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Inventory

Fishes from Yarinacocha lake: an emblematic Amazonian ecosystem in the lower Ucayali River basin, Pucallpa, Peru

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Abstract: The Yarinacocha lake is an emblematic ecosystem of the Peruvian Amazon, representing the main point of fish landing and a tourist attraction in the city of Pucallpa. The wide fauna diversity in this area has made it the target of various studies, although for fish species most of them were focused on commercial species. In this work, we carried out the first ichthyofauna species inventory of the Yarinacocha lake, sampling throughout the entire lake during the rainy and dry seasons and considering also all previously recorded species deposited in the Ichthyological Collection of the MUSM with the same locality. A total of 164 fish species were recorded, representing 10 orders (plus Eupercaria), 34 families and 116 genera. Characiformes was the order with more species (68 spp., 41.5%) followed by Siluriformes (59 spp., 36%), Cichliformes (17 spp., 10.5%), and Gymnotiformes (8 spp., 4.9%). The most highly represented families, including almost 55.5% of the total diversity obtained, were Characidae (23 spp., 14%), followed by Cichlidae (17 spp., 10.4%), Loricariidae (14 spp., 8.5%), Pimelodidae (13 spp., 7.9%), Doradidae (13 spp., 7.4%) and Anostomidae (12 spp., 7.3%). From the total fish species recorded in this study, only 22 are considered protected species following the IUCN criteria and 109 species have commercial importance, including 90 ornamental species (54.8%). Our results contribute to the knowledge of the ichthyofauna of the Yarinacocha lake and can be used as a starting point for its conservation and sustainable management over time.
Keywords: *Amazon; Ichthyofauna; Inventory; Neotropical; South America.*

Peixes do lago Yarinacocha: um ecossistema amazônico emblemático na bacia do baixo rio Ucayali, Pucallpa, Peru

Resumo: O lago Yarinacocha é um ecossistema emblemático da Amazônia peruana, representando o principal ponto de desembarque de peixes e também uma atração turística da cidade de Pucallpa. A grande diversidade faunística nesta área a tornou alvo de vários estudos, embora para as espécies de peixes a maioria deles tenha sido focada em espécies comerciais. Neste trabalho, realizamos o primeiro inventário da ictiofauna do lago Yarinacocha, amostrando todo o lago durante as estações chuvosa e seca, e também considerando todas as espécies depositadas na Coleção Ictiológica do MUSM dessa localidade. Um total de 164 espécies de peixes foram registradas, representando 10 ordens (mais Eupercaria), 34 famílias e 116 gêneros. Characiformes foi a ordem com mais espécies (68 espécies, 41,5%), seguida por Siluriformes (59 espécies, 36%), Cichliformes (17 espécies, 10,5%) e Gymnotiformes (8 espécies, 4,9%). As famílias mais representadas, incluindo quase 55,5% da diversidade total obtida, foram Characidae (23 spp., 14%), seguido por Cichlidae (17 spp., 10,4%), Loricariidae (14 spp., 8,5%), Pimelodidae (13 spp., 7,9%), Doradidae (13 spp., 7,4%) e Anostomidae (12 spp., 7,3%). Do total de espécies de peixes registradas neste estudo, apenas 22 são consideradas espécies protegidas seguindo os critérios da IUCN e 109 espécies têm importância comercial, incluindo 90 espécies ornamentais (54,8%). Nossos resultados contribuem para o conhecimento da ictiofauna do lago Yarinacocha e podem ser utilizados como ponto de partida para sua conservação e manejo sustentável ao longo do tempo.
Palavras-chave: *Amazonia; América do Sul; Ictiofauna; Inventário; Neotropical.*

Introduction

The Peruvian Amazonian ichthyofauna has been the object of numerous and in-depth studies, which register more than 800 species (Ortega et al. 2012). Among lotic water bodies, the most important assessments include the Amazon (Goulding et al. 2003), Huallaga (Ortega et al. 2007), Madre de Dios (Barthem et al. 2003), Aguaytía (Quezada et al. 2017) and Las Piedras (Carvalho et al. 2011) River basins. Likewise, the lentic aquatic ecosystems of the Peruvian Amazon play an important ecological role and contribute to the support of economic activities of the local population (García-Vásquez et al. 2009) due to its value as a source of hydrobiological resources. This is partially the consequence of oxbows migration, which promotes this enormous diversity forming sinuous rivers and lakes during the course changes (Nagel et al. 2022), and the flood pulses that comprise annual oscillations of the average water level (Junk et al. 1989), allowing the interconnection of lakes and small water bodies during the floods (Bartletta et al. 2010).

The Yarinacocha lake, located in the district of Yarinacocha, department of Ucayali, known regionally as "cocha" or "tipishca" by shipibo-conibo populations, is approximately 20 km long, with an area of 13.4 km^2, a maximum depth of 19 m and average width of 650 m (Campbell et al. 2017). Its meandering origin formed by the erosion of Ucayali River banks (Neuendorf et al. 2005) has allowed the occurrence of an enormous diversity, not yet fully monitored, but which supports important fishing activities in the region, local consumption and tourist destination (García-Dávila et al. 2018). During the floods of the Ucayali River in January, February and March, the entire lake acts as a riverside highway for trade and transportation (Campbell et al. 2017). The rest of the year it is supplied with water from small tributaries that can be streams or "caños", which are small channels that connect the lake with other water bodies and represents a key habitat for many species of fish reproduction (MINAM 2021). However, as a result of the human populations growth on the riverbanks (hamlets, communities and the population of the Yarinacocha district), restaurants and tourism, the use of toxic substances in illegal fishing and by hospital wastewater that fail biodiversity and human health (personal comments by José Riofrío), this ecosystem is highly polluted by sewage and solid waste that could affect biodiversity (Rondon-Espinoza et al. 2022). These characteristics and threats as a whole, give Yarinacocha lake an emblematic meaning covering cultural, economic and ecological aspects worthy of being preserved and studied.

Scientific knowledge of the fish species composition at Yarinacocha lake is limited. A recent study reports that the diversity of fish species that arrives at the Yarinacocha lake landing stage, including a large part of the Utuquinía and Callería sub-basins, and to a lesser extent Loreto and Aguaytía-San Alejandro (Salazar-Ramirez et al. 2021). In their results, 63 species between 2015 and 2019 were reported, being the most abundant "carachama" (Loricariidae), "piro" (Doradidae), "palometa" (*Mylossoma* spp.) and "sardina" (*Triportheus* spp.) all of them recorded only as common names that may include several species. Other studies include monitoring of fishing landings in the city of Pucallpa (Vela et al. 2016) and characterization of commercial fisheries in the Ucayali River basin (Zorrilla et al. 2016), without offering precise data on the ichthyofauna of the lake. Also, these studies focus on large fishes with commercial interest, while neglecting the smaller species that contain the highest biomass (Barletta et al. 2010) and to date, no other publication has reported the total diversity of the ichthyofauna of the Yarinacocha lake.

This lack of monitoring and rapid identification tools for the fish fauna of Yarinacocha lake encourages the existence of erroneous records in fishing statistics (García-Dávila et al. 2018) and could be covering up the depredation of the fish populations.

For the above stated, we have formulated as the main purpose of this work to present the first fish species checklist of Yarinacocha Lake, updating the information of continental catalogs (Reis et al. 2003), species threatened status (IUCN 2022) and economic importance of species reported.

Material and Methods

A total of 15 sampling sites were evaluated (Fig. 1, Table 1), covering variable environments inside Yarinacocha lake including streams, water channels and shores (Fig. 2).

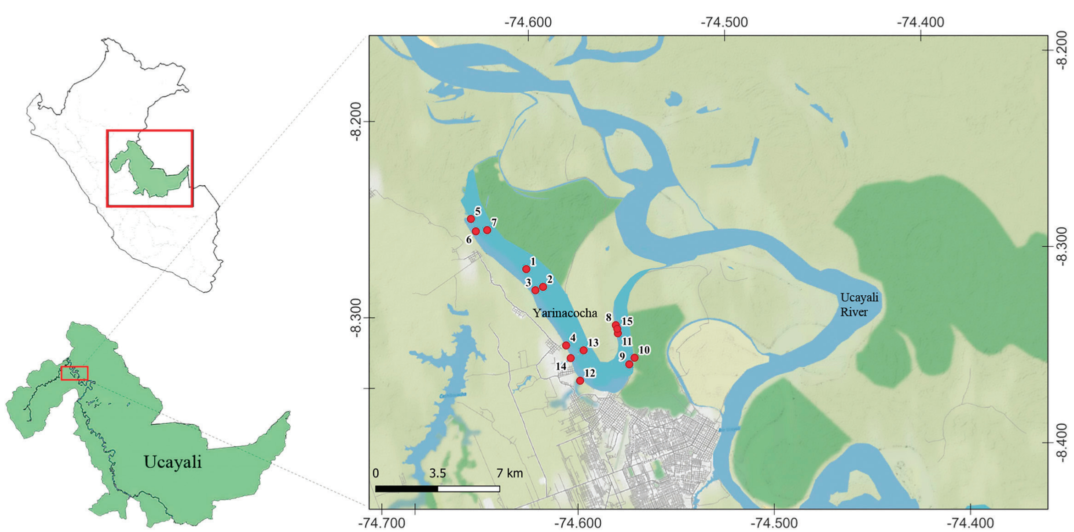

Figure 1. Map of Yarinacocha lake, Ucayali, Peru showing each collecting site (red circles). Numbers follow Table 1 and Fig. 2.

Table 1. Sampled localities in the Yarinacocha lake.

Site	Latitude	Longitude	Hábitat
1	–8.283635°	–74.613530°	Shore
2	–8.293595°	–74.605929°	Shore
3	–8.294893°	–74.610005°	Lake
4	–8.324666°	–74.597307°	Shore
5	–8.255102°	–74.639067°	River canal
6	–8.261677°	–74.637215°	Lake
7	–8.261672°	–74.631376°	Stream
8	–8.317004°	–74.570915°	Lake
9	–8.337667°	–74.566134°	Shore
10	–8.334606°	–74.563095°	Stream
11	–8.321236°	–74.570293°	Lake
12	–8.343393°	–74.592056°	Stream
13	–8.328085°	–74.588685°	Pool
14	–8.331376°	–74.595665°	Shore
15	–8.318975°	–74.570368°	Shore

Sampling efforts occurred during the start of the rainy season in October 2020 and in the dry season in July 2022, mostly during daylight. The collection of specimens involved bottom trawls of 10 and 20 m nets with 5 mm internodes, used on the beaches and areas with vegetation, trunks and leaves; cast nets of 15 m in open areas and channels; and gillnets of 30 m, blocking the passage of fish during the beginning of the day. Obtained specimens were anesthetized in a clove oil solution, muscle tissues were fixed in 96% ethanol (for molecular studies), vouchers and other specimens were fixed in 10% formalin by 48 hours and then preserved in 70% ethanol. Expeditions had a Fish Collection Permit for research purposes under PRODUCE license number 132/2021.

Species identifications to the lowest taxonomic level were conducted consulting the taxonomic literature (Galvis et al. 2006, Queiroz et al. 2013, van der Sleen & Albert 2018) and identification keys for Characiformes (Géry, 1977; Vari, 1991; Malabarba, 2004), Siluriformes (Burgess, 1989; Albert, 2001; Littmann et al. 2021), Cichliformes (Kullander, 1986; Kullander and Ferreira, 2006; Arbour et al. 2014) and Gymnotiformes (Mago-Leccia, 1994; Crampton et al. 2016; de Santana et al. 2019); and valid names were confirmed following Fricke et al. (2022). Classification follows the

Figure 2. Sampled localities in Yarinacocha lake. Numbers 1–12 follows Table 1.

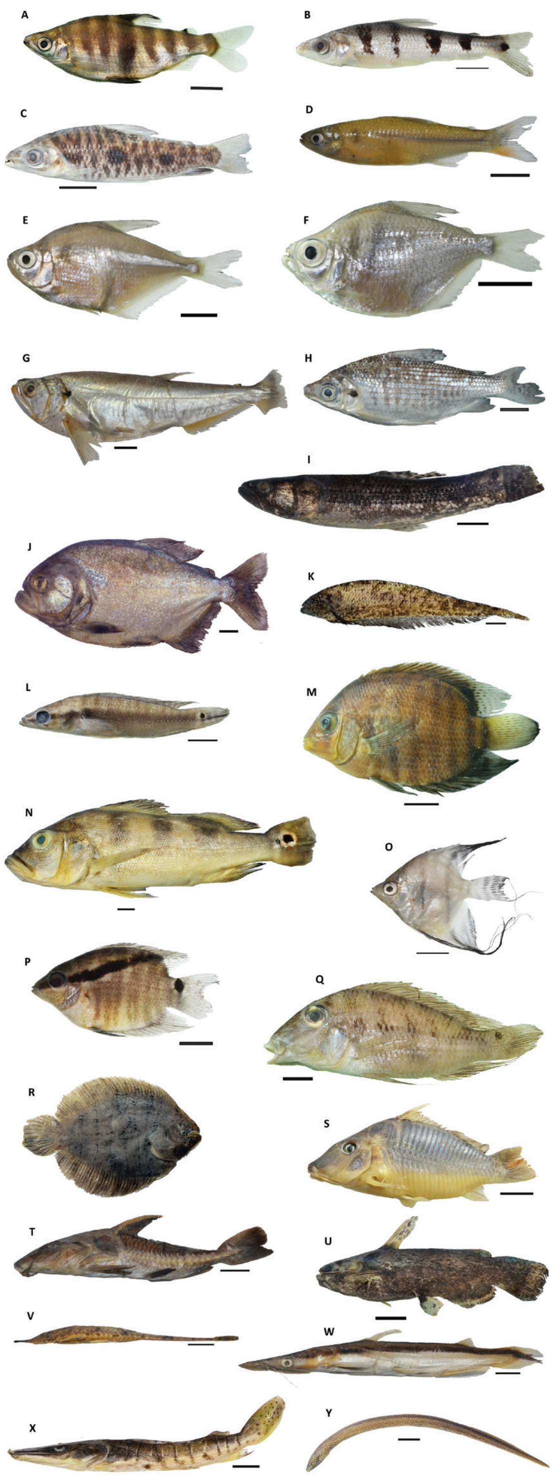

Figure 3. Some fish species collected in Yarinacocha lake, Ucayali basin, Peru. Scale bar 1 cm. **A**) *Abramites hypselonotus,* **B**) *Schizodon fasciatus,* **C**) *Leporinus* cf. *parae,* **D**) *Aphyocharax pusillus,* **E**) *Ctenobrycon hauxwellianus,* **F**) *Tetragonopterus argenteus,* **G**) *Hydrolycus scomberoides*, **H**) *Prochilodus nigricans*, **I**) *Hoplias malabaricus,* **J**) *Pygocentrus nattereri*, **K**) *Adontosternarchus balaenops,* **L**) *Crenicichla proteus,* **M**) *Heros efasciatus*, **N**) *Cichla monoculus,* **O**) *Pterophyllum scalare,* **P**) *Mesonauta mirificus*, **Q**) *Satanoperca jurupari*, **R**) *Hypoclinemus mentalis*, **S**) *Corydoras multiradiatus*, **T**) *Oxydoras niger*, **U**) *Trachelyopterus galeatus*, **V**) *Hemiodontichthys acipenserinus*, **W**) *Sorubim lima*, **X**) *Pseudoplatystoma punctifer*, **Y**) *Synbranchus marmoratus.*

current phylogenetic arrangement of bony fishes sensu according to Betancur et al. (2017) and for Characiformes the classification proposed by Oliveira et al. (2011). To corroborate geographical distribution of species we used CLOFFSCA (Reis et al. 2003), digital platforms like SpeciesLink (http://www.splink.org.br/) and FishNet2 (http://www.fishnet2.net/) and Nijssen and Isbrücker (1986) for additional taxonomic revisions and species descriptions. Vouchers were deposited in the Ichthyology Collection of Museo de Historia Natural of the Universidad Nacional Mayor de San Marcos, Lima, Peru (MUSM).

Specimens collected in the Yarinacocha lake by previous expeditions and deposited in the MUSM Fish Collection, were also recorded after their identifications were verified. In our results, only native species were included without considering invasive or exotic species because they lacked vouchers in the scientific collection; however, its presence was discussed due to previous reports from the Ministerio del Ambiente (MINAM).

The commercial species were classified into ornamental fish (IIAP 2011, García-Dávila et al. 2020) and fish for consumption (García-Dávila et al. 2018). The threatened status of the species was derived from IUCN (2022) criteria available in https://www.iucnredlist.org/.

Results and Discussion

The total of previously reported species is 63 (Vela et al. 2016; Zorrilla et al. 2016; Salazar-Ramirez et al. 2021) reporting only Characiformes and Siluriformes. However, as indicated above, those studies did not include precise data on the location of capture, making impossible a comparison of the total richness previously reported in relation to the results presented here which only include fishes from Yarinacocha lake.

Our contribution carries a very high value due to the fact of representing the first ichthyofauna inventory of Yarinacocha lake in its entire extension, assessing a wide range of habitats, including almost all possible species, not only those with commercial value (Fig. 3). In this manner, a total 164 fish species were recorded (Table 2) representing 10 orders (plus Eupercaria), 34 families and 116 genera.

The order with the most species richness was Characiformes with 68 species (41.5%) followed by Siluriformes with 59 species (36%), Cichliformes with 17 species (10.5%) and Gymnotiformes with eight species (4.9%). These orders represent 92.6% of the total species (Fig. 4). Clupeiformes, with four species, and remaining five orders (plus Eupercaria), with one or two species for each, represent 7.4% of total species. The most highly represented family was Characidae with 23 species (14%), followed by Cichlidae with 17 species (10.4%), Loricariidae with 14 species (8.5%), Pimelodidae with 13 species (7.9%), Doradidae with 13 species (7.4%) and Anostomidae with 12 species (7.3%); together represent 55.5% of the total species (Fig. 5). As in the Neotropical freshwater habitats, the ichthyofauna belongs to the Ostariophysi and in South America mostly represented by Characiformes, Siluriformes and Gymnotiformes (Reis et al. 2016). In the Peruvian Amazon, the families Characidae, Loricariidae y Cichlidae, concentrate the greatest diversity of species (Ortega et al. 2012) and represent some of the dominant families in the composition of Amazonian species (Dagosta & de Pinna 2019).

Table 2. Fish fauna recorded for the Yarinacocha lake. The list includes the Peruvian common name, economic importance of the species as ornamental fish (O) according to IIAP (2011) and García Dávila et al. (2021), or fish for consumption (C) according to García-Dávila et al. (2018), IUCN category (LC = Least Concern, DD = Data Deficient, NT = Near Threatened, CR = Critically Endangered, EN = Endangered, VU = Vulnerable). In addition, the catalog number of the voucher specimens deposited in the MUSM fish collections is also being considered.

Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
CLASS ACTINOPTERYGII				
BELONIFORMES				
Belonidae				
Potamorrhaphis guianensis (Jardine, 1843)	pez aguja	–	–	MUSM 7466
Pseudotylosurus angusticeps (Günther, 1866)	pez aguja	–	–	MUSM 70497
CHARACIFORMES				
Acestrorhynchidae				
Acestrorhynchus abbreviatus (Cope, 1878)	peje zorro	O	LC	MUSM 7424
Acestrorhynchus microlepis (Jardine, 1841)	pez cachorro	O	LC	MUSM 1778
Anostomidae				
Abramites hypselonotus (Günther, 1868)	san pedrito	O	–	MUSM 2056, 70030
Leporellus vittatus (Valenciennes, 1850)	lisa	O	–	MUSM 7447
Leporinus aff. *amazonicus* Santos & Zuanon, 2008	lisa	–	–	MUSM 10307
Leporinus jamesi Garman, 1929	lisa	–	–	MUSM 70419
Leporinus niceforoi Fowler, 1943	lisa	–	–	MUSM 2351
Leporinus cf. *parae* Eigenmann, 1907	lisa	C	–	MUSM 59645, 69652, 69884, 70137, 70175, 70204
Leporinus pearsoni Fowler, 1940	lisa	–	LC	MUSM 70420
Leporinus striatus Kner, 1858	lisa	–	LC	MUSM 69704
Leporinus subniger Fowler, 1943	lisa	–	–	MUSM 69704
Megaleporinus trifasciatus (Steindachner, 1876)	lisa	C	–	MUSM 69876
Rhytiodus microlepis Kner, 1858	lisa	C	–	MUSM 15769, 15914
Schizodon fasciatus Spix & Agassiz, 1829	lisa	C	–	MUSM 481, 6269, 15298, 15769, 15813, 15914, 15917, 59644, 70033, 70048, 70136
Characidae				
Aphyocharax pusillus Günther, 1868	mojarita	O	–	MUSM 7421, 15381, 15804, 59640, 70037, 70041, 70131, 70171
Astyanax bimaculatus (Linnaeus, 1758)	mojara	O	–	MUSM 1887, 2371, 2985, 3453, 5494, 15325
Astyanax maximus (Steindachner, 1876)	mojara	–	–	MUSM 70056, 70138
Brachychalcinus copei (Steindachner, 1882)	palometita	O	LC	MUSM 70207
Charax tectifer (Cope, 1870)	dentón	O	–	MUSM 70467
Ctenobrycon hauxellianus (Cope, 1870)	mojara	O	–	MUSM 59293, 69868, 70039, 70054, 70145, 70170
Cynopotamus amazonum (Günther, 1868)	dentón	–	–	MUSM 69875
Galeocharax gulo (Cope, 1870)	dentón	–	–	MUSM 70031
Moenkhausia barbouri Eigenmann, 1908	mojara	–	–	MUSM 70154
Moenkhausia collettii (Steindachner, 1882)	mojara	O	–	MUSM 5490
Moenkhausia aff. *dichroura* (Kner, 1858)	mojara	–	–	MUSM 59288, 70023, 70055, 70144
Moenkhausia intermedia Eigenmann, 1908	mojara	O	–	MUSM 69649, 70052, 70148

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Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
Moenkhausia grandisquamis (Müller & Troschel, 1845)	mojara	–	–	MUSM 7417, 7425
Moenkhausia oligolepis (Günther, 1864)	mojara	O	–	MUSM 2195, 6280
Odontostilbe fugitiva Cope, 1870	mojarita	O	–	MUSM 5492, 69881
Prionobrama filigera (Cope, 1870)	mojara	O	–	MUSM 1392, 2194, 2272, 3458, 5487, 7422, 10881, 15323, 15800, 17787, 69880, 70034, 70050, 70142, 70153
Protocheirdodon pi (Vari, 1978)	pez vidrio	O	–	MUSM 70418
Psalidodon fasciatus (Cuvier, 1819)	mojarra	O	–	MUSM 2273
Roeboides affinis (Günther, 1868)	dentón	O	–	MUSM 10235, 15717, 15771, 15324, 59286, 70140, 70209
Roeboides myersi Gill, 1870	dentón	O, C	LC	MUSM 15201, 39575, 59289, 70210
Stethaprion erythrops Cope, 1870	palometita	O	–	MUSM 3528, 15328
Tetragonopterus argenteus Cuvier, 1816	mojara	O	–	MUSM 5488, 7418, 7423, 8568, 15297, 15411, 39577, 59290, 70038, 70053,70134, 70164, 70206
Serrapinnus heterodon (Eigenmann, 1915)	mojarita	–	–	MUSM 5493
Crenuchidae				
Characidium zebra Eigenmann, 1909	mojarita	O	–	MUSM 70491
Curimatidae				
Curimatella meyeri (Steindachner, 1882)	chio chio	C	–	MUSM 5213, 69742, 69759
Potamorhina altamazonica (Cope, 1878)	yahuarachi	C	–	MUSM 858, 5134, 15088
Potamorhina latior (Spix & Agassiz, 1829)	llambina	C	–	MUSM 70463
Psectrogaster amazonica Eigenmann & Eigenmann, 1889	ractacara	C	–	MUSM 7462, 15203, 69741, 69758, 70165
Psectrogaster rutiloides (Kner, 1858)	ractacara	C	–	MUSM 2076, 2108, 5133, 7465, 15205, 69743, 69757, 70162
Steindachnerina dobula (Günther, 1868)	julilla	–	–	MUSM 5227, 15322, 70043, 70146
Steindachnerina leucisca (Günther, 1868)	julilla	–	–	MUSM 5228, 15924, 70045, 70129
Cynodontidae				
Cynodon gibbus (Spix & Agassiz, 1829)	chambira	O, C	–	MUSM 69761
Hydrolycus scomberoides (Cuvier, 1819)	chambira	O, C	–	MUSM 69875
Rhaphiodon vulpinus Spix & Agassiz, 1829	chambira	O, C	–	MUSM 7054
Erythrinidae				
Hoplerythrinus unitaeniatus (Spix & Agassiz, 1829)	shuyo	O, C	–	MUSM 69755
Hoplias malabaricus (Bloch, 1794)	fasaco	O, C	LC	MUSM 5123, 5497, 15299, 15915, 69752, 69753, 69871, 69887, 70151
Gasteropelecidae				
Thoracocharax stellatus (Kner, 1858)	pechito	O	–	MUSM 7463, 15399, 15806, 17756, 17785, 70211

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Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
Hemiodontidae				
Anodus elongatus Agassiz, 1829	julilla	C	–	MUSM 7055
Hemiodus aff. *microlepis* Kner, 1858	julilla	–	–	MUSM 69745
Hemiodus amazonum (Humboldt, 1821)	julilla	–	–	MUSM 7451
Prochilodontidae				
Prochilodus nigricans Agassiz, 1829	boquichico	C	–	MUSM 47, 50, 2001, 2023, 2111, 2190, 7455, 7467, 8575, 10302, 15327, 15768, 15803, 17755, 19711, 19721, 59643, 69653, 69874, 69885, 70040, 70159
Parodontidae				
Parodon pongoensis (Allen, 1942)	julilla	O	–	MUSM 70495
Serrasalmidae				
Colossoma macropomum (Cuvier, 1816)	gamitana	C	–	MUSM 62
Mylossoma albiscopum (Cope, 1872)	palometa	C	–	MUSM 59646, 70043
Mylossoma aureum (Spix & Agassiz, 1829)	palometa	O, C	–	MUSM 5489, 17843
Piaractus brachypomus (Cuvier, 1818)	paco	O, C	–	MUSM 1814, 70044
Pygocentrus nattereri Kner, 1858	paña roja	O, C	–	MUSM 84, 15410, 39581, 69740, 69762, 70202
Serrasalmus rhombeus Linnaeus, 1776	paña moteada	O, C	–	MUSM 70462
Triportheidae				
Triportheus albus Cope, 1872	sardina	–	–	MUSM 2384, 5226, 10301, 15766, 15801, 15808, 15918, 69639, 69648, 70114, 70132, 70156
Triportheus angulatus (Spix & Agassiz, 1829)	sardina	C		MUSM 2341, 2374, 7416, 7420, 10300, 15921, 15522, 15810, 15921, 17750, 59281, 70115, 70139, 70155
Triportheus curtus (Garman, 1890)	sardina	–		MUSM 70464
Triportheus rotundatus (Jardine, 1841)	sardina	–	LC	MUSM 575, 70465
CLUPEIFORMES				
Engraulidae				
Anchoviella guianensis (Eigenmann, 1912)	sardina	–	–	MUSM 70205
Anchoviella hernanni Loeb, Varella & Menezes, 2018	sardina	–	–	MUSM 70490
Jurengraulis juruensis (Boulenger, 1898)	sardina	–	–	MUSM 70163
Lycengraulis batesii (Günther, 1868)	sardina	–	–	MUSM 70169
Pristigasteridae				
Pellona castelnaeana Valenciennes, 1847	panshin, bacalao	C	LC	MUSM 5111, 5275
Pristigaster cayana Cuvier, 1829	pechito	–	LC	MUSM 5, 15776, 70171
GYMNOTIFORMES				
Apteronotidae				
Apteronotus bonapartii (Castelnau, 1855)	macana	O	–	MUSM 3027, MUSM 3030
Adontosternarchus balaenops (Cope, 1878)	macana	O	–	MUSM 70485

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Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
Gymnotidae				
Electrophorus varii de Santana, Wosiacki, Crampton, Sabaj, Dillman, Mendes–Júnior & Castro e Castro, 2019	anguila eléctrica	O	–	MUSM 70128
Hypopomidae				
Brachyhypopomus bennetti Sullivan, Zuanon & Cox Fernandes, 2013	macana	O	–	MUSM 70493
Sternopygidae				
Eigenmannia humboldtii (Steindachner, 1878)	macana	O	–	MUSM 3020
Eigenmannia limbata (Schreiner & Miranda Ribeiro, 1903)	macana	–	–	MUSM 70184
Eigenmannia virescens (Valenciennes, 1836)	macana	O	–	MUSM 3019, 70190
Sternopygus macrurus (Bloch & Schneider, 1801)	macana	O	–	MUSM 3018, 70189
CICHLIFORMES				
Cichlidae				
Aequidens tetramerus (Heckel, 1840)	bujurqui	O	–	MUSM 70494
Astronotus ocellatus (Agassiz, 1831)	acahuarazu	O, C	–	MUSM 19724
Bujurquina megalospilus Kullander, 1986	bujurqui	–	–	MUSM 70486
Chaetobranchus flavescens Heckel, 1840	bujurqui	C	–	MUSM 940
Cichla monoculus Agassiz, 1831	tucunare	O, C	–	MUSM 7392, 8571, 69739, 70150
Cichlasoma amazonarum Kullander, 1983	bujurqui	O	–	MUSM 5486, 7391, 15345, 15378, 70146
Crenicara punctulata (Günther, 1863)	bujurqui	O	–	MUSM 2538
Crenicichla cyanonotus Cope, 1870	añashua	–	–	MUSM 59279, 70178
Crenicichla proteus Cope, 1872	añashua	O	–	MUSM 5482, 7394, 7399, 69654, 700051, 70148, 70180
Crenicichla sedentaria Kullander, 1986	añashua	–	LC	MUSM 15379, 70179
Heros efasciatus Heckel, 1840	bujurqui	O, C	–	MUSM 5484, 6272, 7395, 7400, 15073, 15140, 15375, 15781, 59280, 70025, 70147, 70203
Hypselecara temporalis (Günther, 1862)	bujurqui	O, C	–	MUSM 916, 7396
Mesonauta festivus (Heckel, 1840)	bujurqui	O	–	MUSM 1021
Mesonauta insignis (Heckel, 1840)	bujurqui	–	–	MUSM 5483
Mesonauta mirificus Kullander & Silfvergrip, 1991	bujurqui	O	LC	MUSM 3049, 7401, 7403, 10294, 15397, 70027, 70149
Pterophyllum scalare (Schultze, 1823)	pez angel	O	–	MUSM 982, 984, 1041, 1209, 3451, 3469, 5485, 7398, 9124, 10297, 15247, 15376, 15772, 19725, 70026, 70157
Satanoperca jurupari (Heckel, 1840)	bujurqui	O, C	–	MUSM 957, 5503, 7402, 7415, 8572, 10295, 15383, 59282, 70172
EUPERCARIA sensu Betancur et al. 2017				
Scianidae				
Plagioscion squamosissimus (Heckel, 1840)	corvina	O, C	–	MUSM 790, 2110

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Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
PLEURONECTIFORMES				
Achiridae				
Achirus achirus (Linnaeus, 1758)	panga raya, lenguado	O	LC	MUSM 15807, 59292
Hypoclinemus mentalis (Günther, 1862)	panga raya, lenguado	O	LC	MUSM 898, 59641, 69650
OSTEOGLOSSIFORMES				
Arapaimidae				
Arapaimas gigas (Schinz, 1822)	paiche	O, C	DD	MUSM 104
SILURIFORMES				
Auchenipteridae				
Ageneiosus inermis (Linnaeus, 1766)	bocón	O, C	–	MUSM 7045
Epapterus dispilurus Cope, 1878	maparate	O	–	MUSM 17782, 70181
Trachelyopterus galeatus (Linnaeus, 1766)	bocón	O, C	–	MUSM 70474
Trachelyopterus isacanthus (Cope, 1878)	bocón	–	–	MUSM 7457
Trachelyopterus porosus (Eigenmann & Eigenmann, 1888)	bocón	–	–	MUSM 70475
Tympanopleura atronasus (Eigenmann & Eigenmann, 1888)	bocón	–	–	MUSM 70472
Tympanopleura longipinna Walsh, Ribeiro & Rapp Py-Daniel, 2015	bocón	–	–	MUSM 70473
Aspredinidae				
Bunocephalus aleuropsis Cope, 1870	banjo, sapo cunshi	O	–	MUSM 70499
Callichthyidae				
Callichthys callichthys (Linnaeus, 1758)	coridora, shirui	–	–	MUSM 3481
Corydoras leucomelas Eigenmann & Allen 1942	coridora, shirui	O	LC	CAS 36561
Corydoras multiradiatus (Orcés V, 1960)	coridora, shirui	O	LC	MUSM 69877
Corydoras splendens (Castelnau 1855)	coridora, shirui	O	LC	MUSM 69878
Corydoras stenocephalus Eigenmann & Allen, 1942	coridora, shirui	–	LC	CAS 36386
Corydoras trilineatus Cope, 1872	coridora, shirui	O	–	MUSM 7458
Dianema longibarbis Cope, 1872	shirui	C	–	MUSM 1790
Hoplosternum littorale (Hancock, 1828)	shirui	–	–	MUSM 69756
Doradidae				
Acanthodoras aff. *spinosissimus* (Eigenmann & Eigenmann, 1888)	pirillo	O	–	MUSM 15486
Agamyxis pectinifrons (Cope, 1870)	pirillo	O	–	MUSM 2804, 5116
Anadoras grypus (Cope, 1872)	pirillo	O	LC	MUSM 15485, 33335
Hemidoras stuebelii (Steindachner, 1882)	pirillo	–	–	MUSM 5127, 70501
Nemadoras humeralis (Kner, 1855)	pirillo	O	–	MUSM 5122, 5128, 5163, 15484
Ossancora asterophysa Birindelli & Sabaj Pérez, 2011	pirillo	–	–	MUSM 70177
Ossancora eigenmanni (Boulenger, 1895)	pirillo	O	–	MUSM 5130, 15499, 32674

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Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
Ossancora punctata (Kner, 1855)	pirillo	–	–	MUSM 596, 1982, 5105, 5120, 5126, 5159, 5160, 5161, 5501, 7042, 15413, 19714, 70047, 70176
Oxydoras niger (Valenciennes, 1821)	turushuqui	O, C	–	MUSM 2902, 5119, 70183
Platydoras armatulus (Valenciennes, 1840)	rafles	O	–	MUSM 70200
Platydoras costatus (Linnaeus, 1758)	rafles	O	–	MUSM 5103, 5115, 19713
Pterodoras granulosus (Valenciennes, 1821)	cahuara	C	–	MUSM 1637, 1980, 5102, 5114, 15513
Heptapteridae				
Pimelodella cristata (Müller & Troschel, 1849)	cunshi, bagre	–	–	MUSM 5500
Pimelodella cyanostigma (Cope, 1870)	cunshi, bagre	–	–	MUSM 69873, 70036, 70166, 70195
Pimelodella gracilis (Valenciennes, 1835)	cunshi, bagre	–	–	MUSM 5500, 15811, 70049, 70133, 70167
Rhamdia quelen (Quoy & Gaimard, 1824)	cunshi, bagre	O	–	MUSM 70028
Loricariidae				
Ancistrus alga (Cope, 1872)	carachama	–	–	MUSM 69869, 70194
Farlowella amazonum (Günther, 1864)	shitari aguja	–	–	MUSM 69872, 70182
Hemiodontichthys acipenserinus (Kner, 1853)	shitari	O	–	MUSM 7452, 15764, 17753, 70191
Hypoptopoma gulare Cope, 1878	carachamita	O	–	MUSM 15146, 15206, 15237, 15341, 69879, 69886, 70130, 70160, 70197
Hypoptopoma psilogaster Fowler, 1915	carachamita	–	–	MUSM 70141, 70174
Hypoptopoma thoracatum Günther, 1868	carachamita	O	–	MUSM 15349, 69882, 70199
Hypostomus ericius Armbruster, 2003	carachama	–	LC	MUSM 69870, 70173, 70198
Limatulichthys griseus (Eigenmann, 1909)	shitari	–	–	MUSM 1776
Loricaria simillima Regan, 1904	shitari	O	–	MUSM 7453, 70042, 70188
Loricariichthys maculatus (Bloch, 1794)	shitari	–	–	MUSM 70502
Pterygoplichthys pardalis (Castelnau, 1855)	carachama	O	–	MUSM 59278, 69746, 70036, 70152, 70187
Rineloricaria sp.	shitari	–	–	MUSM 70024, 70193
Rineloricaria wolfei Fowler, 1940	shitari	–	LC	MUSM 70192
Sturisoma nigrirostrum Fowler, 1940	shitari	O	LC	MUSM 10106, 70186
Pimelodidae				
Brachyplatystoma platynemum Boulenger, 1898	mota flemosa	O, C	–	MUSM 1813
Calophysus macropterus (Lichtenstein, 1819)	mota	O, C	–	MUSM 7056
Hemisorubim platyrhynchos (Valenciennes, 1840)	toa	O, C	–	MUSM 70498
Hypophthalmus edentatus Spix & Agassiz, 1829	maparate	C	–	MUSM 1505, 1506, 1509, 3249, 12777
Hypophthalmus oremaculatus Nani & Fuster de Plaza, 1947	maparate	–	–	MUSM 69744
Phractocephalus hemioliopterus (Bloch & Schneider, 1801)	peje torre	O, C	–	MUSM 1518
Pimelodina flavipinnis Steindachner, 1876	bagre	C	–	MUSM 10014

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Taxon	Peruvian common name	Economic importance	IUCN	Voucher MUSM
Pimelodus blochii Valenciennes, 1840	cunshi, bagre	O	–	MUSM 15783, 15797, 15814, 17789, 59291, 59642, 69651,70135, 70168, 70196
Pimelodus maculatus Lacepède, 1803	cunshi, bagre	O	–	MUSM 15250, 17751, 17851
Pimelodus pictus Steindachner, 1876	cunshi, bagre	O	–	MUSM 1742, 3465, 5107, 5118, 6288, 15809
Pseudoplatystoma punctifer (Castelnau, 1855)	doncella	O, C	–	MUSM 70496
Sorubim elongatus Littmann, Burr, Schmidt & Isern, 2001	shiripira	–	–	MUSM 70477
Sorubim lima (Bloch & Schneider, 1801)	shiripira	O, C	–	MUSM 643, 681, 5053, 5158, 10105, 15449, 19720, 70201
SYNBRANCHIFORMES				
Synbranchidae				
Synbranchus marmoratus Bloch, 1795	atinga	O	–	MUSM 3057, 12711
TETRAODONTIFORMES				
Tetraodontidae				
Colomesus asellus (Müller & Troschel, 1849)	pez globo	O	–	MUSM 1949

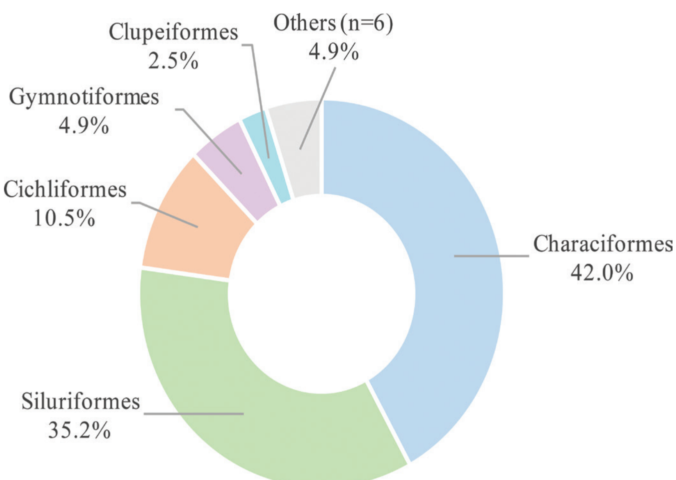

Figure 4. Richness of fish species for orders/series recorded in Yarinacocha lake.

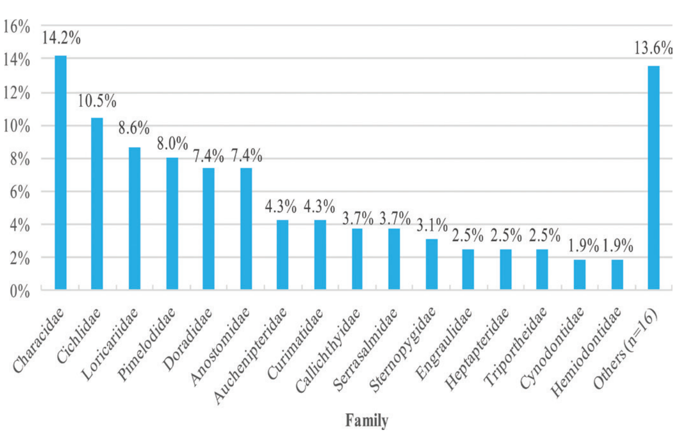

Figure 5. Richness of fish species for families recorded in Yarinacocha lake.

Another interesting novelty is *Leporinus subniger*, with distribution in the Upper Amazon Basin (Colombia and Ecuador) (Britski & Birindelli 2008), species not previously reported by previous peruvian inventories (Ortega et al. 2012, Meza-Vargas et al. 2021, Chuctaya et al. 2022) representing a new record for the department of Ucayali.

The following species could not be identified to the species level *Hemiodus* aff. *microlepis* belongs to the *Hemiodus microlepis* species group, previously reported for the Ucayali River, being a species not formally described (Nogueira et al. 2021), *Leporinus* cf. *parae*, a member of the *Leporinus friderici* species complex (Silva-Santos et al. 2018), and *Leporinus* aff. *amazonicus* represents putative undescribed species. *Leporinus* is the most species-rich genus within Anostomidae and is considered one of the richest genera within Characiformes (Garavello and Britski 2003, Ramirez et al. 2016) and a thorough taxonomic review of this group is needed (Silva-Santos et al. 2018). *Rineloricaria* sp. could only be identified to the genus level without coinciding with *R. morrowi* or *R. wolfei*, the two species described for the region by Fowler (1940), further studies will be needed to classify these specimens. *Moenkhausia* aff. *dichroura* belongs to the *M. dichroura* species group, because it's distributed only in the La Plata basin (Paraguay and lower Paraná rivers) and the morphotype found in the Amazon basin would be a possible new species (Britzke 2011). Several species have the same color pattern, such as *M. dichroura*, *M. intermedia*, *M. barbouri*, *M. bonita* and also the species *Schultzites axelrodi*, which in some cases may make it difficult to correctly identify this species group.

Regarding the species of economic importance, 109 species have commercial importance, of which 90 species (54.8%) are ornamentals, 26 species are used for both purposes and 20 species only for consumption, including *Prochilodus nigricans* (boquichico) which contributes the highest percentage of catches (Riofrío 1998, Riofrío 2002, Wasiw et al. 2012, Salazar-Ramirez et al. 2021) and large migratory catfish, with high commercial value, such as *Pseudoplatystoma punctifer* (doncella) and *Phractocephalus hemioliopterus* (peje torre), whose presence indicates the importance of this ecosystem in its migratory route, since this type of whitewater ecosystems are the most important for commercial migratory species (Duponchelle et al. 2021). Therefore, the majority of species recorded for Yarinacocha lake (66.7%) represent important economic resources. Nevertheless, the abundances of these resources can decline due to human impacts including habitat alteration, water pollution, overfishing, exotic species introduction and other factors (van der Sleen & Albert 2021).

The reduction in landings in Yarinacocha lake has been reported in recent years (Salazar-Ramirez et al. 2021). Species of consumption of high commercial demand such as *Colossoma macropomum* (gamitana) and *Piaractus brachypomus* (paco) have almost disappeared from landings, being replaced by small-sized species (Riofrío 1998, Wasiw et al. 2012, Salazar-Ramirez et al. 2021). This evidences the decrease of fish populations for consumption due to overexploitation.

The global ornamental fish industry is a market expansion grid, and moves approximately US$ 15 billion/year, including equipment, accessories, supplies and publications (Cheong 1996). There are 350 to 400 million ornamental fish sold, where 70% are produced in captivity and 63% are exported by developing countries generating about U.S. $ 202 million/year (Chao et al. 2001). This market is dominated by freshwater fishes and the Amazon basin is a key supplier of wild freshwater fishes to the ornamental trade (Moreau and Coomes 2007). In the Peruvian Amazon, most of these resources are the product of direct extraction from the natural environment (MINAM 2021) and Yarinacocha lake is one of the leading regions for ornamental fish extraction in the Ucayali department (PNIPA 2021). Although the collection of fish from tropical lentic environments can be carried out almost throughout the entire year, this activity can lead to direct depletion of wild populations (Andrews 1990).

In recent years, the global trade for freshwater specimens has led to the overexploitation of native species, and the destruction of these habitats by invasive species (Chang et al. 2009). An example of an exotic species found in Peru would be *Trichopodus trichopterus* (Pallas 1770), order Anabantiformes, family Osphronemidae, that was reported in Yarinacocha in 2016, in the La Restinga fishing area (MINAM 2021). This species is a tropical freshwater fish native to Southeast Asia, known as the three spot gourami, and has a specialized organ (organ labyrinth) that allows them to breathe oxygen from the air (Blank & Burggren 2014), helping them to adapt to an environment of low oxygen concentration in the water (Degani et al. 2021). Specimens of this group were introduced in 1970 for ornamentation (Ortega et al. 2007) and have been reported for the city of Iquitos (department of Loreto, Peru) (Meza-Vargas et al. 2021). The effects of exotic species on lentic water bodies can be complex (Ortega and Hidalgo 2008), although the impact of *T. trichopterus* on native species is uncertain, the introduction of exotic species may imply a risk of co-introduction of parasites, especially with phylogenetically similar native fauna (Trujillo-González et al. 2018), and generate problems of predation, competition for food and occupation of niches (Meza-Vargas et al. 2021). Therefore, *T. trichopterus* can be detrimental to native fish and further studies are required to assess the real impact on native species.

Freshwater fish may currently be one of the most threatened vertebrate groups, mainly based on the more than 5,000 species assessed by the IUCN, where the main threats include habitat modification, fragmentation and destruction; the introduction of invasive species; fisheries overexploitation; environment pollution; and climate change (Reid 2013). Thus, in the long term, it is estimated that 20% of the world's freshwater fish should be in the vulnerable, threatened or extinct category in recent decades (Revenga et al. 1998).

In this study, 22 species are considered protected species (13.4%) following the IUCN criteria. One species, *Arapaima gigas*, was categorized as "Data deficient" (DD), therefore the knowledge about the biology and ecology of this species is limited, in particular the structure of its natural populations (Vitorino et al. 2017) and further information on the species is required. The natural populations of this species have historically been reduced or even eradicated near the main cities (Castello et al. 2011). Currently, its landing in Yarinacocha lake is almost nil (Salazar-Ramírez et al. 2021). The other 21 species are considered "Least concern" (LC), which means that after being evaluated, it doesn't meet any of the criteria that define the other categories. Most of the registered species lack information that allows them to be classified in some category, therefore further studies are necessary for an adequate evaluation of these species and of the Peruvian ichthyofauna in general.

Overall, Yarinacocha lake is an ecosystem with a high diversity of fish species that are valuable resources for the local people. Nonetheless, these resources are vulnerable to pollution, overexploitation and the presence of exotic species that affect native populations. Our study contributes to the knowledge of the ichthyofauna of the Yarinacocha lake and can be used as a starting point for its conservation and sustainable management over time.

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Hernán Ortega: Substantial contribution in the concept and design of the study; Contribution to data collection; Contribution to critical revision, adding intelectual content.

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Ricardo Britzke: Substantial contribution in the concept and design of the study; Contribution to data collection; Contribution to manuscript preparation; Contribution to critical revision, adding intelectual content.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

Ethics

Authors have complied with the guidelines established by the ethics committees of their respective research institutions.

Data Availability

Supporting data are available at: Britzke, Ricardo, 2022, "Fishes from Yarinacocha lake: an emblematic Amazonian ecosystem in the lower Ucayali River basin, Pucallpa, Peru", https://doi.org/10.48331/scielodata.4FNJMY, SciELO Data, DRAFT VERSION.

References

ALBERT, J.S. 2001. Species diversity and phylogenetic systematics of American knifefishes (Gymnotiformes, Teleostei). Misc. Publ. Mus. Zool. University of Michigan 190:1–129.

ANDREWS, C. 1990. The ornamental fish trade and fish conservation. Journal of Fish Biology, 37:53–59. https://doi.org/10.1111/j.1095-8649.1990.tb05020.x

ARBOUR, J.H., SALAZAR, R.E.B. & LÓPEZ-FERNÁNDEZ, H. 2014. A new species of *Bujurquina* (Teleostei: Cichlidae) from the río Danta, Ecuador, with a key to the species in the genus. Copeia:79–86.

BARLETTA, M., JAUREGUIZAR, A.J., BAIGUN, C., FONTOURA, N.F., AGOSTINHO, A.A., ALMEIDA-VAL, V.M.F, VAL, A.L., TORRES, R.A., JIMENES-SEGURA, L.F., GIARRIZZO, T., FABRÉ, N.N., BATISTA, V.S., LASSO, C., TAPHORN, D.C., COSTA, M.F., CHAVES, P.T., VIEIRA, J.P. & CORRÊA, M.F.M. 2010. Fish and aquatic habitat conservation in South America: a continental overview with emphasis on neotropical systems. Journal of Fish Biology, 76:2118–2176. https://doi.org/10.1111/j.1095-8649.2010.02684.x

BARTHEM, R., GOULDING, M., FORSBERG, B., CAÑAS, C. & ORTEGA, H. 2003. Aquatic Ecology of the Río Madre de Dios. Lima: Biblos. 117 p.

BETANCUR-R, R., WILEY, E.O., ARRATIA, G., ACERO, A., BAILLY, N., MIYA, M., LECOINTRE, G. & ORTÍ, G. 2017. Phylogenetic classification of bony fishes. BMC Evol Biol17, 162. https://doi.org/10.1186/s12862-017-0958-3

BLANK, T. & BURGGREN, W. 2014. Hypoxia-induced developmental plasticity of the gills and air-breathing organ of *Trichopodus trichopterus*. J Fish Biol, 84:808–826. https://doi.org/10.1111/jfb.12319

BRITSKI, H.A. & BIRINDELLI, J.L.O. 2008. Description of a new species of the genus *Leporinus* Spix (Characiformes: Anostomidae) from the rio Araguaia, Brazil, with comments on the taxonomy and distribution of *L. parae* and *L. lacustris*. Neotropical Ichthyology, (1):45–51. https://doi.org/10.1590/S1679-62252008000100005

BRITZKE, R. 2011. Revisão taxonômica do grupo *Moenkhausia dichroura* (Kner, 1858) (Characiformes: Characidae). Msc Thesis, Universidade Estadual Paulista, Botucatu, São Paulo, Brasil.

BURGESS, W.E. 1989. An atlas of freshwater and marine catfishes. A preliminary survey of the Siluriformes. TFH Publication, Neptune City, Canada, 28. p. 305–325.

CAMPBELL, E., ALFARO-SHIGUETO, J., GODLEY, B. & MANGEL, J. 2017. Abundance estimate of the Amazon River Dolphin (*Inia geoffrensis*) and the tucuxi (*Sotalia fluviatilis*) in southern Ucayali, Peru. Latin American Journal of Aquatic Research. 45:957–969. 10.3856/vol45-issue5-fulltext-11

CARVALHO, T.P., ESPINO, J., MÁXIME, E., QUISPE, R., RENGIFO, B., ORTEGA, H. & ALBERT, J.S. 2011. Fishes from the lower Urubamba river near Sepahua, Amazon Basin, Peru. Check List, 7(4):413–442. http://dx.doi.org/10.15560/7.4.413

CASTELLO, L., STEWART, D.J. & ARANTES, C.C. 2011. Modeling population dynamics and conservation of *Arapaima* in the Amazon. Reviews in Fish Biology and Fisheries, 21(3):623–640 https://doi.org/10.1007/s11160-010-9197-z

CHANG, A.L., GROSSMAN, J.D., SPEZIO, T.S., WEISKEL, H.W., BLUM, J.C., BURT, J.W., MUIR, A.A., PIOVIA-SCOTT, J., VEBLEN, K.E. & GROSHOLZ, E.D. 2009. Tackling aquatic invasions: risks and opportunities for the aquarium fish industry. Biological Invasions, 11(4):773–785.

CHAO, N.L. 2001. Fisheries, diversity and conservation of ornamental fish of the Rio Negro River, Brazil- a review of Project Piaba (1989–99). 2001. In Conservation and Management of Ornamental Fish Resources of the Rio Negro Basin, Amazonia, Brazil- Project Piaba (L.N. Chao, P. Petry, G. Prang, L. Sonneschein, & M. Tlusty, eds). Manaus: University of Amazonas Press, p. 161–204.

CHEONG, L. 1996. Overview of the current international trade in ornamental fish, with special reference to Singapore. Revue scientifique et technique (International Office of Epizootics), 15(2):445–481.

CHUCTAYA, J., MEZA-VARGAS, V., FAUSTINO-FUSTER, D.R., HIDALGO, M. & ORTEGA, H. 2022. Lista De Especies De Peces De La Cuenca Del Río Ucayali, Perú. Revista Peruana De Biología 29 (4):e20049. https://doi.org/10.15381/rpb.v29i4.20049

CRAMPTON, W.G.R., DE SANTANA, C.D., WADDELL, J.C. & LOVEJOY, N.R. 2016. A taxonomic revision of the Neotropical electric fish genus *Brachyhypopomus* (Ostariophysi: Gymnotiformes: Hypopomidae), with descriptions of 15 new species. Neotropical Ichthyology, v. 14, n. 04:e150146. https://doi.org/10.1590/1982-0224-20150146

DAGOSTA, F. & DE PINNA, M. 2019. The Fishes of the Amazon: Distribution and Biogeographical Patterns, with a Comprehensive List of Species. Bulletin of the American Museum of Natural History. 431. 1. https://doi.org/10.1206/0003-0090.431.1.1

DE SANTANA, C.D., CRAMPTON, W.G.R., DILLMAN, C.B., FREDERICO, R.G., SABAJ, M.H., COVAIN, R., READY, J., ZUANON, J., DE OLIVEIRA, R.R., MENDES-JÚNIOR, R.N., BASTOS, D.A., TEIXEIRA, T.F., MOL, J., OHARA, W., CASTRO e CASTRO, N., PEIXOTO, L.A., NAGAMACHI, C., SOUSA, L., MONTAG, L.F.A, RIBERIRO F., WADDELL, J.C., PIORSKY, N.M., VARI, R.P. & WOSIAKI, W.B. 2019. Unexpected species diversity in electric eels with a description of the strongest living bioelectricity generator. Nat Commun 10, 4000. https://doi.org/10.1038/s41467-019-11690-z

DEGANI, G., VEKSLER-LUBLINSKY, I. & MEERSON, A. 2021. Markers of Genetic Variation in Blue Gourami (*Trichogaster trichopterus*) as a Model for Labyrinth Fish. Biology. 10(3):228. https://doi.org/10.3390/biology10030228

DUPONCHELLE, F., ISAAC, V.J., RODRIGUES DA COSTA DORIA, C., VAN DAMME, P.A., HERRERA-R, G.A., ANDERSON, E.P., CRUZ, R.E.A., HAUSER, M., HERMANN, T., AGUDELO, E., BONILLA-CASTILLO, C., BARTHEM, R., FREITAS, C.E.C.,

GARCÍA-DÁVILA, C., GARCÍA-VASQUEZ, A., RENNO, J.F. & CASTELLO, L. 2021. Conservation of migratory fishes in the Amazon basin. Aquatic Conservation: Mar Freshw Ecosyst, 31: 1087–1105. https://doi.org/10.1002/aqc.3550

FRICKE, R., ESCHMEYER, W.N. & VAN DER LAAN, R. 2022. Catalog of fishes: genera, species, references. Calif. Acad. Sci.

GARCÍA, G.A., VARGAS, G., NOLORBE, C., NÚÑEZ, J., MARIAC, C., DUPONCHELLE, F. & RENNO, J.F. 2018. Peces De Consumo de la Amazonía Peruana. Instituto de Investigaciones de la Amazonía Peruana (IIAP). Iquitos, Peru. 218.

GALVIS, G., MOJICA, J.I., DUQUE, S.R., CASTELLANOS, C., SÁNCHEZ-DUARTE, P., ARCE, M., GUTIÉRREZ, A., JIMÉNEZ, L.F., SANTOS, M., VEJARANO-RIVADENEIRA, S., ARBELÁEZ, F., PRIETO, E. & LEIVA, M. 2006. Peces del medio Amazonas. Región de Leticia. Serie de Guías Tropicales de Campo Nº 5. Conservación Internacional. Editorial Panamericana, Formas e Impresos. Bogotá, Colombia. 548.

GARAVELLO, J.C. & BRITSKI, H.A. 2003. Family Anostomidae. In Check List of the Freshwater Fishes of South and Central America (R.E. Reis, S.O. Kullander, C.J. Ferraris Jr., eds). Porto Alegre: EDIPUCRS, p. 71–84.

GARCÍA-DÁVILA, C., SÁNCHEZ, H., FLORES, M., MEJIA, J., ANGULO, C., CASTRO-RUIZ, D., ESTIVALS, G., GARCÍA-VÁSQUEZ, A., ALONSO, J., CARVAJAL, F., MOREAU, J., NUÑEZ, J., RENNO, J.F., TELLO, S., MONTREUIL, V. & DUPONCHELLE, F. 2009. Life-history characteristics of the large Amazonian migratory catfish Brachyplatystoma rousseauxii in the Iquitos region, Peru. Journal of Fish Biology, 75(10):2527–2551.

GARCÍA-DÁVILA, C., ESTIVALS, G., MEJIA, J., FLORES, M., ANGULO, C., SÁNCHEZ, H., NOLORBE C., CHUQUIPIONDO, C., CASTRO-RUIZ, D., GARCÍA, A., ORTEGA, H., PINEDO, L., MARIAC, C., DUPONCHELLE, F., OLIVEIRA, C., RÖMER, U. & RENNO J.F. 2020. Peces ornamentales de la Amazonia Peruana. Instituto de Investigaciones de la Amazonía Peruana (IIAP). Iquitos, Peru. 503 pp.

GÉRY, J. 1977. Characoids of the World. TFH Publications, Neptune City. 672 pp.

GOULDING, M., BARTHEM, R., FORSBERG, B., CAÑAS, C. & ORTEGA, H. 2003. Las fuentes del Amazonas: Ríos, vida y conservación de la cuenca del Madre de Dios. Asociación para la Conservación de la Cuenca Amazónica (ACCA) / Amazon Conservation Association (ACA). Gráfica Biblos S.A., Lima, Perú. 198.

IIAP. 2011. Peces ornamentales amazónicos: catálogo 2011. Instituto de Investigaciones de la Amazonía Peruana, Iquitos, Peru. 218. https://hdl.handle.net/20.500.12921/138

IUCN. 2022. The IUCN Red List of Threatened Species. Version 2022-1. https://www.iucnredlist.org (last access in 01 Aug 2022).

JUNK, W.J., BAYLEY, P.B. & SPARKS, R.E. 1989 The flood pulse concept in river– floodplain systems. Special Publication of the Canadian Journal of Fisheries and Aquatic Sciences, 106:10–127.

KULLANDER, S.O. 1986. Cichlid fishes of the Amazon River drainage of Peru. Department of Vertebrate Zoology, Research Division, Swedish Museum of Natural History, Stockholm, Sweden. 394.

KULLANDER, S.O. & FERREIRA, E.J.G. 2006. A review of the South American cichlid genus *Cichla*, with descriptions of nine new species (Teleostei: Cichlidae). Ichthyological Exploration of Freshwaters, 17:289–398.

LITTMANN, M.W., LUNDBERG, J.G. & ROCHA, M.S. 2021. Revision of the South American catfish genus *Hypophthalmus* (Siluriformes, Pimelodidae) with descriptions of two new species from the Amazon and Orinoco Basins. Proceedings of the Academy of Natural Sciences of Philadelphia, 167(1), 171–223.

MAGO-LECCIA, F. 1994. Electric Fishes of the Continental Waters of America. Peces Eléctricos de las Aguas Continentales de América. Biblioteca de la Academia de Ciencias Físicas, Matemáticas y Naturales. Vol XXIX. Caracas, Venezuela. 226.

MALABARBA, M.C.S.L. 2004. Revision of the Neotropical genus *Triportheus* Cope, 1872 (Characiformes: Characidae). Neotropical Ichthyology 2:167–204. https://doi.org/10.1590/S1679-62252004000400000

MEZA-VARGAS, V., FAUSTINO-FUSTER, D.R., CHUCTAYA, J., HIDALGO, M. & ORTEGA TORRES H. 2021. Lista de especies de peces de agua dulce de Loreto, Perú. Revista Peruana de Biología 28 (especial): e21911. https://doi.org/10.15381/rpb.v28iespecial.21911

MINAM (MINISTERIO DEL AMBIENTE). 2021. Línea base de los peces ornamentales con fines de bioseguridad en el Peru. https://bioseguridad.minam.gob.pe/wp-content/uploads/2021/12/ldb_pecesornam_2021.pdf

MOREAU, M. & COOMES, O. 2007. Aquarium fish exploitation in western Amazonia: Conservation issues in Perú. Environmental Conservation, 34(1):12–22. doi:10.1017/S0376892907003566

NAGEL, G.W., NOVO, E.M.L.M., MARTIN, V.S., CAMPOS-SILVA, J.V., BARBOSA, C.C.F. & BONNET, M.P. 2022. Impacts of meander migration on the Amazon riverine communities using Landsat time series and cloud computing. Sci. Total Environ, 806, 150449. https://doi.org/10.1016/j.scitotenv.2021.150449

NEUENDORF, K.K.E., MEHL, J.P. & JACKSON, J.A. 2005. Glossary of Geology. 5 ed. Berlin, Heidelberg, New York: Springer-Verlag.

NOGUEIRA, A.F., OLIVEIRA, C., LANGEANI, F. & NETTO-FERREIRA, A.L. 2021. Overlooked biodiversity of mitochondrial lineages in *Hemiodus* (Ostariophysi, Characiformes). Zoologica Scripta, 337–351. https://doi.org/10.1111/zsc.12469

OLIVEIRA, C., AVELINO, G.S., ABE, K.T., MARIGUELA, T.C., BENINE, R.C., ORTÍ, G., VARI, R.P. & CORRÊA E CASTRO, R.M. 2011. Phylogenetic relationships within the speciose family Characidae (Teleostei: Ostariophysi: Characiformes) based on multilocus analysis and extensive ingroup sampling. BMC evolutionary biology, 11(1):1–25. https://doi.org/10.1186/1471-2148-11-275

ORTEGA, H., GUERRA, H. & RAMÍREZ, R. 2007. The Introduction of Non-native Fishes into Freshwater Systems of Peru, in: BERT T.M. (Ed.), Ecological and Genetic Implications of Aquaculture Activities. Methods and Technologies in Fish Biology and Fisheries, vol 6. Springer, Dordrecht, pp.247–278. https://doi.org/10.1007/978-1-4020-6148-6_14

ORTEGA, H. & HIDALGO, M. 2008. Health & Management. Freshwater fishes and aquatic habitats in Peru: Current knowledge and conservation. Aquatic Ecosystem doi: https://doi.org/10.1080/14634980802319135

ORTEGA, H., HIDALGO, M. TREVEJO, G., CORREA, E., CORTIJO, A.M., MEZA, V. & ESPINO, J. 2012. Lista anotada de los peces de aguas continentales del Perú: Estado actual del conocimiento, distribución, usos y aspectos de conservación. Segunda Edición. Ministerio del Ambiente, Dirección General de Diversidad Biológica - Museo de Historia Natural, UNMSM. p. 56.

PNIPA (PROGRAMA NACIONAL DE INNOVACIÓN EN PESCA Y ACUICULTURA). 2021. Estudio de prospectiva: cadena de valor de peces ornamentales. https://hdl.handle.net/20.500.12864/302

QUEIROZ, L.J.D., VILARA, G.T., OHARA, W.M., PIRES, T.H.D.S., ZUANON, J.A.S. & DÓRIA, C.R. 2013. Peixes do Rio Madeira y Cuyari Pirá Ketá, vol. 1, 2, 3. 1172.

QUEZADA-GARCIA, M., HIDALGO, M., TARAZONA, J. & ORTEGA, H. 2017. Ictiofauna de la cuenca del río Aguaytía, Ucayali, Perú. Revista peruana de biología, 24(4):331–342.

RAMIREZ, J.L., CARVALHO-COSTA, L.F., VENERE, P.C., CARVALHO, D.C., TROY, W.P. & GALETTI, P.M. 2016. Testing monophyly of the freshwater fish *Leporinus* (Characiformes. Anostomidae) through molecular analysis. J. Fish Biol. 88:1204–1214. doi: https://doi.org/10.1111/jfb.12906

REID, G.M. 2013. Introduction to freshwater fishes and their conservation. Int. Zoo. Yb. 47:1–5.

REIS, R.E., KULLANDER, S.O. & FERRARIS, JR. C.J. 2003. Check List of the Freshwater Fishes of South and Central America. Edipucrs, Porto Alegre, 742.

REIS, R.E., ALBERT, J.S., DI DARIO, F., MINCARONE, M.M., PETRY, P. & ROCHA, L.A. 2016. Fish biodiversity and conservation in South America. J Fish Biol, 89:12–47. https://doi.org/10.1111/jfb.13016

REVENGA, C., MURRAY, S., ABRAMOVITZ, J. & HAMMOND, A. 1998. Watersheds of the World: Ecological Value and Vulnerability. Washington (DC) World Resources Institute, Washington, DC.

RIOFRÍO, J.C. 2002. Aspectos biométricos y reproductivos de boquichico *Prochilodus nigricans* Agassiz, 1829 (Pisces: Prochilodontidae) en Ucayali, Perú. Revista Peruana de Biología, 9(2):111–115. https://doi.org/10.15381/rpb.v9i2.2529.

RONDÓN-ESPINOZA, J., GAVIDIA, C., GONZÁLEZ, R. & RAMOS, D. 2022. Water Quality and Microbiological Contamination across the Fish Marketing Chain: A Case Study in the Peruvian Amazon (Lagoon Yarinacocha). Water. 14. 1465. https://doi.org/10.3390/w14091465

SALAZAR-RAMÍREZ, L.E., RIOFRÍO-QUIJANDRÍA, J.C., ZAVALETA-FLORES, J.O. & RUBIO-RODRÍGUEZ, J.A. 2021. Análisis de los desembarques de la pesca comercial en Yarinacocha (Ucayali, Perú) entre 2015-2019. Revista de Investigaciones Veterinarias del Perú, 32(4):e20931. http://dx.doi.org/10.15381/rivep.v32i4.20931

SILVA-SANTOS, R., RAMIREZ, J.L., GALETTI, JR. P.M. & FREITAS, P.D. 2018. Molecular Evidences of a Hidden Complex Scenario in *Leporinus* cf. *friderici*. Frontiers in Genetics, 9:1–9. https://doi.org/10.3389/fgene.2018.00047

TRUJILLO-GONZÁLEZ, A., BECKER, J., VAUGHAN, D.B. & HUTSON, K.S. 2018. Monogenean parasites infect ornamental fish imported to Australia. Parasitology Research. 117:995–1011. https://doi.org/10.1007/s00436-018-5776-z

VAN DER SLEEN, P. & ALBERT, J.S. 2017. Field guide to the fishes of the Amazon, Orinoco and Guianas. Princeton University Press, Princeton, USA.

VITORINO, C.A., NOGUEIRA, F., SOUZA, I.L, ARARIPE, J. & VENERE, P.C. 2017. Low Genetic Diversity and Structuring of the *Arapaima* (Osteoglossiformes, Arapaimidae) Population of the Araguaia-Tocantins Basin.Front. Genet. 8:159. https://doi.org/10.3389/fgene.2017.00159

WASIW, J., RIOFRIO, J. & MUÑOZ, V. 2012. Monitoreo de la pesquería comercial en Pucallpa y Yarinacocha, 2010 (Ucayali – Perú). Informe IMARPE, 39(3-4):288–293. https://hdl.handle.net/20.500.12958/2235

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