Additional notes on bariliine cyprinid fishes

Gordon Howes

Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD

This addendum serves to correct and amplify statements and observations published in an earlier study on the anatomy, phylogeny and classification of bariliine cyprinid fishes (Howes, 1980).

The generic status of *Barilius lujae* Boulenger, 1909

In the synoptic account of *Barilius* species given in Howes (1980), *Barilius lujae* Blgr, 1909 was omitted. Examination of syntypes (BMNH 1908.11.26 : 8; 1909.4.26 : 18), together with a series of more recently collected specimens (BMNH 1975.6.20 : 429–438; 1976.6.20 : 407–413, including alizarin preparations), makes it clear that the species *lujae* should be assigned to the genus *Leptocypris*.

Synapomorphies characterising *Leptocypris* (modified from Howes, 1980) are: shallow lower jaw; truncated lateral ethmoid; absence of, or reduced *intermandibularis* muscle; absence of, or few gill-rakers; elongated pectoral and pelvic axial scales, and overlap of the antero-dorsal portion of the 2nd infraorbital by the posterior border of the 1st. The species *lujae* has all these characters and, in addition, a type of ethmoid architecture which supports the hypothesis that *Leptocypris* and *Engraulicypris* are closely related genera (Howes, 1980 : 182).

In *Leptocypris lujae* the medial ethmoid notch is horseshoe-shaped as in *Engraulicypris sardella* (cf. Fig. 1 here with fig. 9 in Howes, 1980). In *Engraulicypris* the ethmoid indentation coincides with a foramen in the underlying vomer, whereas in *L. lujae* the indentation is floored partly by the ethmoid cartilage and partly by the vomer.

Compared with other species of *Leptocypris, L. lujae* is longer-jawed, the posterior tip of the maxilla extending to, or beyond, the posterior rim of the orbit; there is also a lower jaw symphysial process. As in *L. niloticus* and *L. weynsii, L. lujae* has a non-papillate maxillary valve. There is some variability in the length of the pelvic axial scale, it varies between 42%–50% of the pelvic fin length. However, this appears to be positively correlated with the length of the fish and it is noted that in *L. niloticus* the pelvic scale is not developed to its maximum length (25% of the pelvic fin length) until the fish is over 35 mm SL.

In the length of the jaws and the morphology of the ethmoid region, *L. lujae* appears to be the most derived species. The species of *Leptocypris* may be identified by the following key:

1. Gill-rakers on first ceratobranchial absent; branched anal fin rays 8–9 . . . *L. modestus*
   Gillrakers on first ceratobranchial 2–3; branched anal fin rays 11–15 2
2. Branched anal fin rays 11–12 . . . . *L. niloticus*
   Branched anal fin rays 14–15 3
3. Posterior tip of maxilla extending to centre of eye; lateral line scales 44–45 . . . *L. weynsii*
   Posterior tip of maxilla extending to, or beyond posterior border of the eye; lateral line scales 38–40 . . . . *L. lujae*

Attention is drawn to '*Barilius*' *guineensis* Daget, 1962, which appears, from its gross morphology, to belong to *Leptocypris* (see Howes, 1980 : 191). It differs from other species, however, in (according to Daget, 1962) having a total of 8 gill-rakers on the first arch.
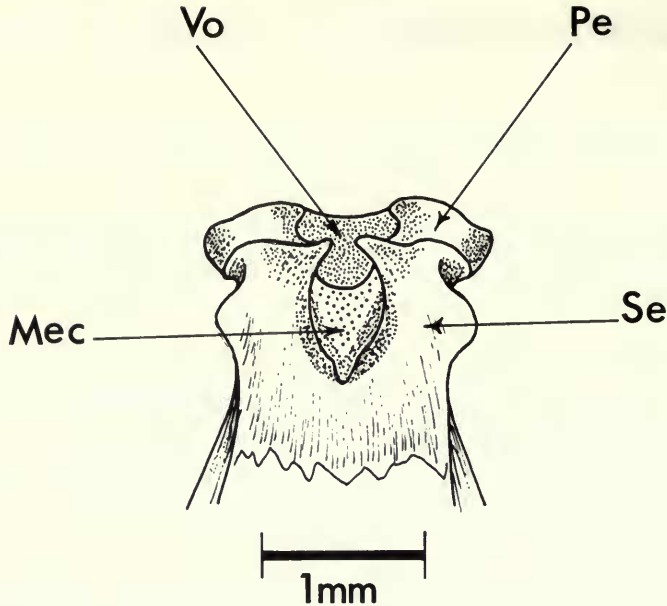
Bull. Br. Mus. nat. Hist. (Zool.) **45** (2): 95–101   Issued 28 July 1983

95

Fig. 1 *Leptocypris lujae*; dorsal view of ethmovomerine region of the neurocranium. Mec = mesethmoid cartilage, Pe = preethmoid, Se = supraethmoid, Vo = vomer.

Comments on south-east Asian *Barilius* species

When offering a revised concept of *Barilius* (Howes, 1980), based on the type species of the genus *B. barila,* few of the south-east Asian species had been examined and their generic attribution remained doubtful. Of those species in this category (Howes, 1980 : 190) the following have now been examined: *B. bernatziki* Koumans, 1937 (Holotype, Basle Museum, NHMB 5155, 77 mm SL); *B. huahinensis* Fowler, 1934 (USNM 103104, 52 & 66 mm SL); *B. infrafasciatus* Fowler, 1934 (USNM 107910, 65–75 mm SL); *B. koratensis* Smith, 1931 (Holotype, USMN 90298 47·3 mm SL); *B. nanensis* Smith, 1945 (Paratypes USNM 107939, 107940, 119474–119476, 53–64 mm SL); *B. pulchellus* Smith, 1931 (Paratypes USNM 90299, 51 & 53 mm SL; USNM 107967, 39·5–69·5 mm SL).

Osteologically and meristically, these species are intermediate between the generic subgroups (i) and (ii) previously postulated (Howes, 1980 : 180), possessing characters of both groups. This suggests that those characters used in defining the two groups are a mixture of plesio- and apomorphies.

In the south-east Asian species, and noticeably in *B. pulchellus,* the ethmoid bloc is somewhat flattened with the vomer extending anteriorly to the mesethmoid. The lateral edges of the supraethmoid are slightly raised to produce a shallow channel. The maxilla has a tall mid-lateral (palatine) ascending process and the palatine is broad anteriorly, slightly overlapping the maxilla and supporting the base of the anterior barbel. Rows of tubercles appear on the lower jaw and infraorbitals. These characters are shared with the Indian species, *B. gatensis* and *B. bendelisis,* and those species referred to group (ii) by Howes (1980 : 190). The morphology of the ethmo-vomerine region, lateral extension of the palatine, and the pattern of tubercle development on the lower jaw appear synapomorphic for this group of species. As such, the concept of *Barilius* presented previously (Howes, 1980) is shown to be a paraphyletic one; see below, p. 99.

The taxonomy of the south-east Asian species is in an unsatisfactory state. Smith (1945) separates *B. nanensis* and *B. huahinensis* on the differences in lateral line scale counts, dorsal fin position, and length of the anterior (rostral) barbel. However, there appears to be

variability and overlap in all these characters, although the differences in body markings between the two species quoted by Smith (1945 : 156–157) are consistent. In *B. nanensis* there are 7–8 gill-rakers on the 1st ceratobranchial cf. 9–10 in *B. huahinensis.*

Barilius pulchellus Smith, 1931 is a distinctive species characterised by a large pectoral axial fin lobe, 3–6 minute, spiny gill-rakers on the 1st ceratobranchial, and a black dorsal fin membrane. Specimens identified as *B. infrafasciatus* Fowler, 1934 (type not seen) are similar in virtually every respect to *B. pulchellus* apart from the length of the pelvic axial scale which is 50% of the pelvic fin length cf. 25% in *B. pulchellus.*

Smith (1931) described *Barilius koratensis* as without barbels. My examination of the unique holotype reveals both anterior and posterior barbels. Smith described only two vertical bars, above the pectoral and below the dorsal fin, but there is also a dark patch above the last ray of the anal fin. In other meristic and morphometric characters *B. koratensis* resembles *B. nanensis*; these taxa may well be only representatives of different populations of one species.

Barilius bernatziki Koumans, 1937 has 30–31 lateral line scales, the least number of all the south-east Asian species. In its markings (7 dark vertical bands and basal caudal spot), large pectoral axial lobe, and narrow cranium, *B. bernatziki* most closely resembles the Indian species, *B. gatensis.*

The phyletic position of *Zacco*

Zacco was excluded from the bariliine group by Howes (1980) on the grounds that it lacked a posttemporal–subtemporal connection. Fink & Fink (1981) claim this feature is present, and an examination of additional material leads me to agree with them. If *Zacco* is included within the bariliine assemblage, characters which were previously regarded as examples of homoplasy (peculiar morphology of the anal fin, ventral prolongation of the caudal peduncle and colour pattern), must now be viewed as synapomorphies.

Zacco must be regarded as the sister taxon to *Opsariichthys* and because of its less derived cranial architecture and relatively unmodified lower jaw, it is the plesiomorph partner. Inclusion of *Zacco* within the bariliine group does not alter the group's distribution mapped in Howes (1980, fig. 47).

Monophyly of the bariliine group

According to Fink & Fink (1981) a number of characters used by Howes (1980) to define the bariliine group are plesiomorphic. Of these they list the ventrally open posterior myodome; trigeminal foramen entirely within the prootic; lateral hyomandibular flange; frontal fossa; lateral temporal foramen, and the metapterygoid postero-dorsal process. They also believe that fusion of the 2nd and 3rd centra, only present in some bariliines, may be synapomorphic for those taxa and other Cyprinidae.

Posterior myodome. Whilst it is recognised that a ventrally open posterior myodome often occurs in what are regarded as plesiomorphic teleosts (Patterson, 1975) it does not follow that the feature is itself plesiomorphic. Amongst otophysans, the posterior myodome in characoids is developed to various degrees. In some taxa currently recognised as mono-phyletic groups (Alestinae) there are some species with an open and others with a closed myodome. Also, in those taxa usually regarded as plesiomorphic (e.g. *Hepsetus*) the myodome is closed, whereas in those considered derived (Serrasalmidae) it is open. Ontogenetic evidence for polarity is contradictory; in a cyprinid investigated the myodome closes during ontogeny (*Opsariichthys*; see Howes, 1980), whereas in salmonids it opens (Verraes, 1974). Functionally, an open myodome serves to extend the length of the posterior eye muscles which then originate either from the rim of the basioccipital or from the anterior vertebrae. From its mosaic distribution and varying morphology, it is more parsimonious to

suppose that an open posterior myodome has developed independently in several lineages, and as such is an unreliable indicator of relationship.

Hyomandibular flange, frontal fossa and *temporal foramen.* For the most part the same argument may be applied to these features as to the posterior myodome, namely, mosaic distribution through independent derivation, and thus I agree with Fink & Fink (1981) in disregarding them. However, some mention must be made of the lateral temporal foramen. Wu, Chen, Chen & Chen (1981) considered that the lateral temporal fossa in the Cobitidae and Gyrinocheilidae, and the supratemporal fossa in Catostomidae are homologues of the post-temporal fossa in other cyprinoids. This certainly appears to be so, as in all cases the fossa is bounded by the epioccipital, pterotic and, usually, the parietal. The lateral temporal foramen described in *Opsaridium* (Howes, 1980) is not to be confused with the above as it occurs between the pterotic and sphenotic and is thus homologous with that aperture in some characoids (e.g. *Salminus*).

Metapterygoid process. Although a metapterygoid dorso-posterior process occurs in other otophysans, it differs markedly from the condition considered derived for some bariliine taxa (Howes, 1980). In *Raiamas* the process is directed anterodorsally at an angle of 45° and is the same length as the upper part of the hyomandibula. Furthermore, the process has a gutter along its posterior border into which the *levator arcus palatini* muscle inserts. In other bariliines the process is not so well developed, but in *Engraulicypris* and *Leptocypris* it is tall and lamellate, occupying a mid-dorsal position on the metapterygoid. In these taxa it also serves to support the LAP muscle. Whilst it is accepted that a metapterygoid process is a common otophysan feature, in none does it possess the morphology of the process in bariliines, nor does it provide the site of attachment of almost the entire LAP muscle.

Vertebral fusion. Fink & Fink's (1981) claim that all other members of the bariliine group are '. . . more specialised than *Opsariichthys* in having the second and third centra fused' must be treated with caution.

Fusion of centra 2 and 3 is a variable character throughout the Cyprinidae. There may be only partial (dorsal) fusion, as in *Zacco* and *Engraulicypris* (Howes, 1980) and *Pseudolaubuca* (Howes, 1978). Monophyletic groups contain taxa exhibiting both fused and unfused centra (e.g. aspinines and squaliobarbines) and in such cases it is not always the more derived members of the groups which display the fusion pattern. Thus, vertebral fusion must be regarded as having been derived independently in several lineages. Supporting Fink & Fink's argument for the derived nature of vertebral fusion simply leads to an unresolved reticulate pattern of relationships (Fig. 2).

Interrelationships of bariliines

Disregarding the posterior open myodome and those characters considered by Fink & Fink (1981) as plesiomorphic, the bariliine group can be defined on only a single synapomorphy, *ie* a connection between the posttemporal and subtemporal fossae. That this character has now been found in *Salmostoma* (placed in the *cheline group* by Howes, 1979) revises the concept of the bariliine group.

Accepting the fossae connection as synapomorphic, then two lineages can be recognised, (1) those species with elongate pectoral and pelvic axial scales, long and expanded processes of the 1st vertebrae, with development of a condylar joint with the basioccipital, and a modified ethmo-vomerine region (see caption to Fig. 3), and (2) those with the pectoral and pelvic axial scales lobate or fleshy, the rostral barbel attached to the lateral border of the palatine, parallel rows of tubercles on the lower jaw, and distinctive body and fin patterning.

Lineage (1) includes *Barilius barila, B. evezardi, B. modestus* and *B. vagra, Salmostoma, Engraulicypris, Raiamas* and *Leptocypris. Salmostoma* was regarded by Howes (1979) as the plesiomorph sister group of 'cheline' genera. The 'chelines' share with *Barilius* and *Salmostoma* the derived form of anterior vertebrae and ethmovomerine region, but lack the
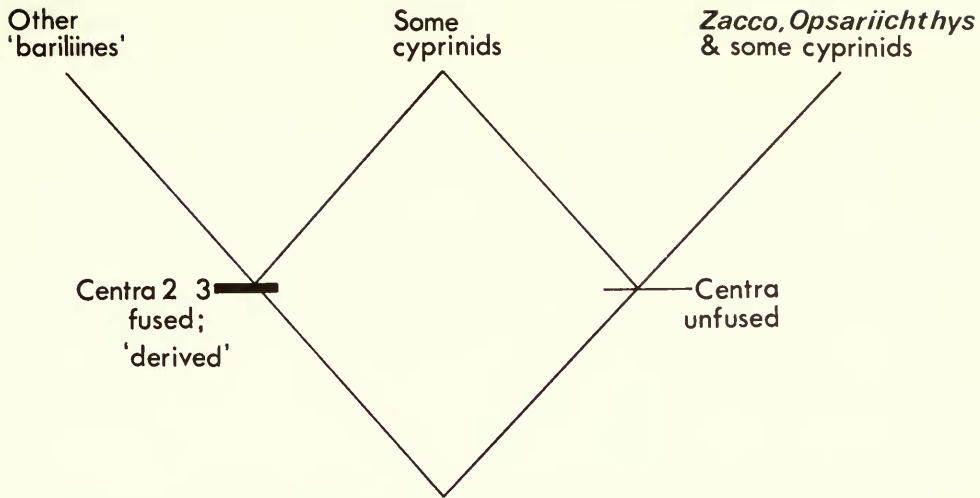
Other
'bariliines'
Some
cyprinids
Zacco, Opsariichthys
& some cyprinids

Centra 2 3▬
fused;
'derived'
Centra
unfused

Fig. 2   A cladogram of cyprinid relationships based on the pattern of vertebral fusion proposed by
Fink & Fink (1981); see text.

posttemporal-subtemporal connection. *Salmostoma,* however, shares with all other chelines
a deep, posteriorly sloped neural complex. Only one 'cheline' genus, *Securicula* shares the
elongate pectoral and pelvic axial scales with *Salmostoma* and *Barilius.* In the absence of
synapomorphies linking the 'cheline' genera with any other cyprinid taxon, the absence of
these features is considered as a phylogenetic loss. Current observations indicate that the
genera *Rastrineobola, Neobola* and *Chelaethiops* also belong to this lineage, and work in
progress attempts to define more precisely the relationships of these three genera.

Lineage (2) contains the remaining *Barilius* species—recognised as group (ii) by Howes
(1980 : 180)—together with *Opsaridium, Opsariichthys* and *Zacco,* plus the luciosomine
genera (*sensu* Howes, 1980).

In summary, it would seem that the bariliine and cheline groups (*sensu* Howes, 1979;
1980) are paraphyletic assemblages; a revised hypothesis of the interrelationships of the
relevant taxa is presented in Fig. 3.

The dates of *Opsaridium* Peters and *Rastrineobola* Fowler

Jordan (1919) mistakenly gives the publication date of *Opsaridium* Peters as 1855.
Howes (1980) followed this error. The correct date is 1853 (see citation in references). The
specific name is correctly *zambezensis.*

The publication date of *Rastrineobola* Fowler is 1936, not 1934 as misprinted in Howes
(1980 : 195).

Bengala Gray, 1832, a senior synonym of *Megarasbora* Günther, 1868

Günther (1868) established the genus *Megarasbora* to contain *Cyprinus elanga* Hamilton,
1822. *Megarasbora* was recognised by Brittan (1954) and Howes (1980) in their respective
revisions and reviews of rasborine cyprinids. However, all three authors had overlooked the
fact that Gray (1832) had already established the genus *Bengala* for Hamilton's species.
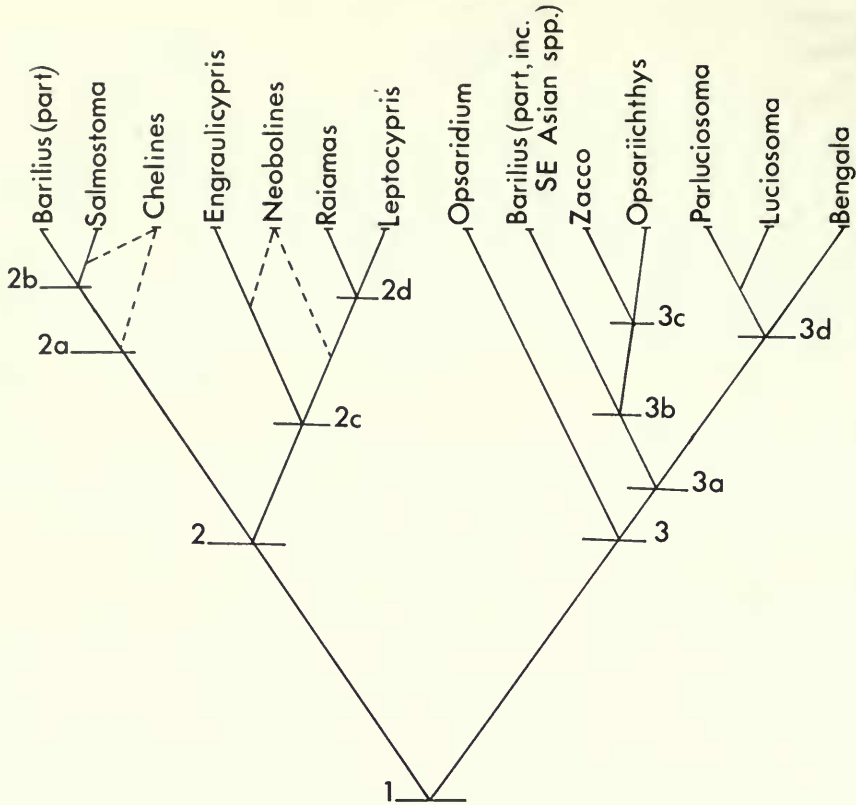Jordan (1919) recorded *Megarasbora* as a junior synonym of *Bengala.*

Fig. 3 Revised cladogram of 'bariliine' and 'cheline' relationships (dashed lines indicate uncertain affinities). 1, posttemporal–subtemporal fossa connection; 2, pectoral and pelvic axial scales elongate (lost in 'chelines' and *Engraulicypris*); 2a, 1st vertebra with expanded lateral processes; 2b, omega-shaped ethmoid notch, vomerine arms extending straight forward; 2c, reduction of dilatator fossa, derived condition of jaw adductor muscles; 2d, loss of *intermandibularis* muscle, jaw elongation, hypertrophy of metapterygoid spine; 3, pectoral and pelvic axial scales lobate or fleshy; 3a, palatine extended laterally, supports rostral barbel (when present); 3b, parallel rows of tubercles on dentary; 3c, dentary with anterior notch, sexual dimorphism exhibited by extension and expansion of anal fin rays in males; 3d, bowl-shaped depression in supraethmoid. Characters described in Howes (1980), except 2b and 2c, taken from work in preparation.

Acknowledgements

References

Brittan, M. R. 1954. *A revision of the Indo–Malayan fresh-water fish genus Rasbora.* Institute of Science & Technology, Manila. 224 pp.

Daget, J. 1962. Les poissons du Fouta Dialon et de las basse Guinée. *Mem. Inst. fr. Afr. noire* **65**: 1–210.

Fink, S. V. & Fink, W. L. 1981. Interrelationships of the ostariophysan fishes (Teleostei). *Zool. J. Linn. Soc.* **72** (4): 297–353.

Gray, J. E. 1832. *Illustrations of Indian Zoology*. Part 2, pl. 96. London

Günther, A. 1868. *Catalogue of fishes in the British Museum* **7**: 1–512.

Howes, G. J. 1978. The anatomy and relationships of the cyprinid fish *Luciobrama macrocephalus* (Lacèpede). *Bull. Br. Mus. nat. Hist.* (Zool.) **34**: 1–64.

—— 1979. Notes on the anatomy of the cyprinid fish *Macrochirichthys macrochirus* with a review of the subfamily Cultrinae. *Bull. Br. Mus. nat. Hist.* (Zool.) **36** (3): 147–200.

—— 1980. The anatomy, phylogeny and classification of bariliine cyprinid fishes. *Bull. Br. Mus. nat. Hist.* (Zool.) **37** (3): 129–198.

Jordan, D. S. 1919. *The genera of fishes* Part 3. Leland Stanford Junior Univ. Pubs. University Series: 285–410 + i–xv.

Peters, W. C. H. 1853. Uebersicht der in Mossambique beobachteten Seefische. *Monats. Ber. Acad. Berlin*: 783.

Smith, H. W. 1945. The fresh-water fishes of Siam, or Thailand. *Bull. U.S. natn. Mus.* **188**: 1–622.

Verraes, W. 1974. Discussion on some functional–morphological relations between some parts of the chondrocramium and the osteocranium in the skull base and the skull roof, and of some soft head parts during postembryonic development of Salmo gairdneri Richardson 1836 (Teleostei: Salmonidae). *Forma Functio* **7**: 281–292.

Wu, X., Chen, Y., Chen, X. & Chen, J. 1981. A taxonomical system and phylogenetic relationship of the families of the suborder Cyprinoidei (Pisces). *Scientia Sinica* **24** (4): 563–572.