MALE (I MAT)
1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1 2·2 2·3 2·4 2·5 2·6 2·7 2·8 2·9 3·0 3·1 3·2 3·3 3·4 3·5 3·6 3·7

Text-fig. 8

(1936). Menon (1963) considered *B. bendelisis chedra* synonymous with *B. bendelisis* Hamilton with the view that with the growth of fish, the paired fins become much expanded and the characteristic muscular pads in front of the base develop ; he (Menon, 1974) included *cocsa*, *chedra* and *tila* under the synonymy of *Barilius bendelisis*. Tilak (1971) found the body scales in *chedra* type of specimens covered over with small tubercles arranged in two irregular rows which impart the fish a rough texture and the tuberculated snout, uniformly in both males and females. He (Tilak, 1971) however, felt that *chedra* and *cocsa* type of specimens might be independent in status but very recently Tilak and Jaffer (1982) studied the pectoral girdle and the fin of both male (*chedra*) and female (*cocsa*) specimens and found it to be correlated with the secondary sexual characters. In order to further strengthen this view, a long series of both *chedra* and *cocsa* type of specimens were dissected and studied in detail and it is established that *chedra* type of specimens are always mature males with thick cord-like paired testes and other external secondary sexual characters. The *cocsa* type of specimens are either females with immature to ripe ovaries or immature males with fine thread-like testes without the indication of any secondary sexual characters. The body proportions of all the three types of specimens of nearly similar total length (89-100 mm) were compared and were found overlapping within the range of the species (*B. bendelisis* Hamilton) except for the distance between the origin of pectoral and ventral fins. In *chedra* type specimens (=mature males), the distance between the origin of paired fins ranges between 5.47-6.62 and 4.55-5.38 times in total length and standard length respectively. In *cocsa* type specimens, it is between 4.54-5.35 and 3.72-4.71 times in immature males and 4.27-6.59 and 3.47-5.44 times in females.

## **Barilius bendelisis** Hamilton

(Text-figs. 1-2)

1807. *Cyprinus bendelisis* Hamilton, *Journey in Mysore*, 3 : 345, (Type-locality : Vedawati stream, head waters of the Kistna near Heriuru, Mysore).

1822. *Cyprinus* (*Barilius*) *bendelisis, cocsa, chedra* and *tila* Hamilton, *Fish. Ganges* : 270-274, 385, pl. 3, fig. 77.

1878. *Barilus bendelisis*, variety *cocsa* and *chedra* : Day, *Fish India* : 590-591, pl. CXLVIII, figs. 7-9.

*Diagnostic characters* :

B III. D II/7, P.I/14, V.I/8, A.II-III/7-8, C.18, Scales : L1, 40-45, Ltr. 7-8/5, rows of scales between lateral line and base of ventral fin 2.5-5.5, predorsal scales 20, Barbels 4 or 2. Pharyngeal teeth 5, 4, 2/2, 4, 5.

TABLE 1. Showing the differences between *Barilius bendelisis* and allied species described by Hamilton (1822).

| *Cyprinus* (*Barilius*) *bendelisis* Hamilton | *C.* (*Barilius*) *cocsa* Hamilton | *C.* (*Barilius*) *chedra* Hamilton | *C.* (*Barilius*) *tila* Hamilton |
|---|---|---|---|
| 1. $B_3$, $D_9$, $P_{13}$ $V_9$. $A_{11}$. $C_{19}$ | $B_3$, $D_9$, $P_{13}$, $V_9$, $A_{11}$, $C_{19}$. | $B_3$, $D_{10}$, $P_{14}$, $V_9$, $A_{11}$, $C_{18}$+ | $B_3$, $D_8$, $P_{14}$, $seu_{15}$, $V_9$, $A_{10}$, $C_{18}$+ |
| 2. Barbels 2. | Barbels 4 | Barbels absent | Barbels absent |
| 3. Incomplete bars on side | With incomplete bars on side and a spot on the middle of each scale. | With a spot on the bottom of each scale on the sides. | With a spot on the middle of each scale on sides. |
| 4. No scale-like appendage above the ventral fin. | Scale-like appendage above each ventral fin. | Scale-like appendage above each ventral fin. | Short scale-like appendage above each ventral fin. |
| 5. — | — | Scale rough on the surface with little blunt grains. | — |
| 6. — | Ventrals don't reach the vent. | Ventrals scarcely reach the vent. | Ventrals don't reach near the vent, |
| 7. Lower lobe of caudal the longest | — | — | Lower lobe of caudal the longest. |
| 8. Each gill-cover contains three plates. | — | — | Each gill-cover contains two plates. |
| 9. Head small, sharp | Head small and sharp. | Head moderate in size and blunt. | Head small and sharp. |
| 10. — | — | Many blunt tubercles on snout. | Both jaws rough with numerous crowded, sharp tubercles. |
| 11. — | Eye moderate. | Eye small | Eye moderate. |
| 12 — | Fins yellow, lower lobe of caudal stained with black. | Dorsal and pectorals dotted, the former brownish, the latter white like the ventrals. Anal and caudal fins reddish, the latter inclined to brown. | — |
| 13. Shaped somewhat like the head of a lance. | Shaped like the head of a lance. | Deeper in form | Form like the head of a lance. |
| 14. Bars descend almost to the lateral line. | A row of small oblong spots on each side of the lateral line. | Each spot diffused over a portion of more than one scale. | — |
| 15. Grows to four or five inches long. | Grows to about a span in length. | Grows to about six inches in length. | Grows to about a span in length. |
| 16. Found in the rivers of Mysore. | Found in the northern rivers of Bengal, Bihar especially in the Mahananda | Found in northern rivers of Bengal. | Found in northern rivers of Bengal. |

For morphometric characters, a reference may be made to tables 1-2.

Body elongated, moderately compressed. Abdomen rounded. Mouth terminal. Jaws compressed ; maxilla reaches to below the anterior 1/3 of eye. 3rd suborbital bone varies in depth in relationto the uncovered portion of the cheek below it. Pores on the snout and on lower jaw present. Barbels short, the rostral and maxillary, the former pair reduced or occasionally absent. Dorsal fin higher than the length of its base ; it commences nearer the base of the caudal fin than the tip of snout and does extend to over the anal fin and is inserted porteriorly to the ventrals. It is without osseous ray. Scales of moderate size. Lateral line complete, slightly concave, and runs in the lower half of the body. Body silvery with greyish back and 8-12 dark bands descending towards the lateral line becoming indistinct in older specimens. Lateral line scales with two black spots at the base. Cleithral bone silvery with black edge. Fins whitish, tinged with orange. Margin of dorsal and caudal greyish.

## Sexual Dimorphism

The *chedra* type specimens or the breeding males are comparatively much larger in size and stoutly built (Text-fig. 1). The paired fins are enlarged and fan-like especially the pectorals with the outer three rays thickened and extending slightly beyond the insertion of ventrals. The bases of pectorals and area in front of them are highly muscular and robust. The pectoral girdle, especially the cleithral bone, is comparatively well developed and enlarged. The ventrals extend to the anal opening. The dorsal and anal fins are also expanded. The tip of snout and its sides and lower jaw are provided with a thick layer of spiny tubercles. The outer branchiostegal rays are studded with a few spiny tubercles. The body is rough due to the presence of fine tubercles on the scales especially of the dorso-lateral sides of the body (Text-fig. 2). The vertical colour bands almost vanish and the margin of dorsal fin becomes dark edged. The females lack all these characters (Text-figs. 3, 4).

It is finally concluded that *Cyprinus chedra*, *C. cocsa*, *C. tila* are synonyms of *B. bendelisis* Hamilton.

In order to assess the authenticity of this decision, a statistical analysis of the morphometric characteristics of 150 examples of the three populations of this species, viz. mature females, functional males and non-functional males has been conducted following Dice and Leraas (1936), Hubbs and Perlmutter (1942), Hubbs and Hubbs

(1953), Rao (1952) and Bailey (1959). Forty five ratios between different morphometric characters of these populations have been utilized in this exercise.

A graphic representation, showing the variation in 45 different characters of the female, functional male and immature male, has been delineated in graphs (Text-figs. 5-8) on the lines of the improved graphical method of Hubbs and Hubbs (1953). For each character, the range (a horizontal line), the mean (small vertical line), standard deviation on each side of the mean (white part of rectangle) and two standard errors on each side of the mean (black part of the rectangle) have been drawn. Through a careful examination of the graphs (Text-figs. 5-8), the extent of overlap in each character in the three populations has been studied and analysed. In order to find out the probability of these populations belonging to the same species and to assess the quantum of inter-population difference, STUDENT'S 't'—test has been applied, using the following formula.

$$\text{'t'} = \frac{x^1 \sim x^2}{\sqrt{\frac{SD_1^2}{N_1} + \frac{SD_2^2}{N_2}}} = \frac{x^1 \sim x^2}{\sqrt{SE_1^2 + SE_2^2}}$$

$x_1$ = mean of first sample

$x_2$ = mean of second sample

$SD_1$ and $SD_2$ = Standard Deviation

$n_1$ and $n_2$ = number of each sample

SE1 and SE2 = Standard error

The 't' values have been worked out and shown in table 2. By analysing the data by way of Student's 't' test, it is possible to classify the characterictics under study here into a groups (A, B, C, Table 2). The significant and insignificant characteristics of the 't' values have been confirmed from the table given by Fisher & Yates (1970).

## CATEGORY A

It pertains to those characteristics in which the difference of mean is insignificant amongst all the three populations of the species. This confirms the ascertion that the three fishes studied belong to the same species as no significant difference exists between them.

## CATEGORY B

It pertains to those characteristics in which the difference of the mean is significant and they are contrary to those of group-A. This

TABLE 2 : SHOWING 't' VALUES

| Characters | Immature Male Vs Female | | Female Vs Mature male | | Mature male Vs ordinary male | |
|---|---|---|---|---|---|---|
| | 't' values | Significance | 't' values | Significance | 't' values | Significance |
| | | | CATEGORY A | | | |
| Total Length/head length | 0.4685 | Insignificant | 1.0932 | Insignificant. | 0.6247 | Insignificant |
| Standard length/head length | 0.4243 | ,, | 1.0607 | ,, | 0.6000 | ,, |
| Head length/width of head | 0.3162 | ,, | 1.5811 | ,, | 1.8974 | ,, |
| Head length/height of head | 0.3162 | ,, | 0.8321 | ,, | 0.8944 | ,, |
| Head length/length of snout | 1.1660 | ,, | 1.5000 | ,, | 0.8894 | ,, |
| Total length/width of body | 1.5108 | ,, | 0.9945 | ,, | 0.6549 | ,, |
| Standard length/width of body | 0.8479 | ,, | 1.8565 | ,, | 0.8536 | ,, |
| Head length/height of anal fin | 1.2649 | ,, | 1.1094 | ,, | 0.00005 | ,, |
| Length of dorsal fin base/ Length of anal fin base. | 1.7889 | ,, | 0.3162 | ,, | 0.8321 | ,, |
| Length of caudal peduncle/ height of caudal peduncle | 1.8856 | ,, | 0.8575 | ,, | 0.5145 | ,, |
| Total length/pre dorsal distance | 0.4472 | ,, | 0.3162 | ,, | 0.5547 | ,, |
| Total length/post dorsal distance | 0.2357 | ,, | 0.4000 | ,, | 0.6000 | ,, |
| Standard length/post dorsal distance | 0.3162 | ,, | 0.8479 | ,, | 0.9945 | ,, |
| Total length/preventral distance | 0.4851 | ,, | 1.3416 | ,, | 0.3536 | ,, |
| Standard length/preventral distance | 1.7889 | ,, | 0.8839 | ,, | 1.6977 | ,, |
| Total length/pre anal distance | 1.8974 | ,, | 1.2649 | ,, | 0.4714 | ,, |

TABLE 2. (*Continued*)

| Characters | Immature Male Vs Female | | Female Vs Mature male | | Mature male Vs ordinary male | |
|---|---|---|---|---|---|---|
| | 't' values | Significance | 't' values | Significance | 't' values | Significance |
| | | | CATEGORY B | | | |
| Width of head/inter orbital width | 5.2697 | Significant | 2.3570 | Significant | 2.4962 | Significant |
| Head length/diameter of eye | 4.7827 | ,, | 7.8032 | ,, | 4.5104 | ,, |
| Length of snout/diameter of eye | 3.7736 | ,, | 9.1981 | ,, | 5.4245 | ,, |
| Inter orbital width/diameter of eye | 3.6056 | ,, | 6.3454 | ,, | 4.4567 | ,, |
| Depth of body/length of cleithrum | 3.5355 | ,, | 6.9338 | ,, | 4.1603 | ,, |
| Distance between pectoral and Ventral fin/length of pectoral fin | 6.0104 | ,, | 11.6673 | ,, | 5.6569 | ,, |
| Head length/length of ventral fin | 2.4749 | ,, | 9.1924 | ,, | 6.7175 | ,, |
| Distance between ventral and anal fin/length of ventral fin | 3.1820 | ,, | 11.3137 | ,, | 8.1317 | ,, |
| Total length/post ventral distance | 5.6000 | ,, | 4.1602 | ,, | 2.9069 | ,, |
| Total length/post anal distance | 4.4653 | ,, | 10.4000 | ,, | 2.1001 | ,, |
| Total length/distance between ventral & anal fin | 9.6097 | ,, | 11.0072 | ,, | 5.6505 | ,, |
| Standard length/distance between ventral & anal fin | 2.7735 | ,, | 4.3732 | ,, | 2.8783 | ,, |
| Standard length/distance between pectoral and ventral fin | 4.9193 | ,, | 11.7917 | ,, | 6.4812 | ,, |

TABLE 2. (*Concluded*)

| Characters | Immature Male Vs Female | | Female Vs Mature male | | Mature male Vs ordinary male | |
|---|---|---|---|---|---|---|
| | 't' values | Significance | 't' values | Significance | 't' value | Significance |
| | | | CATEGORY C | | | |
| Head length/post orbital head length | 0.7071 | Insignificant | 1.3868 | Insignificant | 2.2188 | Significant |
| Total length/depth of body | 2.8169 | Significant | 2.2093 | Significant | 0.3254 | Insignificant |
| Standard lengt/depth of body | 3.2585 | „ | 2.8289 | „ | 0.1715 | Insignificant |
| Head length/length of dorsal fin base | 4.4590 | „ | 0.6860 | Insignificant | 5.6569 | Significant |
| Head length/length of pectoral fin | 2.2361 | „ | 1.7678 | „ | 0.00005 | Insignificant |
| Height of cleithrum/width of cleithrum | 0.2018 | Insignificant | 6.3228 | Significant | 6.4812 | Significant |
| Head length/height of anal fin | 1.7678 | „ | 2.2188 | „ | 0.8321 | Insignificant |
| Total length/length of anal fin | 2.0788 | Significant | 1.6144 | Insignificant | 0.8396 | „ |
| Standard length/length of anal fin | 2.2957 | „ | 2.7610 | Significant | 0.0947 | „ |
| Standard length/pre-dorsaldistance | 0.4961 | Insignificant | 0.40000 | Insignificant | 0.6000 | „ |
| Standard length/post ventral distance | 3.8829 | Significant | 1.4142 | „ | 2.7735 | Significant |
| Standard length/pre anal distance | 1.3416 | Insignificant | 2.6833 | Significant | 1.0607 | Insignificant |
| Standard length/post anal distance | 3.9043 | Significant | 6.0000 | „ | 0.8575 | „ |
| Total length/distance between pectoral and ventral fin | 1.5185 | Insignificant | 4.1602 | Significant | 2.7189 | Significant |
| Total length/length of skull | 3.1081 | Significant | 3.3995 | „ | 0.2357 | Insignificant |

indicates that the three populations belong to same species. These population groups are classified as the functional male, the non-functional male and the female.

## CATEGORY C

This category includes characteristics overlapping between the previous two groups i. e. category A and category B. This intends to prove that there are certain characteristics which are common to functional and nonfunctional males but not found in the female. Similarly, there are certain characters which are found in non-functional male and the female but not in functional male. Characters of group C provide an additional proof that these fishes are of the same species but belonging to different population groups.

*Distribution* : India, Pakistan, Nepal and Bangladesh.

## REMARKS

Hamilton (1822) described four different species, viz. *C. bendelisis*, *C. cocsa*, *C. chedra* and *C. tila* and in table I the important characters of these species, according to the author, are tabulated in order to find out whether the differences among these species shown by Hamilton (1822) are actually valid in the light of the present study. An analysis of some of the points of differences mentioned by Hamilton (1822) is given below :

Hamilton (1822) observed that there are two barbels in *C. bendelisis*, four in *C. cocsa*, and altogether absent in *C. chedra* and *C. tila*, but our observations reveal that there are four barbels in all the specimens and the population of this species is composed of funtional and non-functional or immature males and the females. Hamilton (1822) observed that the lower lobe of the caudal is longer in the case of *C. bendelisis* and *C. tila* but made no comment on this feature for *C. cocsa* and *C. chedra*. In this connection, the present study shows that the lobes of the caudal fin are either equal in length or the upper lobe of the caudal fin is slightly longer in the females and ordinary males. On the other hand, the lower lobe of the caudal fin is always longer in functional males. Hamilton (1822) observed that the gill-cover of the *C. bendelisis* contains three plates and that of *C. tila* two and made no comment in the case of *C. cocsa* and *C. chedra*. It is well known that the gill-cover in cyprinids is always composed of four plates.

Hamilton (1822) observed rough surface of the scales with little blunt grains and many blunt tubercles on the snout in *C. chedra* and

both jaws rough with numerous sharp tubercles in *C. tila*. In the present material of functional males (i. e. *chedra* type specimens) the scales, the snout and the lower jaw are densly covered with tubercles.

On the basis of the characters of the four allied species viz. *C. bendelisis*, *cocsa*, *chedra* and *tila* described by Hamilton (1822), it is difficult to differentiate them from each other. However, from the table I, drawn from the characters given by Hamilton (1822), it is clear that *C. bendelisis* and *C. cocsa* are more closely related with each other while on the other hand *C. chedra* and *C. tila* are allied forms. In both *chedra* and *tila*, the tuberculated snout is a common feature together with tuberculated scales (this character has not been mentioned by Hamilton (1822) in *C. tila*, *C. bendelisis* and *C. cocsa*. During the present study, a dissection of a long series of specimens revealed that the *chedra* and *tila* group belongs to breeding males and *bendelisis* and *cocsa* group to both females and immature males. The observation on barbels in these specimens by Hamilton (1822) appears to be faulty as they are very minute, rudimentary and one or even both the pairs may be absent. Day (1878) has mentioned that rostral pair is occasionally absent. The colouration of the body is very variable especially the lateral bands. In younger specimens, there may be 8-12 bars on the sides which fade away partially or completely with the growth of the fish irrespective of the sex. The base of each scale, especially those of the dorsolateral sides of the body, is provided with single black spot and that on the lateral line with two smaller spots due to the presence of the lateral line canal. The spots are prominent in older specimens.

The characters of *bendelisis*, *chedra*, *cocsa* and *tila*, described by Hamilton (1822), fall within the range of variation of single species and therefore, the species name *bendelisis* has been recognised according to the "Law of Priority" with *chedra*, *cocsa* and *tila* as its synonyms.

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SUMMARY

The systematic status of *Barilius bendelisis* Hamilton has been defined in this paper. Out of the texa described by Hamilton (1822), *Cypriuus chedra* and *C. tila* Hamilton have been found to be breeding males while *C. cocsa* Hamilton includes both immature or nonfunctional males and mature or immature females of *B. bendelisis* to which they are synonymous. A statistical analysis of the morphometric data of different populations of this species has been presented in support of the taxonomic conclusion.

A comparison of body ratios pertaining to 45 characters of males and females of almost the same total length and range of morphological variation among functional and nonfunctional or immature males and females has been given after studying a long series of specimens of *B. bendelisis*.

A comparison of the texa described by Hamilton (1822) indicates that they fall within the morphological range of *B. bendelisis* which exhibits a vivid sexual dimorphism.

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