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Inventory

Fishes of the Mitú Region: middle basin of the río Vaupés, Colombian Amazon

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Abstract: The Amazon River basin hosts the most diverse freshwater ichthyofauna in the world, and yet huge areas of the basin remain unexplored. This is the case for the upper tributaries of the rio Negro, especially those draining the Colombian territory. Here we present a list of 224 species derived from the examination of specimens collected in the Mitú region (Vaupés Department, Colombia), the middle basin of the río Vaupés. Of the species identified in our study, 10 species are recorded from Colombia for the first time, and 26 species are newly recorded from the Colombian Amazon. The number of species we present here comprise almost one-third of the known species diversity of the Colombian Amazon and nearly a tenth of the total number of those known across the entirety of the Amazon basin. The most diverse orders were Characiformes (120 species) and Siluriformes (65 species), and the remaining six orders comprised less than 20% of total species. The study area comprised blackwater systems, which are considered to be nutrient-poor environments. We discuss some ecological aspects that might explain how this highly diverse ichthyofauna originates and is maintain in less productive systems. The list presented here adds an important number of new records and complements the information derived from previous studies, carried out thus far with regards to the fish fauna of the Colombian Amazon.
Keywords: *Distribution; Neotropical ichthyology; species diversity; upper rio Negro basin.*

Peces de la región de Mitú: cuenca media del río Vaupés, Amazonia colombiana

Resumo: La cuenca del río Amazonas alberga la ictiofauna dulceacuícola más diversa del mundo, sin embargo, grandes áreas de la cuenca permanecen inexploradas. Este es el caso de los afluentes de la parte alta del río Negro, especialmente los sistemas que drenan el territorio colombiano. A continuación, presentamos un listado de 224 especies derivadas del análisis de especímenes recolectados en la región de Mitú, cuenca media del río Vaupés (Departamento de Vaupés, Colombia). De las especies identificadas, 10 especies se registran en Colombia por primera vez y 26 especies para la Amazonía colombiana. El número de especies que presentamos aquí comprende casi un tercio de las especies conocidas para la Amazonía colombiana y casi una décima parte del total de las conocidas para la gran cuenca del Amazonas. Los órdenes más diversos fueron Characiformes (120 especies) y Siluriformes (65 especies), y los seis órdenes restantes comprendieron menos del 20% del total de especies. El área de estudio comprende sistemas de aguas negras que se consideran ambientes poco productivos por sus bajos contenidos de nutrientes. Discutimos aquí algunos aspectos ecológicos que podrían explicar cómo esta ictiofauna tan diversa tiene su origen y es mantenida en estos sistemas poco productivos. La información derivada del presente estudio adiciona nuevos registros de especies de peces para Colombia, y complementa la información derivada de los estudios realizados a la fecha en la Amazonía colombiana.
Palavras-chave: *Distribución de especies; diversidad de especies; cuenca alta del río Negroictiología Neotropical.*

Introduction

The río Vaupés is one of the main affluents of the río Negro in the Amazon Basin in Colombia (IDEAM 2004, Latrubesse & Franzinelli 2005). Its headwaters are located at the Department of Guaviare in the Vega of Caquetá. An area named by Hamilton Rice (1910), where he assumed as the commencement of the Amazon forest and where the río Guaviare and río Inírida also originate. Even though the upper reaches of the Vaupés system are located in the Vega de Caquetá, it is termed as the río Vaupés downstream of the confluence of the río Unilla and the río Itilla, at 300 MASL (IGAC 1999), NW of the Miraflores Municipality. The río Vaupés drains from west to east, through the southeastern territory of the Guaviare department and the central region of the Vaupés Department, extending to the confluence with the río Papurí, at the border between Colombia and Brazil, where it becomes the rio Uaupés (Figure 1).

The río Vaupés forms a meandric system with high sediment load at its upper reaches. Downstream, it becomes less meandric and water properties turn out to typically Amazonian blackwaters (Hamilton Rice 1910). Blackwater systems drain *terra firme* forests and savannas. Electrolyte sequestering by the root-mycorrhiza of the forest and the highly leached soils of the catchment area, account for the low turbidity and nutrient levels. Because these systems are typically free of sediment and the high contents of humic compounds, they are darkly stained (Sioli 1984a, Leenheer 1980).

As a typical Amazonian system, it exhibits a flood pulse, such as the adjacent forest remains flooded during high water periods – which in this case lasts up to five months of the year. This flood regime is regulated by the pluviosity conditions of the regional watershed, as well as local rainy events. The seasonal cycle consists of four well-recognized

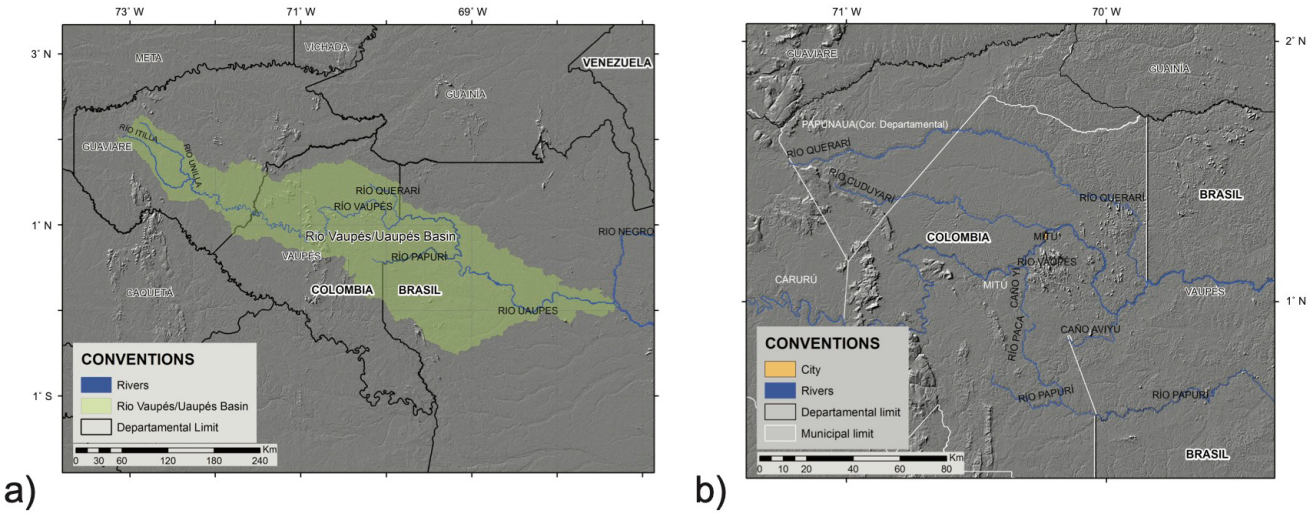

Figure 1. a) Río Vaupés/Uaupes Basin. Red square = study area. b) Study area: Mitú Region. Dots = collecting sites.

hydrological periods: high waters, low waters, and two transition periods of rising and falling waters (IGAC 1996, 1999).

The area contains well-preserved forested areas, with 3 main floristic types: flooded forests, white-sand forests, and terra firme forests (Rudas Lleras 2009). Those three floristic types are found along the margin of the aquatic systems. The main river channel has a strong influence on its smaller tributaries, due to transportation of higher volumes of water, 8.200 m^3/s (IGAC 1999). Streams are characterized by a stained brown color, with sandy and rocky substrates, which may present considerable areas of beach during the low water season.

Studies have reported lower fish species richness in blackwater systems compared to nutrient rich environments (Henderson & Crampton 1997, Bogotá-Gregory, Lima, et al. 2020). Nevertheless, studies have shown that they support relatively diverse ichthyofaunas composed mainly of small fishes adapted to survive in less productive habitats (Goulding et al. 1988, Arbeláez, Duivenvoorden, Maldonado-Ocampo, et al. 2008, Arbelaez et al. 2004, Mojica et al. 2009, Machado-Allison et al. 2013, Antonio & Lasso 2003, Machado-Allison et al. 2003). Fish community comparisons (Saint-Paul et al. 2000) support the notion of "rich life in poor water" as originally described by Goulding et al. (1988), which maintains that the paradoxically high fish species richness of tropical oligotrophic waters is possible because the energy sustaining fish populations is derived primarily from allochthonous forest inputs, rather than *in situ* autochthonous productivity. Studies of terrestrial-aquatic trophic linkages in blackwater rivers have subsequently confirmed that allochthonous inputs from flooded forests are the dominant energy source for fish in blackwater rivers (Correa & Winemiller 2018).

Consistent with the rich life in poor water hypothesis (Goulding et al. 1988), we report high species diversity, with a list of 224 fish species from the Mitú Region, an area in which the freshwater fish diversity was previously underestimated. Previous fish reports are mostly based on reviews that have attempted to compile available information for the río Vaupes (e.g. Mojica 1999; Bogotá-Gregory and Maldonado-Ocampo 2006). These studies have reported fewer than 30 fish species for the whole río Vaupés basin in the Colombian territory. The relatively small number of reports from the basin only reflects the paucity of scientific research studies pertaining to fishes in the region. The most likely explanation for why more complete species inventories has yet to be undertaken in the region is due to its geographical location. Access to the area is logistically demanding for a number of reasons, and further limited for social reasons, given that a history of armed conflict has hampered biological surveys in general. Nevertheless, because of recent

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improvements in the social context of the region, it is now relatively accessible for biological surveys, and more complete species inventories in the region can be carried out.

Despite the recognition of the Amazon River basin as the region with the highest freshwater fish diversity, there are huge areas that remain unexplored. One such area is the hydrographic network that drains the soils of the Mitú Region, an Amazonian system that was previously poorly explored and may be characterized by specialized ichthyofaunas. Our results are part of an inter-institutional initiative of the Instituto Amazónico de Investigaciones Científicas-SINCHI, the environmental corporation CDA, the Universidad del Tolima-UT, and WWF-Colombia, with the intention to fill major gaps in our knowledge of remote areas of the Amazon Basin. The aim of this initiative is to contribute to national species inventory (DoNascimiento et al. 2017, Maldonado-Ocampo et al. 2008) and strengthen the scientific reference collections with the aid of local communities.

Materials and Methods

The study area is located near to the Mitú municipality, department of Vaupés, Colombia, along the main channel of the río Vaupés, río Papuri, río Cuduyari, río Paca, and the Mituceño, and Yi streams (Figure 1). The area is a typical equatorial zone, where daily temperature range between and 18 – 34˚C. The area presents a unimodal precipitation regime, that is to say, the highest precipitation values are registered between June and July, followed by a transition period where rainfall decrease in August and September, and the period with the lowest precipitation values falls between December and March (IGAC 1996).

To document species composition in the study area and not for comparative purposes, a series of sampling events were conducted between 2012 and 2019, during both dry and rainy seasons. Fishes were collected with conventional fishing gear (*i.e.* gill-nets, beach seines, and dipnets). Once fishes were captured, they were euthanized with 600 mg L^{-1} eugenol, fixed with 10% formaldehyde solution and later preserved in 70% ethanol solution. Specimen vouchers are deposited in the ichthyological collections of the Universidad del Tolima (CZUT-IC) and SINCHI institute (CIACOL). The taxonomic list herein, follows the classification adopted in Fricke et al. (2020) for orders and families and genera and species are listed alphabetically. Validity of the species identified were confirmed also with Fricke et al. (2020). Usma et al. (2009) was used to determine species that present relatively long-distance migratory longitudinal movements.

Acronyms of fish collection where specimens are deposited are provided for future revisions. Data from CIACOL will be available at the Catalogue of Species of the Colombia Biodiversity Information System (http://www.biodiversidad.co/). Currently, CIACOL data is hosted in the online collection's catalogue (https://sinchi.org.co/ciacol) and those of CZUT-IC are available at: https://doi.org/10.15472/bhprvq

We classified species based on standard length (SL) into four size classes; miniature species, less than 2.6 cm of SL; small species, over 2.6 and less than 15 cm of SL; medium species, between 15 and 45; and large species, with over 45 cm of SL. This simple scheme for size classification is a unification of Weitzman and Vari (1988), Castro (1999), and Castro et al. (2005), which allowed us to calculate percentage of miniature and small body species that represent the overall species composition in our study area. Body sizes were obtained with Reis et al. (2003), original species descriptions, and direct measurements in the case of undetermined species. To calculate the proportion of species exclusive to blackwaters we defined species affiliations to water type (i.e. whitewater, clearwater, and blackwater) sensu Sioli (1984b). Designation of the species to a given water type was based on empirical evidence.

Results

A total of 224 species belonging to eight taxonomic orders, 37 families, and 123 genera (Table 1) were recognized for the Mitú Region. The orders with most families, genera, and species were Characiformes (17 families, 52 genera, and 120 species) and Siluriformes (10 families, 46 genera, and 65 species) (Figure 2a). The remaining five orders account less than 20% of the total genera and species identified. At the family level, Characidae and Cichlidae were the richest families, with 45 and 13 species, respectively (Figure 2b).

Of the species reported here (Table 1), 10 are new records for Colombia and 26 constitute new records for the Colombian Amazon River basin (DoNascimiento et al. 2017). Most of the species that are recorded for the Colombian Amazon for the first time (over the 10 % of total species reported herein), were previously recorded for other sections of the rio Negro in Brazil. None of the listed species are categorized as threatened (Mojica et al. 2012) or considered exotic or invasive (see natural distributions in Reis et al. 2003 and Fricke et al. 2020). 15 of the species are classified as migratory (Usma et al. 2009).We included in the list six undetermined species of *Odonthocharacidium*, *Tetragonopterus*, *Tyttocharax*, *Ituglanis, Myoglanis*, *Nemuroglanis*, and *Aequidens*. Unequivocal identification for these species could not be reached and further studies are required to review their specific identities. Moreover, we anticipate that some of these species may eventually be recognized as undescribed.

The percentage of species unique to blackwater systems greatly exceed those that are present in two types of water of the ones present in all three blackwater, clearwater, and whitewater systems (Figure 3a). According to the criterion defined herein for designation of size classes, the proportion of miniature and small body size species greatly exceeded that of medium and large size species (Figure 3b).

Discussion

Overall, the species composition found in the middle basin of the río Vaupés (Mitú region), with taxonomic dominance of Characiformes and Siluriformes, agrees with the general pattern documented for the ichthyofaunas of the basin in the Brazilian territory (Beltrão et al. 2019) and other basins of the Neotropical Region (Maldonado-ocampo et al. 2006, Ortega et al. 2006, Ortega-lara et al. 2012, Bogotá-Gregory, Lima, et al. 2020).

The list presented here adds 26 new species records for the Colombian Amazon. Among the new records, *Melanocharacidium dispilomma* Buckup 1993 was indeed reported in Bogotá-Gregory & Maldonado-Ocampo (2006). Nevertheless, this report was based on specimens collected in Brazil, near the border of Colombia [Buckup, 1993: MNRJ 5934, río Tiquié (trib. of río Vaupés)]. Therefore, this record was dismissed in DoNascimiento *et al*. (2017) by not coming from the Colombian Amazon. The specimens referenced herein are actually the first record of the species in Colombian territory. *Copella compta* (Myers 1927) was included in Galvis *et al*. (2007). Nevertheless, the specimens referenced in that paper are misidentifications and belong to a species with a more conspicuous lateral band [see comments and details on diagnostic characters in Zarske & Géry (2006)].

Table 1. List of species. New records: Col = Colombia, Amz = Amazon basin. System: cud = río Cuduyarí, gav = Caño Gavilán, mic = Caño Mico, mit = Caño Mituseño, pac = río Paca, pap = río Papurí, tuc = Tucundira, vau = río Vaupes, yi = Caño Yi. CZUT-IC = Colección Zoológica, Universidad del Tolima. CIACOL = Colección Ictiológica de la Amazonía Colombiana. Commercial species: orna = ornamental, cons = consumption. BW = balckwater, CW = clearwater, and WW = whitewater.

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Order Characiformes															
Family Crenuchidae															
Characidium crandellii Steindachner 1915	pac, vau		708, 961, 962, 963, 983	small	x	x	x								x
Characidium longum Taphorn, Montaña & Buckup 2006	vau		706	small	x	x					x				
Characidium pellucidum Eigenmann 1909	cud, tuc	4424, 4474, 4530, 4867, 4872	707, 709, 3051, 3052, 4359	small	x	x			orna						
Characidium zebra Eigenmann 1909	pap	3607	958-960	small	x	x	x		orna						
Elachocharax pulcher Myers 1927	cud	4889		miniature	x	x								x	
Melanocharacidium dispilomma Buckup 1993	pap	3608		small	x	x			orna		x		x		
Melanocharacidium pectorale Buckup 1993	cud, pap	3593, 4908, 12284		small	x										
Odontocharacidium sp.	cud	4534, 4552		miniature	x										
Poecilocharax weitzmani Géry 1965	cud, vau	4123, 4838	2377, 3104, 3111, 3112, 3822, 3823-3825, 4342	small	x				orna						
Family Erythrinidae															
Erythrinus erythrinus (Bloch & Schneider 1801)	yi		732	medium	x	x									
Hoplerythrinus unitaeniatus (Spix & Agassiz 1829)	pap, vau, yi	3603	731, 829, 1167, 3018, 3752, 3753, 3754, 3788	medium	x	x	x		cons, orna			x	x	x	
Hoplias malabaricus (Bloch 1794)	cud, pac, pap, vau, yi	3587, 4521, 4904, 12296	726-730, 826, 975-982, 1155, 1302, 2338, 2360, 3017, 3794, 4340, 4349, 4353, 4360	large	x	x	x		cons, orna					x	
Family Cynodontidae															

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Hydrolycus wallacei Toledo-Piza, Menezes & Santos 1999	cud, mit		695, 696, 824, 828, 1169	medium	x			Yes	cons					x	
Family Serrasalmidae															
Metynnis hypsauchen (Müller & Troschel 1844)	cud	4856		small	x	x	x	Yes	orna					x	
Myloplus asterias (Müller & Troschel 1844)	vau		1173	medium	x	x									
Myloplus rubripinnis (Müller & Troschel 1844)	cud, vau	3495, 4942	1459	medium	x	x		Yes	cons, orna						
Serrasalmus gouldingi Fink & Machado-Alison 1992	pac		974	medium	x	x									
Serrasalmus manueli (Fernández-Yépez & Ramírez 1967)	pac		973	medium	x	x									
Serrasalmus rhombeus (Linnaeus 1766)	vau	4286		medium	x	x	x		cons						
Family Hemiodontidae															
Argonectes longiceps (Kner 1858)	cud		739	medium	x										
Bivibranchia fowleri (Steindachner 1908)	cud	3545, 4391		small	x	x			orna					x	
Hemiodus gracilis Günther 1864	vau		965, 967, 968, 2352, 4328	medium	x	x		Yes	orna						
Hemiodus immaculatus Kner 1858	cud	4498		medium	x				orna					x	
Hemiodus semitaeniatus Kner 1858	cud, mit, vau	4506, 4512, 4517, 4944	738, 741, 742	medium	x	x	x		orna					x	
Hemiodus thayeria Böhlke 1955	cud, mit, vau, yi	3501, 3537, 4381, 4511, 4555, 4911	964, 966, 1079, 1080, 2353, 2354	small	x									x	
Hemiodus unimaculatus (Bloch 1794)	cud	4401		medium	x	x	x		orna						
Family Anostomidae															
Anostomoides atrianalis Pellegrin 1909	vau		821	small	x	x	x								
Anostomus ternetzi Fernández-Yépez 1949	cud	4836		small	x		x		orna		x				
Gnathodolus bidens Myers 1927	vau	12278		small	x	x					x				

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Laemolyta garmani (Borodin 1931)	vau		954, 955, 1166	medium	x	x	x	Yes	orna						
Laemolyta taeniata (Kner 1858)	cud		743, 744, 745	medium	x	x	x		orna						
Leporinus agassizi Steindachner 1876	vau		1149	medium	x		x							x	
Leporinus aripuanaensis Garavello & Santos 1981	pap	3594		small	x	x									
Leporinus brunneus Myers 1950	cud, vau, yi	3493	746, 823	medium	x	x	x							x	
Leporinus fasciatus (Bloch 1794)	vau	3479, 3480, 4402, 12269	1156	medium	x	x	x	Yes	cons, orna						
Leporinus friderici (Bloch 1794)	cud, pap, vau, yi	3491, 3647, 4061	748, 749, 1154, 3789	medium	x	x	x	Yes	cons, orna					x	
Leporinus klausewitzi Géry 1960	cud, pac, vau	4440, 4489, 4493, 4851, 12289, 12292	956	medium	x		x							x	
Synaptolaemus latofasciatus (Steindachner 1910)	vau	4092, 12279		medium	x	x									
Family Chilodontidae															
Caenotropus mestomorgmatos Vari, Castro & Raredon 1995	vau	3492	724, 725	medium	x				orna						
Chilodus punctatus Müller & Troschel 1844	cud	4515, 4846		small	x	x	x		orna						
Family Curimatidae															
Curimatella immaculata (Fernández-Yépez 1948)	vau		659, 720, 1506, 1507, 1509	small	x	x	x								
Curimatopsis evelynae Géry 1964	cud	4913		small	x		x		orna		x			x	
Curimatopsis macrolepis (Steindachner 1876)	cud, mit	4477		small	x		x								
Cyphocharax festivus Vari 1992	cud, mit, vau	4861, 4870, 4917, 4945	711, 721, 1494	small	x	x	x								
Cyphocharax leucostictus (Eigenmann & Eigenmann 1889)	vau		948-950	small	x		x							x	

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Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Cyphocharax multilineatus (Myers 1927)	cud, pac, pap, mit, vau, yi	3562, 3598, 4412	714-718, 937-946, 1492, 3772	small	x				orna					x	
Cyphocharax spiluropsis (Eigenmann & Eigenmann 1889)	pap	3599	713, 951, 952, 1089	small	x		x								
Cyphocharax spilurus (Günther 1864)	cud, pac	4505, 4919	647	small	x	x	x		orna						
Steindachnerina guentheri (Eigenmann & Eigenmann 1889)	cud	4529		small	x		x								
Family Lebiasinidae															
Copella compta (Myers 1927)	pap	7881	2415, 3019-3024, 3779	small	x				orna	x				x	
Copella eigenmanni (Regan 1912)	cud, vau	4542, 4854, 4932		small	x	x	x		orna						
Copella nattereri (Steindachner 1876)	vau, yi		993-996, 1081, 3778, 3780, 3781	small	x		x		orna						
Nannostomus eques Steindachner 1876	pac		998	small	x	x			orna						
Nannostomus marginatus Eigenmann 1909	cud, pac, vau	3496, 3529, 3583, 4096, 4492, 4547	997, 4337	small	x	x			orna						
Nannostomus trifasciatus Steindachner 1876	vau		2339, 3025-3027, 3787	small	x	x									
Pyrrhulina laeta (Cope 1872)	pap	3588		small	x				orna						
Family Ctenuluciidae															
Boulengerella cuvieri (Spix & Agassiz 1829)	vau		755, 992, 1144, 2022	large	x	x	x								
Boulengerella lucius (Cuvier 1816)	vau		753	medium	x	x	x				x				
Boulengerella maculata (Valenciennes 1850)	cud, vau	4420, 4833, 4898	991	medium	x	x	x		orna						
Family Chalceidae															
Chalceus macrolepidotus Cuvier 1818	cud	4482	733, 734, 1151	medium	x	x		Yes	orna				x	x	
Family Triportheidae															
Triportheus albus Cope 1872	cud, vau		650, 735, 736, 830	small	x	x	x	Yes						x	
Family Gasteropelecidae															
Carnegiella marthae Myers 1927	vau	4076		small	x				orna						

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Carnegiella strigata (Günther 1864)	cud, vau, yi	3586	704, 705, 957, 4332	small	x	x			orna						
Family Bryconidae															
Brycon pesu Müller & Troschel 1845	cud, vau	3538, 4375, 4428, 4933	657, 2057	medium	x	x	x	Yes	orna					x	
Family Iguanodectidae															
Bryconops alburnoides Kner 1858.	vau	4119		small	x	x	x								
Bryconops caudomaculatus (Günther 1864)	pac, pap, vau, yi	12295, 12316	686, 1058, 1076, 3090-3093, 3795, 3827	small	x	x	x		orna						
Bryconops giacopinii (Fernández-Yépez 1950)	cud, pac, vau, yi	4899, 4914, 4915, 4837	681, 702, 1060, 1064, 1066-1071, 1085, 1333, 2021, 2026, 2345-2347, 2349, 2350, 3089, 3094, 3095, 3451, 3456, 3830, 3831, 3834	small	x	x			orna						
Bryconops humeralis Machado-Allison, Chernoff & Buckup 1996	cud, vau	3531, 3539, 3551, 3557, 4847	1062, 1063, 2056, 2340	small	x						x				
Bryconops inpai Knöppel, Junk & Géry 1968	yi		1061, 1072, 1078, 2031, 3796, 3828, 3835	small	x									x	
Iguanodectes purusii (Steindachner 1908)	cud, vau		653, 658, 1056	small	x	x									
Iguanodectes spilurus (Günther 1864)	cud	4538, 4855		small	x	x	x		orna						
Family Acestrorhynchidae															
Acestrorhynchus falcatus (Bloch 1794)	cud, pac, pap, vau	3613, 4322, 4484, 4496, 4844, 12293	661, 665, 666, 668, 987, 988, 989, 990, 1305, 4358	medium	x	x									
Acestrorhynchus falcirostris (Cuvier 1819)	cud, mit, vau	4941	667, 751, 752, 827, 1170	medium	x	x								x	
Acestrorhynchus microlepis (Jardine 1841)	pac	12294	984, 985, 986	medium	x	x	x		orna						
Acestrorhynchus nasutus Eigenmann 1912	cud		662	small	x						x				
Family Characidae															

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Acestrocephalus sardina (Fowler 1913)	vau	12313	697, 1039	small	x	x									
Astyanax anterior Eigenmann 1908	vau, yi	4415	699, 1019, 1021, 1026, 1073, 2369, 2799, 3829, 3832, 3833	small	x	x									
Bryconamericus orinocoensis Román-Valencia 2003	cud	4916, 4949		miniature	x	x									
Charax delimai Menezes & Lucena 2014	cud, vau, yi	4852	651, 700, 1035, 1036, 2375, 3797	small	x					x			x		
Charax pauciradiatus (Günther 1864)	mit		1037, 1413, 2059	small	x					x					
Creagrutus maxillaris (Myers 1927)	pap	3601		small	x	x									
Hemigrammus analis Durbin 1909	cud, vau	3523, 3528, 3543, 3552, 3559, 3566, 3574, 3582, 4175, 4383, 4959, 4920, 4959, 18076	675, 1049, 2378	small	x	x									
Hemigrammus bellottii (Steindachner 1882)	cud, vau	3526, 3534, 3573, 3581, 3650, 4361, 4439, 4843	673, 1011, 2365, 2465, 2469, 2470	miniature	x	x									
Hemigrammus luelingi Géry 1964	mit, pac, vau, yi	4207, 4308	671, 674, 1031, 1042, 1655, 2459	miniature	x	x									
Hemigrammus microstomus Durbin 1918	cud	3579, 3617, 4399, 4553, 4900	676, 2814, 2872, 3444	small	x	x	x								
Hemigrammus newboldi (Fernández-Yépez 1949)	vau		2785	small	x		x								
Hemigrammus ocellifer (Steindachner 1882)	vau	3536		small	x				orna						
Hemigrammus orthus Durbin 1909	tuc		672, 1047, 1048, 1050, 1053, 1657, 3099, 3100, 3105	small	x					x					

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Hemigrammus schmardae (Steindachner 1882)	cud, vau	3499, 4419, 4840, 4845, 4866, 4869, 4957, 12282	1045, 1046	small	x	x									
Hemigrammus vorderwinkleri Géry 1963	cud	4896		small	x	x			orna						
Hemigrammus yinyang Lima & Sousa 2009	cud	4323, 4533, 4857, 4903	2879	small	x										
Hyphessobrycon agulha Fowler 1913	vau	3618, 4540, 4848	2366, 2372, 3097	small	x	x			orna						
Hyphessobrycon bentosi Durbin 1908	cud	4427		small	x	x			orna						
Hyphessobrycon copelandi Durbin 1908	cud, vau	3535, 3576, 4432, 4510, 4859	710, 1040, 1088	small	x	x	x		orna						
Hyphessobrycon dorsalis Zarske, 2014	cud		2781	small	x						x				
Jupiaba abramoides (Eigenmann 1909)	mit		3050	small	x	x					x				
Jupiaba anteroides (Géry 1965)	pap	3596, 12314	698, 3455	small	x	x							x		
Jupiaba poekotero Zanata & Lima 2005	cud, pap, vau	3542, 3572, 3611	1057	small	x								x		
Jupiaba zonata (Eigenmann 1908)	vau	4405	1024, 1055, 2809	small	x	x									
Knodus heteresthes (Eigenmann 1908)	vau	4151, 4200, 12308		small	x	x							x		
Knodus tiquiensis Ferreira & Lima 2006	pac	12307	999, 1001, 1003, 1004, 1029	small	x	x									
Makunaima guianensis (Eigenmann 1909)	vau		1041, 3762-3765	small	x	x									
Microschemobrycon callops Böhlke 1953	pac		1000	small	x						x				
Microschemobrycon casiquiare Böhlke 1953	pac, vau	4404, 4936	1002, 2357	small	x	x								x	
Microschemobrycon geisleri Géry 1973	cud	3505, 4337, 4341, 4426, 4431, 4868		small	x	x									
Moenkhausia ceros Eigenmann 1908	cud, vau	4509, 4907		small	x	x					x				

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Moenkhausia collettii (Steindachner 1882)	cud, pac, pap, vau	3503, 3610, 4199, 4860, 4901, 4906, 18075	684, 1005-1010, 1030, 1083, 1276, 2367	small	x	x			orna						
Moenkhausia comma Eigenmann 1908	yi		693, 703, 2364, 3056	small	x	x			orna						
Moenkhausia cotinho Eigenmann 1908	cud, mit, vau	3554, 3564, 3648, 4194,, 18074	679, 680, 1012, 1013, 1681, 2040	small	x	x	x	Yes							
Moenkhausia diktyota Lima & Toledo-Piza 2001	vau, yi		1022, 1023, 1087, 2370, 2414, 3053, 3054, 3057	small	x										x
Moenkhausia grandisquamis (Müller & Troschel 1845)	vau		1028	small	x	x	x								
Moenkhausia lata Eigenmann 1908	mit		690	small	x	x	x								x
Moenkhausia lepidura (Kner 1858)	mit, pac, pap, vau	3568, 3605, 4961, 5383, 18078	685, 688, 689, 694, 1065, 1075, 1077, 1686, 3447, 3449, 3450	small	x	x	x	Yes	orna					x	
Moenkhausia mikia Marinho & Langeani 2010	cud, pap, vau	3498, 3555, 3584, 4910, 4918, 8069	1084, 2368	small	x										
Moenkhausia oligolepis (Günther 1864)	cud, pac, pap, vau	3500, 3502, 3504, 3561, 3595, 4386, 4409, 4514, 4539, 4865	663, 664, 678, 1014-1017, 2028, 2052, 2054, 2355, 2802, 2884, 3820, 3821	small	x	x	x		orna						
Petitella bleheri (Géry & Mahnert 1986)	vau	4174		small	x						x				
Phenacogaster pectinatus (Cope 1870)	cud, pap, vau	3506, 3532, 3602, 4481, 4548, 4864		small	x	x	x								
Tetragonopterus chalceus Spix & Agassiz 1829	vau, yi	12315	649, 660, 1018	small	x	x			orna				x		
Tetragonopterus sp.	vau	4177		small	x										
Tyttocharax sp.	mic		3114	small	x										
Order Gymnotiformes															

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Family Apteronotidae															
Apteronotus albifrons (Linnaeus 1766)	pac	12323	882, 1386	large	x	x	x								
Family Sternopygidae															
Distocyclus conirostris (Eigenmann & Allen 1942)	vau	12290		large	x	x	x								
Eigenmannia macrops (Boulenger 1897)	pac, vau		879-881	medium	x		x				x				
Eigenmannia sp.	pap	3635	773-777, 877	medium	x				orna						
Rhabdolichops eastwardi Lundberg & Mago-Leccia 1986	pap	3642, 3987		medium	x		x								
Sternopygus macrurus (Bloch & Schneider 1801)	cud, vau, yi	4550, 4948, 12288, 12324	781, 784, 883, 1146, 1384, 1385, 2669, 2671, 2672	large	x	x	x		cons, orna					x	
Sternopygus obtusirostris Steindachner 1881	vau		2670	large	x		x			x					
Family Gymnotidae															
Gymnotus anguillaris Hoedeman 1962	mit, vau		2473, 2520, 2521, 2538, 2576, 2578, 2580, 2581, 2583, 2590-2593, 2597	medium	x		x				x				
Gymnotus carapo Linnaeus 1758	cei, cud, mit, vau, yi	4141	782, 785, 884, 885, 2484, 2517, 2572, 2587, 2588, 2594	medium	x	x	x		orna				x	x	
Gymnotus coropinae Hoedeman 1962	vau		2499, 2501-2504, 2615	medium	x										
Gymnotus javari Albert, Crampton & Hagedorn 2003	pap	3636		medium	x		x		orna						
Gymnotus tiquie Maxime, Lima & Albert 2011	mit		2498	medium	x										x
Family Hypopomidae															
Brachyhypopomus batesi Crampton, de Santana, Waddell & Lovejoy 2016	gav, vau		2474-2477, 2486-2493, 2495, 2500, 2532, 2605, 2608, 2610, 2611, 2612, 2613, 2614	medium	x										

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Brachyhypopomus beebei (Schultz 1944)	gav		2514, 2515, 2546, 2547, 2556-2558, 2567, 2569, 2571, 2574, 2579, 2584-2586, 2589, 2598, 2601-2604, 2606, 2607, 2609, 2652, 2653	medium	x	x	x								
Brachyhypopomus hamiltoni Crampton, de Santana, Waddell & Lovejoy 2017	gav, mit		2480, 2668	medium	x		x			x					
Microsternarchus aff. bilineatus Fernández-Yépez 1968	cei, mit		2485, 2505, 2508-2510, 2518, 2530, 2531, 2533, 2537, 2539, 2541, 2543, 2544, 2548, 2550, 2553, 2562-2566, 2655, 2656, 2880, 3761	small	x						x				
Family Rhamphichthyidae															
Gymnorhamphichthys hypostomus Ellis 1912	pap	3637		medium	x		x								
Gymnorhamphichthys rondoni (Miranda Ribeiro 1920)	mic, yi		779, 2551, 2552, 2595, 2596, 2599, 2600, 3816, 4329	medium	x	x	x								
Hypopygus lepturus Hoedeman 1962	cud, pac, vau	4147, 4429, 4513, 4946	875, 876, 2478, 2481-2483, 2494, 2516, 2524-2528, 2559, 2560, 2568, 2570, 2573, 2616-2651, 2654	small	x	x	x		orna						
Rhamphichthys rostratus (Linnaeus 1766)	vau		783, 2673-2676	large	x		x		orna						
Steatogenys elegans (Steindachner 1880)	yi		778	medium	x	x	x		orna						
Order Siluriformes															
Family Trichomycteridae															
Ituglanis sp.	mit		855	small	x										

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Ituglanis metae (Eigenmann 1917)	pap	3638		small	x						x				
Ochmacanthus reinhardtii (Steindachner 1882)	vau	4414		small	x		x								
Paracanthopoma parva Giltay 1935	vau		2029	small	x		x								
Stauroglanis gouldingi de Pinna 1989	mic		3116, 3624	small	x					x					
Family Callichthyidae															
Callichthys callichthys (Linnaeus 1758)	pap, mit, vau	3629, 4491	851, 4352	medium	x	x	x		orna					x	
Callichthys serralabium Lehmann A. & Reis 2004	yi		852	medium	x										x
Corydoras melanistius Regan 1912	cud	4389		small	x				orna		x				
Corydoras melini Lönnberg & Rendahl 1930	cud, pap	3597, 3622, 3623, 4873	810	small	x				orna				x		
Corydoras sp.	cud, yi		811, 833	small	x										
Hoplosternum littorale (Hancock 1828)	vau	4049		small	x	x	x		orna						
Megalechis picta (Müller & Troschel 1849)	cud		809, 853, 3609	medium	x	x	x								
Family Loricariidae															
Hemiancistrus subviridis Werneke, Sabaj Pérez, Lujan & Armbruster 2005	vau	4830, 4934		small	x				orna		x				
Hypancistrus inspector Armbruster 2002	vau		1599	small	x						x				
Hypostomus oculeus (Fowler 1943)	cud	4541		medium	x		x								
Loricaria cataphracta Linnaeus 1758	cud, vau	4519, 12301	3809	medium	x	x	x							x	
Rineloricaria daraha Rapp Py-Daniel & Fichberg 2008	pac		850	medium	x										
Rineloricaria formosa Isbrücker & Nijssen 1979	pac, yi		843-848, 3045-3047	small	x		x		orna		x				
Spatuloricaria caquetae (Fowler 1943)	vau	4421		medium	x		x		orna						
Family Cetopsidae															

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Cetopsis coecutiens (Lichtenstein 1819)	vau	12275	1650	medium	x	x	x								
Denticetopsis seducta Vari, Ferraris & de Pinna 2005	cei		857	small	x						x				
Helogenes marmoratus Günther 1863	pap, vau	3640	856, 2358, 3041, 3042, 4343, 4344	small	x				orna					x	
Family Aspredinidae															
Bunocephalus coracoideus (Cope 1874)	yi		820	small	x	x	x								
Bunocephalus knerii Steindachner 1882	cud		858	small	x		x								
Family Auchenipteridae															
Ageneiosus inermis (Linnaeus 1766)	vau	12274		large	x	x	x								
Ageneiosus polystictus Steindachner 1915	cud, vau		786, 1158	medium	x										x
Ageneiosus ucayalensis Castelnau 1855	vau	4834		medium	x	x	x								
Auchenipterichthys coracoideus (Eigenmann & Allen 1942)	cud, vau		792-795, 866, 1159	small	x	x	x								
Centromochlus heckelii (De Filippi 1853)	cud	4902, 12285		small	x	x	x								
Balroglanis macracanthus (Soares-Porto 2000)	pap	14318		small	x										
Tatia brunnea Mees 1974	pac, pap	3631	796, 867, 869, 870, 3607	small	x										x
Tatia gyrina (Eigenmann & Allen 1942)	mit		3606, 3608	small	x										
Tatia intermedia (Steindachner 1877)	cud	4472, 4495, 4526		small	x	x			orna						
Tatia nigra Sarmento-Soares & Martins-Pinheiro 2008	vau	4441, 4544		small	x										
Tatia strigata Soares-Porto 1995	vau	4527		small	x										
Trachelyopterus galeatus (Linnaeus 1766)	cud, pap, vau, yi	3490, 3494, 3630, 3633, 4897	787-791, 868, 1163	medium	x	x	x		orna					x	
Family Doradidae															
Acanthodoras cataphractus (Linnaeus 1758)	cud, vau		871, 3861	small	x							x			

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Acanthodoras spinosissimus (Eigenmann & Eigenmann 1888)	pap, vau	3624, 3625, 4288, 4363		small	x				orna						
Amblydoras affinis (Kner 1855)	cud, pap, vau, yi	3486, 3627, 4418, 4480, 4525, 4951	812, 813, 814, 872, 3605	small	x										
Anduzedoras oxyrhynchus (Valenciennes 1821)	vau	3487	873	medium	x				orna		x				
Hassar orestis (Steindachner 1875)	vau	4135, 4137		medium	x	x			orna						
Leptodoras copei (Fernández-Yépez 1968)	vau	12297		small	x		x			x					
Megalodoras uranoscopus (Eigenmann & Eigenmann 1888)	vau	4832		large	x				cons						
Rhinodoras boehlkei Glodek, Whitmire & Orcés V. 1976	vau	12272, 12318	1648	small	x		x								
Scorpiodoras heckelii (Kner 1855)	pap	3626		medium	x	x			orna						
Family Heptapteridae															
Gladioglanis conquistador Lundberg, Bornbusch & Mago-Leccia 1991	vau		3622	small	x										
Leptorhamdia sp.	vau	12320		small	x										
Mastiglanis asopos Bockmann 1994	cud, pac, yi	4384, 4871	819, 859, 860, 3043, 3044, 3616, 4334	small	x	x			orna					x	
Myoglanis sp.	vau	4953, 12273		small	x										
Nemuroglanis sp.	cud		2386	small	x										
Pariolius armillatus Cope 1872	vau		887, 888, 4348	small	x										
Pimelodella buckleyi (Boulenger 1887)	yi		816, 818, 2343	medium	x										
Pimelodella cristata (Müller & Troschel 1849)	vau	4376	862	medium	x	x	x								
Rhamdia laukidi Bleeker 1858	cud, yi		799, 800, 822, 863, 864	medium	x				cons		x				
Rhamdia muelleri (Günther 1864)	vau	12291		medium	x	x	x				x				
Rhamdia sp.	cud, pap, yi		797, 798, 865, 3615	medium	x				cons						
Family Pimelodidae															

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Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Megalonema platycephalum Eigenmann 1912	vau		1164	medium	x		x				x				
Pimelodus albofasciatus Mees 1974	vau	12299		medium	x	x									
Pimelodus blochii Valenciennes 1840	cud, vau	3482, 3483, 3484, 3485, 4422	801, 802, 1153	medium	x	x	x	Yes	cons, orna					x	
Pimelodus ornatus Kner 1858	vau	3481, 4136, 12298	3614	medium	x	x		Yes	cons, orna						
Pinirampus pirinampu (Spix & Agassiz 1829)	vau		1143	large	x	x	x								
Pseudoplatystoma tigrinum (Valenciennes 1840)	vau		1171	large	x		x								
Family Pseudopimelodidae															
Batrochoglanis raninus (Valenciennes 1840)	vau	4388		medium	x	x	x		orna						
Batrochoglanis villosus (Eigenmann 1912)	cud		815, 854	small	x	x	x						x		
Pseudopimelodus bufonius (Valenciennes 1840)	mit	12319		medium	x	x									
Order Synbranchiformes															
Family Synbranchidae															
Synbranchus marmoratus Bloch 1795	cud, pap, vau, yi	3639, 4494, 4874	889, 2341, 2359	large	x	x	x		orna			x	x		
Order Cichliformes															
Family Cichlidae															
Aequidens sp.	vau	4935	3029-3032, 3037, 3038	small	x										
Apistogramma regani Kullander 1980	cud	4362, 4523		small	x		x		orna	x					
Cichla orinocensis Humboldt 1821	mit		927, 1147	large	x			Yes	cons				x		

Taxa/Taxon	System	Collection		Size class	Water type			Migratory	Trade	New Records		Reported previously			
		CZUT-IC/ IAvH-P	CIACOL		BW	CW	WW			Col	Amz	Mojica 1991	Bogotá-Gregory & Maldonado 2006	Galvis et al. 2007	Bogotá-Gregory et al. 2020
Cichla temensis Humboldt 1821	cud, mit	4479, 12302	756, 1145	large	x				cons, orna					x	
Crenicichla anthurus Cope 1872	cud, pac, vau	4332, 4339, 4483, 4487	772, 919, 922, 923, 925, 926	medium	x				orna						
Crenicichla lenticulata Heckel 1840	cud	4360, 4895, 12276, 12303		medium	x				orna				x		
Crenicichla lugubris Heckel 1840	cud	3488		medium	x	x									
Crenicichla marmorata Pellegrin 1904	mit		928	medium	x										x
Crenicichla saxatilis -group	pap, yi		918, 921, 924, 3033	medium	x				orna						
Geophagus abalios López-Fernández & Taphorn 2004	vau		768, 1161	small	x	x			orna					x	
Geophagus winemilleri López-Fernández & Taphorn 2004	pac		935, 936	small	x				orna						
Heros efasciatus Heckel 1840	pac		916, 917	small	x				orna						
Satanoperca jurupari (Heckel 1840)	cud, vau	4955, 12305	760, 761, 767	medium	x	x	x		orna					x	
Order Cyprinodontiformes															
Family Rivulidae															
Anablepsoides ornatus (Garman 1895)	vau	4940	2380	small	x				orna						
Laimosemion amanapira (Costa 2004)	vau		890, 891	small	x					x					
Order Beloniformes															
Family Belonidae															
Potamorrhaphis guianensis (Jardine 1843)	cud, pac, vau		892, 893, 1389, 2657-2664, 3808	medium	x	x	x							x	
Incertae sedis in Eupercaria															
Family Sciaenidae															
Plagioscion squamosissimus (Heckel 1840)	vau		1168	large	x	x	x		cons						

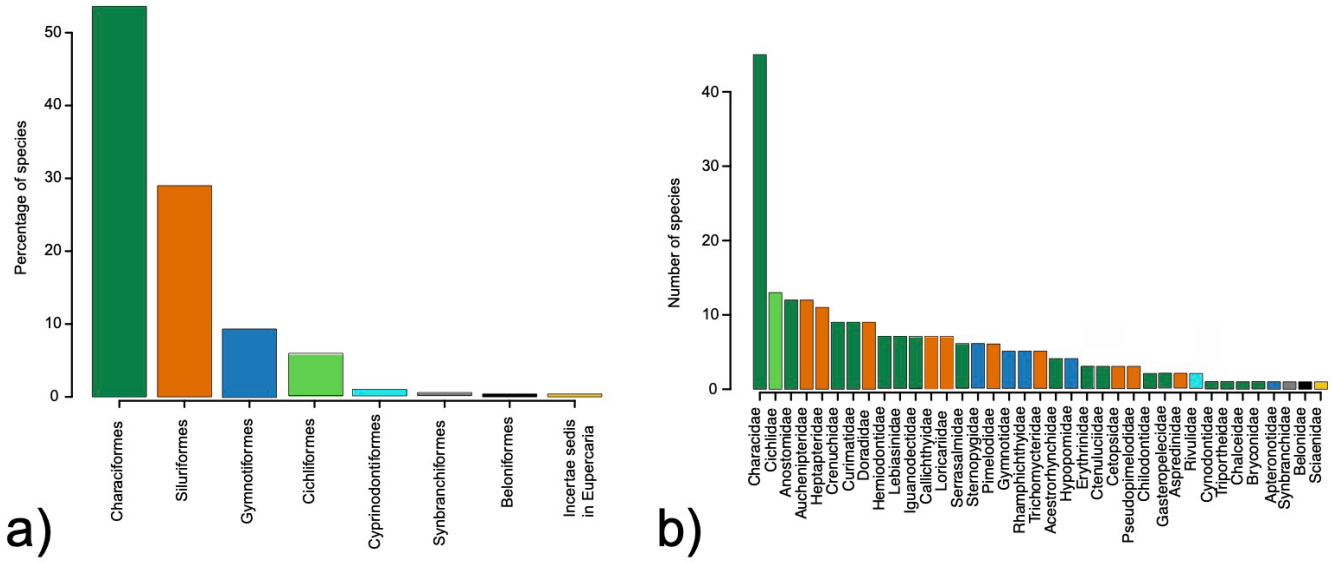

Figure 2. (a) Percentage of species by order and (b) number of species per family.

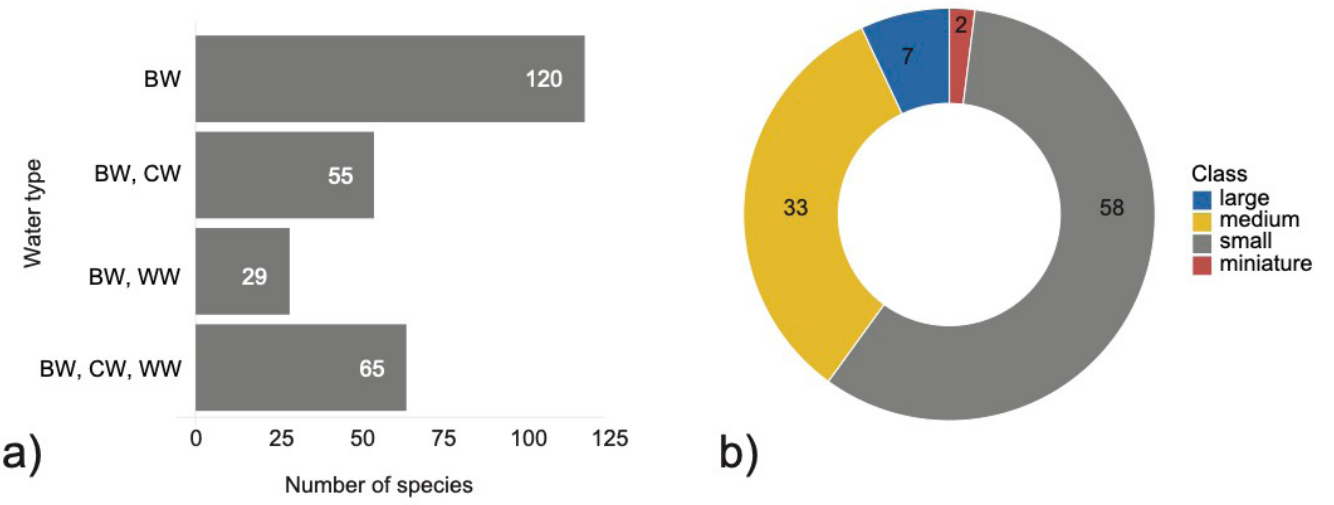

Figure 3. (a) number of species per water type: BW = blackwater, CW = clearwater, and WW = whitewater and (b) Percentage of species per size-class

In one of the first efforts to document the freshwater fishes from Colombia (Mojica 1999), only four species were listed across the entirety of the río Vaupés basin: *Hoplerythrinus unitaeniatus, Acanthodoras cataphractus, Platydoras hancockii*, and *Synbranchus marmoratus.* We confirmed the presence of these species, except *Platydoras hancockii*, which is the only species of the genus reported for the río Negro basin (Piorski et al. 2008). Because of this, its presence in the río Vaupés is expected to be documented when more sampling efforts can be conducted in the area. Bogotá-Gregory and Maldonado-Ocampo (2006) increased species number in the río Vaupés to 24 species, from which 14 were here recorded (see Table S1 for species not identified in our study, but which were previously reported). Galvis et al. (2007) in his study focused on fish species used in ornamental trade, also reported additional species for the río Vaupés basin. Lima and collaborators (2020) described *Hemigrammus xaveriellus*, from the río Itilla, at the headwaters of the río Vaupés basin. More recently, Bogotá-Gregory et al. (2020a) reported eight species in the Mitú Region that were not previously registered from Colombia and are included here. As can be verified from this brief account, studies regarding fish composition of the río Vaupés basin are scant. Additionally, the low species richness previously reported (Bogotá-Gregory & Maldonado-Ocampo 2006) was mainly the result of isolated sampling events, rather than the actual figure derived from extensive collection efforts in the implied region, as demonstrated in this work. The previous studies in the area are not exclusively based on specimens available in ichthyological collections, but also in literature records. This type of taxonomic lists may contain discrepancies in species identification, which are difficult to assess due to unavailability of reference specimens of the bibliographic records. Discrepancies can also arise from outdated taxonomic identifications. In our study, we counted with the collaboration of specialists in different taxonomic groups that ensures reliable taxonomic identifications.

A recent checklist for the entire portion of the rio Negro basin in Brazil, reported 1,165 species (Beltrão et al. 2019). However, there is little published information concerning the ichthyofauna from its upper section, above São Gabriel da Cachoeira, and particularly from the rio Uaupés basin. Lima et al. (2005) reviewed the available information for the area published at that time. The same authors presented a list for the species found in the upper portion of the rio Tiquié, an important tributary of the rio Uaupés, with headwaters within the Departamento of Vaupés, and reported 147 species for the area. Subsequent collecting in the middle portion of the rio Tiquié raised the number of species to 265 (F.C.T. Lima, unpubl. data). Several species were described in the last years, based on this fish survey (Lima & Sousa 2009, Marinho & Lima 2009, Carvalho et al. 2010, Maxime et al. 2011, Birindelli et al. 2012, Lima & Sazima 2017, Pablo Lehmann et al. 2018, Soares et al. 2019). However, other portions of the rio Uaupés basin in Brazil remain virtually unknown ichthyologically.

Despite recent efforts documenting fish migrations in Colombia (e.g. Usma et al. 2009), the río Vaupés and more generally, the Amazon basin are still incompletely studied, and movement patterns of fishes remain poorly documented. Therefore, species listed as migratory here might not be the only ones that perform large longitudinal migrations in the basin. Upstream migrations of some *Leporinus* species were reported by Lima et al. (2005) from the rio Tiquié.

Blackwaters have extremely low pH values, due to high content of acidic humic compounds, largely derived from incompletely decomposed organic matter, which gives the water its typical tea stained coloration (Goulding et al. 1988, Leenheer 1980). The extremely low pH exerts physiological constraints on the biota, which affects ionic balance and osmoregulation in freshwater fishes (McDonald 1982, Wilson et al. 1999, Matsuo & Val 2002). Physiological studies have provided experimental support for mechanisms to prevent acidification in some fish species of these kind of environments (Hirata et al. 2003). Thus, the fish communities that characterizes the blackwater systems, like those we sampled in our study area, are most likely represented by species especially adapted to extreme pH conditions (Val & de Almeida 1995). As we evidenced in our study, more than 50% of the species identified are unique to these low pH aquatic systems.

Blackwater systems are also known for their low productivity in terms of biomass (Goulding et al. 1988, Bogotá-Gregory, Lima, et al. 2020). This is partially reflected in the small number of blackwater-endemic fishes, only 16 species, collected commercially for human consumption (Lasso et al. 2011). In contrast, 85 species have commercial importance in the ornamental trade in Colombia (Galvis et al. 2007, AUNAP 2016, Nogueira et al. 2012, Landines et al. 2005) (Table 1). The majority of the species in this study have small body size, which agrees with similar findings in other recent studies that have shown that the relatively nutrient-poor systems can indeed maintain a relatively diverse ichthyofauna, yet mainly composed of small fishes that had acquired proper adaptations to thrive in less productive habitats (Arbeláez, Duivenvoorden & Maldonado-Ocampo 2008, Arbelaez et al. 2004, Mojica et al. 2009, Goulding et al. 1988, Machado-Allison et al. 2013, 2003, Lasso et al. 2006). On the contrary, the majority of medium to large size species are associated with large longitudinal migratory movements (Castro & Polaz 2020). And because of this they're mostly found in the main channels of more productive systems where they found better conditions as nursery areas (De Lima & Araujo-Lima 2004).

In less productive systems, like the blackwater rivers of the Amazon basin, most of the energy obtained by the aquatic fauna is of allochthonous origin. The adjacent forests provide food resources in the form of fruits, seeds, and arthropods (Goulding et al. 1988, Lowe-McConnell 1987). One of the strategies by which these highly diverse communities can be maintained could be by reducing their biomass. In this manner, blackwater systems can maintain highly diverse fish communities with relatively low abundances, as shown by Saint-Paul et al. (2000), in a comparison between blackwater and whitewater floodplain fish communities. Another of the most important adaptations observed thus far is miniaturization, which includes paedomorphic retention of juvenile characteristics and reductive morphological evolution. Miniaturization has evolved on multiple occasions in Neotropical fishes, as a way to occupy interstitial habitats of marginal vegetation and leaf litter of the substrate (Crampton 2011, Weitzman & Vari 1988).

The new records presented here for the Colombian Amazon reflects scarcity in the studies carried out thus far with regards to the fish fauna of the region. While most ichthyological surveys have been performed in the surroundings of populated localities, with emphasis on species of commercial importance (Bogotá-Gregory & Maldonado-Ocampo 2006), this study was carried out to survey previously little-explored areas. Over the last four decades, intensive field collections and improvements in taxonomy have yielded an improved understanding of how Amazonian fish species are distributed among the Amazon's aquatic ecosystems. However, there are still huge remote areas that remain unexplored, and we are not yet close to knowing the species diversity of these pristine areas.

Initiatives that encompass studies like ours, allow us to document the ichthyofauna of the most diverse region in the world. The information and analyses generated by this study will be of utility to a broad range of researchers interested – including from the fields of ecology, biogeography, and taxonomy. Aditionally, it constitute important baselines for its application in management and conservation plans. This is important in light of the habitat degradation that freshwater fish species are facing due to anthropogenic activities. Deforestation, mining, dam-construction, and overfishing threaten most of the Amazon region, and management and conservation plans are still lacking (Abell et al. 2008).

Supplementary Material

The following online material is available for this article:

Table S1 - Species not reported in our study but previously registered for the Vaupés basin.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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