Procatopus websteri: A New Species of Lampeye Killifish from Akaka Camp, Western Gabon (Teleostei: Poeciliidae: Aplocheilichthyinae), Exhibiting Similarities of Pattern and Morphology with Another Sympatric Lampeye Species, *Aplocheilichthys spilauchen*

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A new species of lampeye killifish *Procatopus websteri* is described from Akaka camp, western Gabon. It is readily distinguished from all other lampeye species (subfamily Aplocheilichthyinae) by the unique character of an advanced insertion of the dorsal fin relative to the insertion of the anal fin in both sexes. The new species exhibits similarities in color and morphology with another sympatric lampeye species *Aplocheilichthys spilauchen*, but the resemblance is superficial and the two species are easily separated by the shape of fins in male, the size, the color background in male, and the type of pigments; in addition, the new species shares several other morphological characteristics with members of the genus *Procatopus* sensu lato, dominant in the coastal plain and foothills of plateau from Senegal to Cabinda (Angola).

Certain killifish genera, grouped under the common name lampeyes—because of their unique brilliant spot on the eye of both sexes—comprise about 70 species (Huber, 2006, 2007). Lampeyes are largely distributed in Africa, from the western Sahel to the eastern Republic of South Africa, but there is only one genus, *Fluviphylax*, with five species in South America. Although they are sometimes sympatric with members of a second large group of killifish, the aplocheiloids, they do not dwell in the same ecological niche (running waters vs. stagnant or slightly moving waters), do not exhibit the same behavior (schooling groups vs. hierarchical tribes), and do not show the same structure of color patterns (Huber, 1998).

In her cladistic global monograph of Cyprinodontiformes fishes, Parenti (1981) has shown that lampeyes were related to the viviparous Poeciliidae. The detailed study of lampeyes has been more or less dormant for decades, presumably because they are extremely fragile to collect and typically only 5 to 10 percent can be kept alive for a few days in the field; their bright electric blue reflecting colors need very special conditions and care in aquarium to remain present; and they often prefer somewhat larger bodies of waters than standard killifishes and thus can only represent a secondary objective of collections. All these reasons contribute to the poor interest shown in them by specialized killie aquarists, which means collections are rare and live material available for study scarce.

Three recent publications have somewhat changed that undesired situation: Costa (1996) has reviewed the neotropical genus *Fluviphylax* and confirmed Parenti's move; Huber (1999a) has studied the African species and established a matrix of 19 predefined phylogenetic groups and 74 characters to determine trees, based exclusively on characters of the external phenotype, processed using PAUP software, that confirmed a previously overlooked finding (Huber, 1981) that the genus *Aplocheilichthys* was monotypic; Ghedotti (2000) has studied a limited number of lampeyes within a global osteological study of the poecilioid fishes (Poeciliidae and Anablepsidae), confirmed Parenti's move, established that not only the genus *Aplocheilichthys* was monotypic, but in addition that it was primitive to all Poeciliidae, and proposed to restrict Aplocheilichthyinae to the genus *Aplocheilichthys* and move all oviparous species to Procatopodinae (herein the golden standard of Eschmeyer's families and subfamilies, at http://www.calacademy.org/research/ichthyology/annotated/AnnChkAlph.html, is conservatively followed and all lampeyes are allocated to the subfamily Aplocheilichthyinae). However, despite these recent studies, the molecular analysis of most lampeye species, the osteological study of all species-groups and the understanding of the micro-morphological variation of cephalic sensitive systems and of frontal squamation systems remain to be addressed. In this context, the new species herein described, with its unique characteristics, is a milestone in our understanding of this neglected fish group.

Materials and Methods

Specimens were collected by dipnet from the river that fronts the lodge of Akaka, a small town inland of western Gabon, but not far from the Atlantic coast. Counts and measurements follow Huber (1999a) and were made to the nearest 0.1 mm. The meristic characteristic of the relative deviation of dorsal to anal insertion, important to killifish systematics, but

■ *Procatopus websteri*, female above, male below.

unusual for other fish groups, is defined by the first counted ray below the vertical level of dorsal fin insertion if the dorsal fin is inserted behind anal fin (and reciprocally if the contrary): for example if D/A = +1, the first ray of dorsal fin is positioned at the level between the first and second ray of anal fin (if "0," the insertions of the two fins are superimposed). Cephalic sensitive systems and frontal squamation systems respectively follow Clausen (1967) and Hoedeman (1958) and, specifically for lampeyes, Huber (1981). Institutional abbreviations are as listed in Leviton et al. (1985).

Procatopus websteri, new species (Figs. 1&2)

Holotype: MNHN 2007-1652, 30.8 mm SL, 40.9 mm TL, aquarium-maintained adult male, Gabon, Akaka, about sea level, (approximately 2° 14' S, 9° 40' E), Kent Webster coll., on the night of 26 December 2004.

Paratypes: MNHN 2007-1653 (5 specimens) and BMNH 2007.6.14.1-6 (6 specimens), in total, 11 adult specimens (18.2-27.7 mm SL, 24.2-30.9 mm TL), aquarium bred (F1) from wild parents; AMNH 239292, 6 specimens, 20.2-31.2 mm SL, CAS 224489, 6 specimens, 28.9-19.2 mm SL, aquarium bred (F3) from wild parents.

Diagnosis

Distinguished from all other lampeyes (subfamily Aplocheilichthyinae) by the superimposed insertion of dorsal and anal fins (vs. dorsal fin insertion always posterior to anal fin insertion by at least 4 rays); besides it is separated from the similarly patterned and sympatric *Aplocheilichthys spilauchen* by the smaller maximum size in both sexes, by the more advanced dorsal fin (vs. D/A = +7 on average), by the less high peduncular depth, by the presence of red pigment markings on male sides and unpaired fins (vs. silvery or gold markings), by the absence of a barred pattern on male sides (vs. presence), by the absence of melanistic pigments on body (vs. with many dark small dots), by the absence of extended rays in male posterior anal fin (vs. presence), by being more laterally compressed, i.e. more flattened (vs. less flattened); separated from its congeners in *Procatopus sensu lato* (i.e., including *Procatopus, Plataplochilus, Rhexipanchax* as subgenera) by the more sharply pointed mouth in addition to the D/A value; separated from its congeners living in the same region from southern Equatorial Guinea to Cabinda, currently in *Plataplochilus* (also seen as a full genus, depending on authors) by the rounded shape of the posterior margin of dorsal and anal fins in both sexes (vs. cut straight along the last ray), by the vertical red bars in male (vs. never such a pattern), by the more conspicuous reticulated gray "net" along scale edges (vs. faint or absent), by the absence of an upper acumen or extension in caudal fin of dominant male (vs. presence).

Description

Small, deep-bodied lampeye killifish with a pointed mouth and snout, with advanced superimposed vertical fins, with an orange (not blue, not silvery-golden) spot on upper eye margin of both sexes, with red curved bars on unpaired fins of male, with a gray reticulation on sides.

Morphometric and meristic data for the holotype (in bold) are followed by those for 11 paratypes in parentheses (minimum, maximum, italicized mean): dorsal fin rays (**9**, 7, 9, *8.2*), anal fin rays (**12**, 11, 13, *12.0*),

■ **Fig. 1:** ***Procatopus websteri*, male, aquarium bred topotype (F2 generation), not preserved, Akaka camp, Gabon.**

anal fin rays (9, 7, 9, *8.2*), D/A dorsal/anal insertion deviation (0, -1, +1, *+0.1*), LL scales in longitudinal line (26, 25, 28, *26.3*), TRAV transversal scales obliquely from dorsal fin insertion towards ventral fins (8, 7.5, 8.5, *7.9*), CIR circumpeduncular scales (13, 13, 15, *13.9*); predorsal length short (63.6%, 61.3%, 65.8%, *63.8%* of SL), preanal length (65.9%, 61.5%, 65.9%, *63.9%* of SL), preventral length (50.3%, 45.9%, 50.7%, *48.0%* of SL), caudal fin, longer than deep (32.8%, 28.5%, 35.5%, *30.4%* of SL) and rounded body, very deep with a strong allometry in growth (30.2%, 20.3%, 28.5%, *23.9%* of SL), head short (25%, 23.5%, 28.0%, *26.1%* of SL); other characters: pectoral fin rays (9 or 10) with a relatively lower median insertion, tip of ventral fins reaching 5th or 6th anal fin ray in adult male, terminally branched rays in unpaired fins, two or three series of scales on peduncle, eye large (about 10% of SL) like all lampeyes, interorbitar narrow (about 15% of SL). Sexual dimorphism is marked in adults, not in subadults that besides are less deep-bodied: in male, the length of unpaired fins is longer and with a posterior disruption and the length of ventral fins is much longer and pointed terminally in male. Micromorphological characters (see discussion on systematics): teeth unicuspid, conical, like all lampeyes, very rare ctenoidy on scales, no branchiostegal appendages in male, no enlarged post-opercular scales, four preopercular pores, supraorbital neuromast cephalic pattern variable and intermediate, G-type frontal squamation, with minute scales covering sensitive supraorbital organs.

Color in life, similar in both sexes, notably for the body gray reticulation and the upper orange spot on eye (except the unpaired fins, red-barred in male with five to six curved bars in caudal fin and posteriorly in vertical fins, hyaline in female). In some dominant males, a few red spots are seen on sides near peduncle and the ventral fins.

Color after preservation in 75 percent ethyl alcohol, the red markings become fainter than in life and the orange spot on eye vanishes. The thin dark line on mid sides, characteristic of lampeyes, is present but only conspicuous on juveniles (from after the opercle to the peduncle) and only seen posteriorly in subadults and hardly seen in fully adult specimens; the other typical thin dark line along lower body base is also conspicuous in juveniles, but less so in subadults and not seen in adults; in both sexes, a faint slightly oblique dark short band on preopercular region, just above the level of insertion of pectoral fins, a dark spot just behind the lower part of eye, and a minute gray dot at base of each anal fin ray, not seen in other lampeyes, are present; the pectoral fins of adult dominant male are somewhat dusky gray with a thin lower dark edge.

Etymology

Named for Kent Webster (Rancho Palos Verdes, California, born 1959), discoverer of the species on the night of the Asian Tsunami, who has devoted much of his life to breeding aquarium fishes, notably Australian and New Guinean Rainbows, professionally in the Peninsula Hatchery (Gardena, California).

Akaka Camp Region and Habitat

Akaka is a small inland town in coastal plain of Gabon that boasts an impressive forest lodge for the well-heeled ecotourist (a first response by Gabonese authorities to ecologists' international conservation concerns, along with the creation of forest reserves). The Akaka camp is located where the Rembo Ngowe and Rembo Echira meet. The fish were caught from the river fronting the lodge, together with *Aplocheilichthys spilauchen*. Most died two nights later in the hotel when the temperature dropped to about 65°F (the room temperature was preset and unchangeable). After the bags had been warmed up by running them under temperate water in the sink, three specimens made it to the U.S. alive, one male and two females, which led to a strong progeny. Ecological conditions are, according to Kent Webster, typical of the small rivers inhabited by lampeyes (less than 10 meters wide, less than 1 meter depth during dry season, warm water of over 80°F during the day, slightly acid water—pH just over 6) in primary forest. At camp, the river appears to be strictly freshwater and it is not known if the new species, like *Aplocheilichthys spilauchen*, is also living much more downstream where waters are influenced by tide: no *Procatopus* species has ever been collected in brackish waters. During the night of collection, *Aplocheilichthys spilauchen* was easy to net as they swam at the top of the water, whereas the new species was sleeping on the bottom. The behavior during daylight is unknown for the new species, while *Aplocheilichthys spilauchen* is more often seen in schools in mid open strata of deep waters (except strongly dominant adults, i.e., much above average in size and in fin extensions and with brighter colors that are found isolated).

Breeding and Social Behavior

The two sympatric species present the same behavior, typical of lampeyes: non-annual reproduction with two weeks' water incubation of eggs and schooling in small groups of a few dozens of specimens of various ages and dominance. After a long period in the aquarium and several generations, the new species remains much smaller than *Aplocheilichthys spilauchen*. According to preliminary observations (Webster, pers. comm.) several individuals may have gone through a sex change: this is notably documented for the wild trio, when the male died, one of the 2 adult females turned into a male, with developed red markings and produced fry; such a sex reversal behavior has also been reported sporadically by aquarists among all groups of Cyprinodontiformes fishes, a unique group of teleosts with oviparous, ovoviviparous, reversed oviparous, and hermaphroditic species (Huber, 1998).

■ **Fig. 2:** ***Procatopus websteri,*** **female, aquarium bred topotype (F2 generation), not preserved, Akaka camp, Gabon.**

Discussion

The matrix used for our PAUP study of lampeyes (Huber, 1999a) has been loaded with data of the new species being added, and PAUP as a phylogenetic software has been changed to Phylip due to shortage of resources. The PAUP initially produced tree is absolutely identical when re-running the data set with Phylip and the addition of the characters of the new species into the matrix produces four equi-parsimonious trees with no change in the structure of the tree: *websteri* falls within the *Procatopus* assemblage (comprising the clade of three subgenera *Procatopus* + *Plataplochilus* + *Rhexipanchax*), closest to the *Plataplochilus* branch. In addition, the following systematic definition of *Procatopus* proposed in Huber (1981, 1999a) fits with the characters of the new species, except for the fin extensions: "*Procatopus* s. l. (=*Procatopus* + *Plataplochilus* + *Rhexipanchax*). Synapomorphies (= shared derived characters): red markings on male body and fins (unlike *Hylopanchax* and *Hypsopanchax*); upper and lower caudal fin extensions in dominant male. Other characteristics: deep-bodied; higher than *Hylopanchax* but less so than *Hypsopanchax*, with no break at the frontal level (unlike *Hypsopanchax*); with a truncated caudal fin with extensions in male; acuminate dorsal and anal fins in male; and a pointed transversal profile of mouth."

Therefore, the new species is assigned to the genus *Procatopus* s. l. The placement of the new species in one of the three subgenera or in a new subgenus is beyond the scope of the present study (in prep.) and, because several characters of *websteri* do not fit with their present diagnoses, a complete re-appraisal of the characters in the matrix will have to be worked on. It is not possible to address the phylogenetic position of the new species within Ghedotti's findings (2000), because the osteological characters of the new species have not been studied, because Ghedotti's work was focused on viviparous Poeciliidae, and because *Plataplochilus* was not covered therein.

Procatopus websteri shares several characters with the sympatric lampeye species *Aplocheilichthys spilauchen* (bars in unpaired fins, posterior shape of dorsal and anal fins): however, the new species does not show the silvery/golden characters unique to *spilauchen* among lampeyes, does not have a deep peduncle (14 circumpeduncular scales, vs. 19), does not exhibit the unique pinpointed upper maxillary of *spilauchen*, has a more advanced dorsal fin (predorsal length = 64% of SL, vs. 71%), has a more advanced anal fin (preanal length = 64% of SL, vs. 69%), does not show a strongly shortened caudal fin, is more flattened and is definitely smaller.

Instead, *Procatopus websteri* shares many characters with members of *Procatopus* s. l.: red markings on body sides and fins of male, blue hue (not silvery) on body sides of male (not of female), a deep and flattened body shape with allometry in growth, rounded posterior border of caudal fin in male. And *Procatopus websteri* shares major characters with members of the subgenus *Plataplochilus*, dwelling the same region in the coastal plain of Gabon: the broken blue hue on body sides of male (but more irregular and not in two zones), the supraorbital neuromast system (but not fully, see further), and the relatively lower position of pectoral fin insertion. It is distinctive from all known *Plataplochilus* species by the pointed shape of the snout (not obtuse), by the shape of posterior fins in male (not sharply cut), by the absence of an upper extension of the male's caudal fin, by the conspicuous presence of a gray reticulation on sides of both sexes, by the absence of branchiostegal appendages in the male (rare in *Plataplochilus*, typical of *Procatopus* s. s.), by the near lack of ctenoid scales on sides of old males, limited to a few near peduncle (frequent and numerous in *Plataplochilus*, rare and overall in *Procatopus* s. s.) and, likewise from all lampeyes, by the superimposed insertion of vertical fins.

Despite the large geographical gap between the distribution of the new species and the subgenus *Rhexipanchax* (in the Fouta Djalon old lands of Senegal to Ivory Coast), both

exhibit the conspicuous gray reticulation on sides that is not seen in *Plataplochilus* or *Procatopus* s. s., but this may be a plesiomorphic (= primitive) character, since it is also present in other lampeye lineages (Huber, 1999a: e.g. in *Micropanchax*, among the slender-bodied groups).

Nonetheless, the phylogenetic position of the new species appears to be isolated because of its superimposed insertion of dorsal and anal fins, its smaller size, and the neuromast system.

The supraorbital neuromast system has been shown (Clausen, 1967) as being characteristic of species groups (i.e., genera) among African Cyprinodontiformes fishes, notably lampeyes, but this observation has been challenged by Huber (1981) on the basis of continuous variations. If only the dominant condition is considered (Huber, 1999a), it is useful in diagnosing groups (among other characters, not alone). However the discovery, also in western Gabon, of a new population of the slender genus *Poropanchax* (Huber, 1999b), later renamed as *P. stigmatopygus* by Wildekamp and Malumbres (2004), has shed a new light on that theme with species showing fully intermediate characters: Gabon's *stigmatopygus* presents the standard pattern of 2 to 3 pores with an underlying channel, diagnostic for the genus, together with a pattern of an open groove with visible neuromastic buttons in a significant proportion of specimens. The case of *Procatopus websteri* is parallely the same: among 12 and 8 specimens independently studied by the present author and Paul Loiselle, two types of pattern have been disclosed: either with three to four discrete pores and underlying channels (four pores are diagnostic to *Plataplochilus*) or with an open groove and neuromastic buttons (diagnostic to *Procatopus*), with small scales protecting the system in both types and with strong variations between these two types on an individual basis (e.g., pores on left side, groove on right side of upper head for a single specimen). Huber (1999b) has hypothesized that this may be size related and Loiselle (pers. comm.) confirms that among the AMNH-CAS specimens, the smallest studied specimens show clearly an open groove system. The occurrence of such a specificity for two very distinct species, *Poropanchax stigmatopygus* and *Procatopus websteri*, living in the same biogeographical region and belonging to two genera within two unrelated phylogenetic lineages—the slender genera and the deep-bodied genera—(Huber, 1999a, on morphology, Ghedotti, 2000, on osteology) may not be independently acquired. Further studies may suggest that one of the two types is phylogenetically even older than the other among all lampeyes whatever is their body depth and that these two intermediate species may be the mirror of the palaeo-history of the region as a very important center of speciation for Cyprinodontiformes fishes (Huber, 1998), the lower Ogooué River, with the present and past positions of its delta acting as a major refugium.

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