

## Two new species of Loricariidae (Teleostei: Siluriformes) from main channels of the upper and middle Amazon Basin, with discussion of deep water specialization in loricariids

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*Hemiancistrus pankimpuju*, new species, and *Panaque bathyphilus*, new species, are described from the main channel of the upper (Marañon) and middle (Solimões) Amazon River, respectively. Both species are diagnosed by having a nearly white body, long filamentous extensions of both simple caudal-fin rays, small eyes, absence of an iris operculum and unique combinations of morphometrics. The coloration and morphology of these species, unique within Loricariidae, are hypothesized to be apomorphies associated with life in the dark, turbid depths of the Amazon mainstem. Extreme elongation of the caudal filaments in these and a variety of other main channel catfishes is hypothesized to have a mechanosensory function associated with predator detection.

### Introduction

In 1955, members of the Catherwood Foundation Peruvian-Amazon Expedition were among the first scientists to sample the benthos of a Neotropical river's main-channel habitat with an otter trawl. Böhlke (1970: 54) reports that Charles Chaplin and Ruth Patrick of the Academy of Natural Science in Philadelphia made only a single downstream haul in the Marañon River of Northern Peru because of the swiftness of the current, but that this single sample yielded a "fascinating group of mostly new and rare catfishes". The distinctiveness of fish assemblages from the depths of Neotropical rivers was confirmed quantitatively by Stewart et al. (2002), who

compared fishes collected by trawling the Napo River main channel in Ecuador, with fishes collected by seining its margins. Main channel trawl efforts produced 41 of the 132 total species recorded. Twenty of the 41 trawled species were restricted to the main channel, while beach samples were more similar to other beach samples up to 325 km away than they were to immediately adjacent main channel samples.

The boundary between shallow and deep water faunas observed by Stewart et al. (2002) occurred at approximately two meters depth, approximately the same depth at which fish vision in turbid rivers of the Amazon is no longer possible (Muntz, 1982), and just beyond the depth at which seining or wade sampling becomes inef-

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Fig. 1. The Pongo de Manseriche, a narrow canyon in Northern Peru through which flows the Río Marañon; type locality of *Hemiancistrus pankimpuju*.

factive (pers. obs.). Sampling of fishes specialized for life in this dark environment therefore requires dedicated effort and specialized equipment. Major expeditions with the deep water ichthyofauna of main Neotropical river channels as their focus have been undertaken at least twice to the Orinoco River, and four times to the Amazon River. In 1978 and 1979 the Duke University research vessel Eastward trawled the lower channel of the Orinoco (Mago-Leccia et al., 1985) and in three expeditions during the low water seasons of 1992–1994 and one during the high water season of 1996, the Calhamazon Project sampled main river channels of the Brazilian Amazon (Cox Fernandes et al., 2004). Dozens of new species were discovered during these efforts, with the majority being gymnotiform knifefishes or pimelodoid catfishes (e.g. Lundberg et al., 1996, Parisi et al., 2006, Lundberg & Cox Fernandes, 2007).

A single specimen of an undescribed and putatively deep-water specialized *Panaque* (Loricariidae: Hypostominae) was collected during the 1996 Calhamazon expedition by trawling a 12.8 to 17.8 m deep channel of the Solimões River upstream of the Purus River mouth. The strik-

ingly pale coloration of this specimen, its long caudal-fin filaments and small eyes, characters that in combination are otherwise unknown in Hypostominae, identify it as a species new to science. Its evertible cheek odontodes in conjunction with acutely angled rows of spoon-shaped teeth diagnose it as a member of the genus *Panaque*; it is described below as *P. bathyphilus*.

Two specimens of a second species of loricariid that shares some of the same putative adaptations to deep-water were collected by the first author during a 2006 expedition to the upper-middle Marañon River, a tributary of the upper Amazon in northern Peru. These specimens were collected at night by electroshocking a torrential chute along the margin of the deep and shear-sided Pongo de Manseriche canyon (Fig. 1). The strikingly white coloration of these specimens, long caudal filaments and small eyes also identify them as a species new to science. The moderately depressed body of this species, its villiform teeth, and dentaries angled at more than 100° diagnose it as a *Hemiancistrus* (Armbruster, 2008); it is described herein as *H. pankimpuju*.



Fig. 2. *Hemiancistrus pankimpuju*, MUSM 32337, holotype, 130.1 mm SL; Peru: Departamento Amazonas: Río Marañon, Pongo de Manseriche.

### Materials and methods

Counts, measurements and descriptions follow Armbruster (2003). Names of plate rows follow Schaefer (1997). Institutional abbreviations are as follows: AUM, Auburn University Museum, Auburn; MUSM, Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima; MZUSP, Universidade de Sao Paulo, Museu de Zoologia, Sao Paulo. Meristics and measurements for *H. pankimpuju* pertain to both holotype and paratype unless given separately, in which case the first number refers to the holotype and the second to the paratype. the dorsal-fin spinelet is treated as a spine. We follow Arm-

bruster & Page (2006) in treating the dorsal-adipose plates as those plates in dorsal series from plate posterior to posterior insertion of dorsal fin to plate anterior to insertion of adipose-fin spine.

### *Hemiancistrus pankimpuju*, new species (Fig. 2)

**Holotype.** MUSM 32337, 130.1 mm SL; Peru: Departamento Amazonas: Río Marañon, Pongo de Manseriche above Borja, 35.5 km NE Juan Velasco (Santa Maria de Nieva), 4°27'38"S 77°34'53"W; N. K. Lujan, D. C. Werneke, D. C. Taphorn, D. P. German & D. Osorio, 6 Aug 2006.

**Paratype.** AUM 45595, 1, 98.5 mm SL; same data as holotype.

**Diagnosis.** *Hemiancistrus pankimpuju* is diagnosed from all other *Hemiancistrus* by having an entirely white body and fin rays (vs. pigmented body and fin rays), by having a smaller orbit diameter (9.1-9.8 % of head length, vs. 12.3-26.9), by having long filamentous extensions of the unbranched principal caudal-fin rays (vs. fila-

ments absent), and by lacking an iris operculum (vs. present); from *H. cerrado*, *H. chlorostictus*, *H. fulginosus*, *H. guahiborum*, *H. landoni*, *H. medians*, *H. megalopteryx*, *H. meizospilos*, *H. punctulatus*, *H. subviridis*, and *H. votouro* by having a forked caudal fin (vs. caudal fin emarginate); from *H. cerrado*, *H. chlorostictus*, *H. fulginosus*, *H. medians*, *H. megalopteryx*, *H. meizospilos*, *H. micrommatos*, *H. punctulatus*, *H. snethlageae*, *H. spilomma*, *H. spinosissimus*, and *H. votouro* by having a greater

**Table 1.** Selected morphometrics of *Hemiancistrus pankimpuju* and *Panaque bathyphilus*. Interlandmarks represent the two landmarks the measurement is between (see Armbruster, 2003).

	interlandmarks	<i>H. pankimpuju</i>		<i>P. bathyphilus</i>
		holotype MUSM 32337	paratype AUM 45595	holotype MZUSP 56970
Standard length (mm)	1-20	130.1	98.5	73.5
<b>In percent of standard length</b>				
Predorsal length	1-10	40.5	40.3	45.0
Head length	1-7	31.3	31.4	36.2
Head-dorsal length	7-10	9.5	9.0	8.3
Cleithral width	8-9	26.6	27.1	31.8
Head-pectoral length	1-12	22.1	23.4	28.2
Thorax length	12-13	20.3	22.5	22.1
Pectoral-spine length	12-29	31.8	29.6	31.2
Abdominal length	13-14	21.8	21.9	22.4
Pelvic-spine length	13-30	26.8	27.1	28.5
Postanal length	14-15	39.4	38.2	34.4
Anal-fin spine length	14-31	16.5	17.9	16.1
Dorsal-pectoral depth	10-12	27.0	26.8	30.8
Dorsal-spine length	10-11	29.6	30.9	32.8
Dorsal-pelvic depth	10-13	20.8	19.5	25.6
Dorsal-fin base length	10-16	20.8	20.7	26.8
Dorsal-adipose depth	16-17	22.4	18.5	14.7
Adipose-spine length	17-18	8.9	9.5	9.3
Adipose-upper caudal depth	17-19	19.3	21.2	14.4
Caudal peduncle depth	15-19	10.7	10.8	10.1
Adipose-lower caudal depth	15-17	23.6	24.8	20.7
Adipose-anal depth	14-17	20.9	20.4	20.4
Dorsal-anal depth	14-16	13.9	13.8	15.6
Pelvic-dorsal depth	13-16	22.8	21.4	29.0
<b>In percent of head length</b>				
Head-eye length	5-7	40.6	39.9	35.7
Orbit diameter	4-5	9.8	9.1	11.6
Snout length	1-4	59.7	57.3	71.2
Internares width	2-3	9.4	8.8	14.2
Interorbital width	5-6	32.1	37.2	50.9
Head depth	7-12	70.7	67.5	71.4
Mouth length	1-24	45.7	50.3	47.3
Mouth width	21-22	46.9	48.0	44.6
Barbel length	22-23	10.8	11.0	2.9
Dentary tooth cup length	25-26	13.6	13.7	15.4
Premaxillary tooth cup length	27-28	13.9	15.4	14.5

postanal length (38.2-39.4 % SL vs. 29.6-37.8); from *H. chlorostictus*, *H. fuliginosus*, *H. medians*, *H. meizospilos*, *H. punctulatus*, and *H. votouro* having a narrower interorbital width (37.2-34.7 % HL vs. 37.7-56.2); from *H. guahiborum*, and *H. medians* by having a greater dorsal-adipose distance (18.5-22.4 % SL vs. 9.5-16.9).

**Description.** Morphometrics presented in Table 1. Body moderately depressed. Head sloped from snout to supraoccipital at approximately 35° above horizontal, supraoccipital and nuchal region slightly elevated, forming a low horizontal ridge back to dorsal-fin origin. Dorsal profile gently sloped down from dorsal-fin origin to posterior insertion of adipose fin, then up along dorsal lobe of caudal fin. Ventral profile flat from snout to anal-fin origin, modestly arched from anal-fin origin to insertion of ventral unbranched principal caudal-fin ray. Caudal peduncle compressed, ovate in cross section. Body widest at insertion of pectoral-fin spines, narrowest at base of caudal fin. Snout rounded in dorsal view.

Eye small (orbit diameter 9.8, 9.1 % HL). Iris operculum absent. Supraorbital regions not elevated. Interorbital surface slightly convex. Infraorbitals, frontal, nasal, pterotic, and supraoccipital supporting odontodes. Preopercle and opercle without odontodes. Evertible cheek plates supporting hypertrophied odontodes that can be everted just short of perpendicular to longitudinal axis. Cheek odontodes 28, 21; longest evertible cheek odontodes not reaching beyond cleithrum. Oral disk covered with papillae; buccal papillae absent. Maxillary barbel terminating approximately half distance from buccal valve to evertible cheek plate, connected to lower lip via skin flap with concave posterior margin.

Lateral median plates 28, middorsal plates 28, midventral plates 28. Five caudal peduncle plate rows. Body covered with plates except for small region between oral disk and pectoral girdle. Two predorsal plates not including nuchal plate. Dorsal fin II,7; spinelet short and V-shaped; dorsal-fin lock functional. Nine dorsal-adipose plates. Adipose fin with single preadipose plate, adipose-fin membrane with concave posterior margin. Caudal fin I,14,I; forked; four dorsal procurrent rays, two ventral procurrent rays. Pectoral fin I,6; spine reaching beyond pelvic-fin base when adpressed ventral to pelvic fin; distal surface of pectoral-fin spine supporting hypertrophied odontodes. Pelvic fin I,5; spine extending beyond base of anal

fin when adpressed. Anal fin I,4; spine longest ray.

Teeth bicuspid with mitten-shaped cusps, lateral lobe smaller than medial lobe. Left dentary teeth 24, 28; left premaxillary teeth 25, 21.

**Color.** White head, body, abdomen, fin spines and fin rays. Eyes dark gray to black. Fin membranes hyaline. Chromatophores absent. Plates of body somewhat translucent, allowing pink flesh tones of underlying muscle to show through when alive.

**Distribution.** Known only from a marginal right bank boulder field at the head of the Pongo de Manseriche in the middle Marañon River (Fig. 3).

**Habitat.** Holotype and paratype were collected together at night in the same effort by electroshocking a chute between two boulders with torrential flow approximately 1.5 m deep. Habitat to one side consisted of the river's main channel and, to the other side, bedrock and large boulders. Repeated day and night sampling of all workable habitat yielded no additional specimen.

**Etymology.** In reference to the species' color: 'pankim' meaning beautiful and 'puju' meaning white in the language of the Aguaruna (Awajun) people indigenous to northern Peru. A noun in apposition; pronounced pãnkimpühü.

***Panaque bathyphilus*, new species**  
(Fig. 4)

**Holotype.** MZUSP 56790, 73.5 mm SL; Brazil: Amazonas: Solimões River, upstream of its confluence with Purus River, 3°39'52"S 61°28'53"W; A. Akama, C. Cox Fernandes, M. Garcia, J. Alves-Gomes, F. Langeani, J. Lundberg, O. Oyakawa, N. Menezes, Roberval, M. Toledo-Piza & A. Zanata, 30 Jul 1996.

**Diagnosis.** *Panaque bathyphilus* is diagnosed from all other *Panaque* by having an entirely white body, pectoral- and pelvic-fin rays and spines, and adipose fin spine (vs. pigmented body and fin rays); from all *Panaque* except *P. nocturnus* by having unbranched principal caudal-fin rays elongated as filaments (vs. caudal filaments absent); from *P. albomaculatus*, *P. changae*, *P. dentex*,

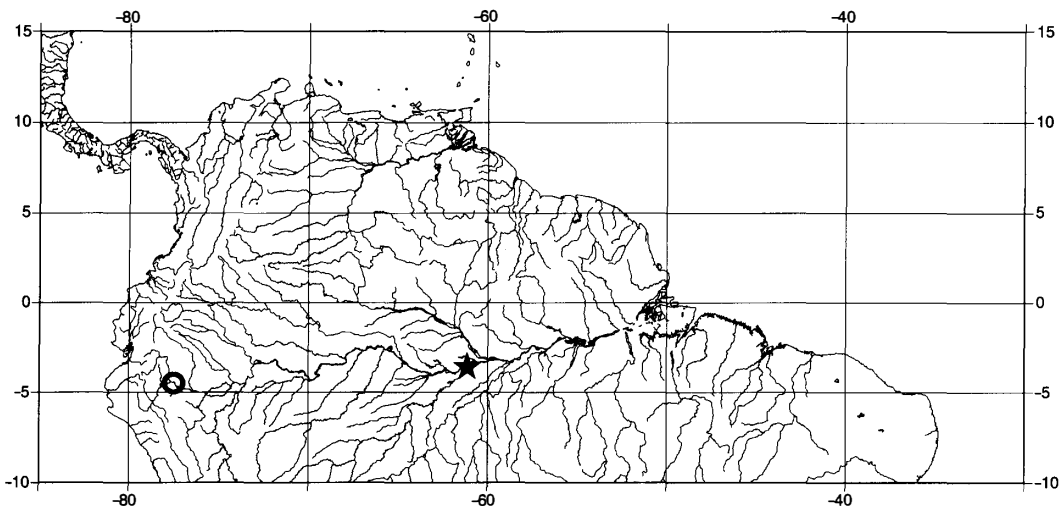


Fig. 3. Type localities of *Hemiancistrus pankimpuju* (O) and *Panaque bathyphilus* (★).

*P. gnomus*, *P. maccus*, *P. nocturnus*, and *P. perusiensis* by having a deeper body (30.8 % SL vs. 22.3-27.4); from *P. albomaculatus*, *P. changae*, *P. dentex*, *P. gnomus*, *P. maccus*, and *P. nocturnus* by having a smaller orbit (11.6 % HL, vs. 12.7-16.2); from *P. albomaculatus*, *P. dentex*, *P. maccus*, *P. nocturnus*, and *P. perusiensis* by having a shorter interorbital distance (50.9 % HL vs. 56.6-65.7); and from *P. dentex*, *P. gnomus*, and *P. perusiensis* by having a shorter caudal peduncle depth (10.1 % SL vs. 11.1-13.4).

**Description.** Morphometrics presented in Table 1. Body deep (30.8 % SL). Dorsal profile of snout and head strongly convex from snout tip to posterior tip of parieto-supraoccipital, curved from this point to dorsal-fin origin, sloped down between dorsal-fin origin and adipose-fin origin, straight from that point to caudal-fin origin. Ventral profile of head and body straight from oral disk to anal-fin origin. Greatest body depth at dorsal-fin origin, least at caudal peduncle. Caudal peduncle ovate in cross section.

Head wide; snout and cheeks completely covered by numerous small plates, except for a small naked area on tip of snout. Orbit small (11.6 % HL). Iris operculum absent. Oral disk ovoid. Lips moderate in size, totally covered by papillae; size of papillae decreasing towards posterior margin of lower lip. Two rows of papillae located mesial to each premaxillary and dentary. Central buccal papilla absent. Lower lip

short, not reaching anterior margin of coracoid. Maxillary barbels short (3 % HL). Premaxillae and dentaries acutely angled. Teeth unicuspid, well developed, spoon-shaped. Premaxillary teeth 5, dentary teeth 7. Preopercular odontodes absent. Cheek odontodes 29.

Head, body and abdomen entirely plated, naked areas on abdomen restricted to a small area immediately medial to pelvic-fin origin. Two predorsal plates not including nuchal plate. Pterotic-supracleithrum large and expanded laterally. Supraoccipital medium sized and conspicuously distinct from pterotic-supracleithrum. Body with pronounced lateral ridge extending from cleithrum to posterior margin of fifth mid-ventral plate, reducing gradually toward trunk; trunk otherwise without elevated ridges.

Dorsal fin II,7, spinelet large and V-shaped, posterior fin margin almost straight. Pectoral and pelvic fins well developed, medial portion much expanded relative to base; posterior margins straight. Pectoral fin I,6; spine covered with odontodes. Tip of adpressed pectoral fin almost reaching middle of pelvic-fin spine. Pelvic fin I,5; spine reaching anal-fin base when adpressed. Anal fin I,4. Adipose fin triangular, spine strongly curved. Caudal fin I,14,I; upper and lower unbranched principal caudal rays extended as long filaments (upper filament of holotype broken). Dorsal procurrent caudal-fin rays five, ventral four.



Fig. 4. *Panaque bathyphilus*, MZUSP 56970, holotype, 73.5 mm SL; Brazil: Amazonas: Solimões River, upstream of confluence with Purus River. Both unbranched principal caudal-fin rays originally elongate as long filaments, dorsal filament broken but retained with specimen.

**Color.** Base color of body, head and fins white. Eyes dark gray to black. All fin spines white. Membranes of all but dorsal fins hyaline. Dorsal-fin rays and membranes with diffuse dark brown to black pigment. Posterior edge of caudal fin with light brown to black band. Ventral surface totally white, chromatophores absent. Color in alcohol is the same as color alive (O. T. Oyakawa & F. C. T. Lima, pers. comm.).

**Distribution.** Known from a single specimen, collected in the Solimões River upstream of its confluence with the Purus River (Fig. 3).

**Habitat.** Collected by trawling whitewater, main channel habitat at 12.8-17.8 m depth over organic detritus substrate, approximately 50 m from li-near beach with grass and shrub.

**Etymology.** From the Greek 'bathos' meaning deep and 'phileos' meaning to love as a friend, in reference to the deep river channel habitat of the species. Gender masculine.

## Discussion

Schaefer & Stewart (1993) diagnosed the *Panaque dentex* clade (*P. albomaculatus*, *P. dentex*, *P. gnomus*, *P. maccus*, *P. nocturnus*, *P. purusiensis*) based on four osteological characters that distinguished these species from the *P. nigrolineatus* group (*P. cochliodon*, *P. nigrolineatus*, *P. suttonorum*): dorsal margin of fifth ceratobranchial with elongate posterior indentation, symplectic foramen of the preopercle greatly enlarged, anterior preopercle-quadrante suture positioned well posteriorly when viewed laterally, and preopercle with a deep lateral groove posterolaterally. They gave other external non-synapomorphic characteristics that are useful to identify members of the *P. dentex* group: absence of the posterior orbital notch, and absence of a keel on the caudal peduncle (features present in all members of the *P. nigrolineatus* group). More recently, Chockley & Armbruster (2002) identified another feature that distinguishes the *P. dentex* clade: an elongate, lateral process of the ventral process of the complex Weberian centrum (mistakenly referred to as the tripus). Verification of these osteological synapomorphies on the single known specimen of *P. bathyphilus* was not possible, but despite this, we consider *P. bathyphilus* as belonging to the *P. dentex* clade based on the absence of a posterior orbital notch and absence of a caudal peduncle keel.

*Hemiancistrus pankimpuju* and *P. bathyphilus* are clearly diagnosed as new species, in part, by their loss of pigment, their small eyes, and the extreme elongation of their unbranched principal caudal-fin rays. Eye reduction or loss, reductions in pigment, and increased development of non-visual sensory systems are adaptations most frequently described for species with specialized hypogean existence (Culver & Wilkens, 2000). Among loricarioid catfishes, for example, loss of pigmentation and reduction in eye size are almost entirely restricted to specialized cave dwelling species (e.g. *Trichomycterus chaberti*, Pouilly & Miranda, 2003; *T. uisae*, Castellanos-Morales, 2008; *Astroblepus riberae*, Cardona & Guerao, 1994; *Ancistrus cryptophthalmus*, Reis, 1987; *A. galani*, Perez & Viloria, 1994; *A. formoso*, Sabino & Trajano, 1997).

Eye reduction or loss and reduction in pigment have also been described in hyporheic fishes from rapids of the lower Congo River (Roberts & Stewart, 1976), and benthic fishes collected from

main channel habitats of the Kapuas River in Indonesia (Roberts, 1989), and the Orinoco and Amazon Rivers in South America (Lundberg et al., 1991; Lundberg & Rapp Py-Daniel, 1994; Friel & Lundberg, 1996). World-wide, depigmented and blind or small-eyed fishes from main river channel habitats are known in at least six orders (Cypriniformes, Gymnotiformes, Osteoglossiformes, Perciformes, Siluriformes, Synbranchiformes) and nearly twice as many families. Most taxa with apomorphic reductions in pigmentation and eye-size come from lineages with plesiomorphically enhanced chemosensory (Cypriniformes, Siluriformes) or electrosensory (Gymnotiformes, Mormyridae) systems and can therefore be assumed to have been preadapted for non-visual navigation, prey capture, and predator avoidance. For fishes that occupy turbid river habitats more than a couple meters deep, vision can be as useless as it might be in a cave. Muntz (1982), for example, demonstrated that light attenuation at 2.3 meters depth in the Solimões River is so great that below this point, vision by fishes is impossible. The geographically and phylogenetically broad convergence upon eye and pigment reduction in tropical, main river channel fish faunas supports the hypothesis that darkness in these habitats either provides a strong evolutionary selection force against these characters, or that eyes and pigments are only selectively retained at the surface (Poulson, 1987). Further support for the existence of a strong selection gradient from shallow to deep channel habitats is provided by Thomas & Rapp Py-Daniel (2008) who describe three species of *Loricaria* with populations spanning this gradient. Each of these species exhibits correlative clinal reduction in eye size and pigmentation with depth. In two of these species for which sample sizes allowed statistical analysis, the relationship between habitat depth and eye size was highly significant (Thomas & Rapp Py-Daniel, 2008).

Light attenuation has also been demonstrated to be a primary environmental gradient predicting fish community structure in floodplain lakes of the Orinoco and Araguaia rivers by Rodríguez & Lewis (1997) and Tejerina-Garro et al. (1998), respectively. In the more turbid of these lakes, the primary benthic predators were catfishes and, in the Orinoco, drum (*Plagioscion squamosissimus*), which have enhanced bioacoustic capabilities (Ramcharitar et al., 2006; although the contribution of this sensory modality to prey detection



has not been investigated). Rodríguez & Lewis (1997) hypothesized that the effect of water transparency on fish community structure was largely mediated via its effect on the dominant mode of prey detection by piscivorous predators (visual versus chemo-, electro-, or mechanosensory). This also appears to be the case for main Neotropical river channel habitats where the dominant piscivores sampled by the Calhamazon (Amazon) and Eastward (Orinoco) expeditions were electric knife-fishes (Gymnotiformes), drum (*Plagioscion* spp.), and pimelodid catfishes (Lundberg et al., 1996; Lundberg & Parisi, 2002; Lundberg, pers. comm.).

Under such conditions, and among benthic fishes small enough to be prey, one might predict evolutionary selection to drive the development of mechanosensory or electrosensory means to detect predators. Chemosensory means are likely ineffective given the ability and likelihood of predators approaching from downstream. Among smaller size classes of siluriform species from main channels of South American rivers, there is a pattern of caudal fin elongation and filamentation that may serve to enhance mechanosensory detection of predators. In addition to adults of smaller-bodied, putatively deep-water specialized species such as *H. pankimpuju* and *P. bathyphilus*, juveniles of both large channel dwelling loricariids (e.g. *Acanthicus*, *Pseudacanthicus*) and pimelodids (e.g. *Brachplatystoma* spp.) express long filamentous extensions of their caudal fins. Although modest elongation of the lower lobe of the caudal fin has been associated with rheophily in Himalayan hillstream fishes (Hora, 1922), the extreme, filamentous elongation (as long as or longer than standard length) of both upper and lower simple caudal rays among South American channel dwelling catfishes is well beyond that observed among rapids-specialized species. The great degree of filamentous caudal fin elongation observed among main-channel catfishes, the restriction of this elongation to the caudal fin, and the predominant frequency with which this character is associated with smaller bodied species, or smaller size classes of larger species, has led K. O. Winemiller (pers. comm.) to hypothesize that among these taxa, fin filamentation may be a mechanosensory adaptation specialized for detection and avoidance of predators approaching from behind. Under this scenario, one can imagine that as these small benthic fish forage in darkness, facing upstream, the disturbance of trailing cau-

dal filaments by the probing barbels or mouth of a predatory catfish approaching from downstream might give the potential prey ample opportunity to escape unharmed, or with only the loss of a fin structure that can be regenerated. We predict that if these conditions (i.e. fish with caudal filaments, darkness, unidirectional flow) were replicated artificially, disturbance of the caudal filaments should result in rapid evasive movement by the fish.

One further possible apomorphy associated with occupation of deep water habitat by *H. pankimpuju* and *P. bathyphilus* is the absence of an iris operculum or iris flap. The iris flap is detectable in preserved specimens of most loricariids, regardless of how dilated the iris is, as a small dorsal convexity at the top of the otherwise round iris perimeter. Douglas et al. (2002) investigated vision in the loricariid genus *Pterygoplichthys* and discussed possible functions of the iris flap. They found that upon transition from dark to light conditions, the iris flap developed such that the iris changed from almost round to crescent shaped. Eye function, however, remained largely unaffected and they hypothesized that the main function of the operculum is to disrupt the round profile of the iris, and camouflage it from visual predators that might otherwise more-easily detect the distinct, round outline of the iris. The absence of an iris operculum among *H. pankimpuju* and *P. bathyphilus* is consistent with the species' other putative morphological specializations for deep water habitat, where the predominant sensory vectors for predator-prey interactions are nonvisual.

Main channel habitats of the Amazon have been subject to intensive bottom trawling during four consecutive field seasons of the Calhamazon project. Together, however, these efforts yielded only a single specimen of *P. bathyphilus* and no specimens of *H. pankimpuju*. Scarcity of these species in collections may be reflective of their true rarity in nature, or perhaps also the preference that most anastrin loricariids have for solid structures of rock or wood (Zuanon, 1999; NKL & CCC, pers. obs.). *Panaque*, in particular, are known to frequent coarse woody debris dams where they feed predominantly on wood (Schaefer & Stewart, 1993; Nonogaki et al., 2007; NKL, pers. obs.). Trawling of main river channels can be difficult and potentially dangerous because of the risk to boats and crew of bottom snags and frequently high flow rates, evidenced by an accident

in the Pastaza River that turned tragic and resulted in the death of Peruvian ichthyologist Fonchi Chang (see Isbrücker et al., 2002; Weber & Montoya-Burgos, 2002; Chockley & Armbruster, 2002; Salcedo, 2006). Trawl sampling can therefore only be safely accomplished in debris-free, relatively flat river bottoms (Herzog et al., 2005). Likewise, electrofishing is effectively limited to either shallow or slow water habitats (NKL pers. obs.).

Under the hypothesis that *P. bathyphilus* and *H. pankimpuju* are specialized members of the deep-water fauna, the collections described herein, from a deep, featureless detrital field and a shallow chute respectively, may represent sampling of peripheral habitat. Highly structured deep water habitat that *P. bathyphilus* and *H. pankimpuju* might be expected to prefer is largely inaccessible to known sampling techniques, suggesting that these species are likely to remain rare in collections. Indeed, the interstices of rocks and woody debris on the bottoms of Neotropical river channels are a potentially diverse and largely undescribed habitat that is likely to retain most of its mysteries until the advent and implementation of new sampling technologies.

**Material examined.** *Panaque maccus* MZUSP 22265, 1, 43.37 mm SL; Brazil: Pará: Oriximiná, Trombetas drainage, 1°46'00"S 55°52'00"W.

*Panaque* cf. *nigrolineatus* MZUSP 94453, 1, dry skeleton; Brazil: Goiás; UHE Serra da Mesa Tocantins drainage.

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