

New species of *Aborichthys* (Cypriniformes: Balitoridae) from Arunachal Pradesh, India

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ABSTRACT

The genus *Aborichthys* was described in 1913 from specimens in streams/rivers of Abor hills area of northeastern India during the Abor expedition 43. The type species was described as *Aborichthys kempi*. Since that time, three additional species have been added to the genus from northeastern India. These include *A. garoensis* from Darjiling, *A. elongatus* from Assam, and *A. tikaderi* from Arunachal Pradesh. Recently, our expeditions in Arunachal Pradesh have yielded many specimens of *Aborichthys* from the lower and upper Subanshri district that represents two additional new species to the genus. Herein, we describe *Aborichthys cataracta* and *Aborichthys verticauda* from this region and provide a taxonomic key for the genus based on the examination of all species known from India.

Key Words: Cypriniformes, Balitoridae, *Aborichthys*, New Species, India

Abbreviations and Acronyms: The following abbreviations are used herein: SL=Standard Length and HL = Head Length. Institutional abbreviations include MSUMNH- Manonmaniam Sundaranar University Museum of Natural History, ZSI/SRS- Zoological Survey of India/Southern Regional Station, and CMA- Collection of M. Arunachalam

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1. INTRODUCTION

The genus *Aborichthys* was established by Chaudhuri in 1913 from specimens sampled in northeastern India during the Abor expedition 43. The new genus was distinguished from the closely related genera of *Nemachilus* and *Nemachilichthys* by the position of vent, position of the dorsal fin and the lateral line being much higher on the body. The type species, *Aborichthys kempfi*, is diagnosed based on its incomplete lateral line, terminating anterior to a vertical from the pelvic fin insertion, and the position of vent being equidistant between the post orbit and the base of the caudal fin. Later, Hora (1921) described *Aborichthys elongatus* from the Riang River in Darjiling district and diagnosed this species on the basis of the position of its snout and position of and number of branched rays in the dorsal fin. Hora (1925) described *Aborichthys garoensis* from Tura, Garo Hills, Assam. *Aborichthys tikaderi* was described by Barman (1984) from Namdapha Wildlife Sanctuary in Tirap district, Arunachal Pradesh. Thus, species of *Aborichthys* are thus far known from only the northeastern part of India. In recent studies of the streams of upper and lower Subanshri district in Arunachal Pradesh specimens of two new forms of *Aborichthys* were obtained and identified as new to science and are herein described and diagnosed from others of the genus.

2. MATERIALS AND METHODS

Methods for measurements and counts follow those of Hubbs and Lagler (1964) except that body depth was taken at the dorsal fin origin. Measurements were taken to the nearest 0.1mm using digital caliber. Body measurements expressed as percentage of Standard length (%SL) and head measurements as percentage of head length (%HL). Methods for Sheared Principal Component analysis follow those of Burr and Mayden (1999) and Layman and Mayden (2012). The following samples were used as comparative materials. *Aborichthys elongatus*—ZSI/Kolkatta, F10087/1, Holotype, 72.3mm SL, Reang River in Darjiling Dist, G.C. Shaw. No Date. *Aborichthys elongatus*, ZSI/Kolkatta, F10725/1—Paratype, 58.9mm SL, Balasan River, 9 miles from Kurseong, B. N. Chopra. No Date. *Aborichthys garoensis*—ZSI/ Kolkatta, F 10669/1, Holotype, 84.2mm SL, Tura, Garo hills, Assam, S.W. Kemp. No Date. *Aborichthys tikaderi*—ZSI/Kolkatta, FF 2135 Holotype, 95.1mm SL, Namdapha Wildlife Sanctuary, Arunachal Pradesh, S. Biswas and Party, 18 Dec. 1983. *Aborichthys tikaderi*—ZSI/Kolkatta, FF 2136, Paratype, 96.8mm SL, Namdapha Wildlife Sanctuary, Arunachal Pradesh, S. Biswas and Party, 18 Dec. 1983. *Aborichthys kempfi*—ZSI/ Kolkatta, Genotypes F 7721/1, 7722/1, 7723/1 Genotypes, 69.2-83.6mm SL, Egar stream, between Renging and Rotung, Abor expedition, Abor country, S.W. Kemp. No date. *Nemacheilus anguilla*—ZSI/Kolkatta, F. 9692/1, Holotype, 45.4mm SL, Yenna river at Medha, Satara Dist, Annandale. No Date.

3. NEW SPECIES

3.1. *Aborichthys cataracta*, New Species

Types—Holotype: MSUMNH 2, Male. 75.5mm SL, India, Arunachal Pradesh, stream joining with Ranga River, Hong Village, Upper Subanshri District (27° 32' 716'' N, 93°51' 57'' E), Collectors: M. Arunachalam, M. Raja, C. Vijayakumar and S. Nandagopal. 18 June 2011 (Figures 1-2).

Paratypes: ZSI/SRS F8575, 1 ex. Male. 92.6mm SL, MSUMNH 57, 6 ex. 51.1-75.3 mm SL CMA 15, 2 ex, 85.4 – 88.9mm SL. All other details same as Holotype.

Diagnosis—*Aborichthys cataracta* is distinguished from *Aborichthys elongatus* using the following combination of characters: more vertical bands along body (32-35 vs. 31-33), distance between distal end of depressed pectoral fin and pelvic fin insertion equal to pectoral fin length (vs. 1½ times pectoral fin length), distance between distal tip of depressed pelvic fin and anal-fin origin equal to 1½ times pelvic fin length (vs. 1), edge of dorsal fin straight (vs. concave), shorter anal fin height (12.7-18% SL vs. 9.9-12.1%), longer caudal fin (19.4-21.9% SL vs. 12.6-18.3%), longer anal fin base (5.7-10.4 % SL vs. 2.7-3.9%), greater distance between pelvic fin insertion and anal fin origin (26.2-28.3% SL vs. 19.6-22.6%), greater distance between vent and anal fin origin (19.6-23.5% SL vs. 12.9-15.0%), greater distance between tip of snout and vent (49.7-56.7% SL vs. 60.16-71.8%), greater inter orbital width (27.4-32% HL vs. 18.2-22.2%) and greater distance from lower jaw to isthmus (42.7-55.9% HL vs. 27.7-35.3%).

Aborichthys cataracta is distinguished from *Aborichthys garoensis* using the following combination of characters: greater pre-anal length (72.1-78.2% SL vs. 71.1-71.8%), greater pre-dorsal length (45.4-51.2% SL vs. 41.7-43.8%), greater pre-pelvic fin length (42.3-49.5% SL vs. 40.4-41.0%), greater distance between dorsal-fin origin and pelvic fin insertion (12-14.6% SL vs. 9.6-9.7), longer base of anal fin (5.7-10.4 % SL vs. 4.0-4.1%), deeper body (10.4-13.2% SL vs. 9.4-10.1%), wider body (9.9-12.2% SL vs. 7.5-7.8%), greater distance between vent and caudal-fin base (40.4-49.1% SL vs. 35.9-37.4%), greater distance between anal fin origin and caudal fin base (20.6-27.9% SL vs. 14.1-14.7 %), greater distance between snout opercle opercle (70.8-75.3% HL vs. 80.6-85.5%), greater orbit width (13.4-17.9% HL vs. 6.98-7.98 %), wider inter orbital width (27.4-32.0% HL vs. 24.4-25.3%) and head width (60.8-65.3% HL vs. 52.1-55.9 %).



Figure 1

Lateral (a) and ventral (b) views of a freshly preserved specimen of *Aborichthys cataracta* from Hong Village, Upper Subanshri District, Arunachal Pradesh, India

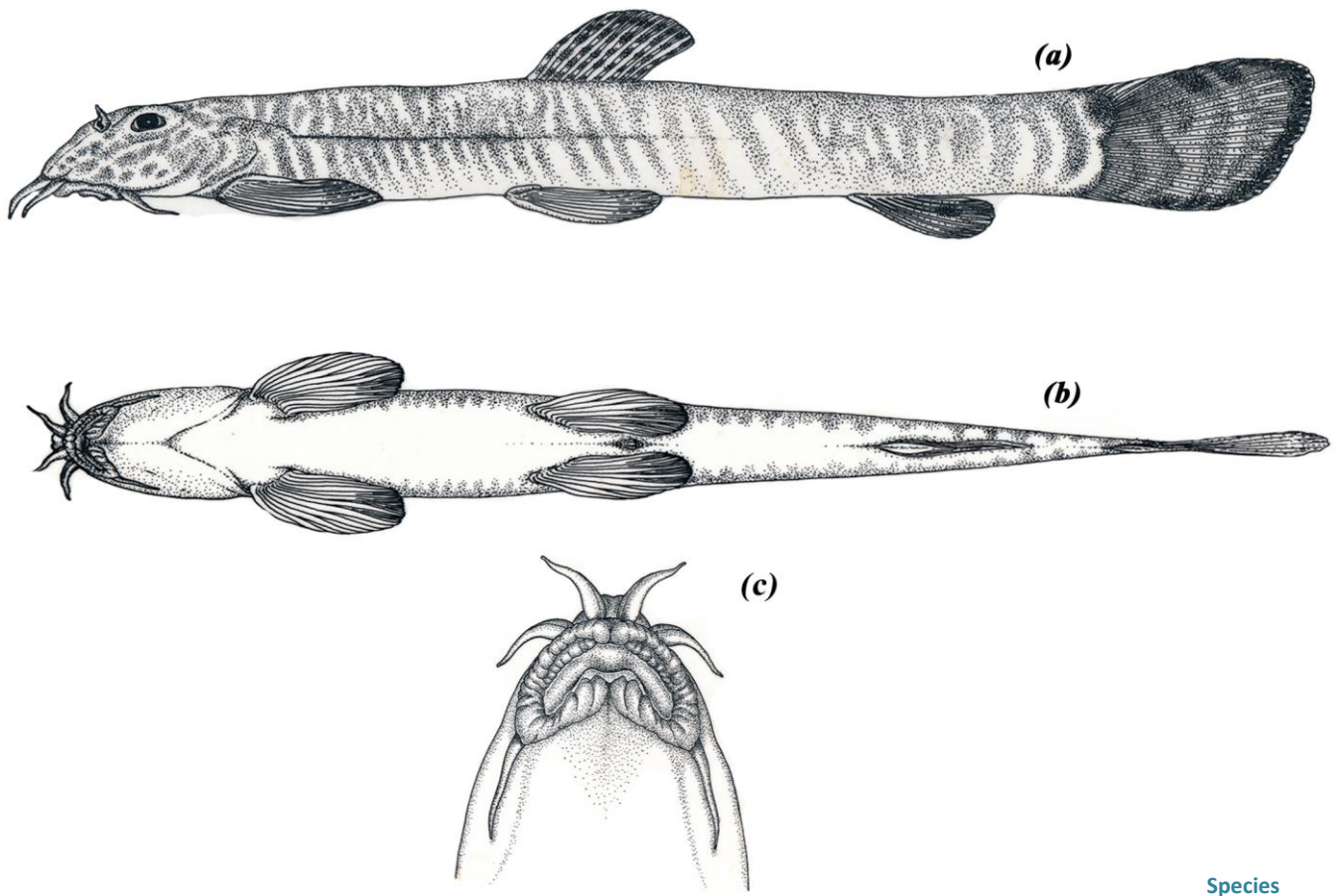


Figure 2

Line drawings of lateral (a), ventral (b) and (c) mouth views of *Aborichthys cataracta*, from Hong Village, Upper Subanshri District, Arunachal Pradesh, India

Aborichthys cataracta can be distinguished from *Aborichthys tikaderi* using the following combination of characters: number of vertical bands along body (32-35 vs.16), distance between distal end of depressed pectoral fin to pelvic fin origin equal to pectoral fin length (vs. 2 times pectoral fin length), distance between distal end of depressed pelvic fin and anal fin origin 1½ times pelvic fin length (vs. 2 times), greater pre-anal length (72.1-78.2% SL vs. 67.9-71.6%), greater pre-pelvic length (42.3-49.5% SL vs. 37.8-41.4%), greater dorsal-fin height (13.8-18.7% SL vs. 11.2-13.1%), greater pectoral-fin length (13.1-19.1% SL vs. 11.9-12.8%), greater pelvic-fin length (13.4-18.2% SL vs.10.3-12.6%), longer base of dorsal fin (10.3-14.2% SL vs. 8.2-9.1), greater distance between insertions of pectoral and pelvic fins (25.5-30.3% SL vs. 22.6-24.7 %), deeper body (10.4-13.2% SL vs. 7.63-8.3%), greater distance between pelvic fin insertion and vent (8.6-12% SL vs. 6.6-7.4%), wider body (9.9-12.2% SL vs. 6.4-9.0%), shorter distance between snout and opercle (70.8-75.3% HL vs. 87.6-93.1%), greater orbit width (13.4-17.9% HL vs. 8.95-9.60%), greater inter-orbital width (27.4-32% HL vs. 18.7-22%) and greater head depth at nostril (38.1-48.2% HL vs. 29-33.6%).

Aborichthys cataracta can be distinguished from *Aborichthys kempfi* using the following combination of characters: more vertical bands (32-35 vs. 20-22), smaller caudal peduncle depth (8.9-11.9% SL vs. 11.8-12.9%), greater distance between dorsal fin origin to anal fin origin (30.5-33% SL vs. 29.3-30.1%), greater distance between dorsal fin insertion to anal fin origin (20.1-24.9% SL vs. 18-20.1%), longer upper jaw (26.6-33.2% HL vs. 21.6-24.2%), narrower head (60.8-65.3% HL vs. 66.9-67.6%), wider gape (30.4- 43.6% HL vs. 26.5-28.4%), greater distance between lower jaw and isthmus (42.7-55.9% HL vs. 31.6-34.8%), and deeper head at nostril (38.1-48.2% HL vs. 31-34.2%).

Aborichthys cataracta is distinguished from *Aborichthys verticauda* using the following combination of characters: caudal fin length greater than head length (vs. equal), distance between distal end of depressed pectoral fin to pelvic fin origin equal to pectoral fin length (vs. less than pectoral fin length), distance between distal end of depressed pelvic fin and anal fin origin 1½ times pelvic fin length (vs. less pelvic fin length), longer caudal fin (19.4-21.9% SL vs. 12.5-14.6%), shorter distance from tip of snout to vent (49.7-56.7% SL vs. 56.7-61.4%), and greater upper jaw length (26.6-33.2% HL vs. 21.7-27.1%).

Description: Body extremely elongate; dorsal and ventral profiles parallel and horizontal; dorsal portion of head rounded, ventral surface of head flattened; snout conical and broadly rounded; mouth inferior; eyes small and situated more dorsally and located equidistant between tip of snout and posterior rim of opercle; eyes not visible in ventral view; lips thick, strongly papillate and continuous at angle of mouth; lower lip interrupted in middle; barbels six, 2 pairs of maxillary and one pair of rostral barbels; nostril situated close to inner anterior border of eye and its membrane between two nostrils produced as tube-like projections. Head depressed, length 10.92-17.87% SL; greatest body depth at dorsal fin origin (10.4-13.2% SL) (Figures 1, 2; Tables 1, 2).

Paired fins rounded, horizontally placed and with ventral adhesive pads. Pectoral fin shorter than head length; fin length more than double length the distance between pectoral fin and pelvic fin insertions. Pelvic fin slightly shorter than pectoral fin and situated away from anal fin by a distance equal to 2.5 times its own length. Dorsal-fin origin slightly posterior to vertical to origin of pelvic fin; fin with 7 branched rays (2 unbranched) and a dark spot at base of 1st unbranched ray. Upper edges of dorsal fin with regularly arranged melanophores.

Dorsal fin with longest ray slightly shorter than depth of body. Dorsal origin considerably nearer to tip of snout than to caudal base. Pelvic-fin extending beyond anal opening. Vent distinctly nearer to the caudal base than to tip of snout. Anal fin short and rounded with 6 rays (5 branched) and nearer to caudal base than to pelvic fin origin. Skin on ventral surface of unbranched pectoral and pelvic fin rays thick and covered with layer of unculi forming friction or adhesive pads. Scales small and elliptical; lateral line incomplete, reaching to before vertical to pelvic fin origin. Caudal fin lunate, its length slightly longer than head length. Body with 30-35 distinct, dark, and elongated, narrow, transverse bands separated by narrower yellow inter spaces.

In live specimens, upper surface of head and anterior part of head and dorsum anterior to dorsal fin origin dusky, venter dull white. Posterior part of the body marked with several black lines, anastomosing with narrow bands of yellowish orange. Body marked with 30.-35 black forked transverse bands not extending to ventral surface and separated by narrower interspaces. Dorsal fin banded with two rows of black spots, a black spot at base of anterior two rays; edge of black spot marked with black ring. Pectoral, pelvic, anal, and caudal fins dusky white. Caudal fin lunate and with two broad black bands, one centrally located and blurred, second band almost bordering the margin of the fin and intensively black.

Distribution and Habitat—*Aborichthys cataracta* is currently known from only one population from a pool at the base of an unnamed waterfall near Hong village in Upper Subanshri district (Figure 3). The habitat associated with the species is a typical waterfall habitat with a plunge pool where the specimens were collected. Additionally, a few more specimens were collected by washing the surf zone on the vertical sides of rocks. The waterfall and downstream reach represents what would be considered a typical first-order stream flowing through bedrock crevices. At the collection location the gradient is above 5%.

The name *cataracta* is a noun in apposition and Latin, derived from *cataracta* meaning “water fall” for the allusion to the habitat where this only population of the species has been discovered and may be restricted.



Figure 3

Type locality of *Aborichthys cataracta*, Hong Village, Upper Subanshri District, Arunachal Pradesh, India



Figure 4

Lateral (a) and ventral (b) views of a freshly preserved specimen of *Aborichthys verticauda* collected 7 km from Hola camp, Lower Subanshri District, Arunachal Pradesh, India

3.2. *Aborichthys verticauda*, New Species

Types—Holotype: MSUMNH 3, 77.5mm Standard Length (SL), Male, India (Holotype): Arunachal Pradesh, (Tributary of Ranga River) 7 km away from Hola camp, Lower Subanshri District, (27° 18' 50.7" N 93° 57' 51.2" E), Collectors: M. Arunachalam, M. Raja, C. Vijayakumar and S. Nandagopal. 17 June 2011 (Figures 4, 5).

Paratypes: ZSI/SRS. F. 8579, 1 ex. 65.61mm SL, MSUMNH 58, 6 ex, 51.4-65.61mm SL, CMA 16, 2 ex, 54.53 – 60.44mm SL., (Paratypes), other details same as Holotype.

Diagnosis—*Aborichthys verticauda* is distinguished from *Aborichthys elongatus* by the following morphological characters or combination of characters: depressed distal end of pectoral fin to pelvic fin origin, less than 1 time of pectoral fin length (vs. 1½ times), depressed distal end of pelvic fin to anal fin origin, less than 1 time of pelvic fin

length (vs. one time), greater pre-pectoral fin length (20-24.2% SL vs. 16.2-19.6%), greater anal-fin height (14.6-17.5% SL vs. 9.9-12.1%), greater pelvic fin length (15.3-18.8% SL vs. 12.6-13.9%), occipital to pectoral fin insertion (10.6-13.4% SL vs. 8.6-10%), greater distance between dorsal and anal fin insertions (24.8-37.2% SL vs. 19.4-21.6%), longer base of dorsal-fin (11.2-19.6% SL vs. 9.6-10.8%), longer anal-fin base length (7.9-9.0% SL vs. 2.7-3.9%), greater distance between pelvic-fin insertion to anal-fin origin (25.2-29.3% SL vs. 19.6-22.6%), greater distance between vent and anal fin origin (18.7-22.4% SL vs. 12.9-15%), narrower body width (7.3-10.1% SL vs. 11-13.9%), greater inter-orbital width (23.4-29.5% HL vs. 18.2-22.2%) and greater distance from lower jaw to isthmus (45.1-54.2% HL vs. 24.7-35.3%).

Aborichthys verticauda is distinguished from *Aborichthys garoensis* in the depressed pectoral fin distal end to pelvic-fin origin, less than 1 time of pectoral fin length (vs. 1time), depressed pelvic fin distal end to anal-fin origin, less than equal of pelvic fin length (vs. 1½ times), greater pre-anal length (76.0-82.5% SL vs. 71.1-71.8%), greater pre-dorsal length (48.9-53.7% SL vs. 41.7-43.8%), greater pre-pelvic length (48-53.7% SL vs. 40.4-41.0%), greater pre-pectoral length (20-24.2% SL vs. 15.3-15.8%), greater pre-occipital length (16.7-20.9% SL vs. 13.2-13.9%), greater distance between dorsal-fin origin and pelvic-fin insertion (12.5-14.6% SL vs. 8.3-8.8%), greater anal-fin height (14.6-17.5, % SL vs. 12.2-12.4%), greater peduncle depth (11.0-16.6, % SL vs. 9-9.2%), shorter caudal fin (12.5-14.6% SL vs. 20.6-21.9%), greater pelvic-fin length (15.3-18.8% SL vs. 12.9-13.3%), greater distance between dorsal-fin origin and pelvic-fin insertion (13-17.3% SL vs. 9.6-9.7%), anal fin base length (7-9.1% SL vs. 4.4.1%), post dorsal length (46.5-51% SL vs. 57.9-59.7%), deeper body (11.4-14.7% SL vs. 9.4-10.1%), greater distance between pectoral fin to vent (38.2-42.3% SL vs. 32.8-34.2%), wider body (11-13.9% SL vs. 7.5-7.8%), greater distance between anal-fin origin and base of caudal fin (21.1-24.6% SL vs. 14.1-14.7%), shorter upper jaw (21-7-27.1% HL vs. 31.8-34%), greater orbit width (14-20.5% HL vs. 6.9-7.9%), wider head (63.7-73.7% HL vs. 52.1-55.9%), and greater distance from lower jaw to isthmus (45.1-54.2% HL vs. 39.5-40.6%).

Aborichthys verticauda can be distinguished from *Aborichthys tikaderi* in having narrow vertical bands on sides (30-35 vs. 16), fewer caudal-fin rays (16 vs. 18), depressed pectoral fin distal end to pelvic-fin origin, less than equal to pectoral fin length (vs. 2 times), distal tip of depressed pelvic fin end to anal-fin origin, less than equal to pelvic fin length (vs. 2 times), greater pre-anal length (76-82.5% SL vs. 67.9-71.6%), pre-dorsal length (48.9-53.7% SL vs. 42.6-44.3%), pre-pelvic length (48-53.2% SL vs. 37.8-41.4%), pre-pectoral length (20-24.2% SL vs. 14.6-16.2%), pre-occipital length (16.7-20.9% SL vs. 13.1-15.3%), anal fin height (14.6-17.5% SL vs. 11.9-13.5%), shorter caudal fin (12.5-14.6% SL vs. 20.2-21.2%), longer pectoral-fin (14.6-17.5% SL vs. 11.9-12.8%), longer pelvic-fin (15.3-18.8% SL vs. 10.3-12.6%), dorsal insertion to caudal base (36.5-41.4% SL vs. 44.3-49.9), longer dorsal-fin base (7.0-9.1% SL vs. 5.3-6.5%), wider body (11-13.9% SL vs. 6.4-9%), deeper body (11.4-14.7% SL vs. 7.63-8.3%), greater distance between pectoral fin and vent (38.2-42.3% SL vs. 30.4-32.1%), between dorsal-fin origin and pelvic-fin insertion (12.5-14.6% SL vs. 9.7-10.5%), between pelvic fin and vent (8.6-12.6% SL vs. 6.6-7.4%), between tip of snout and vent (56.7-61.4% SL vs. 45.8-51.6%), between snout and opercle (70.5-83.6% HL vs. 87.6-93.1%), shorter snout (39.3-45.1% HL vs. 42.1-46.8%), greater orbit width (14-20.5% HL vs. 8.95-9.60%), between lower jaw and isthmus (45.1-54.2% HL vs. 35.8-42.7%) and usually greater head depth at nostril (31.4-39.9% HL vs. 31-34.2%).

Aborichthys verticauda distinguished from *Aborichthys kempfi* by having fewer caudal-fin rays (16 vs. 18), more narrow vertical bands on sides (30-35 vs. 16), depressed pectoral fin distal end to pelvic-fin origin, less than equal to pectoral fin length, (vs. one time); distal end of depressed pelvic fin to anal-fin origin, less than equal to pelvic fin length (vs. 1½ times); greater pre-pelvic fin length (48-53.2% SL vs. 45.6-47.2%), shorter caudal fin (12.5-14.6% SL vs. 19.6-22.4%), shorter dorsal fin height (9.7-14.8% SL vs. 15.3-17.1%), greater distance between dorsal-fin origin and anal-fin origin (30.5-34.4% SL vs. 29.3-30.1%) and greater distance between lower jaw and isthmus (45.1-54.2% HL vs. 31.6-34.8%).

Description—Body elongate and strongly compressed, its depth 7-9 times in standard length. Dorsum and venter profile parallel and horizontal. Head rounded, depressed in dorsum and slightly flattened in venter; head length less than 1½ times as long as broad. Snout conical, broadly rounded; snout length slightly shorter than post-orbital of head. Mouth inferior, half as wide as width of head, and surrounded by a circular suctorial lip, and two fleshy knobs in the middle of the lower lip. Eyes small and situated dorsally in the middle of the head, not visible from below ventral surface. Lips thick and strongly papillate, continuous at angle of mouth; lower lip interrupted in the middle. Barbels 3 pairs, 2 pair of maxillary barbels being longest and two and half times diameter of eye; one pair of rostral barbels. Nostrils separated by thin partition close to inner anterior boarder of eye; membrane between two nostrils produced by a nostril like projection (Figures 4a, b; 5a, b, c; Tables 1, 2).

Paired fins rounded, horizontally placed and with adhesive pads on ventral surface. Pectoral fins shorter than head length, and at a distance more than double the length of pectoral fin from pelvic fin. Pelvic fin situated away from the anal fin equal to two times its own length and extending beyond anal opening. Dorsal fin with 7 branched rays (2 unbranched); origin slightly behind origin of pelvic fin by distance equal to snout length and caudal base. The

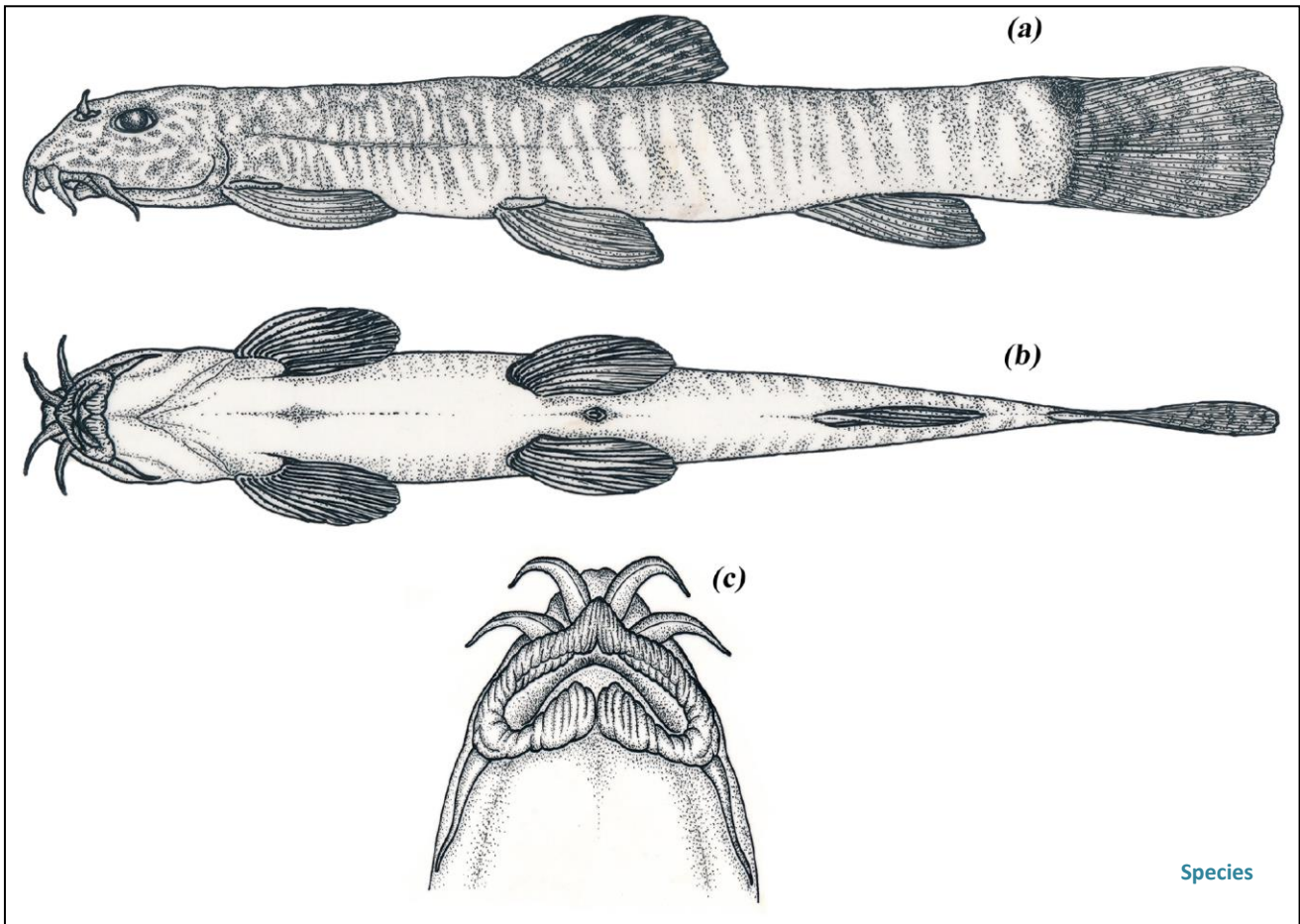


Figure 5

Line drawings of lateral (a), ventral (b) and (c) mouth views of *Aborichthys verticauda* collected 7 km from Hola camp, Lower Subanshri District, Arunachal Pradesh, India

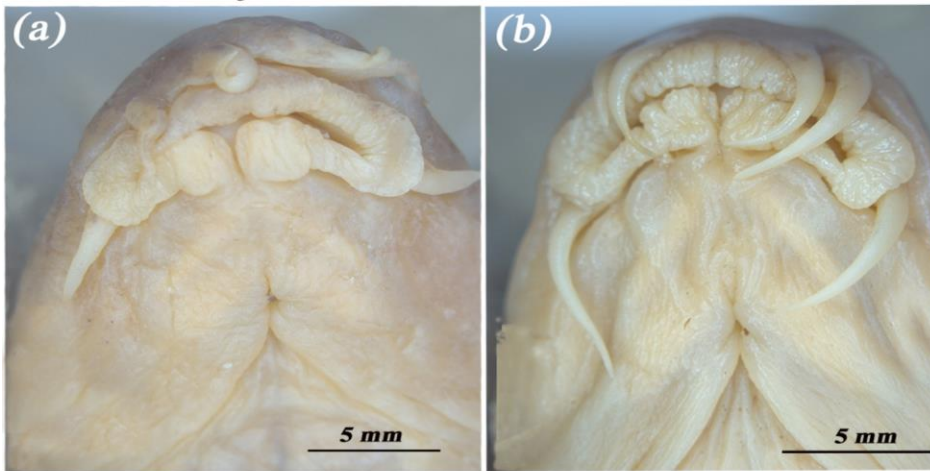


Figure 6

Type locality of *Aborichthys verticauda*, 7 km from Hola camp, Lower Subanshri District, Arunachal Pradesh, India

Aborichthys tikaderi

Aborichthys kempfi



Aborichthys garoensis *Aborichthys elongatus*

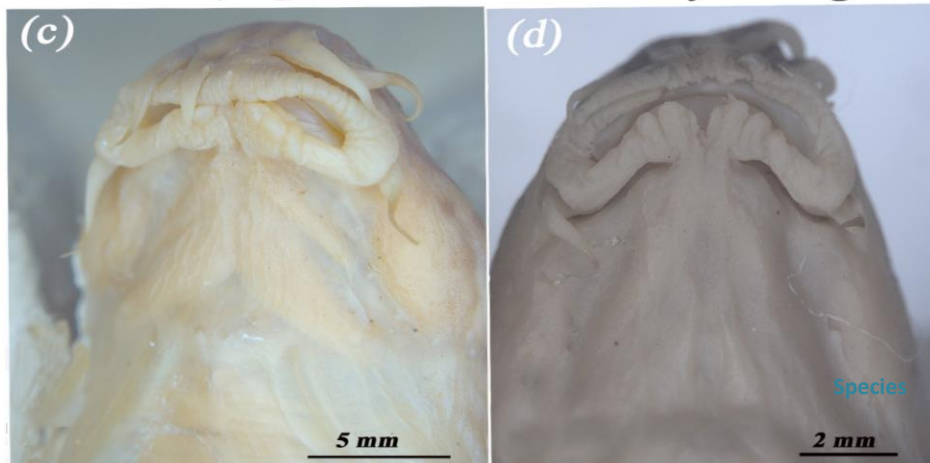


Figure 7

Ventral views of mouths of (a) *Aborichthys tikaderi*, (b) *A. kempfi*, (c) *A. garoensis*, and (d) *A. elongatus*

longest ray of dorsal fin slightly longer than body depth. A dark spot present at base of 1st unbranched ray. Upper edges of dorsal fin with three rows of regularly arranged melanophores.

Vent situated closer to caudal base than to snout. Anal fin short and with 6 rays (5 branched). Scales minute and deciduous. Lateral line incomplete, extending to before the base of pelvic fin. Caudal fin truncate, its length slightly longer than head.

Color—In life, the upper surface of the head and anterior part of the head in front of the dorsal fin marbled with round black and grey blotches. Body with 30-35 dark brown transverse bands, inclined backwards and on yellowish-white background body coloration. Dark stripes broader at the dorsum and gradually thinning until they disappear before reaching the ventral surface. Pectoral, pelvic, anal, and ventral surface of the body dull white. Dorsal fin immaculate with four rows of irregularly arranged black stripes. Caudal fin truncate and with 4-5 black bands starting slightly away from caudal base to end of the caudal fin. Upper edge of caudal fin slightly but noticeably longer than lower edge. Dorsum of caudal base with black spot, its edge marked with black ring.

Distribution and Habitat—Only one population is currently known from a stream near Hola camp. This stream conflues with Ranga River in Lower

Subanshri district (Figure 6). With few human settlements in the area, the terrestrial habitats and stream appears to be relatively undisturbed. As a third-order stream it contains numerous rocks and large boulders. At the time of collection flow was not high and the stream is located in a valley with “U”-shaped morphology as this reach is not steep enough and the slopes on both sides are shallow. Because of the U-shaped valley, the velocity is low and the gradient is less than 5%. Loaches were collected in areas where there are cobbles and sand. Water clear and unpolluted though there were visual signs of the stream being used by nearby villagers for bathing and washing clothes.

Etymology—The species epithet “*verticauda*” is Latin for vertical and in reference to the caudal fin. Among all the species of *Aborichthys*, this species has a straight or slightly truncate caudal fin.

4. DISCUSSION

Hora (1921) distinguished *Aborichthys elongatus* from *Aborichthys kempfi* Chaudhuri (1913) by (six vs. seven) branched dorsal fin rays. However, the holotype and paratypes of this species have seven branched rays and all the known species, including the present two new species, have only 7 branched rays. The branched pectoral fin rays in all the species are 10; *Aborichthys kempfi*, *A. cataracta* and *A. verticauda* have 2 unbranched rays while others have one. Caudal-fin rays are in the range of 15-16 for all species except *A. tikaderi* that has 18. The caudal fin is rounded in *A. elongatus* while in other species the fin is either lunate-shaped or, as in *A. verticauda*, a straight fin margin. The number of vertical bands distinguishes all species of *Aborichthys*. Three species, *A. cataracta*, *A. elongatus*, and *A. garoensis*, have 30-35 dark transverse lateral bands while *A. tikaderi* and *A. kempfi* only have 16 and 20-22 bands respectively.

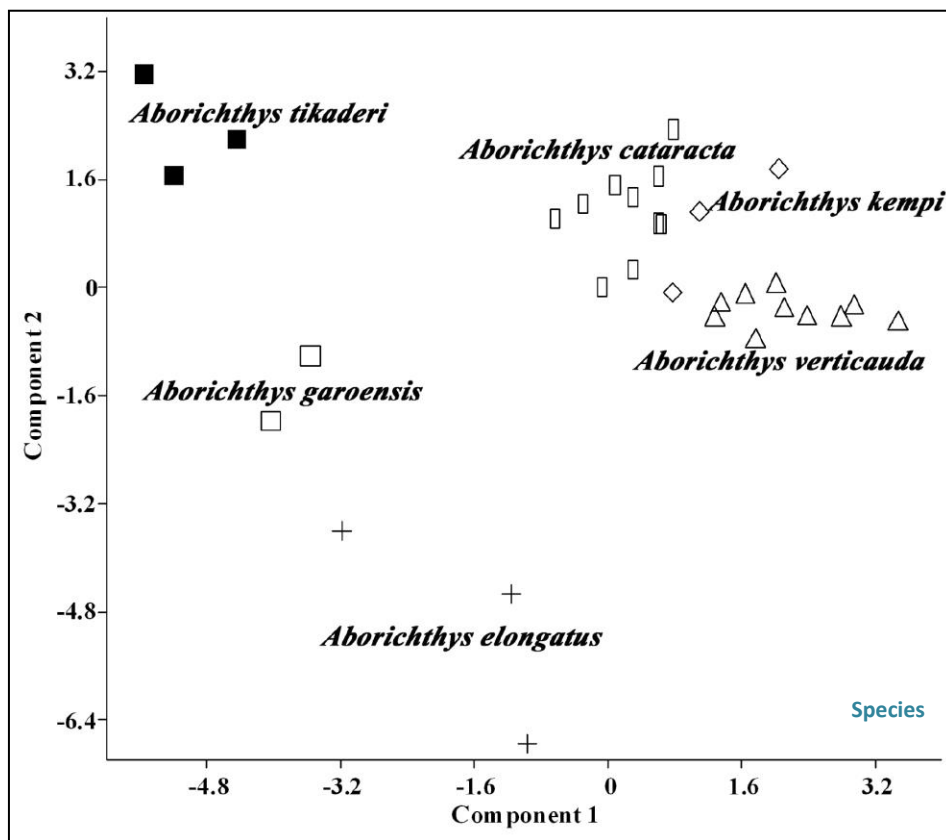


Figure 8

Principal Component plot of axes 1 and 2 for pooled morphometric data derived from all of the six known species of *Aborichthys* (*Aborichthys cataracta* (Bar), *Aborichthys verticauda* (triangle), *Aborichthys tikaderi* (filled square), *Aborichthys kempfi* (diamond), *Aborichthys garoensis* (square), *Aborichthys elongatus* (cross))

Based on the examination of type species of *Aborichthys*, the mouth structure of *Aborichthys kempfi* is semicircular, lips moderately fleshy, and deeply crumpled in two rows; the upper and lower lips are interrupted medially; the lower lip has two fleshy knobs on each side; the dentiform process is well developed; barbels are short, subequal with thread like; and the maxillary extends perpendicular to the middle of the eye (Figure 7). In *Aborichthys tikaderi* the mouth is slightly behind the tip of the snout and bordered by thick papillated lips, that hang loosely and prominently at angles of mouth; lips are thick, lower lip interrupted medially and possesses two fleshy knobs each side; barbels in 3 pairs, 2 pair of rostral barbels and 1 pair of maxillary barbels; barbels are of equal length and equal to diameter of eye. In *Aborichthys garoensis* the lips are fleshy and furrowed; upper and lower lips are interrupted medially and are papillate; lower lip with two fleshy knobs on each side; dentiform process moderately developed; barbels well developed and of equal length, outer rostral barbel not extending to border of eye; and maxillary extending to vertical from middle of eye. In *Aborichthys elongates* the mouth is semicircular and lips are fleshy but not

furrowed; the lower lip has two moderately developed fleshy knobs; the dentiform process feebly developed; the inner rostral barbel is shorter, while the outer barbel is equal to maxillary but not extending to margin of eye. Maxillary extending to vertical from anterior border of eye.

Menon (1987) considered *Aborichthys* a subgenus of *Nemachilus*. However, Kottelat (1990) considered *Aborichthys* to be a separate genus based on characters such as caudal fin rounded or truncate, 7½ branched dorsal rays, pectoral fin rays not produced and reaching at most about midway to base of pelvic fin, pelvic fin origin in anterior to vertical from the dorsal fin origin and with more vertical thin bars. However, based on his illustrations (figure 5) the genera *Acanthocobitis*, *Nemachilus*, and *Schistura* can be distinguished by the placement of the ocellus at the upper extremity of the base of caudal fin. The ocellus is located at the midline of the caudal fin base in *Nemachilus* and as a bar in *Schistura*. *Aborichthys* can be further distinguished by 9-18 branched dorsal-fin rays being and 7 branched dorsal fin rays. The position of the vent in *Aborichthys* is unique when compared to the genera *Acanthocobitis* and *Nemachilus*.

Principal component analysis is a commonly used algorithm in statistical analyses. Each axis contains characters that are correlated and each explains levels of variation observed between specimens for correlated features on each axis. The first axis, in general includes only body size. Axes 2 or greater have limited size effect and the visualization of specimens in space is based on variability and disjunctions of variability between forms in the plots. Sheared PCA provides the user an option to extract any size that bleeds over into axes 2 or above.

In this analysis of mensural characters the sheared PCA clearly demonstrates the distinctiveness of the species of *Aborichthys*, as well as the two new species described herein (Figure 8). These results support the diagnoses presented for species above, as well as the distinctiveness of all species of *Aborichthys*. *Aborichthys cataracta* is presumed to be closely related to *A. kempfi* and their spatial positions in PCA plots may represent a similar reflection of shared plesiomorphic and apomorphic morphologies. However, despite these similarities in Sheared PCA, the two species are diagnosable on other traits identified above and below in the taxonomic key for *Aborichthys*.

5. KEY TO THE SPECIES OF *ABORICHTHYS*

1. Vent almost equidistant between tip of snout and base of caudal fin (or) slightly closer to tip of snout than to base of caudal fin-----2
 Vent distinctly closer to base of caudal fin than to tip of snout-----3
2. Black transverse bands along sides numbering 30-35; body depth 9.4 to 10.7 in SL; eye diameter 6.98- 7.98 in HL ----
 -----***Aborichthys garoensis***
 Black transverse bands along sides numbering 15-20; dorsal fin origin nearer to tip of the snout than to base of caudal; vent situated nearer the tip of the snout than to base of caudal; body depth 7.63-8.3 in SL; eye diameter 8.95-9.60 in HL; eye diameter less than maxillary and rostral barbel length-----***Aborichthys tikaderi***
3. Black transverse bands along sides numbering 15-20; snout slightly shorter than post-orbital length; dorsal fin equal distance to tubular nostrils and caudal base; vent nearer tip of snout than end of caudal fin-----
 -----***Aborichthys kempi***
 Black transverse bands along sides numbering 30-35 -----
 ----- 4
4. Vent and origin of dorsal fin equidistant between tip of snout and caudal fin base; snout equal to post-orbital length -----***Aborichthys elongatus***
 Vent distinctly closer to base of caudal fin than to the tip of snout-----5
5. Origin of dorsal fin equidistant from tip of the snout and base of caudal fin-----***Aborichthys verticauda***
6. Origin of dorsal fin considerably closer to snout than to base of caudal fin-----***Aborichthys cataracta***

FUTURE ISSUES

1. The freshwater fish order Cypriniformes is the most diverse monophyletic group in the world with an expected 5,000+ species.
2. Inventories of streams typically inhabited by species of *Aborichthys* have been limited and voucher materials are rare.
3. Increasing access to the types of habitats that species of this genus inhabit should yield several additional new species.

SUMMARY POINTS

1. The genus *Aborichthys* of the family Balitoridae is not currently known to be very diverse and this is likely due to limited access to habitats of these species.
2. The two new species described herein is the beginning of what is expected to be an increase in the discovered and descriptions of species following increased inventory efforts
3. Efforts should be made for collaboration and coordination of characters being used in descriptions and comparisons so as to better diagnose species.

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Table 1

Proportional measurements of all known six species of *Aborichthys* (characters 2-39 expressed as % SL and characters 40-52 expressed as % HL)

No.	Morphometric measurements	<i>Aborichthys elongatus</i>		<i>Aborichthys garoensis</i>		<i>Aborichthys tikaderi</i>		<i>Aborichthys kempfi</i>		<i>Aborichthys cataracta</i>		<i>Aborichthys verticauda</i>	
		F10087/1 (Holotype)	Range n=3 (including Holotype)	F10669/1 (Holotype)	Range n=2 (including Holotype)	FF 2135 (Holotype)	Range n=3 (including Holotype)	F 7721/1 (Genotype)	Range n=3 (including Genotype)	(Holotype)	Range n=10 (including Holotype)	(Holotype)	Range n=10 (including Holotype)
1	Standard length	72.3	33.7-72.3	84.2	84.2-87.8	95.1	95.1-110.7	73.0	69.2-83.6	72.6	51.1-92.6	77.48	51.4-77.5
2	Snout to urocentrum	96.6	95.7-96.6	96.7	96.2-96.7	95.3	95.3-97.2	95.6	95.2-95.6	93.8	93.8-97.9	97.77	94.4-97.8
3	Pre anal length	76.6	74.0-83.5	71.1	71.1-71.8	71.2	67.9-71.6	76.4	74.8-76.4	74.6	72.1-78.2	76.72	76.0-82.5
4	Pre dorsal length	50.0	48.7-51.0	41.7	41.7-43.8	43.3	42.6-44.3	50.2	46.8-50.2	46.7	45.4-51.2	50.34	48.9-53.7
5	Pre pelvic length	49.9	48.6-49.9	41.0	40.4-41.0	40.2	37.8-41.4	47.2	45.6-47.2	44.2	42.3-49.5	48.21	48.0-53.2
6	Pre pectoral length	19.0	16.2-19.6	15.3	15.3-15.8	15.2	14.6-16.2	20.2	19.7-20.2	17.0	16.7-21.5	20.96	20.0-24.2
7	Pre occipital length	15.0	15.0-17.9	13.9	13.5-13.9	14.1	13.1-15.3	17.3	16.6-17.3	15.7	14.6-18.9	17.15	16.7-20.9
8	Peduncle length	18.2	13.9-19.6	14.3	14.3-16.1	16.3	16.3-20.1	15.5	15.5-17.6	17.7	14.0-18.4	15.47	11.0-16.6
9	Dorsal origin to pelvic fin insertion	11.2	10.2-12.7	8.3	8.3-8.8	9.7	9.7-10.5	13.4	12.0-13.4	10.4	9.6-13.3	14.61	12.5-14.6
10	Dorsal spinous height	10.8	9.8-11.3	12.6	11.2-12.6	10.2	9.0-10.2	9.5	9.5-9.8	10.2	8.1-12.2	11.55	9.7-14.8
11	Anal fin height	12.0	9.9-12.1	12.4	12.2-12.4	13.5	11.9-13.5	13.8	13.8-17.5	14.3	12.7-18.0	14.57	14.6-17.5
12	Peduncle depth	11.6	9.6-11.6	9.2	9.0-9.2	10.6	10.6-11.6	12.9	11.8-12.9	10.2	8.9-11.9	15.47	11.0-16.6
13	Caudal fin length	15.2	12.6-18.3	21.9	20.6-21.9	21.2	20.2-21.2	19.6	19.6-22.4	21.7	19.4-21.9	14.61	12.5-14.6
14	Dorsal fin height	15.1	13.6-16.4	14.7	14.0-14.7	13.1	11.2-13.1	17.1	15.3-17.1	15.9	13.8-18.7	11.55	9.7-14.8
15	Pectoral fin length	13.9	12.3-16.1	13.8	13.5-13.8	12.4	11.9-12.8	16.8	15.1-17.3	15.7	13.1-19.1	14.57	14.6-17.5
16	Pelvic fin length	13.4	12.6-13.9	13.3	12.9-13.3	10.9	10.3-12.6	16.6	14.7-16.6	15.0	13.4-18.2	15.29	15.3-18.8
17	Occiput to dorsal fin origin	33.6	33.4-35.8	29.3	28.7-29.3	31.5	29.4-31.5	33.8	30.3-33.8	31.8	30.1-33.2	34.32	30.6-37.2
18	Occiput to pectoral fin insertion	8.6	8.6-10.0	9.9	8.2-9.9	9.3	9.2-11.4	12.5	12.2-13.0	10.8	9.6-13.1	12.34	10.6-13.4
19	Occiput to pelvic fin insertion	36.7	35.2-37.6	31.5	28.7-31.5	33.0	30.8-33.1	35.0	32.1-35.0	33.2	30.9-39.6	35.47	32.7-39.9
20	Dorsal fin insertion to pelvic fin insertion	15.0	13.6-15.0	9.7	9.6-9.7	13.1	12.3-13.4	15.7	14.6-15.7	14.1	12.0-14.6	16.38	13.0-17.3
21	Dorsal fin origin to pectoral fin insertion	24.0	23.6-24.0	25.9	22.6-25.9	23.4	23.4-27.1	29.5	25.9-29.5	27.2	24.7-28.0	31.38	23.0-31.4

22	Dorsal fin origin to anal fin origin	27.6	27.6-33.6	27.9	27.9-30.0	30.4	28.3-32.1	29.3	29.3-30.1	31.5	30.5-33.0	31.43	30.5-34.4
23	Dorsal fin insertion to caudal fin base	37.2	31.6-37.2	41.5	40.2-41.5	44.3	44.3-49.9	40.8	39.6-42.5	42.2	39.0-46.0	39.06	36.5-41.4
24	Dorsal fin insertion to anal fin origin	17.3	16.6-19.5	19.6	17.9-19.6	19.1	19.1-24.2	18.3	18.0-20.1	22.4	20.1-24.9	20.73	19.5-23.2
25	Dorsal fin insertion to anal fin insertion	21.6	19.4-21.6	27.4	26.4-27.4	24.7	20.9-24.7	24.7	24.7-26.8	26.2	23.0-28.1	26.42	24.8-37.2
26	Dorsal fin base length	10.8	9.6-10.8	11.6	10.4-11.6	8.2	8.2-9.1	14.2	11.3-14.2	11.2	10.3-14.2	12.02	11.2-19.6
27	Anal fin base length	3.9	2.7-3.9	4.1	4.0-4.1	6.5	5.3-6.5	7.2	7.2-9.5	7.9	5.7-10.4	7.72	7.0-9.1
28	Pectoral fin insertion to pelvic fin insertion	31.7	30.3-32.9	30.6	28.2-30.6	24.7	22.6-24.7	28.3	27.1-28.3	27.7	25.5-30.3	28.01	28.0-31.6
29	Pectoral fin insertion to anal fin origin	54.2	50.2-54.2	56.5	55.4-56.5	50.6	47.1-50.6	54.0	51.3-54.0	54.0	50.3-56.8	53.60	52.7-57.8
30	Pelvic fin insertion to anal fin origin	22.6	19.6-22.6	30.1	29.6-30.1	27.6	22.3-28.4	26.6	26.6-26.9	27.9	26.2-28.3	26.10	25.2-29.3
31	Post-dorsal length	47.8	43.0-49.1	57.9	57.9-59.7	55.3	49.8-55.3	51.4	50.2-52.6	52.9	48.9-56.2	49.92	46.5-51.0
32	Body depth	12.7	8.5-13.7	9.8	9.4-10.1	7.98	7.63-8.3	12.5	11.6-12.5	10.4	10.4-13.2	14.57	11.4-14.7
33	Distance b/w pectoral fin to vent	39.7	39.7-42.8	34.2	32.8-34.2	30.8	30.4-33.1	39.1	36.6-39.1	37.4	34.2-39.0	38.24	38.2-42.3
34	Distance b/w pelvic fin to vent	9.0	9.0-11.31	9.4	9.1-9.4	6.6	6.6-7.4	10.8	10.3-11.0	10.1	8.6-12.0	9.05	8.6-12.6
35	Vent to anal fin origin	15.0	12.9-15.0	22.1	21.2-22.1	24.5	19.2-24.5	19.9	19.4-20.6	22.1	19.6-23.5	20.33	18.7-22.4
36	Body width	7.3	7.3-10.1	7.8	7.5-7.8	9.0	6.4-9.0	11.2	10.1-11.2	10.2	9.9-12.2	12.00	11.0-13.9
37	Tip of snout to vent	58.2	60.16-71.8	50.6	48.5-50.6	51.6	45.8-51.6	56.4	54.4-56.7	51.9	49.7-56.7	56.69	56.7-61.4
38	Vent to base of caudal fin	40.3	37.8-40.26	37.4	35.9-37.4	50.1	45.4-50.1	44.1	44.1-45.3	45.6	40.4-49.1	42.69	38.6-44.0
39	Anal fin origin to caudal base	24.1	15.2-25.6	14.7	14.1-14.7	26.3	24.9-27.4	25.2	25.2-27.0	25.4	20.6-27.9	21.1	21.1-24.6
% of HL													
40	Snout to opercle	87.2	71.0-87.2	80.6	80.6-85.5	87.6	87.6-93.1	76.2	76.2-78.4	73.9	70.8-75.3	74.50	70.5-83.6
41	Upper jaw length	29.3	19.1-29.3	34.0	31.8-34.0	26.7	23.7-26.7	21.6	21.6-24.2	26.6	26.6-33.2	21.69	21.7-27.1
42	Snout length	44.2	38.5-44.2	42.5	41.7-42.5	46.8	42.1-46.8	41.5	41.5-46.0	38.4	38.4-48.9	45.06	39.3-45.1

43	Pre nasal length	24.0	22.6-28.7	28.4	28.4-31.5	35.9	30.2-35.9	34.5	31.4-35.4	32.7	29.1-39.2	36.50	28.0-37.0
44	Orbit width	15.5	15.5-22.8	7.92	6.98-7.98	9.35	8.95-9.60	15.5	14.9-17.0	13.8	13.4-17.9	14.00	14.0-20.5
45	Inter orbital width	19.4	18.2-22.2	24.4	24.4-25.3	21.4	18.7-22.8	28.2	24.7-28.2	30.8	27.4-32.0	23.44	23.4-29.5
46	Inter nasal width	15.2	13.1-18.4	19.8	14.5-19.8	15.4	11.7-15.4	20.2	18.3-21.7	18.6	16.2-21.6	17.38	14.5-20.0
47	Head width	50.9	50.9-61.7	52.1	52.1-55.9	61.9	61.9-62.4	66.9	66.9-67.6	64.4	60.8-65.3	73.44	63.7-73.7
48	Gape width	32.2	32.2-39.1	28.8	28.0-28.8	33.4	25.5-33.4	26.5	26.5-28.4	34.9	30.4-43.6	32.13	26.4-35.6
49	Lower jaw to isthmus	32.3	27.1-35.3	40.6	39.5-40.6	42.7	35.8-42.7	31.6	31.6-34.8	47.9	42.7-55.9	60.69	45.1-54.2
50	Head depth at nostril	36.1	21.1-36.1	36.5	34.6-36.5	30.3	29.0-33.6	31.0	31.0-34.2	33.0	38.1-48.2	39.94	31.4-39.9
51	Head depth at pupil	40.5	38.7-44.7	41.2	39.5-41.2	37.4	37.4-42.5	40.3	40.3-44.9	40.2	36.1-48.3	45.50	41.3-48.7
52	Head depth	47.1	47.1-52.5	49.6	49.6-49.6	44.8	44.8-46.7	44.8	44.8-47.6	48.6	46.2-55.4	51.75	45.3-51.8

Table 2

Comparative meristics of species of *Aborichthys* from India

		<i>Aborichthys elongatus</i>		<i>Aborichthys garoensis</i>		<i>Aborichthys tikaderi</i>		<i>Aborichthys kemp</i>	<i>Aborichthys cataracta</i> n=10 (including Holotype)	<i>Aborichthys verticauda</i> n=10 (including Holotype)
		F 10087/1 Holotype	F 10725/1 Paratype	F 10669/1 Holotype	Paratype	FF 2135 Holotype	FF 2136- FF 2137 Paratype	Genotypes 7721/1, 7722/1, 7723/1		
1	Dorsal fin rays	ii. 7	ii. 7	ii. 7	ii. 7	ii. 7	ii. 7 - ii. 7	ii. 7	ii. 7	ii. 7
2	Pelvic fin rays	i. 7	i. 7	i. 7	i. 7	i. 7	i. 7 - i. 7	i. 7.	i. 7.	i. 7.
3	Pectoral fin rays	i. 10	i. 10	i. 10	i. 10	i. 10	i. 10	i. 10 -11	i. 10 -11	i. 10 -11
4	Anal fin rays	i. 5	i. 5	i. 5	i. 5	i. 5	i. 5	i-ii. 5	i- 5	i- 5
5	Caudal fin rays	16	16	16	16	18	18	15-16	15-16	16
6	Pectoral fin ends to pelvic fin origin (by pectoral fin length)	1½ times	1½ times	1 time	1 time	2 times	2 times	1 time	1 time	Less than 1 time
7	Pelvic fin ends to anal fin origin (by pelvic fin length)	1 time	1 time	1½ times	1½	2 times	2 times	1½	1½	Less than 1 time
8	Body with vertical bands	31	33	32	33	16	16	20-22	32-35	30-35
9	Edge of dorsal fin	straight	straight	Almost straight	Almost straight	slightly concave	slightly concave	Almost straight	Concave	Concave
10	Position of vent	Near to tip of pelvic fin	Near to pelvic fin	Near to pelvic fin	Near to pelvic fin	Near to pelvic fin	Near to pelvic fin	Near to pelvic fin	Near to pelvic fin	Near to pelvic fin
11	Caudal fin	longer than head length	longer than head length	considerably longer than head length	considerably longer than head length	Equal to head length	Equal to head length	Longer than head length	Considerably longer than head length	Equal to head length
12	Caudal fin shape	rounded	rounded	Upper half longer and lunate	Upper half longer and lunate	Upper half longer and lunate	Upper half longer and lunate	Upper half longer and lunate	Upper half longer and lunate	Straight or slightly truncate
13	End of lateral line	Pelvic origin	Pelvic origin	Slightly behind the pelvic origin	Slightly behind the pelvic origin	Pelvic origin	Pelvic origin	Pelvic origin	Pelvic origin	Pelvic origin