

A STUDY OF VARIATIONS IN *BARBUS (PUNTIUS) TICTO* (HAMILTON).

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INTRODUCTION.

In studying several collections of freshwater fishes from India and Burma Hora found considerable variations in the specific characters usually relied upon for the determination of Hamilton's¹ *Cyprinus (Puntius) ticto*. Though he² recently made an attempt to give the diagnostic features of *Barbus (Puntius) stoliczkanus* Day, a form closely allied to *B. ticto*, a collection from Dalu, in the Upper Chindwin drainage, showed that those characters were not of much use in separating the two species. Moreover, the specimens of *B. ticto* from Peninsular India³ were found to exhibit gradations between the two forms, while Day's⁴ *B. punctatus* from South India appeared to be identical with the Burmese *B. stoliczkanus*.

We may here quote from a communication received from Dr. H. M. Smith to whom a named example of *B. stoliczkanus* from Sandoway,

¹ Hamilton, F., *Fish. Ganges*, pp. 314, 389, pl. viii, fig. 87 (1822).

² Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 330 (1937).

³ Hora, S. L. and Misra, K. S., *Journ. Bombay Nat. Hist. Soc.* XL, p. 28 (1938); Hora, S. L., *Rec. Ind. Mus.* XL, p. 240 (1938).

⁴ Day, F., *Proc. Zool. Soc. London*, p. 302 (1865).

Burma, was sent in exchange for comparison with his Siamese material. He wrote as follows :—

“ The receipt of the specimen of *Puntius stoliczkanus* from Lower Burma has permitted the identification as that species of numerous examples from Northern Siam (Mepin basin) and Western Siam (Salwin basin).”

Dr. Smith's statement brought to our mind the distribution of Hamilton's *Cyprinus cosuatus* (= *Oreichthys cosuatus*)¹ and it occurred to us that in *Barbus ticto* we have probably a species which is found over a wide area, and which exhibits certain morphological variations in different types of environments encountered in its wide range of distribution. To test this hypothesis a number of characters were tabulated in a large series of specimens from different parts of India and Burma. As a result of these studies it is now definitely established that Day's *stoliczkanus* and *punctatus* cannot be regarded as distinct species, but should be merged in the synonymy of *B. ticto*. Though in the tables (*vide infra*, pp. 274-279) measurements, scale counts, etc., of only a limited number of specimens are given, the actual material examined has been very considerable. Unfortunately, it has not been possible to examine any specimen of *B. ticto* from the Punjab and Sind, but all the same the results given below seem to be fairly conclusive.

HISTORICAL.

Cyprinus (Puntius) ticto was described by Hamilton (*op. cit.*) from “ the south-east parts of Bengal ” ; he referred to its strong resemblance with *Cyprinus (Puntius) sophore* and noted that it “ wants the golden mark on the gill-covers, and seldom is found above two inches long ”. Among the diagnostic features of the species he directed attention to “ one black spot on the lateral line above each pectoral fin, and another near the end of the tail ; and with the back fin spotted, and its second ray indented behind ” He further noted that “ in old individuals, the dorsal, anal, and ventral fins are slightly stained with red ; the dorsal is marked with two rows of dark spots ” The absence of barbels was noted and the lateral line was characterised as “ scarcely distinguishable ”

In his account of *Cyprinus (Puntius) titius* (p. 315), a species characterised by the possession of a smooth dorsal spine, Hamilton remarked as follows :—

“ In the north-east parts of Bengal I saw another fish called by the same name, and procured a drawing, now in the possession of the Bengal Government. It differed in a few particulars from the *Ticto*, but, the drawing being sufficient to point out the difference, I took no notes, and therefore, until I recover the drawings, I cannot give this fish a specific character, although I call it *Tictis*.”

Hamilton's original drawing of the form *tictis* was reproduced by Hora,² and a comparison of this figure with Hamilton's figure of *ticto* brings out the following points of differences :—

i. The Dorsal fin of *tictis* is better developed and more extensive ; the dorsal spine is longer than the head and very coarsely serrated internally. In *ticto* the dorsal spine is shorter than the head and finely serrated.

¹ Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 321 (1937).

² Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxiii, fig. 6 (1929).

ii. The anterior dark spot is much closer to the head in *tictis* than that of *ticto*. The gill-membrane and the area between operculum and preoperculum are stained with black in *ticto*, while this is not so in *tictis*. Moreover, the dorsal fin of *ticto* is marked with two rows of spots which are absent in *tictis*.

iii. The shape of the fins is somewhat different in the two forms.

iv. The body is proportionately deeper in *tictis* than in *ticto*.

The value of some of the characters tabulated above is discussed below (pp. 267-270) and it is surmised that the form *tictis* probably represents the males of *ticto*.

McClelland¹ referred Hamilton's *ticto* to his genus *Systemus* and gave the number of scales along the lateral line as 24 and "eight in depth from the base of the dorsal to the ventral on either side" McClelland states that "A variety of this species with two rows of dots on the dorsal is figured by Buchanan as *Cyp. bimaculatus*, but as it has two black spots on each side, it should rather have been named *quadrimaculatus*". McClelland seems to have confused the drawing of *tictis* with *ticto*, for the illustration of the latter species published by Hamilton himself shows two rows of spots on the dorsal fin. Moreover, *Cyprinus bimaculatus*, which was described by Hamilton in manuscript while stationed near Calcutta, has been shown to be *ticto* by Hora.²

Probably on account of the serrated nature of the dorsal spine, and the deep body, Sykes³ referred *Cyprinus ticto* to his genus *Rohtee*, but as *ticto* is provided with a short anal fin it cannot belong to that genus. Sykes found this species in the "Mota Mola river, at Poona" and noted that the fish is provided "with from 4 to 6 black spots on the body, made up of minute dots; one small spot above each pectoral fin, one larger one is situated on the tail, above the last anal ray, and one minute spot, sometimes wanting, near the base of the first dorsal ray" His examples were 1½ inches long and in them the lateral line was very obscure.

Jerdon⁴ included a large number of species of South Indian Minnows in the genus *Systemus*, but it is difficult to define their precise specific limits without a fresh collection of topotypes. Regarding *ticto* he observed that "This may be an *Opsarius*" However, he does not seem to have examined any specimen of the species. Day⁵ assigned *S. tripunctatus* Jerdon to the synonymy of *ticto*. The specimens of *S. tripunctatus* were obtained by Jerdon in a small stream near the coast in Canara and are noted to possess "2 black spots under end of dorsal, and another at base of tail" The colouration of the species is against its having any relationship with *ticto*.

In 1865, Day⁶ described a new Carp Minnow from Cochin as *Puntius punctatus* and characterized it by the possession of a serrated dorsal spine

¹ McClelland, J., *As. Res.* XIX, p. 382 (1839).

² Hora, S. L., *Journ. As. Soc. Bengal*, (N. S.) XXVII for 1931, p. 135 (1933).

³ Sykes, W. H., *Trans. Zool. Soc. London*, II, p. 365 (1841).

⁴ Jerdon, T. C., *Madras Journ. Lit. Sci.* XV, pp. 314-319 (1849).

⁵ Day, F., *Fish. India*, p. 576 (1877).

⁶ Day, F., *Proc. Zool. Soc. London*, p. 302 (1865).

and complete lateral line. He described the colouration of the species as follows :—

“ Olive-green above, gradually fading into silvery on the abdomen. A black diffused spot on the twentieth and twenty-first scales of the lateral line. The anterior half of the fourth scale from the operculum, of the row next below the lateral line, deep black, and also a portion of the scale above and beneath it. Fins yellowish. Dorsal and anal tipped with orange. Dorsal spotted with black, in two longitudinal rows, with a third in the front part between the other two. The dark markings are much more visible in the months when the freshes are coming down.”

The colouration of the dorsal fin is similar to that shown by Hamilton for his *Cyprinus tictis* (*vide supra*, p. 265) and, as the colours are stated to be better marked during the monsoon months, it would appear that *B. tictis* probably represents the male of *B. ticto*. As both the colouration and the extent of the lateral line are found to be variable characters in *B. ticto*, we have not found it possible to recognise *B. punctatus* as a distinct species. So far as we are aware this form has not been recorded again since Day's time. *Systomus conchoni* Jerdon¹ (*nec* Hamilton) appears to be a doubtful synonym of Day's *B. punctatus* (= *B. ticto*). It may be noted that *B. conchoni* has not yet been recorded from Peninsular India.

Günther² placed *ticto* in the genus *Barbus* and doubtfully assigned *Rohtee ticto* Sykes to its synonymy. He redescribed the species from 12 specimens, including 2 “ Adult : not in good state. Dekkan. From Colonel Sykes' Collection ”, and gave as its habitat Bengal, Assam and the Himalayas. In his description he pointed out that the osseous dorsal ray is of moderate strength and serrated, the lateral line is incomplete and the fish is provided with “ A small black spot on the commencement of the lateral line, another larger one on the lateral line, immediately behind the anal fin. Upper two-thirds of the dorsal fin black ”

In 1869, Day³ described *Barbus m'Clellandi* from Burma (Pegu and Moulmein) and noted that

“ This species bears a strong resemblance to the *B. ticto*, H. B., which it appears to supersede in Eastern Burma. But it is distinguished by a complete instead of incomplete lateral line, and its body is not so compressed ; its dorsal spine and colouring also differ”.

In his “ Monograph of the Indian Cyprinidae ”, he⁴ changed the name of the species to *Barbus (Puntius) stoliczkanus* and in the description the proportion of the head to the length of the fish gave as $\frac{1}{6}$ instead of $\frac{1}{5}$. In the *Fishes of India* the species is described and figured from Eastern Burma, but it is noted that “ Some Darjeeling examples agree with the Burmese fish ”

Since Day's time *B. stoliczkanus* has been recorded from Burma by Boulenger⁵ (S. Shan States), Chaudhuri⁶ (Putao Plains) and Hora⁷ (Sandoway). In the case of the specimens from Fort Stedman, Boulenger remarked that “ the anterior black spot is absent or indistinctly

¹ Jerdon, T. C., *Madras Journ. Lit. Sci.* XV, p. 317 (1849).

² Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 153 (1868).

³ Day, F., *Proc. Zool. Soc. London*, p. 620 (1869).

⁴ Day, F., *Journ. As. Soc. Bengal*, XL, p. 328 (1871).

⁵ Boulenger, G. A., *Ann. Mag. Nat. Hist.* (6) XII, p. 202 (1893).

⁶ Chaudhuri, B. L., *Rec. Ind. Mus.* XVI, p. 283 (1919).

⁷ Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 330 (1937).

indicated". Basing his observations on young specimens from Sandoway Hora relied on the number of predorsal scales in separating *ticto* from *stoliczkanus*. He found considerable variation in the extent of the lateral line. Though Day mainly relied on the extent of the lateral line in separating the two species, he¹ refers to a specimen of *ticto* from Calcutta with the "lateral-line distinct for 6 scales, indistinct for 10 more, when it ceases"². He further observed that in *B. ticto* "Cutch examples have 23 to 25 scales along the lateral-line, and one specimen had two blotches on either side of the base of the caudal fin. In Sind the dorsal spine is thin and very finely serrated. One Ganjam example had L. 1.27, as had also one from Bheer Bhoom. In Orissa they had as a rule L. 1.25, in the Wynaad L. 1.23" Hora and Misra³, and Hora⁴ found the lateral line in *B. ticto* extending over 10 to 12 scales; they also observed well-marked sexual dimorphism with regard to colouration; the specimens with coloured dorsal and anal fins were found to be males. Just before full maturity the dorsal fin of the male becomes marked with two or more rows of black spots till finally the entire fin assumes that colour. Annandale⁵ described melanic specimens of what he considered to be *B. ticto* from Rajsbahi District, Bengal, and compared them with the normal paler individuals collected from the same place at the same time. We have examined these specimens and find them to belong to *B. conchoniis* (Ham.); the two melanic individuals, about 81 mm. in length, are males, while the four paler individuals, about 68 to 76 mm. in length, are females.

Variation in the colouration of the Punjab examples are described by Fowler⁶ as follows :—

"Variation seen in the Himalayan examples, in black at tip of dorsal, ventral and anal, absent in 2 examples. Black blotch above anal usually present and only evident in young just behind shoulder. Smaller and young from Loodianali with shoulder-spot more conspicuous, also some with 2 oblique dark bars on dorsal. The largest examples from Kalla Weddee, with the tubes of lateral line on 6 to 8 scales. Ends of dorsal and anal, and all of ventrals, jet black, also scale-edges narrowly with vertical blackish margin, even to those along edge of preventral region".

In the above account we have referred to the variations observed in *B. ticto* by the previous writers, and in the following pages we propose to give a detailed account of the variations undergone by some of the salient diagnostic features of the species.

MORPHOLOGICAL.

Dorsal spine.—It is not possible to tabulate the variations observed in the nature of the dorsal spine, which, as a rule, is moderately strong and serrated, but in some individuals, especially from the hilly areas, it is feeble and the number of teeth along its posterior border is small.

¹ Day, F., *Fish. India*, p. 577 (1877).

² We have examined this specimen which is now preserved in the collection of the Indian Museum.

³ Hora, S. L. and Misra, K. S., *Journ. Bombay Nat. Hist. Soc.* XL, p. 28 (1938).

⁴ Hora, S. L., *Rec. Ind. Mus.* XL, p. 240 (1938).

⁵ Annandale, N., *Rec. Ind. Mus.* I, p. 81 (1907).

⁶ Fowler, H. W., *Proc. Acad. Nat. Sci. Philadelphia* LXXVI, p. 86 (1924).

In this connection attention may be invited to an interesting observation made by Day¹ regarding *Barbus conchonioides* (Ham.). He observed that—

“Nainee tal specimens have the dorsal spine much less coarsely serrated than those from the plains, from whence they were introduced not many years since; they have also a darkish band along the side.”

It is very difficult to assign any definite reason for the relative weakness of the spine in specimens from the hills, but it seems quite possible that in pools and puddles on the hills there is probably less competition for existence than in the case of the plain-dwelling forms, and in consequence the protective armature is more or less feebly developed. In this connection it may also be noted that in the Siluroid fishes of the plains, especially of the muddy waters, the dorsal and the pectoral spines are well developed, while the same structures are feebly developed in the hill-stream forms.

Lateral line.—With the exception of the 3 specimens from Sandoway in Lower Burma, 5 specimens from the Sittang river below Pegu, 6 specimens from Beeling near Pegu, one specimen from the Putao Plain and one specimen of *B. punctatus* from Madras, the lateral line is incomplete in all the other examples studied by us. In the majority of the specimens it ceases after 5-7 scales, but in some it extends up to the 21st scale. The extent of the lateral line very frequently varies even on two sides of the same fish. In quite a number of cases the lateral line is interrupted for a scale or two; and is usually faintly marked towards its termination.

From the information so far available it seems that the lateral line is usually complete in the Burmese examples (specimens of *B. stoliczkanus* reported so far: Day's 6 specimens from Pegu and 15 from Moulmein; Boulenger's ? specimens from S. Shan States; Chaudhuri's 1 specimen from Putao Plains and Hora's 3 specimens from Sandoway) and certain examples from South India (*Puntius punctatus* Day). In two specimens from Pagoda Twante the lateral line extends up to the 18th and the 21st scale respectively. In one specimen from Sandoway the lateral line extends over 17 scales and in another only up to the 5th scale on one side and the 7th scale on the other. In 3 specimens from Dalu, Myitkyina District (Upper Chindwin drainage), the lateral line extends up to the 7th scale and its extent sometimes varies on two sides of the same specimen.

From Dr. H. M. Smith's observations referred to above (p. 264), it seems likely that in the Siamese specimens of the species the lateral line is invariably complete.

From Assam we have examined specimens from the Naga Hills, Mangaldai, Shillong and Goalpara. The extent of the lateral line varies from the 6th to the 11th scale, and in some specimens it varies even on the two sides of the same specimen. In Bengal specimens the lateral line may extend up to 14 scales.

In the Bihar examples (Saran, Hazaribagh District and Chota Nagpur), the lateral line extends from the 6th to the 9th scale, while

¹ Day, F., *Fish. India*, p. 576 (1877).

in 2 specimens from Orissa the lateral line is present on 8 and 10 anterior scales respectively.

In specimens from the United Provinces (Naini Tal, Bhim Tal and Dehra Dun), the lateral line extends over 6 to 10 scales. Its extent frequently varies on two sides of the same fish. In the two Peshawar examples the lateral line ceases after the 6th scale. From the Central Provinces we have examined specimens from the Narbada river (Rewa State, Ramgarh, Mandla, etc.) and the Bastar State; the lateral line is generally more extensive and may be present on 12 anterior scales.

From Peninsular India we have examined large series of specimens from a number of localities. In specimens from Deolali and Poona (Western Ghats) the lateral line is considerably more extensive and is present on 9 to 16 scales. In one specimen from Poona the lateral line is continued after 2 interruptions up to the 21st scale. In the examples from the Eastern Ghats the lateral line, as a rule, is present on 7 to 8 scales, but in certain specimens it extends, with interruptions, up to the 14th scale. In the specimens from the Coorg and the Mysore States its extent varies from 6 to 8 scales, while, according to Deraniyagala¹, in the Ceylon specimens the lateral line may extend up to the 15th scale, though in a few specimens examined by us it was found to be present only on 7 scales.

Judging from the variations noted above in the extent of the lateral line it seems that this character is undergoing retrogression and that it cannot be employed for the separation of varieties or races. Though, as a rule, the lateral line is complete in the Burmese examples, a number of individuals have been found in which the lateral line is very short. Further, specimens with extended or complete lateral line have also been found in South India.

Number of Predorsal Scales.—Hora² attached great importance to the number of predorsal scale in separating the Burmese species *stoliczkanus* from the Indian form *ticto*, but a detailed study of the character has shown that specimens from India show considerable variation in this respect. The Burmese examples, however, do not exhibit much variation in the number of predorsal scales as in 14 out of 16 specimens the number of predorsal scales is 9, while in the remaining 2 specimens, one from Sandoway and one from Beeling, it is only 8. In specimens from India, the number varies from 9 to 12, though the common number is 11. The specimens from Shimoga and Coorg, however, form an exception as the usual number of predorsal scales in them is 9 or 10. According to Deraniyagala (*op. cit.*), there are only 8 or 9 predorsal scales in the Ceylonese examples. In this respect the South Indian and Ceylonese specimens show a distinct affinity to specimens from Burma.

Length of head.—In his *Fishes of India* Day gives the proportion of the length of the head to the total length as $\frac{1}{5}$ in *B. ticto* and $\frac{1}{6}$ in *B. stoliczkanus*. In the original description of the latter species, however, he³ gave it as $\frac{1}{5}$ and not $\frac{1}{6}$. Similar discrepancies are to be found in Day's

¹ Deraniyagala, P. E. P., *Ceylon Journ. Sci.* (B) XVI, p. 21 (1930).

² Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 330 (1937).

³ Day, F., *Proc. Zool. Soc. London*, p. 619 (1869); *vide* description of *Barbus mcClellandi*.

earlier and later descriptions of *Barbus (Puntius) punctatus*. In the specimens that we have examined the length of head is contained from 3·1 to 4·1 times in the length without the caudal, but in a majority of the specimens the proportion varies from 3·3 to 3·6. The length of the head varies considerably with the length or age of the specimens ; it is proportionately longer in smaller individuals than in the larger ones. In this respect we have not found much difference between the Burmese and Indian examples. Attention may, however, be directed to the fact that according to Deraniyagala the length of the head of the Ceylon examples is contained from 3 to 3·25 times in the standard length.

Depth of body.—The form of the body of a fish varies considerably according to whether it lives in swift currents, slow streams or stagnant waters (*vide* Hora¹). *Barbus ticto* is found in sluggish waters and pools of both hills and plains and the form of its body is, therefore, subject to considerable variation. In the specimens that we have examined it is contained from 2·3 to 3·0 times in the standard length, but in a majority of the individuals the proportion varies from 2·4 to 2·6. The specimens collected from clear waters of hill-streams are, as a rule, narrower and more graceful.

Colouration.—The colouration in fishes varies according to the age, sex and habitat of a fish and the variations in colour that we have noticed in the case of specimens of *B. ticto* from different localities can be readily explained. We have referred above (p. 267) to the melanic colouration of the males during the breeding season ; the extent of this secondary sexual feature is different in different individuals at various seasons of the year. A black mark at the commencement of the dorsal fin is present only in very young specimens, usually below one inch in length. It fades away in older individuals. The two characteristic lateral spots of the species are fairly well marked in young specimens up to about 1½ to 2 inches in length, but with growth the anterior spot gradually disappears. The anterior spot, when present, extends over 3rd and 4th scales of the lateral line. In some individuals it is somewhat oblong so that when its upper portion fades away, it is represented by a spot below the lateral line. The position of the posterior spot is somewhat variable, probably in accordance with the number of scales in the lateral line. As a rule it covers 2 to 3 scales (16th to 18th) but may extend over a few more of the posterior scales. Sometimes it is only present on the 18th and 19th scales and in very rare cases it extends to the 20th scale. In some large individuals the posterior spot may be faintly marked or totally absent.

As in the case of other freshwater fishes, the Burmese examples are, as a rule, more brilliantly coloured, and in this respect the South Indian specimens from Coorg and Shimoga show greater affinity to the Burmese than to the Indian examples.

GEOGRAPHICAL DISTRIBUTION.

Judging from the variations undergone by the characters discussed above, it seems that *Barbus ticto* is a very variable species and

¹ Hora, S. L., *Journ. As. Soc. Bengal*, Science I, pp. 1-7 (1935).

that *Cyprinus tictis* Ham., *Puntius punctatus* Day and *P. stoliczkanus* Day should be included in its synonymy. Its range of distribution is here extended from India to Burma and Siam. From the records of fresh-water fishes so far available it seems that *B. ticto* is perhaps not so common in Burma and Siam, as it is in India. Though the Burmese examples are, as a rule, characterised by the possession of a complete lateral line and 8 to 9 predorsal scales, these features cannot be regarded as specific owing to the wide range of variations undergone by examples from India by these characters.

We have referred above to the similarity between examples of *B. ticto* from Burma and South India, especially with regard to the extent of the lateral line, number of predorsal scales and colouration. In this connection it is of particular interest to establish the identity of *B. stoliczkanus* Day with *B. punctatus* Day. We give below measurements, scale counts, position of colour spots, etc., in a specimen of the latter species and when these are compared with similar measurements, etc., of Burmese examples on page 274 it will be noticed that there is practically no difference between the two sets of specimens. The occurrence of the same form of *B. ticto* in Burma and Peninsular India lends further support to the view expressed by one¹ of us in recent years that the fresh-water fish-fauna of India is derived from the eastern countries and that in the distribution of hill-stream forms the once extensive Satpura trend of mountain chains played a very important part.

Measurements in millimetres, scale counts, and position of colour spots of a specimen of Barbus (Puntius) punctatus Day.

Standard length	..	..	..	48.5
Depth of body	..	..	..	18.5
Length of head	..			12.5
Length of snout		..	..	2.0
Diameter of eye				4.5
Interorbital distance	..	..	.	5.3
No. of scales along lateral line	..	..	..	26
No. of perforated scales	..	..	..	26
No. of predorsal scales	..	..	..	9
No. of scales between L. l. and base of pelvic fin			..	3½
Position of anterior black spot	..	..		3
Position of posterior black spot	..		..	20-21

BARBUS (PUNTIUS) TICTO (HAM.) AND ALLIED SPECIES.

Both in literature and in the large named collection in the Indian Museum we have found great confusion regarding the precise specific limits that have been assigned to *Barbus ticto* and to several other closely allied forms. Day² included 11 species in his group of *Barbus* characterised by the total absence of barbels and by the possession of an osseous and serrated dorsal ray. These are, (i) *Barbus apogon* (Kuhl) C. and V ; (ii) *B. ambassis* Day ; (iii) *B. conchoni* (Ham.) ; (iv) *B. ticto* (Ham.) ; (v) *B. stoliczkanus* Day ; (vi) *B. punctatus* Day ; (vii) *B. gelius* (Ham.) ;

¹ Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 255 (1937).

² Day, F., *Fish. India*, pp. 575-579 (1877).

(viii) *B. phutunio* (Ham.); (ix) *B. cumingii* Günther; (x) *B. nigrofasciatus* Günther; and (xi) *B. guganio* (Ham.). Of these, the first two possess more than 35 scales along the lateral line and can thus be readily distinguished from the remaining species in which the number of lateral line scales is below 30. *B. guganio* is so insufficiently characterised that it is not possible to define its precise specific limits. *B. stoliczkanus* and *B. punctatus* have been shown above to be synonyms of *B. ticto*. The remaining six species, among which considerable confusion prevails, can be distinguished with the help of the table on page 273.

From a study of the table it would seem probable that this group of species may have evolved from a common parental stock and that the present-day differences between them in the form of the body, the number of scales, the extent of the lateral line and colouration are the result of some kind of habitual segregation or isolation of the various forms. As detailed data regarding the bionomics of the different species are not available, it is not possible for us at this stage to say much about the probable ancestry of these species.

SUMMARY.

Attention is directed to the great range of variations exhibited by Hamilton's *Cyprinus (Puntius) ticto* in the nature of its dorsal spine, the extent of its lateral line, the number of predorsal scales, proportions and colouration. These characters, which have been tabulated in a large series of specimens from different parts of India and Burma, show gradations between different types hitherto regarded as distinct species. It is thus shown that Day's *Barbus punctatus* from Peninsular India and *B. stoliczkanus* from Burma cannot be regarded as distinct species but should be treated as synonyms of *B. ticto*. In the historical review comments are made on the various forms that have been found to be identical with *B. ticto*. In discussing the geographical range of the species special attention is directed to the fact that the Burmese and Siamese examples (*stoliczkanus*-type) show greater affinity to specimens from Southern India (*punctatus*-type). At the end a table of comparison between *B. ticto* and five other allied species is given and it is surmised that they may have evolved from a common parental stock along slightly divergent lines.

TABLE I.—*BARBUS (PUNTIUS) TICTO* (HAM.) AND ALLIED SPECIES.

<i>Barbus ticto</i> (Ham.).	<i>Barbus conchoniuis</i> (Ham.).	<i>Barbus gelius</i> (Ham.).	<i>Barbus phutunio</i> (Ham.).	<i>Barbus comingii</i> (Günth.).	<i>Barbus nigrofasciatus</i> (Günth.).
1. Height of body 3 to 3½ in total length.	Height of body 2¾ in total length.	Height of body 3 to 3½ in total length.	Height of body 3 to 3½ in total length.	Height of body 3 in total length.	Height of body 2¾ in total length.
2. L.1. 22-26; complete or incomplete.	L.1. 24-28; incomplete, extending up to 18 scales.	L.1. 23-24; incomplete extending up to 5 or 6 scales.	L.1. 20-23; incomplete extending up to 3 or 4 scales.	L.1. 21; incomplete extending up to 4 scales.	L.1. 20-21; complete.
3. An anterior spot on 3rd or 4th scale (frequently absent). Posterior spot ranges between 16th to 20th scales.	Anterior spot absent posterior spot ranges between 17th to 20th scales.	A black band over tail somewhat anterior to base of caudal fin; another less distinct band behind base of that fin. A black spot passes across base of the anterior half of dorsal extending one-third the distance up the rays. A black band over the base of the anal which is highest in front.	A black band passing from the back to opposite the middle of pectoral fin; a second from the back to the posterior end of the base of anal, two other lighter bands pass downwards one from the anterior the other from the posterior extremity of dorsal. A black band down the centre of dorsal, another at base of caudal. In adults the pectoral band decreases in size whilst that on the dorsal fin breaks up into spots.	In colouration more or less similar to <i>B. phutunio</i> two dark vertical bands one descending to the pectoral, the second across the free portion of the tail.	A black band passing from eye to eye: body with 3 vertical bands, the first from the back to middle of pectoral fin; the second from base of dorsal to behind base of ventral, and the third across free portion of tail; dorsal, anterior portion of pelvics and outer edge of anal black.
4. Throughout India, Ceylon, Burma and Siam.	Assam, Lower Bengal, Orissa, Behar, N. W. F. Province, Punjab and Deccan (?).	Ganjam, Orissa, Bengal and Assam.	Ganjam, Orissa and through Bengal to Burma.	Ceylon	Southern Ceylon.

TABLE II.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM BURMA.*Measurements in millimetres, scale counts and position^a of colour spots.*

	Beeling, East of Pegu.				Sittang river below Pegu.				Tanja, N. E. Burma.	Sandoway.				Pagoda Twante.		Dalu, Upper Chindwin.		
Standard length	29.0	32.0	36.0	33.0	34.0	32.2	29.0	32.5	37.0	31.0	28.0	31.0	32.0	22.0	23.0	30.0	33.0	31.0
Depth of body	12.5	13.5	15.5	13.8	13.5	12.0	11.5	12.5	16.0	11.5	10.5	12.2	13.0	9.0	9.5	11.3	12.5	11.0
Length of head	7.5	8.0	10.0	8.0	9.5	9.0	9.0	9.0	10.5	8.0	7.3	8.0	8.0	6.0	7.0	8.5	9.0	9.0
Length of snout	1.5	2.0	2.0	1.5	2.0	2.0	1.8	2.0	2.0	2.0	2.0	2.0	2.5	1.5	2.0	2.0	2.0	2.0
Diameter of eye	3.5	3.5	4.0	3.5	4.0	3.5	3.5	3.5	4.0	2.6	2.6	2.5	3.0	2.7	3.0	3.5	3.5	3.5
Interorbital distance	3.4	3.0	4.0	3.0	4.0	3.4	3.5	3.4	4.0	3.8	3.8	3.5	4.0	2.7	3.0	4.0	4.0	4.0
No. of scales along lateral line	24	25	25	25	25	24	24	24	22	22	23	23	24	22	23	23	24	23
No. of perforated scales	24	25	25	25	24	24	24	24	22	22	23	7	24	18	21	6	7	7
No. of predorsal scales	9	9	9	10	9	9	8	9	9	9	9	8	9	9	9	9	9	9
Position of anterior black spot	3	3	3	3	4	3	3	4	..	4	3	4	4	3	4	abs.	abs.	abs.
Position of posterior black spot	18.19	18.19			18	18	18	18	..	17	17	17	18	17	18	20	20	20

TABLE III.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM ASSAM.*Measurements in millimetres, scale counts and position of colour spots.*

	Naga Hills.					Mangaldai, Garo Hills.			Shillong.				Goalpara.	
Standard length	29.0	24.0	23.5	29.0	20.0	34.0	33.0	26.0	43.0	42.5	27.0	30.0	26.0	22.0
Depth of body	10.0	9.0	9.0	10.0	7.8	14.0	14.0	10.0	15.0	16.0	10.0	10.0	10.0	8.0
Length of head	8.5	7.5	7.5	8.0	6.0	9.0	9.0	8.0	12.0	13.0	7.5	8.6	8.0	7.0
Length of snout	2.5	2.0	2.0	2.5	2.0	3.0	3.0	2.8	3.5	3.5	2.5	2.7	2.5	2.0
Diameter of eye	3.2	3.0	3.0	3.2	2.5	4.0	4.0	3.5	4.0	4.0	3.0	3.0	3.0	2.5
Interorbital distance	3.2	3.0	3.0	3.2	2.5	4.0	4.0	3.0	4.5	4.5	3.5	3.5	3.2	2.8
No. of scales along lateral line	22	22	23	22	23	23	23	23	22	22	22	22	26	27
No. of perforated scales	6	6	6	7	7	8	8	6	6	7	6	7	9	6
No. of predorsal scales	9	9	9	9	9	11	11	10	10	10	11	10	11	11
Position of anterior black spot	4	4	4	4	4	4	4	4	abs.	abs.	abs.	abs.	abs.	abs.
Position of posterior black spot	18	18	18	18	18	18	18	18	16	16	18	17	abs.	abs.

TABLE IV.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM BENGAL, BIHAR AND ORISSA.

Measurements in millimetres, scale counts and position of colour spots.

	BENGAL.										BIHAR.						ORISSA.		
	Darjeeling.			Ranigunge.							Hazaribagh.			Saran District.			Chota-Nagpur.	Orissa.	Puri.
Standard length	39.0	36.5	33.0	50.0	44.0	49.0	43.5	37.0	34.0	38.0	38.0	40.0	37.0	38.0	31.0	33.0	26.0	36.5	32.0
Depth of body	16.0	15.0	14.0	21.0	18.0	21.0	18.0	15.0	13.5	15.0	14.0	17.0	16.0	15.0	12.0	14.0	10.0	14.0	13.0
Length of head	11.5	10.5	9.7	13.0	12.5	13.0	12.0	11.0	9.5	11.0	11.0	11.0	10.5	10.5	9.5	9.0	8.0	10.0	9.0
Length of snout	3.0	3.0	2.1	3.2	3.0	3.1	3.0	2.5	2.5	2.9	2.8	3.0	2.9	3.0	2.7	2.8	2.5	3.2	3.0
Diameter of eye	4.0	4.2	4.0	5.5	5.0	5.3	4.8	4.5	3.5	4.0	4.0	4.0	4.0	4.0	3.4	3.5	3.0	4.0	4.0
Interorbital distance	4.2	4.2	4.0	5.5	5.3	5.4	5.0	4.5	3.5	4.5	4.3	4.4	4.0	4.0	3.4	3.5	3.2	4.0	4.0
No. of scales along lateral lines ..	25	26	23	25	25	24	24	22	22	23	23	24	26	25	24	25	24	25	25
No. of perforated scales. ..	12	6	12	13	14	9	9	7	6	7	8	7	8	8	7	9	6	10	8
No. of predorsal scales ..	11	10	10	11	10	10	10	9	9	11	11	11	11	11	9	11	9	10	11
Position of anterior black spot ..	4	3	4	abs.	abs.	abs.	abs.	abs.	abs.	3	4	abs.	4	3	abs.	4	abs.	4	3
Position of posterior black spot ..	19	18	16	abs.	abs.	abs.	abs.	abs.	abs.	17	17	18	19	18	18	18	18	19	17

TABLE V.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM UNITED PROVINCES, N.-W. F. PROVINCE AND CENTRAL PROVINCES.

Measurements in millimetres, scale counts and position of colour spots.

	UNITED PROVINCES.					N.-W. F. PROVINCE.		CENTRAL PROVINCES.									
	Naini Tal.		Dehra Dun.		Bhim Tal.			Peshawar.		Mandla.		Bastar State.				Rewa State.	
Standard length	29.5	41.5	44.0	43.0	40.0	33.0	36.5	24.0	26.0	41.0	51.0	56.0	35.0	49.0	41.5	39.0	
Depth of body	11.5	16.5	18.0	16.5	16.5	14.0	14.5	9.0	10.0	15.0	21.0	22.0	14.0	18.5	16.5	15.0	
Length of head	8.5	11.2	12.7	12.0	12.0	9.5	10.5	7.5	8.0	10.0	13.0	14.0	10.0	13.5	10.5	10.0	
Length of snout	2.5	3.0	4.0	2.9	3.0	2.5	2.5	2.0	2.5	2.5	3.5	4.0	2.6	3.5	3.3	3.1	
Diameter of eye	3.6	4.5	4.5	4.3	4.0	3.5	4.0	3.0	3.0	4.2	5.0	5.2	4.1	4.0	4.0	4.0	
Interorbital distance	3.8	5.0	5.0	5.0	5.0	3.5	4.5	3.0	3.2	4.5	5.3	6.0	4.5	4.2	4.1	4.0	
No. of scales along lateral line	26	23	23	24	23	24	25	23	23	23	22	23	24	22	22	22	
No. of perforated scales	8	9	10	6	8	6	6	8	9	9	11	10	12	7	7	7	
No. of predorsal scales	11	10	11	11	11	10	11	10	9	9	8	10	9	10	9	10	
Position of anterior black spot	abs.	abs.	abs.	abs.	abs.	4	abs.	abs.	abs.	3	4	3	3	4	4	4	
Position of posterior black spot	19	17	17	18	17	17	19	18	18	17	17	18	17	17	17	19	

TABLE VI.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM EASTERN AND WESTERN GHATS.*Measurements in millimetres, scale counts and position of colour spots.*

	EASTERN GHATS.								WESTERN GHATS.							
	Cuddapah District, Ganjam river near Kodur.			Nallamalai Hills 800 ft. Mahanadi river.					Deolali.				Poona.			
Standard length	32.0	37.0	33.0	42.0	34.0	32.0	48.5	46.0	41.0	39.0	31.5	52.0	45.0	46.0	51.0	
Depth of body	13.0	14.5	13.5	16.0	14.0	13.0	20.0	18.0	16.5	15.0	12.0	21.0	17.5	19.0	20.0	
Length of head	9.0	10.0	9.0	12.0	9.5	9.0	13.0	12.5	12.0	11.5	9.0	13.5	13.0	13.0	14.0	
Length of snout	2.6	3.0	2.9	3.2	3.0	2.9	3.4	4.0	3.5	3.0	2.8	3.5	3.3	3.3	3.5	
Diameter of eye	4.0	4.0	4.0	4.5	4.0	4.0	4.5	5.0	4.0	3.8	3.4	4.5	4.5	4.5	4.5	
Interorbital distance..	4.0	4.0	4.0	4.8	4.0	4.0	4.5	5.5	4.2	4.0	3.5	4.5	4.5	4.6	4.7	
No. of scales along lateral line ..	24	23	24	25	24	24	25	23	25	26	25	23	25	24	25	
No. of perforated scales	10	7	7	7	14	7	14	13	11	15	9	10	13	9	16	
No. of predorsal scales	11	11	10	10	10	11	11	11	11	10	9	9	10	10	10	
Position of anterior black spot ..	4	4	4	4	4	4	abs.	abs.	abs.	abs.	abs.	..	4	4	4	
Position of posterior black spot ..	19	18	18	19	18	19	19	17	17	19	18	18	19	18	18	

TABLE VII.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM SOUTH INDIA AND CEYLON.*Measurements in millimetres, scale counts and position of colour spots.*

	SOUTH INDIA.				CEYLON.	
	Shimoga.			Coorg State.		
Standard length ..	30.0	26.0	21.0	27.5	35.0	22.5
Depth of body ..	11.5	10.0	8.0	10.0	13.0	8.5
Length of head ..	9.0	8.0	6.5	8.0	10.5	7.0
Length of snout ..	2.0	2.0	1.9	2.0	2.0	1.5
Diameter of eye ..	4.0	3.0	2.5	3.0	3.8	2.6
Interorbital distance ..	4.0	3.0	2.5	3.0	3.8	2.6
No. of scales along lateral line.	23	23	23	23	22	22
No. of perforated scales ..	8	6	6	7	7	7
No. of predorsal scales ..	9	9	10	10	9	10
Position of anterior black spot.	4	4	4	4	3	4
Position of posterior black spot.	18	17	17	17	17	18